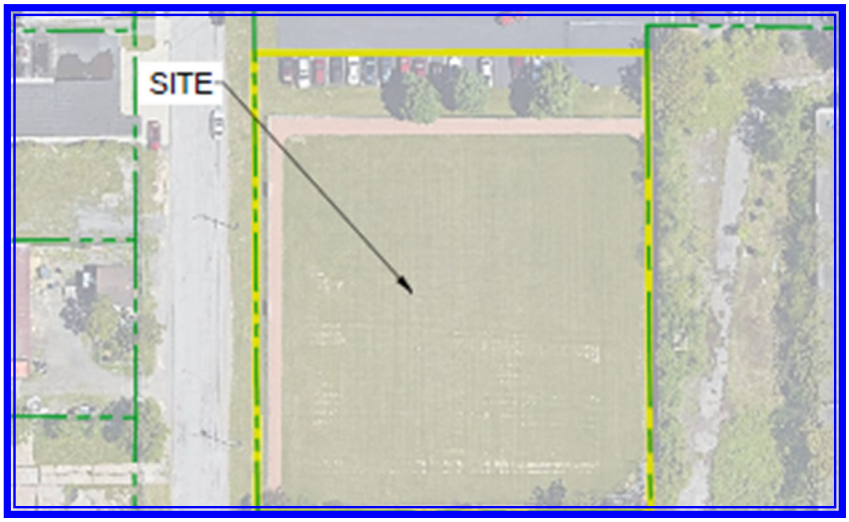
Remedial Action Work Plan

Mt. Olive Senior Manor Site
BCP Site No. C915377
1.3 Acre Portion of 703 East Delavan Avenue
Buffalo, New York

May 2023 0670-022-001-005

Prepared For:

Mt. Olive Senior Manor LLC



Prepared By:
Benchmark Civil/Environmental Engineering & Geology, PLLC

BENCHMARK

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REMEDIAL ACTION WORK PLAN

MT. OLIVE SENIOR MANOR SITE

BUFFALO, NEW YORK

(SITE NO. C915377)

May 2023 0670-022-001-005

Prepared for:

Mt. Olive Senior Manor LLC

Prepared By:

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Certification

I, Thomas H. Forbes, certify that I am currently a NYS registered professional engineer and that this Remedial Action Work Plan (RAWP) for Site No. C915377 was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

5-5-23

Date



REMEDIAL ACTION WORK PLAN

Mt. Olive Senor Manor Site
Buffalo, New York

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1.0 INTRODUCTION

Benchmark Civil/Environmental Engineering & Geology, PLLC (Benchmark), has prepared this Remedial Action Work Plan (RAWP) on behalf of Mt. Olive Senior Manor LLC (Mt. Olive). Mt. Olive has elected to pursue cleanup and redevelopment of the Mt. Olive Senior Manor Site, located at 703 East Delavan Avenue, Buffalo, New York (Site; see Figures 1 and 2), under the New York State Brownfield Cleanup Program (BCP or Program) through an executed Brownfield Cleanup Agreement (BCA) with the New York State Department of Environmental Conservation (NYSDEC) dated August 24, 2021 (BCA Index No. C915377-08-21).

This document presents the scope of work and procedures for completion of a planned pre-design investigation (PDI) and remedial activities on the Site. The work will be completed in general accordance with 6 NYCRR Part 375 (Ref. 1) and NYSDEC DER-10 guidelines (Ref. 2).

1.1 Site Background

The Site is ±1.3-acres in size and is the southern portion of a larger parcel (±4.63 acres) addressed as 703 East Delavan, Buffalo, Erie County, New York (see Figure 2).

The Site primarily comprises the former church athletic field and is substantially grass covered. A small northern portion of the Site is asphalt paved and used for parking (see Figure 2). It is unknown what capacity the Site was used, if any, prior to development as an athletic field. Mt Olive Baptist Church purchased the Site from an adjacent facility (Hard Manufacturing Company) in 1988.

The greater property including the Site is currently and has historically been developed with a church building with an associated parking lot and athletic field.

The BCP Remedial Investigation (RI) activities were completed by Benchmark from August through October 2022 under a NYSDEC-approved Remedial Investigation/Alternatives Analysis Work Plan (RI/AA WP, Ref. 3). The RI/AA is documented in the December 2022 RI/AA Report (Ref. 4) prepared by Benchmark. A summary of historic and RI activities is provided below in Section 1.2.

1.2 Previous Environmental History

A summary of the findings of the previous subsurface environmental investigations completed at the Site is provided below.

1.2.1 *March 2021 – Phase I Environmental Site Assessment*

Benchmark completed a Phase I Environmental Site Assessment (ESA, Ref. 5) on the southern 1.3-acre portion of 703 East Delavan that currently comprises the BCP Site. Benchmark identified the following Recognized Environmental Conditions (REC):

- A previous geotechnical report completed by Terracon Consultants identified fill materials across the Site consisting of mixtures of red-brown and black silt and sand with cinders and fragments of rock, brick, and concrete. Miscellaneous urban fill materials from unknown sources are considered a REC due to the potential for impacts.
- The Site is located in a historically industrial area with fuel oil and gasoline storage tanks and an oil storage area identified in close proximity to the Site. In addition, historic automobile repair and rug/furniture cleaning, possibly with dry-cleaning operations, were identified adjacent to the Site. These adjacent and nearby operations represent RECs and a potential Vapor Encroachment Condition (VEC) at the Site.
- The "closed" and "inactive" spill incidents identified for adjacent/nearby properties are considered historical RECs (HRECs) as such have been addressed to the satisfaction of the NYSDEC.
- No Controlled RECs (CRECs) were identified.

1.2.2 *March 2021 – Limited Phase II Environmental Investigation Report*

Benchmark completed a Limited Phase II Environmental Investigation (Phase II; Ref. 6) on the Site. The Phase II activities consisted of advancement of eight (8) test pits designated as TP-1 through TP-8 within the proposed redevelopment area and installation of one (1) bedrock monitoring well (MW-1). The test pits were advanced to the top of bedrock which was encountered at a depth of 1 to 2 fbgs. Eight (8) soil/fill samples were selected for laboratory analysis, which included semi-volatile organic compounds (SVOCs) and metals. One (1) groundwater sample was collected from the bedrock well for laboratory analysis for volatile organic compounds (VOCs). Appendix A contains the analytical tables from the Phase II. Figures 3 and 4 show the Phase II locations and analytical results.

Findings of the Phase II are summarized below:

- The Site is currently used as an athletic field in an area that is mixed commercial, industrial, and residential in the City of Buffalo.
- Fill materials consisting of black fines, brick, concrete debris, ciders, wood, glass, and coal were observed across the Site. Bedrock was present underlying the fill material at depths of 1 to 2 fbgs. Bedrock underlying the Site is limestone from the Onondaga Formation.
- Polycyclic aromatic hydrocarbons (PAHs) were detected in three (3) of the four (4) samples analyzed for SVOCs at concentrations above their respective 6 NYCRR Part 375 Soil Cleanup Objectives (SCOs), including Unrestricted SCOs (USCOs), Restricted-Residential SCOs (RRSCOs), Commercial SCOs (CSCOs), and Industrial SCOs (ISCOs).
- Metals were detected in seven (7) of the eight (8) samples analyzed for metals above their respective USCOs, RRSCOs, and/or CSCOs.
- Trichloroethene (TCE) was the only VOC detected in the groundwater sample collected from bedrock well, MW-1, above method detection limits (MDLs) but below the laboratory Reporting Limit (RL). The detected concentration was 0.36 ug/l which is well below its respective TOGS 1.1.1 Groundwater Quality Standards/Guidance Values (GWQS/GVs, Ref. 7) of 5 ug/l.

1.2.3 December 2022 RI/AA Report

Benchmark completed RI activities from August 2022 through October 2022. Results of the RI activities completed are summarized below. Appendix A contains the analytical tables from the RI. Figures 3 through 5 show the RI locations and analytical results.

Remedial Investigation

RI activities completed at the Site include the collection of four (4) surface soil/fill samples (SS-1 through SS-4) for laboratory analysis, advancement of 12 test pits (TP-9 through TP-20) to bedrock refusal, and installation of three (3) bedrock groundwater monitoring wells (MW-2 through MW-4) to depths ranging from 19.9 to 21.4 fbgs. Soil/fill samples were collected from the test pits for visual, olfactory, and photoionization detector

(PID) assessment and select samples were collected for laboratory analysis. Groundwater samples were collected from each of the newly installed bedrock monitoring wells and the bedrock monitoring well installed during the Phase II (MW-1). Four (4) soil vapor points (SV-1 through SV-4) were installed within the proposed building footprint to the top of bedrock. Soil vapor samples were collected from SV-1, SV-3, and SV-4 in concurrence with an outdoor air sample (OA-1). No sample was collected at SV-2 as a surface seal could not be established due to the shallow nature of the point (1.1 fbgs). Results of the RI are summarized below.

Soil/Fill

- Based on the Phase II and RI activities, SVOCs, metals, polychlorinated biphenyls (PCBs), pesticides, and/or per- and polyfluoroalkyl substance (PFAS) concentrations were observed exceeding USCOs in the surface and subsurface soil/fill material across the Site at depths ranging from below the vegetative cover to approximately 6 fbgs.
- No VOCs were detected in soil/fill samples collected as part of the RI, nor were elevated PID measurements noted in the soil/fill. The potential source of the VOCs detected in the groundwater discussed below is unknown.
- Waste characterization samples collected during the RI indicate non-hazardous waste disposal.

Groundwater

- No SVOCs, PCBs, herbicides, or 1,4-dioxane were detected above their respective GWQS at the groundwater monitoring locations at the Site. Beta-BHC was the only pesticide detected slightly above its GWQS at one (1) location, MW-3. Antimony and cobalt were each detected at one (1) location slightly above their respective GWQS, and the presence of iron and sodium in the groundwater are not uncommon in urban environments. PFAS were detected above the NYSDEC action levels for perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) at MW-1 and MW-4.
- Cis-1,2-dichloroethene (cis-DCE) and TCE were detected at MW-4 above their respective GWQS. VOCs were not detected in soil/fill samples analyzed from the Site, nor were PID measurements noted in on-Site soil/fill. They may be attributed to an upgradient off-site source, based on groundwater flow direction.

Soil Vapor

- The New York State Department of Health (NYSDOH) Decision Matrices for evaluating soil vapor intrusion (SVI) have guidance for eight (8) compounds. Of those eight (8) compounds, tetrachloroethene (PCE) and TCE were the only compounds detected in the soil vapor samples. PCE was detected in in the three (3) soil vapor samples and the outdoor air sample and TCE was detected in SV-1 and SV-4. Based on the concentrations detected in the soil vapor, it does not appear to be a concern. However, a formal soil vapor intrusion assessment would need to be completed after building construction and prior to occupation to confirm.

Alternatives Analysis

An Alternatives Analysis was completed to evaluate potential remedial alternatives that satisfy site-specific remedial action objectives. Based on that analysis, the selected remedy was a Track 1 Unrestricted Use Soil Cleanup, which will also include groundwater treatment to address chlorinated VOCs (cVOCs) detected in the southern portion of the Site. This remedy is fully protective of human health and the environment, and fully satisfies the RAOs for the Site. Therefore, this alternative is the recommended final remedial approach for the Site.

1.3 Summary of Environmental Conditions

Based on the previous investigations and RI activities completed, the following environmental conditions exist at the Site that should be addressed to fulfill the requirements of the Track 1 Unrestricted Use cleanup:

- SVOCs, metals, pesticides, PCBs, and PFAS were detected at concentrations exceeding USCOs in overburden soil. Excavation activities will be completed to bedrock and to the property boundaries to achieve USCOs.
- cVOCs were detected in the groundwater in the southeastern corner of the Site exceeding their respective GWQS. A groundwater amendment will be used to treat the cVOCs in the bedrock groundwater. PFAS and select metals were also detected in the groundwater, however removal of soil/fill to achieve USCOs, will address source of PFAS and metals detected in groundwater.
- Due to cVOCs detected in groundwater and PCE and TCE detected in soil vapor, an SVI assessment will be completed after new building construction to assess the need for SVI mitigation in the new building.

1.4 Constituents of Concern (COCs)

Based on the previous investigations and RI, and the planned redevelopment of the Site, the constituents of concern (COCs) for a Track 1 Unrestricted Use are presented below:

Soil/Fill: SVOCs, metals, pesticides, PCBs, PFAS

Groundwater: cVOCs

Sub-slab Vapor/Indoor Air: impact of cVOCs to be assessed

1.5 Remedial Action Objectives

The remedial actions for the Mt. Olive Senior Manor Site must satisfy Remedial Action Objectives (RAOs). RAOs are site-specific statements that convey the goals for minimizing substantial risks to public health and the environment. For the Site, appropriate RAOs have been defined as:

Soil/Fill RAOs

- Prevent ingestion/direct contact with contaminated soil;
- Prevent migration of contaminants that would result in groundwater or surface water contamination; and
- Prevent inhalation exposure to contaminants volatilizing from soil.

Groundwater RAOs

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards;
- Prevent contact with, or inhalation of, volatiles from contaminated groundwater;
- Restore ground water aquifer to pre-disposal/pre-release conditions, to the extent practicable; and
- .

Soil Vapor

- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at the Site.

1.6 Project Organization and Responsibilities

Mt. Olive was accepted into the BCP as a non-responsible party (volunteer) per ECL§27-1405. Benchmark will complete PDI activities and provide oversight of the remedial actions identified in this RAWP to be performed in accordance with the Brownfield Cleanup Agreement, the approved RAWP, the NYSDEC Decision Document, and NYSDEC DER-10 guidance.

2.0 PRE-DESIGN INVESTIGATION

Prior to the completion of remedial activities, a Pre-Design Investigation (PDI) will be completed to further assess the southeastern boundary of the Site where suspected migration of off-site impacts onto the Site have occurred. The PDI will consist of the completion of three (3) borings into the overburden and underlying bedrock and installation of a bedrock injection well at each of the boring locations. These wells will allow for collection of soil and groundwater data to better determine the concentration and extents of impacts at the property line. In addition, as further discussed in Section 4.0 the remedial approach for the Site will include an injection program to treat groundwater cVOCs in-situ. The wells will therefore be constructed as injection wells to facilitate the introduction of remediation product(s) to bedrock groundwater.

The locations of the proposed soil boring/groundwater injection wells (deemed IW-1 through IW-3) are shown on Figure 6. Borings will be advanced to the top of competent bedrock using traditional hollow stem augers (HSAs). Upon bedrock refusal at each location, a temporary casing will be installed and sealed with bentonite at the top of bedrock. An approximate 3-inch diameter core barrel will be used to core into bedrock and into the upper water bearing zone. Based on the groundwater elevations measured during the RI (see Figure 5), the depth of groundwater ranges from 4.25 fbgs (MW-4) to 10.97 fbgs (MW-1) and has a westerly flow direction.

Drill cuttings will be placed in sealed NYSDOT-approved drums and labeled for disposal during remedial activities. Non-dedicated drilling tools and equipment will be decontaminated between boring locations using potable tap water and a phosphate-free detergent (e.g., Alconox).

2.1 Soil/Fill Sample Collection

Soil/fill samples retrieved from the borings will be examined by a qualified Benchmark personnel for characterization by visual observation in accordance with ASTM Method D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Field personnel will create a field log and collect photograph documentation from the investigation locations. Soil/fill will be inspected for impacts via visual and olfactory observations, and field screened for total volatile organics using a PID equipped with a 10.6 eV lamp as a procedure for ensuring the health and safety of personnel and to

identify potentially impacted soil/fill samples for laboratory analysis. One (1) soil /fill sample will be collected from each boring location. En-core samplers will be used to collect VOC soil samples as described in EPA Method 5035.

2.2 Soil/Fill Sample Analysis

Sample analysis will include Total Compound List (TCL) VOCs plus tentatively identified compounds (TICs). Samples will be collected and placed on ice and transported under chain-of-custody command to a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified analytical laboratory.

2.3 Bedrock Drilling & Injection Well Installation

After the temporary casing seal has set, an approximate 3-inch diameter core barrel will be used to core into bedrock and into the upper water bearing zone. Based on wells installed during the RI, borings will be advanced into bedrock to depths of approximately 20 fbgs. Following drilling/coring activities, the bedrock injection wells will be constructed of 2-inch I.D. flush-joint Schedule 40 PVC solid riser and a minimum 5-foot flush joint, machine slotted screen (0.010-inch slot size). The screen length will be determined in the field based on Site conditions and discussions with NYSDEC but assumed not to exceed 10 feet in length. A silica sand filter pack (size #4) will be installed from the base of the well to the top of the screen to isolate the bedrock groundwater from any potential perched overburden groundwater. Relatively coarse sand will be used to maximize permeability, allowing for injection material to be injected into the bedrock groundwater. A bentonite chip seal will then be installed and allowed to hydrate sufficiently to mitigate the potential for down-hole grout contamination and seal off any potential perched overburden groundwater. A cement and bentonite grout mixture will be installed to fill the remaining annulus to approximately 1 foot below ground surface. The newly installed bedrock injection wells will be completed with a lockable J-plug and keyed alike locks and a steel protective casing (if deemed necessary). Injection well construction details are shown on Figure 6.

Water generated from the bedrock coring will be containerized and staged on Site for disposal during remedial activities.

2.4 Well Development

After installation, but not within 24 hours, newly installed injection wells will be developed in accordance with Benchmark and NYSDEC protocols. Development of the injection wells will be accomplished with dedicated disposable HDPE or PVC bailers via surge and purge methodology. Field parameters including pH, temperature, turbidity, dissolved oxygen (DO), oxidation-reduction potential (ORP), and specific conductance will be measured periodically (i.e., every well volume or as necessary) during development. Field measurements will continue until they become relatively stable. Stability will be defined as variation between measurements of approximately 10 percent or less with no overall upward or downward trend in the measurements. A minimum of three (3) well volumes will be evacuated from each injection well. Development water from the injection wells will be containerized and staged on-Site for disposal during remedial activities.

2.5 Groundwater Sample Collection

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 injection well purging or sample collection, static water levels will be measured and recorded from the injection wells to facilitate the preparation of an isopotential map.

Following water level measurement, field personnel will purge and sample injection 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 HDPE or PVC bailer will be used to purge and sample the well. Prior to sample collection via low-flow methodology, groundwater will be evacuated from each well at a low-flow rate (typically less than 0.1 L/min) while maintaining a generally consistent water level. Field measurements for pH, temperature, turbidity, DO, ORP, specific conductance and water level, as well as visual and olfactory field observations, will be periodically recorded and monitored for stabilization. Low-flow purging will be considered complete when pH, specific conductivity, DO, ORP, and temperature stabilize and when turbidity measurements fall below 50 Nephelometric Turbidity Units (NTU), or become stable above 50 NTU regardless of volume purged. Purging via disposable bailer, if necessary, will be considered

complete following the removal of three (3) well volumes and field parameter stabilization or to dryness, whichever occurs first. In general, stability is defined as variation between field measurements of 10 percent or less and no overall upward or downward trend in the measurements.

Groundwater sampling methods will conform with protocols acceptable for the collection of the PFAS in accordance with the NYSDEC's November 2022 Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) (Ref. 8) and Benchmark's PFAS Groundwater/Surface Water Sample Collection Procedures Field Operating Procedure (FOP; see Appendix B). 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 will 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 PDI include:

- **Submersible Pump with Dedicated Pump Tubing**
  Injection 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 fbgs) 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 rope and lowered into the well smoothly and slowly as not to agitate the groundwater or damage the well.

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

2.6 Groundwater Sample Analyses

Samples will be collected from the three (3) injection wells and analyzed for TCL VOCs and PFAS. Groundwater samples will be collected and analyzed in accordance with USEPA SW 846 methodology with equivalent NYSDEC Category B deliverables to allow for independent third-party data usability assessment. Samples collected for PFAS analysis will be analyzed via a modified USEPA Method 1633.

3.0 PRE-REMEDIATION TASKS

3.1 Public Information and Outreach

A fact sheet containing information about the planned remedial work was prepared by the NYSDEC and distributed electronically through their listserv system on January 18, 2023, to those individuals signed up to receive the information. A copy of this RAWP will be made available for public review at the NYSDEC Region 9 office and the Buffalo-Erie County Public Library Leroy R. Coles, Jr. Branch, the designated document repository.

3.2 Underground Utilities Location

The contractor(s) will contact underground facilities protection organization (Dig Safely New York, UFPO) to locate utility lines within the work area a minimum of three (3) business days in advance of the remedial work to locate utility lines on the Site. If underground utilities are present and anticipated to interfere with intrusive activities, Mt. Olive and NYSDEC will be contacted to discuss mitigating measures.

3.3 Health and Safety Plan Development

A Health and Safety Plan (HASP) will be prepared and enforced by the contractor in accordance with the requirements of 29 CFR 1910.120. The HASP will cover on-site remedial activities associated with soil, groundwater, and soil vapor intrusion. Mt. Olive, or their designee, will be responsible for Site control and Benchmark will be responsible for the health and safety of its authorized site workers. Benchmark's HASP is provided for informational purposes in Appendix C. The remediation contractor will be required to develop a HASP as or more stringent than Benchmark's HASP.

3.4 Pre-Construction Meeting

A project coordination meeting will be held with Mt. Olive (or their designee), construction manager, selected contractor(s), and Benchmark's Project Manager and field staff. The designated NYSDEC Project Manager and NYSDOH representative will also be notified and invited to attend. Agenda items will include:

- Designation of responsibilities, project personnel, and mobile phone numbers;
- Project documentation requirements;

- Staging of equipment;
- Transportation routes/Site egress;
- Health and safety requirements;
- Temporary controls (dust suppression, storm water management);
- Construction schedule;
- Work hours; and
- Site security.

Progress meetings will be conducted throughout the remedial action and redevelopment period, as needed. Progress meetings will be attended by Benchmark Project Manager and field management personnel. NYSDEC and NYSDOH will have access to all progress meetings.

3.5 Mobilization and Site Preparation

The contractor's field operations at the Site will commence with mobilizing equipment and materials to the Site and other temporary controls as described below.

3.6 Temporary Facilities and Controls

Temporary facilities for use during the remedial work may include a construction field trailer and portable toilet(s). Temporary controls, as necessary, will be employed for protection against off-site migration of soil/fill and safety hazards during remedial action and redevelopment, including excavation safety fencing, dust suppression, and erosion control as further described below.

3.6.1 Access Controls

Fencing is currently in place around the perimeter of the Site. Daily work areas will be identified with construction cones and/or snow fencing, if necessary, to distinguish the work zone. Work areas will be determined daily based on the planned remedial activities and may be changed throughout the workday to ensure safe operations. Access control will consider site worker and general public safety, and tenant access requirements, if necessary.

3.6.2 Material Storage

Temporary on-Site storage will be needed for the remedial activities, which will include in-Situ groundwater treatment reagents. The location of the temporary storage area will be determined based on the remedial activities that are on-going at the time.

3.6.3 Dust Monitoring and Controls

A Community Air Monitoring Plan (CAMP), as more fully described in Section 6.1.1 and Appendix D, will be implemented during Site work that will disturb subsurface soil/fill materials. If community air monitoring indicates the need for dust suppression or if dust is visually observed leaving the Site, the contractor will apply a water spray across the excavation and surrounding areas, and on-Site haul roads as necessary to mitigate airborne dust formation and migration. Potable water will either be obtained from a public hydrant or provided by the on-Site water service, if available.

If CAMP data indicate exceedance of VOC thresholds the contractor will be required to adjust work practices to minimize the area of soil disturbance. Based on the previous investigation and RI data, VOCs are not expected to be a concern in the soil/fill present at the Site.

3.6.4 Erosion and Sediment Control

Provisions will be put in place along the perimeter of the Site for erosion and sedimentation control (silt sock) prior to initiation of Site work and will be inspected regularly to insure effectiveness through the disturbance of soil/fill materials activities.

Provisions will be made to keep surrounding sidewalks and roadways free of soil from construction and trucking activities, as needed.

4.0 CLEANUP APPROACH

The approved RI/AA Report identified the cleanup approach for the Site. Specifically, the selected remedy is a Track 1 Unrestricted Use cleanup approach incorporating the following major remedial elements:

- Completion of a PDI to determine the extent of the treatment area along the eastern/southern property boundary and better assess the potential source of TCE and cis-DCE in groundwater (see Section 2.0).
- Excavation of overburden soil/fill extending to the property boundaries and to the top of bedrock.
- Collection of post-excavation sidewall samples at property boundaries.
- Backfilling with clean NYSDEC-approved soil/stone.
- Groundwater amendment injections into bedrock groundwater at the three (3) injection wells installed during the PDI to treat TCE and cis-DCE, enhance natural attenuation, and/or prevent further migration onto the Site. Injection wells will be protected during soil/fill excavation activities in the event that additional injections are needed.
- Groundwater monitoring at MW-1 through MW-4 every 2 months after amendment injections for TCL VOCs.
- Groundwater monitoring at MW-1 through MW-4 for PFAS, concurrent with post-injection VOC monitoring, to monitor the effectiveness of natural attenuation after source removal (soil/fill impacted with PFAS).
- Installation of sub-slab piping during construction as a preventative measure.
- Completion of a Soil Vapor Intrusion Assessment in accordance with a NYSDEC and NYSDOH approved work plan to assess the need for soil vapor mitigation in the newly constructed building.

If long-term institutional and engineering controls are necessary to achieve RAOs, a Track 2 Residential Use cleanup would be achieved by default. This would occur if groundwater contamination cannot be addressed to achieve RAOs within a 5-year period from issuance of the certificate of completion (COC) and/or an ASD system is permanently required for vapor intrusion mitigation within the building. A Track 2 Residential Use cleanup approach therefore would incorporate the remedial elements included in the Track 1 scenario, as well as the following elements:

- Implementation of a Site Management Plan (SMP). The SMP will include:
  - **Institutional Controls and Engineering Controls (IC/EC)** Engineering controls include any physical barrier or method employed to actively or passively contain, stabilize, or monitor contaminants; restrict the movement of contaminants; or eliminate potential exposure pathways to contaminants. Institutional controls at the site will include groundwater use restrictions and use restrictions of the Site to commercial or industrial use.
  - **An Operation and Maintenance Plan** that describes the measures necessary to operate, monitor, and maintain any mechanical components of the remedial work;
  - **An Excavation Work Plan** to assure that future intrusive activities and soil/fill handling at the Site are completed in a safe and environmentally responsible manner;
  - **A Site Monitoring Plan** that includes: provisions for a Site-wide inspection program and post-remedial groundwater monitoring to assure that the IC/ECs have not been altered and remain effective; and,
- **An Environmental Easement** filed with Erie County.

4.1 Excavation of Impacted Soil/Fill

The soil/fill present across the entire approximate ±1.3-acre Site will be excavated to the Site boundaries and to the top of bedrock. Soil/fill removed will be disposed of as non-hazardous waste, as waste characterization samples were collected during the RI, at a permitted landfill facility. Remedial excavation work will be directed by an experienced Benchmark professional to remove impacted soil/fill material. A PID will be used to screen soil/fill materials, and as required by the HASP, in addition to visual/olfactory observations of the impacted soil/fill. Vertical excavation will continue to the top of bedrock, encountered during the Phase II and RI at depths ranging from 1 to 6 fbgs. The lateral extents of the remedial excavation will be to the boundaries of the BCP Site. Excavation will be continued until the property line is reached or NYSDEC agrees that no further excavation is required. No groundwater management is expected during excavation activities, as groundwater was not encountered in the overburden during the Phase II or RI and is present in the bedrock underlying the Site.

During excavation activities, if asbestos-contained materials (ACM) are encountered, required ACM work will comply with the procedures outlined in NYS Department of Labor

regulations at 12 NYCRR Part 56, including amendments. Fugitive dust control measures will be implemented during excavations. Any ACM debris will be properly transported and disposed of in accordance with local, state, and federal regulations.

During excavation activities, if lead-based paint materials are encountered, excavation work associated with the LBP material will comply with procedures outlined in United States Department of Housing and Urban Development's "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing," dated 2012, including revisions (HUD Guidelines).

Existing monitoring wells and newly constructed injections wells, as further discussed in Section 4.4, will be protected during excavation activities.

4.2 Excavation Documentation Sampling

Post-excavation documentation samples will be collected from the limits of the excavation (Site boundaries), with bias toward material exhibiting evidence of visual and olfactory contamination, if remaining. Post-excavation documentation sample locations will include samples from the excavation sidewalls. No samples will be collected from the bottom of the excavation, as the excavation will be completed to the top of bedrock. A minimum of one (1) sample per 30 linear feet of sidewall will be collected in accordance with DER-10.

Based on previous investigation results, samples from the remedial excavation will be analyzed for TCL SVOCs, TAL Metals, PCBs, and PFAS in accordance with USEPA Methodology with an equivalent Category B deliverables package to facilitate data evaluation by a third-party validation expert. TCL VOCs may also be analyzed along the eastern and southern boundaries of the Site if identified in the soil/fill during the PDI, in consultation with the NYSDEC.

If ACM debris is encountered, additional sampling will be completed in accordance with NYS Department of Labor regulations at 12 NYCRR Part 56, including amendments.

If LBP material is encountered, additional sampling will be completed in accordance with HUD Guidelines.

4.3 Excavation Backfill

The excavation will be backfilled with materials (clean soil and/or stone) brought to the Site for use as backfill will be in accordance with DER-10 requirements and subject to NYSDEC approval. Table 1 includes the chemical criteria for import of backfill material to the Site. The imported materials will be placed in accordance with redevelopment requirements.

4.4 In-Situ Groundwater Treatment

Based on the data collected during the RI, bedrock groundwater beneath the Site has been impacted with cVOCs (specifically TCE and cis-1,2-DCE) exceeding GWQS at MW-4 (southeast corner of the Site). These two (2) compounds were also detected at well MW-3 (southwestern portion of the Site and downgradient from MW-4), but at lower concentrations below their respective GWQS. These compounds have been known to be associated with operations such as machine shops, degreasing equipment, dry cleaning, varnishing and tanneries. None of these operations are suspected to have occurred on the BCP Site.

Groundwater has a westerly flow direction as shown on Figure 5. As cVOCs were not detected above GWQS at any other well locations and VOCs were not detected above their respective USCOs in any soil/fill sample analyzed for VOCs at the Site, the source of the cVOCs detected in the groundwater is unknown and potentially off-Site. Groundwater samples collected from three (3) bedrock injection wells to be installed during the PDI will be analyzed for VOCs to further assess the potential off-site source of TCE and cis-DCE in groundwater.

PFOA and PFOS were encountered at concentrations above NYSDEC action levels at MW-1 and MW-4 in groundwater. Elevated concentrations of PFOA and PFOS were detected in the Site soil/fill above NYSDEC unrestricted guidance levels. Therefore, by removing the soil/fill at the Site, the source of the PFAS in groundwater may be removed, therefore reducing concentrations in the groundwater through natural attenuation. However, if high concentrations of PFOA and/or PFOS are detected in the groundwater at the three (3) injection wells to be installed during the PDI, an upgradient off-site source may be considered, in consultation with the NYSDEC.

4.4.1 *Technology Description*

Enhanced bioremediation of cVOCs in groundwater will be accomplished using two (2) amendments developed by Regenesis Corporation. These amendments include:

- 3-D Microemulsion (3DME, also known as HRC Advanced®); and
- Sulfidated Zero-Valent Iron (S-MicroZVI™).

3DME is a slightly viscous lactic acid-based liquid that is mixed with water and pressure injected into saturated soils using small diameter probe rods and a high-pressure injection pump. The 3DME facilitates anaerobic bioremediation by slow hydrolysis of the lactic acid that release hydrogen when metabolized by naturally-occurring microbes. The resulting hydrogen is then used in a microbially mediated process known as reductive dechlorination. 3DME produces a sequential, staged release of its electron donor components; this staged fermentation provides an immediate, mid-range and long-term, controlled-release supply of hydrogen (electron donor) to fuel the reductive dechlorination process for up to four years.

S-MicroZVI™ is an in-situ chemical reduction reagent composed of colloidal, sulfidated zero-valent iron particles suspended in glycerol using proprietary environmentally acceptable dispersants. S-MicroZVI can destroy chlorinated contaminants through direct chemical reaction and will also stimulate anaerobic biological degradation by rapidly creating a reducing environment that is favorable for reductive dechlorination.

Information regarding the amendments, Safety Data Sheets (SDSs) and application instructions are included in Appendix E. The reagents will be delivered in 275-gallon totes and/or 55-gallon drums to the Site and properly stored on-Site w until the injections occur.

Prior to implementing the in-situ groundwater treatment, an underground injection permit will be obtained from the United State Environmental Protection Agency.

4.4.2 *Site Specific In-Situ Treatment Details*

The site-specific remedial program was developed using design software provided by Regenesis. This remedial program will involve directly injecting the amendments upgradient of MW-4 to address impacts due to potential off-site contamination (see Figure 6).

Approximately 2,800 lbs. of 3DME will be injected into the bedrock groundwater via the three (3) bedrock groundwater injection wells. The injection wells will consist of 2-inch diameter Schedule 40 PVC and will be installed to a depth of approximately 20 fbgs. The

injection interval will target the 8 to 20-foot depth. The depth to groundwater in the vicinity of MW-4 is approximately 4.25 fbgs. In addition to the 3DME, 2,500 lbs. of S-MicroZVI will also be injected into the bedrock groundwater. These two (2) amendments will be mixed with potable water on-site in a mixing tank prior to injection. Approximately 933 lbs. of 3DME and 833 lbs. of S-MicroZVI will be mixed with 2,354-gallons of water and injected at each injection well[1]. However, dilutions may be modified in the field based upon achieved application rates.

4.4.3 *Groundwater Monitoring*

A groundwater sampling program will be implemented to evaluate the effectiveness of the in-situ groundwater treatment program and effectiveness of the source removal associated with the soil/fill on natural attenuation. Groundwater sampling will be completed every 2 months for TCL VOCs via EPA Method 8260 and PFAS via EPA Method 1633 at MW-1, MW-2, MW-3, and MW-4 to monitor the short-term effectiveness of the in-situ treatment and source removal prior to obtaining the COC (see Figure 6 for the post-remedial monitoring well network). Although metals (iron, sodium, antimony, and cobalt) were detected in soil/fill present at the Site and in the groundwater above their respective GWQS, these analytes do not have respective SCOs and are common in urban environments. Therefore, metals will not be included in post-remedial groundwater monitoring.

If needed, additional details for long-term groundwater monitoring will be provided in the SMP, which will be a component of the overall Site Remedy if it becomes apparent that groundwater contamination cannot be addressed to achieve RAOs within a 5-year period from issuance of the COC.

Groundwater sampling will be completed utilizing low-flow techniques as outlined in the FOP provided in Appendix B. PFAS sampling will be completed as discussed in Section 2.5 and as outlined in the PFAS groundwater sample collection procedures FOP also provided in Appendix B. In addition to VOC and PFAS analysis, standard field measured parameters (pH, specific conductance, DO, ORP, temperature, and turbidity) will be monitored.

[1] Injection quantities may vary from well to well dependent upon PDI findings.

Additional analytical parameters to evaluate effectiveness of the in-situ treatment include, dissolved iron, manganese, sulfate, nitrate-nitrite, and dissolved gases including methane, ethane, and ethene, may be collected, if deemed necessary to further assess the groundwater remedy.

Monitoring wells MW-1, MW-2, MW-3, and MW-4, as shown on Figure 6, will be gauged during each monitoring event to develop a groundwater contour map.

5.0 SVI INVESTIGATION PLAN

Sub-slab depressurization system (SSD) sub-slab piping will be installed during new building construction as a preventative measure for radon and/or cVOCs. The approximate locations of the proposed sub-slab piping to be installed are shown on Figure 6. Redevelopment building layout plans and details with locations of the proposed sub-slab piping are included in Appendix F. The sub-slab piping will be stubbed up through the building floor and capped until radon and SVI sampling is completed. As the Site is receiving Home and Community Renewal (HCR) funding, a radon evaluation must be performed within the building after construction, and bedrock is relatively shallow in the vicinity of the building footprint. A radon assessment will be completed by others to determine whether radon mitigation is required in the building. An SVI letter Work Plan will be provided to the NYSDEC and NYSDOH for review detailing the proposed SVI investigation to be completed at the Site by Benchmark within the new building in the fall/winter 2023 heating season prior to building occupancy. The SVI Work Plan will include a proposed sampling plan that will involve collecting three (3) indoor air (IA) and three (3) sub-slab vapor (SSV) samples within the new building and one (1) outdoor air (OA) sample. Figure 6 shows the proposed location of the SVI investigation samples to be collected.

5.1 Sub-Slab Vapor Pre-Sample Assessment

Prior to completing the SVI sampling, a pre-sampling inspection will be performed within the building to identify and minimize conditions that may interfere with the proposed testing. The inspection will evaluate the type of structure, floor layout, chemical and product contents of the building, and physical conditions of the building. This information, along with information on sources of potential indoor air contamination, will be identified on a building inventory form. If products are identified that may interfere with the SVI sampling, these contents may require removal at least 48-hours prior to completing the sampling.

5.2 Sub-Slab Vapor Sample Collection

At each SVI sampling location, Benchmark personnel will drill a ¼-inch diameter hole through the concrete slab using a hand-held hammer drill. SSV samples will be collected in the following manner:

- The SSV sample tubing will be sealed to the surface with permagum grout, melted beeswax, putty, or other non-VOC containing and non-shrinking products for temporary installation;
- The integrity of the surface seal of the sub-slab sampling point will be assessed using tracer gas (e.g. helium) per the Soil Vapor Sample Collection Field Operative Procedure (FOP) in Appendix B.
- Purge approximately one to three volumes (i.e., the volume of the sample tube) prior to collecting the samples to ensure samples collected are representative;
- SSV sample canisters will be equipped with a 24-hour regulator to allow the sample to be collected over an approximate 24-hour period; and,
- Samples will be collected into laboratory provided sampling canisters and regulators (e.g., Summa® canisters) and analyzed by EPA Method TO-15.

Holes in the concrete slab will be filled and sealed after completion of the sampling event.

5.3 Indoor Air and Outdoor Air Sample Locations

Concurrent with the SSV samples, IA and OA samples will be collected. IA samples will be co-located with each SSV location. One (1) OA sample will be collected from an outdoor upwind location of the Site, as determined on the day of field activities. IA and OA sample canisters will also be equipped with 24-hour regulators to allow the samples to be collected over the same approximate 24-hour period as the SSV samples.

5.4 SVI Assessment Reporting

Upon completion of the SVI investigation, the analytical results will be compared to the appropriate Decision Matrices associated with NYSDOH's Guidance for Evaluating Soil Vapor Intrusion in New York State (Ref. 9) to determine if SVI is a concern exists at the Site. An SVI Assessment Report will be prepared and submitted to NYSDEC/NYSDOH for review. The report will include:

- A summary of the activities completed;
- Tables and figures summarizing the analytical results and identifying the SVI investigation locations;
- Laboratory report and field form from sampling; and

- Recommendation and conclusion regarding SVI.

If SVI is determined to be a concern at the Site, the SSD system installed during construction would be permanently required for vapor intrusion mitigation within the building. The Site would be remediated under a Track 2 Residential Use cleanup approach, which would incorporate implementation of an SMP. The SMP would include an Operation and Maintenance (O&M) Plan describing the measures necessary to operate, monitor, and maintain the active sub-slab depressurization (ASD) system.

6.0 REMEDIAL ACTIVITIES SUPPORT DOCUMENTS

6.1 Health and Safety Protocols

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

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

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

Health and safety activities will be monitored throughout the remedial field activities. A member of the field team will be designated to serve as the Site Safety and Health Officer (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.

6.1.1 *Community Air Monitoring*

Real-time community air monitoring will be performed during intrusive activities at the Site. A CAMP is included with Benchmark's HASP and in Appendix D. Particulate and VOC monitoring will be performed along the downwind perimeter of the work area during excavation, grading, and soil/fill handling activities in accordance with this plan. Upwind

concentrations will be field monitored at the start and periodically throughout the workday. Monitoring locations will be evaluated throughout the workday, as described in the CAMP. 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 (May 2010) Appendix 1A (NYSDOH's Generic Community Air Monitoring Plan) and Appendix 1B (Fugitive Dust and Particulate Monitoring).

6.2 Citizen Participation Activities

NYSDEC will coordinate and lead community relations throughout the course of the project with support from Benchmark as requested. A Citizen Participation (CP) Plan has been prepared by Benchmark and approved by NYSDEC. A copy of the CP Plan has been placed in the Buffalo and Erie County Public Library, the designated project document repository. The NYSDEC, with input from Benchmark and Mt. Olive, will issue project fact sheets to keep the public informed of remedial activities.

7.0 REPORTING

7.1 Final Engineering Report

A Final Engineering Report (FER) will be prepared at the conclusion of remedial activities. The FER will include the following information and documentation, consistent with the NYSDEC's DER-10 Technical Guidance for Site Remediation:

- Introduction and background;
- A Site or area planimetric map showing the portion of the parcel remediated, including significant site features;
- A Site map showing the lateral limits of the excavation;
- Tabular summaries of unit quantities including: volume of soil excavated, disposition of excavated soil, and volume of backfill material transported to the Site;
- Documentation on the disposition of impacted soil removed from the Site;
- Documentation of the clean soil/stone imported to the Site;
- Planimetric map showing location of groundwater injection and post-remedial monitoring locations;
- Documentation of the in-Situ injection of groundwater amendments including the amount of material used at each injection location;
- Documentation on the installation of the SSD/Radon Mitigation System;
- Results of the SVI and radon investigations (and details ASD system startup, if needed).
- Results of the groundwater monitoring events for VOCs and PFAS;
- Drawings and figures related to completed remedial measures (survey elevations, ASD systems (if needed), injection well locations, etc.) will be stamped and certified by a NYS licensed professional engineer;
- Copies of daily inspection reports and, if applicable, problem identification and corrective measure reports;
- Photo documentation of remedial activities; and
- Text describing the remedial activities performed; a description of any deviations from the Work Plan and associated corrective measures taken; and other pertinent information necessary to document that the Site activities were carried out in accordance with this Work Plan.

7.2 Site Management Plan

A Site Management Plan (SMP) that describes site-specific Institutional Controls and/or Engineering Controls (IC/EC) may be prepared for the Site if they are required as a part of the remedial approach. If groundwater contamination cannot be addressed to achieve RAOs within a 5-year period from issuance of the COC and/or an ASD system is permanently required for vapor intrusion mitigation within the building, a Track 2 Residential Use cleanup would be achieved by default and would be required and an SMP will be prepared for long-term groundwater monitoring and ASD system OM&M. Consistent with NYSDEC BCP requirements, components of the SMP would include the following control measures:

- **Engineering and Institutional Controls Plan**. Engineering controls include any physical barrier or method employed to actively or passively contain, stabilize, or monitor contaminants; restrict the movement of contaminants; or eliminate potential exposure pathways to contaminants. Institutional controls at the Site will include groundwater use restrictions and use restrictions of the Site to restricted use (i.e., residential or commercial purposes).
- **Operation and Maintenance Plan** that describes the measures necessary to operate, monitor, and maintain the mechanical components of the Sub-Slab Depressurization System.
- **Master Erosion Control Plan (MECP)** to prevent the potential migration of contaminants off-Site during remedial activities.
- **Excavation Work Plan** to assure that future intrusive activities and soil/fill handling at the Site are completed in a safe and environmentally responsible manner.
- **Site Monitoring Plan** that includes: provisions for a groundwater monitoring plan and a Site-wide inspection program to assure that the IC/ECs have not been altered and remain effective.
- **Environmental Easement** filed with Erie County.

8.0 PROJECT SCHEDULE

The anticipated project schedule for the major tasks to be performed during implementation of the RAWP are discussed below. The major tasks planned with the anticipated schedule are summarized in Figure 7 and as follows.

- Injection Well Installation – May 2023
- Groundwater Injections – May/June 2023
  - Groundwater monitoring for VOCs and PFAS to be conducted every 2 months after injections (e.g. May, July, September, and November 2023)
- Remedial Excavation – June and July 2023
- Site Devevlopment and SSD System Installation for New Building – August through December 2023
- SVI Investigation – heating season 2024
- Submit Draft SMP (if needed) – October 2023
- Submit Draft FER – October 2023
- Submit Final SMP (if needed) and FER – November 2023
- Receive COC – December 2023

9.0 REFERENCES

1. New York State Department of Environmental Conservation. *6 NYCRR Part 375 Environmental Remediation Programs Subparts 375-1 to 375-4 and 375-6*. Effective December 14, 2006
2. New York State Department of Environmental Conservation. *DER-10 - Technical Guidance for Site Investigation and Remediation*, dated May 2010.
3. Benchmark Civil/Environmental Engineering & Geology, PLLC. *Remedial Investigation/Alternatives Analysis Work Plan, Mt. Olive Senior Manor Site, Portion of 703 East Delevan Avenue, Buffalo, New York, BCP Site no. C915377*. January 2022.
4. Benchmark Civil/Environmental Engineering & Geology, PLLC. *Remedial Investigation and Alternatives Analysis Report, Mt. Olive Senior Manor Site, BCP Site No. C915377, 703 East Delavan Avenue, Buffalo, New York*. December 2022.
5. Benchmark Civil/Environmental Engineering & Geology, PLLC. *Phase I Environmental Site Assessment (ESA), A Portion of 703 East Delevan Avenue, Buffalo, New York*. March 2021.
6. Benchmark Civil/Environmental Engineering & Geology, PLLC. *Limited Phase II Environmental Investigation. A Portion of 703 East Delevan Avenue, Buffalo, New York*. April 2021.
7. New York State Department of Environmental Conservation Division of Water. *Technical Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations*. June 1998.
8. New York State Department of Environmental Conservation. *Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs*. November 2022.
9. New York State Department of Health. *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*. October 2006 and subsequent updates.

TABLE

BENCHMARK

TABLE 1
CRITERIA FOR USE OF OFF-SITE SOIL - PARK 375 UNRESTRICTED SCOs
REMEDIAL ACTION WORK PLAN
MT. OLIVE SENIOR MANOR SITE
BCP SITE NO. C915377
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

Parameter	Unrestricted Import Criteria[1]
Volatile Organic Compounds - mg/kg	
1,1,1-Trichloroethane	0.68
1,1-Dichloroethane	0.27
1,1-Dichloroethene	0.33
1,2-Dichlorobenzene	1.1
1,2-Dichloroethane	0.02
cis -1,2-Dichloroethene	0.25
trans-1,2-Dichloroethene	0.19
1,3-Dichlorobenzene	2.4
1,4-Dichlorobenzene	1.8
1,4-Dioxane	0.1
Acetone	0.05
Benzene	0.06
n-Butylbenzene	12
Carbon tetrachloride	0.76
Chlorobenzene	1.1
Chloroform	0.37
Ethylbenzene	1
Hexachlorobenzene	0.33
Methyl ethyl ketone	0.12
Methyl tert-butyl ether	0.93
Methylene chloride	0.05
n - Propylbenzene	3.9
sec-Butylbenzene	11
tert-Butylbenzene	5.9
Tetrachloroethene	1.3
Toluene	0.7
Trichloroethene	0.47
1,2,4-Trimethylbenzene	3.6
1,3,5-Trimethylbenzene	8.4
Vinyl chloride[c]	0.02
Xylene (mixed)	0.26
Semivolatile Organic Compounds - mg/kg	
Acenaphthene	20
Acenapthylene	100 [a]
Anthracene	100 [a]
Benz(a)anthracene	1
Benzo(a)pyrene	1
Benzo(b)fluoranthene	1
Benzo(g,h,i)perylene	100
Benzo(k)fluoranthene	0.8
Chrysene	1
Dibenz(a,h)anthracene	0.33
Fluoranthene	100
Fluorene	30
Indeno(1,2,3-cd)pyrene	0.5
m-Cresol	0.33
Naphthalene	12
o-Cresol	0.33
p-Cresol	0.33
Pentachlorophenol	0.8
Phenanthrene	100
Phenol	0.33
Pyrene	100

BENCHMARK

TABLE 1
CRITERIA FOR USE OF OFF-SITE SOIL - PARK 375 UNRESTRICTED SCOs
REMEDIAL ACTION WORK PLAN
MT. OLIVE SENIOR MANOR SITE
BCP SITE NO. C915377
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

Metals - mg/kg	
Arsenic	13
Barium	350
Beryllium	7.2
Cadmium	2.5
Chromium, hexavalent	1
Chromium, trivalent	30
Copper	50
Total Cyanide	27
Lead	63
Manganese	1600
Total Mercury	0.18
Nickel	30
Selenium	3.9
Silver	2
Zinc	109
Pesticides - mg/kg	
4,4'-DDE	0.0033
4,4'-DDT	0.0033
4,4'-DDD	0.0033
Aldrin	0.005
alpha-BHC	0.02
beta-BHC	0.036
Chlordane (alpha)	0.094
delta-BHC	0.04
Dibenzofuran	7
Dieldrin	0.005
Endosulfan I	2.4
Endosulfan II	2.4
Endosulfan sulfate	2.4
Endrin	0.014
Heptachlor	0.042
Lindane	0.1
Herbicides - mg/kg	
2,4,5-TP Acid (Silvex)	3.8
Polychlorinated Biphenyls (PCBs) - mg/kg	
Total PCBs	0.1
Perfluorinated Alkyl Acids - ug/kg [2]	
Perfluorooctanoic Acid (PFOA)	0.66
Perfluorooctanesulfonic Acid (PFOS)	0.88

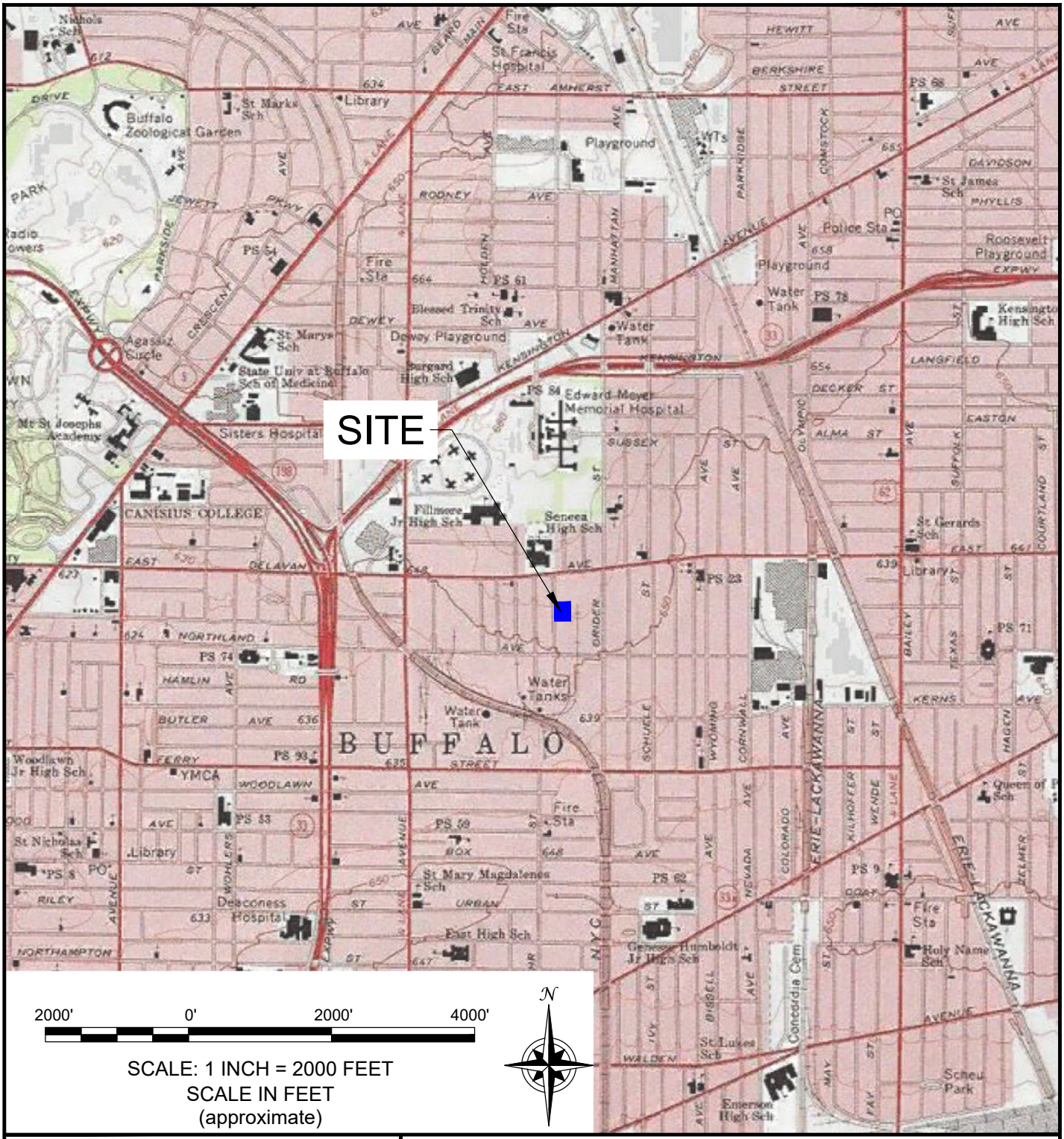
Notes:

1. Values per DER-10 Appendix 5, Allowable Constituent Levels for Imported Fill or Soil, Subdivision 5.4(e)
2. Guidance Values per NSYDEC Sampling, Analysis, and Asssessment of Per- and Polyfluoroalkyl Substances (PFAS).

FIGURES

F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\Figure 1; Site Location and Vicinity Map.dwg, 12/30/2022 2:22:51 PM, DWG To PDF.pc3

FIGURE 1



BENCHMARK

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

PROJECT NO.: B0670-022-001

DATE: JANUARY 2023

DRAFTED BY: CEH

SITE LOCATION AND VICINITY MAP

REMEDIAL ACTION WORK PLAN

MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

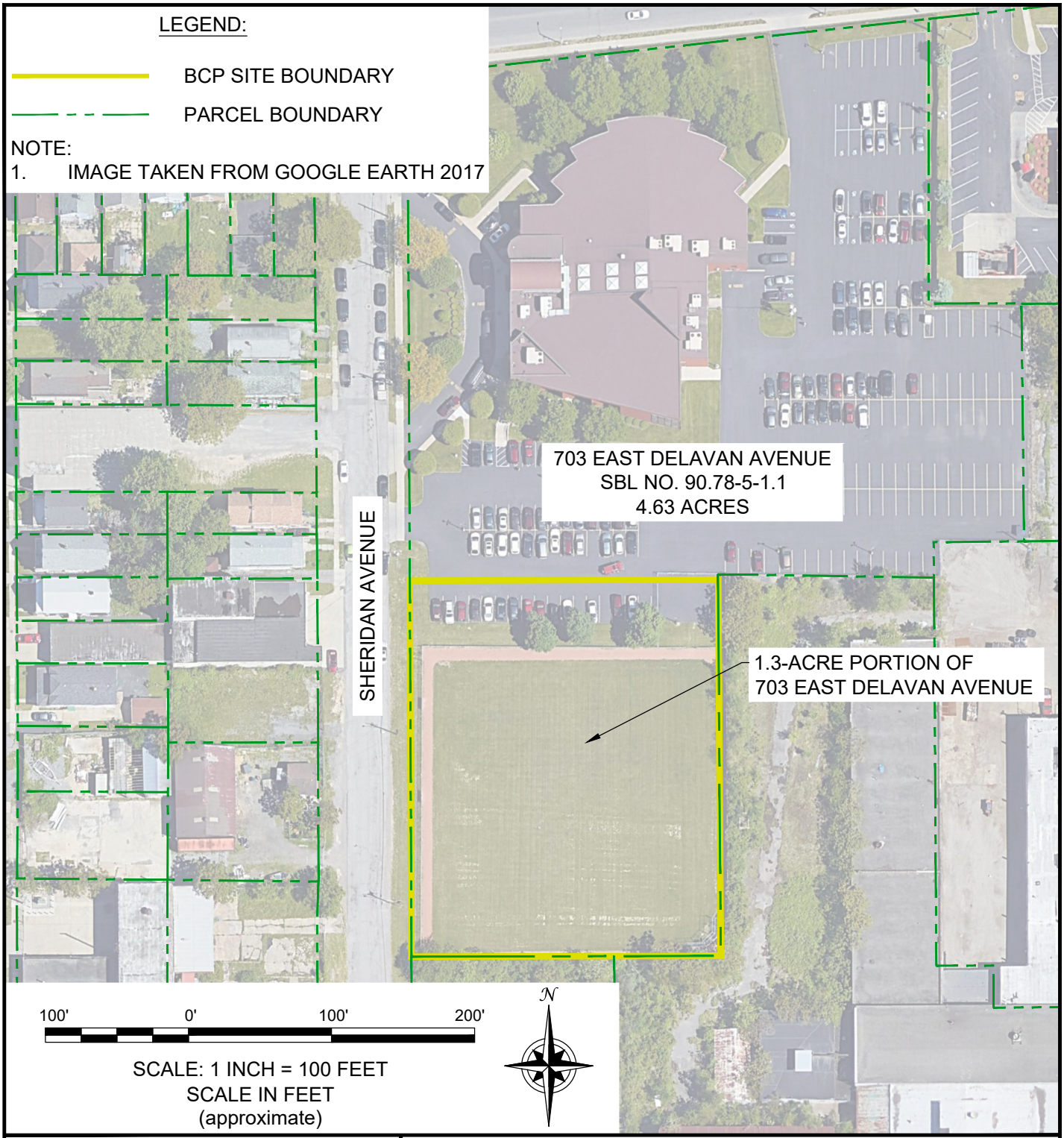
PREPARED FOR

MT. OLIVE SENIOR MANOR LLC

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F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\Figure 2- Site Plan (Aerial).dwg, 1/25/2023 3:19:04 PM, DWG To PDF.pc3

FIGURE 2



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

PROJECT NO.: B0670-022-001

DATE: JANUARY 2023

DRAFTED BY: CNK

SITE PLAN (AERIAL)

REMEDIAL ACTION WORK PLAN

MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

PREPARED FOR

MT. OLIVE SENIOR MANOR LLC

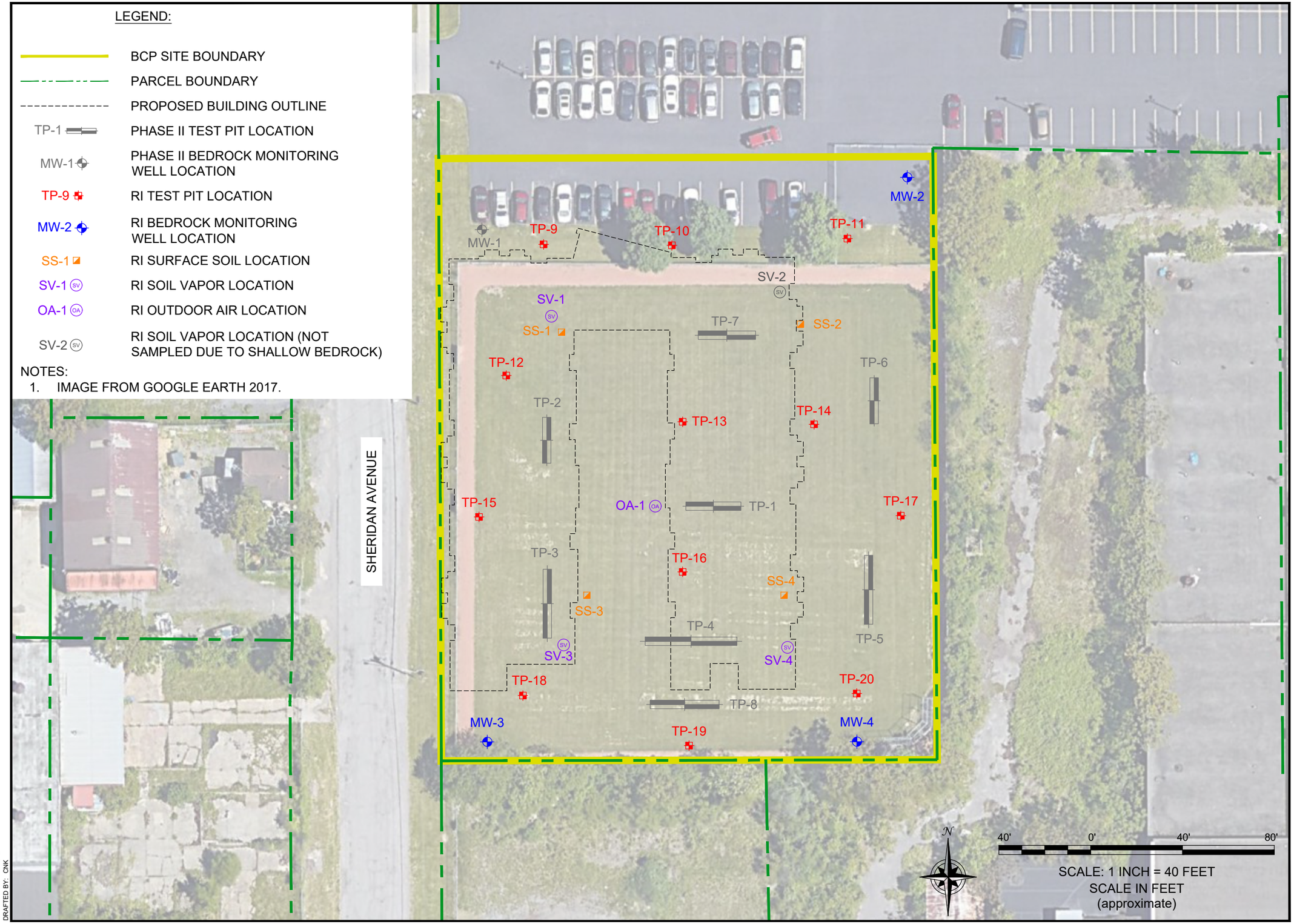
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F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\Figure 3; Phase II and Remedial Investigation Sample Locations.dwg, 12/30/2022 2:24:02 PM, DWG To PDF.pc3

LEGEND:

- BCP SITE BOUNDARY
- PARCEL BOUNDARY
- PROPOSED BUILDING OUTLINE
- TP-1 — PHASE II TEST PIT LOCATION
- MW-1 — PHASE II BEDROCK MONITORING WELL LOCATION
- TP-9 — RI TEST PIT LOCATION
- MW-2 — RI BEDROCK MONITORING WELL LOCATION
- SS-1 — RI SURFACE SOIL LOCATION
- SV-1 (SV) — RI SOIL VAPOR LOCATION
- OA-1 (OA) — RI OUTDOOR AIR LOCATION
- SV-2 (SV) — RI SOIL VAPOR LOCATION (NOT SAMPLED DUE TO SHALLOW BEDROCK)

NOTES:
1. IMAGE FROM GOOGLE EARTH 2017.



DATE: JANUARY 2023
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2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218,
(716) 856-0599

JOB NO.: B0670-022-001

PHASE II AND REMEDIAL INVESTIGATION SAMPLE LOCATIONS

REMEDIAL ACTION WORK PLAN

MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

PREPARED FOR
MT. OLIVE SENIOR MANOR LLC

FIGURE 3

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F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\Figure 4, Summary of Phase II and RI Soil Exceedances.dwg, 1/3/2023 3:00:50 PM, DWG To PDF.pc3

LEGEND:

- BCP SITE BOUNDARY
- PARCEL BOUNDARY
- PROPOSED BUILDING OUTLINE
- TP-1 PHASE II TEST PIT LOCATION
- TP-9 RI TEST PIT LOCATION
- SS-1 RI SURFACE SOIL LOCATION
- EXCEEDS UNRESTRICTED SCOs
- EXCEEDS RESIDENTIAL SCOs
- EXCEEDS COMMERCIAL SCOs
- EXCEEDS INDUSTRIAL SCOs

N

80' 0' 80' 160'

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

NOTES:
1. IMAGE FROM GOOGLE EARTH 2017.
2. RESULTS COMPARED TO 6 NYCRR PART 375 SOIL CLEANUP OBJECTIVES (SCOs).
3. PFAS RESULTS COMPARED TO NYSDEC SCO GUIDANCE VALUES

DEFINITIONS:
PFOA = PERFLUOROOCTANOIC ACID
PFOS = PERFLUOROOCTANESULFONIC ACID

TP-10 (0-1.6 FT)	8/24/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	3.1
BENZO(A)PYRENE	3.1
PENZO(B)FLUORANTHENE	3.5
BENZO(K)FLUORANTHENE	1.7
CHRYSENE	3.2
DIBENZO(A,H)ANTHRACENE	0.62
INDENO(1,2,3-CD)PYRENE	1.8
CHROMIUM	45.3
COPPER	60.1
LEAD	210
NICKEL	46.1
ZINC	170
DIELDRIN	0.0065
TOTAL PCBs	2.9
PFOA	0.69
PFOS	2.6

TP-7 (0.25-1 FT)	2/24/2021
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	5.5
BENZO(A)PYRENE	5.5
PENZO(B)FLUORANTHENE	5.7
BENZO(K)FLUORANTHENE	3.5
CHRYSENE	5.6
DIBENZO(A,H)ANTHRACENE	1
INDENO(1,2,3-CD)PYRENE	3
CHROMIUM	93.6
LEAD	132
MERCURY	0.18

TP-11 (0-2.1 FT)	8/25/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	2.8
BENZO(A)PYRENE	2.9
PENZO(B)FLUORANTHENE	3.5
BENZO(K)FLUORANTHENE	1.5
CHRYSENE	2.9
DIBENZO(A,H)ANTHRACENE	0.48
INDENO(1,2,3-CD)PYRENE	2.1
CHROMIUM	97.7
COPPER	58.6
LEAD	183
MERCURY	0.2
NICKEL	92.9
ZINC	195
TOTAL PCBs	3.5

SS-2 (0-2 IN)	8/26/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	6.3
BENZO(A)PYRENE	6.6
PENZO(B)FLUORANTHENE	7.4
BENZO(K)FLUORANTHENE	3.7
CHRYSENE	6.8
DIBENZO(A,H)ANTHRACENE	1
INDENO(1,2,3-CD)PYRENE	3.7
CHROMIUM	66.5
LEAD	86.1
NICKEL	130
ZINC	124
4,4'-DDE	0.014
4,4'-DDT	0.015
TOTAL PCBs	0.22
PFOS	3.1

TP-9 (0-0.25 FT)	8/25/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	5.4
BENZO(A)PYRENE	5.5
PENZO(B)FLUORANTHENE	6.5
BENZO(K)FLUORANTHENE	2.8
CHRYSENE	5.6
DIBENZO(A,H)ANTHRACENE	1
INDENO(1,2,3-CD)PYRENE	3.3
ARSENIC	17.9
BARIUM	387
CHROMIUM	85.1
COPPER	141
LEAD	402
MERCURY	0.32
NICKEL	107
ZINC	234
TOTAL PCBs	2.4

TP-13 (0-1.3 FT)	8/24/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	10
BENZO(A)PYRENE	11
PENZO(B)FLUORANTHENE	13
BENZO(K)FLUORANTHENE	6.2
CHRYSENE	11
DIBENZO(A,H)ANTHRACENE	1.6
INDENO(1,2,3-CD)PYRENE	4.4
CHROMIUM	52.8
LEAD	106
MERCURY	0.27
NICKEL	73.9
ZINC	132
TOTAL PCBs	0.3

TP-14 (0-2.1 FT)	8/25/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	16
BENZO(A)PYRENE	16
PENZO(B)FLUORANTHENE	17
BENZO(K)FLUORANTHENE	8.1
CHRYSENE	16
DIBENZO(A,H)ANTHRACENE	2.6
INDENO(1,2,3-CD)PYRENE	9.7
CHROMIUM	106
COPPER	65.7
LEAD	274
MERCURY	0.27
NICKEL	219
ZINC	177
TOTAL PCBs	0.59

SS-1 (0-2 IN)	8/26/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	2.3
BENZO(A)PYRENE	2.5
PENZO(B)FLUORANTHENE	2.8
BENZO(K)FLUORANTHENE	1.3
CHRYSENE	2.5
DIBENZO(A,H)ANTHRACENE	0.41
INDENO(1,2,3-CD)PYRENE	1.4
CHROMIUM	31.3
LEAD	95.8
MERCURY	0.2
NICKEL	43.8
ZINC	144
4,4'-DDE	0.0085
4,4'-DDT	0.014
TOTAL PCBs	0.23

TP-12 (0-2.6 FT)	8/24/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	1.4
BENZO(A)PYRENE	1.8
PENZO(B)FLUORANTHENE	2.1
BENZO(K)FLUORANTHENE	1
CHRYSENE	1.6
INDENO(1,2,3-CD)PYRENE	0.86
CHROMIUM	50.4
LEAD	120
ZINC	116
4,4'-DDE	0.021
TOTAL PCBs	0.15
PFOA	1
PFOS	11

TP-2 (0.25-1 FT)	2/24/2021
PARAMETER	MG/KG
BARIUM	14.9
CHROMIUM	58
LEAD	216

TP-6 (0.25-2 FT)	2/24/2021
PARAMETER	MG/KG
CHROMIUM	33.8
LEAD	152
MERCURY	0.21

TP-1 (0.25-1.5 FT)	2/24/2021
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	1.9
BENZO(A)PYRENE	2.2
PENZO(B)FLUORANTHENE	3.1
BENZO(K)FLUORANTHENE	1.2
CHRYSENE	2.3
DIBENZO(A,H)ANTHRACENE	0.65
INDENO(1,2,3-CD)PYRENE	2.2
CHROMIUM	30.6
LEAD	105
MERCURY	0.19

TP-17 (0-1.9 FT)	8/25/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	10
BENZO(A)PYRENE	10
PENZO(B)FLUORANTHENE	12
BENZO(K)FLUORANTHENE	4.7
CHRYSENE	11
DIBENZO(A,H)ANTHRACENE	1.7
INDENO(1,2,3-CD)PYRENE	5.9
ARSENIC	30.3
BARIUM	361
CHROMIUM	158
COPPER	118
LEAD	211
NICKEL	216
ZINC	204
TOTAL PCBs	0.68

TP-15 (0-2.2 FT)	8/24/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	1.7
BENZO(A)PYRENE	2.1
PENZO(B)FLUORANTHENE	2.4
BENZO(K)FLUORANTHENE	1.2
CHRYSENE	1.9
DIBENZO(A,H)ANTHRACENE	0.43
INDENO(1,2,3-CD)PYRENE	1
CHROMIUM	30.7
COPPER	51.3
LEAD	136
4,4'-DDE	0.0036
PFOA	1
PFOS	4.7

TP-3 (0.25-1 FT)	2/24/2021
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	3.7
BENZO(A)PYRENE	3.6
PENZO(B)FLUORANTHENE	4.4
BENZO(K)FLUORANTHENE	1.6
CHRYSENE	3.6
DIBENZO(A,H)ANTHRACENE	0.64
INDENO(1,2,3-CD)PYRENE	1.9

TP-5 (0.25-1 FT)	2/24/2021
PARAMETER	MG/KG
ARSENIC	14.8
CHROMIUM	44
LEAD	2570
MERCURY	0.34

SS-4 (0-2 IN)	8/26/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	6.5
BENZO(A)PYRENE	6.8
PENZO(B)FLUORANTHENE	7.9
BENZO(K)FLUORANTHENE	3.3
CHRYSENE	7
DIBENZO(A,H)ANTHRACENE	1.2
INDENO(1,2,3-CD)PYRENE	4.3
CHROMIUM	72.3
COPPER	74
LEAD	81.5
NICKEL	205
ZINC	121
4,4'-DDE	0.011
4,4'-DDT	0.015

TP-8 (0.25-1 FT)	2/24/2021
PARAMETER	MG/KG
ARSENIC	14.1
CHROMIUM	196
LEAD	337
MERCURY	0.26

TP-20 (0-1.6 FT)	8/24/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	41
BENZO(A)PYRENE	40
PENZO(B)FLUORANTHENE	49
BENZO(K)FLUORANTHENE	19
CHRYSENE	41
DIBENZO(A,H)ANTHRACENE	6.3
DIBENZOFURAN	8.6
INDENO(1,2,3-CD)PYRENE	17
ARSENIC	19.1
CHROMIUM	171
COPPER	116
LEAD	293
MERCURY	0.52
NICKEL	300
ZINC	315
4,4'-DDD	0.016
4,4'-DDE	0.016
4,4'-DDT	0.07
TOTAL PCBs	0.28
PFOS	1.8

SS-3 (0-2 IN)	8/26/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	8
BENZO(A)PYRENE	8.4
PENZO(B)FLUORANTHENE	9.6
BENZO(K)FLUORANTHENE	3.7
CHRYSENE	8.1
DIBENZO(A,H)ANTHRACENE	1.3
INDENO(1,2,3-CD)PYRENE	4.4
CHROMIUM	41.6
LEAD	105
NICKEL	65
ZINC	138
4,4'-DDE	0.01
TOTAL PCBs	0.17

TP-18 (1.2-2.1 FT)	8/24/2022
PARAMETER	MG/KG
CHROMIUM	30.4
4,4'-DDT	0.012

TP-16 (0-2.2 FT)	8/24/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	20
BENZO(A)PYRENE	20
PENZO(B)FLUORANTHENE	22
BENZO(K)FLUORANTHENE	12
CHRYSENE	22
DIBENZO(A,H)ANTHRACENE	4.5
INDENO(1,2,3-CD)PYRENE	11
CHROMIUM	96.2
COPPER	63.4
LEAD	167
NICKEL	172
ZINC	167
4,4'-DDD	0.015
4,4'-DDE	0.013
TOTAL PCBs	0.26
PFOS	1.6

TP-4 (0.25-1 FT)	2/24/2021
PARAMETER	MG/KG
CHROMIUM	224
LEAD	273

TP-19 (0-1.3 FT)	8/25/2022
PARAMETER	MG/KG
BENZO(A)ANTHRACENE	19
BENZO(A)PYRENE	18
PENZO(B)FLUORANTHENE	21
BENZO(K)FLUORANTHENE	7.7
CHRYSENE	19
DIBENZO(A,H)ANTHRACENE	3
INDENO(1,2,3-CD)PYRENE	10
ARSENIC	24
BARIUM	958
CHROMIUM	110
LEAD	195
MERCURY	0.33
NICKEL	138
ZINC	243
TOTAL PCBs	1.3

TP-9 TP-10 TP-11 TP-12 TP-13 TP-14 TP-15 TP-16 TP-17 TP-18 TP-19 TP-20 TP-1 TP-2 TP-3 TP-4 TP-5 TP-6 TP-7 TP-8 SS-1 SS-2 SS-3 SS-4 SHERIDAN AVENUE

DATE: JANUARY 2023
DRAFTED BY: CNK

BENCHMARK

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

JOB NO.: B0670-022-001

SUMMARY OF PHASE II AND REMEDIAL INVESTIGATION SOIL EXCEEDANCES

REMEDIAL ACTION WORK PLAN

MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

PREPARED FOR

MT. OLIVE SENIOR MANOR LLC

FIGURE 4

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F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\Figure 5, Groundwater Isopotential Map.dwg, 1/25/2023 3:11:41 PM, DWG To PDF.pc3

LEGEND:

- BCP SITE BOUNDARY
- PARCEL BOUNDARY
- MW-1 — PHASE II BEDROCK MONITORING WELL & GROUNDWATER ELEVATION (FT)
- MW-2 — RI BEDROCK MONITORING WELL & GROUNDWATER ELEVATION (FT)
- EXCEEDS GWQS/GV
- EXCEEDS ACTION LEVELS
- GROUNDWATER ISOPOTENTIAL
- GROUNDWATER FLOW DIRECTION

NOTES:

1. IMAGE FROM GOOGLE EARTH 2017.
2. WATER LEVEL MEASUREMENTS COLLECTED OCTOBER 14, 2022.
3. DASHED LINES INDICATE INTERPOLATED DATA.
2. RESULTS COMPARED TO TOGS 1.1.1 GROUNDWATER QUALITY STANDARDS/GUIDANCE VALUES.
3. PFAS RESULTS COMPARED TO NYSDEC ACTION LEVELS.

DEFINITIONS:

PFOA = PERFLUOROOCTANOIC ACID
PFOS = PERFLUOROOCTANESULFONIC ACID

489 FT
491 FT
487 FT
MW-1
488.0
MW-2
490.1
MW-3
485.4
MW-4
491.8
486 FT
488 FT
490 FT
SHERIDAN AVENUE

MW-2	10/7/2022
PARAMETER	UG/L
TOTAL IRON	2000
TOTAL SODIUM	34000
DISSOLVED SODIUM	39200

MW-1	10/7/2022 & 10/10/2022
PARAMETER	UG/L
TOTAL ANTIMONY	6.8
TOTAL IRON	3400
TOTAL SODIUM	43500
PARAMETER	NG/L
PFOA	75
PFOS	390

MW-3	10/7/2022
PARAMETER	UG/L
TOTAL SODIUM	50700
BETA-BHC	0.026

MW-4	10/7/2022
PARAMETER	UG/L
CIS-1,2-DICHLOROETHENE	40
TRICHLOROETHENE	210
TOTAL COBALT	11
TOTAL IRON	430
TOTAL SODIUM	23100
PARAMETER	NG/L
PFOA	20
PFOS	16

N

40' 0' 40' 80'

SCALE: 1 INCH = 40 FEET
SCALE IN FEET
(approximate)

DATE: JANUARY 2023
DRAFTED BY: CNK

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

JOB NO.: B0670-022-001

GROUNDWATER ISOPOTENTIAL MAP (10/15/22) AND GROUNDWATER EXCEEDANCES

REMEDIAL ACTION WORK PLAN

MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

PREPARED FOR
MT. OLIVE SENIOR MANOR LLC

FIGURE 5

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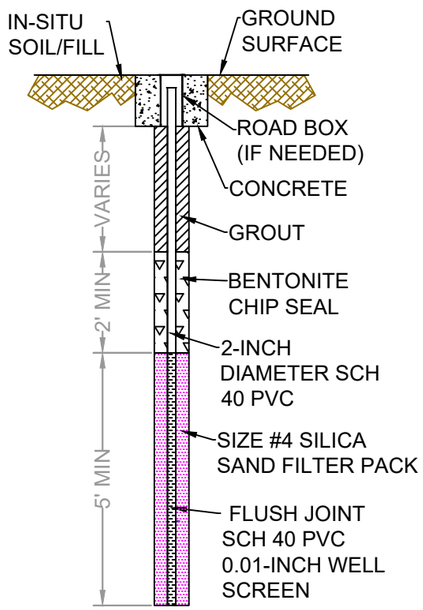
F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\Figure 6; Remedial Plan-Strategy.dwg, 5/5/2023 8:44:32 AM, DWG To PDF.pc3

LEGEND:

- BCP SITE BOUNDARY AND LIMITS OF SOIL/FILL EXCAVATION TO THE TOP OF BEDROCK AT DEPTHS RANGING FROM 2 TO 6 FEET BELOW GROUND SURFACE.
- PARCEL BOUNDARY
- PROPOSED BUILDING OUTLINE
- MW-1 — POST-REMEDIAL MONITORING WELL LOCATION
- IW-1 — PROPOSED PRE-DESIGN INVESTIGATION LOCATIONS AND INJECTION WELLS
- SSV/IA-1 — PROPOSED SOIL VAPOR INTRUSION SUB-SLAB AND INDOOR AIR LOCATIONS
- APPROXIMATE AREAS OF PROPOSED SUB-SLAB PIPING TO BE INSTALLED.

NOTES:
1. IMAGE FROM GOOGLE EARTH 2017.
2. THE PROPOSED INJECTION WELLS WILL BE CONSTRUCTED AS DETAILED BELOW:

INJECTION WELL DETAIL
SCALE: 1" = 3'





DATE: MAY 2023
DRAFTED BY: CNK

BENCHMARK

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

JOB NO.: B0670-022-001

REMEDIAL PLAN/STRATEGY

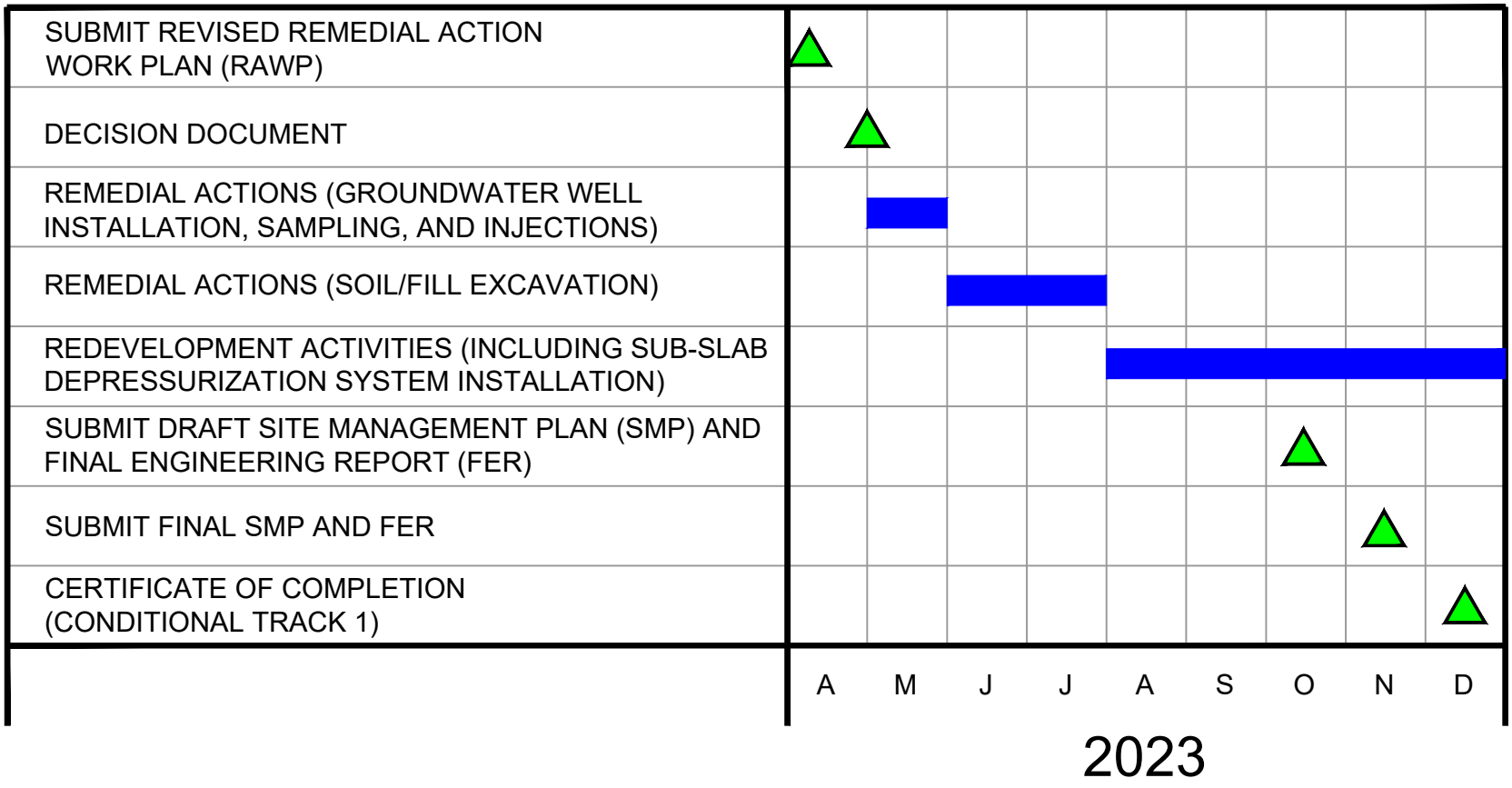
REMEDIAL ACTION WORK PLAN
MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK
PREPARED FOR
MT. OLIVE SENIOR MANOR LLC

FIGURE 6

DISCLAIMER:
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F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\Figure 7; Preliminary Project Schedule_April 2023.dwg, 4/4/2023 11:59:07 AM, DWG To PDF.pc3

PROJECT TASKS:



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

PROJECT NO.: 0670-022-001

DATE: APRIL 2023

DRAFTED BY: CNK

PRELIMINARY PROJECT SCHEDULE

REMEDIAL ACTION WORK PLAN

MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

PREPARED FOR

MOUNT OLIVE SENIOR MANOR LLC

FIGURE 7

DISCLAIMER:
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APPENDIX A

ANALYTICAL SUMMARY TABLES FROM PHASE II & REMEDIAL INVESTIGATION

BENCHMARK

TABLE 4
SUMMARY OF RI SURFACE SOIL/FILL ANALYTICAL RESULTS
REMEDIAL INVESTIGATION / ALTERNATIVES ANALYSIS REPORT
MT. OLIVE SENIOR MANOR SITE
BCP SITE NO. C915377
PORTION OF 703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

Parameter [1]	Unrestricted SCOs[2] (mg/kg)	Residential SCOs[2] (mg/kg)	Commercial SCOs[2] (mg/kg)	Industrial SCOs[2] (mg/kg)	RI Surface Soil Sample Locations			
					SS-1 (0-2 inches)	SS-2 (0-2 inches)	SS-3 (0-2 inches)	SS-4 (0-2 inches)
					8/26/2022			
TCL Semi-Volatile Organic Compounds (SVOCs) - mg/kg [3]								
2-Methylnaphthalene	--	--	--	--	ND	0.52 J	0.48 J	0.27 J
Acenaphthene	20	100	500	1000	0.41 J	1.9	2.1	1.4 F1
Acenaphthylene	100	100	500	1000	ND	0.12 J	0.21 J	0.15 J
Anthracene	100	100	500	1000	0.85 J	3.2	4	2.7 F1
Benzo(a)anthracene	1	1	5.6	11	**2.3**	**6.3**	**8**	**6.5 F1**
Benzo(a)pyrene	1	1	1	1.1	**2.5**	**6.6**	**8.4**	**6.8 F1**
Benzo(b)fluoranthene	1	1	5.6	11	**2.8 J**	**7.4**	**9.6**	**7.9**
Benzo(g,h,i)perylene	100	100	500	1000	1.5	4.1	5.1	4.7 F1
Benzo(k)fluoranthene	0.8	1	56	110	**1.3**	**3.7**	**3.7**	**3.3 F1**
Bis(2-ethylhexyl) phthalate	--	--	--	--	1.4	0.5 J	0.58 J	ND
Butyl benzyl phthalate	--	--	--	--	0.27 J	ND	ND	0.37 J
Cabazole	--	--	--	--	0.5 J	2.4	2.4	1.8 F1
Chrysene	1	1	56	110	**2.5**	**6.8**	**8.1**	**7 F1**
Dibenzo(a,h)anthracene	0.33	0.33	0.56	1.1	**0.41 J**	**1**	**1.3**	**1.2 F1 F2**
Dibenzofuran	7	14	350	1000	0.18 J	1.5	1.4	0.84 J F1
Fluoranthene	100	100	500	1000	5.4 J	16	19	15
Fluorene	30	100	500	1000	0.38 J	2	2.3	1.4 F1
Indeno(1,2,3-cd)pyrene	0.5	0.5	5.6	11	**1.4**	**3.7**	**4.4**	**4.3 F1**
Naphthalene	12	100	500	1000	ND	0.96	0.75 J	0.44 J F1
Phenanthrene	100	100	500	1000	3.8 J	15	17	13
Pyrene	100	100	500	1000	4 J	12	15	12
Total PAHs	--	--	--	--	29.6	90.8	109	87.8
SVOC TICs	--	--	--	--	6.03 TJN	27.5 TJN	42.8 TJN	27.3 TJN
1,4-Dioxane - mg/kg								
1,4-Dioxane	1.8	9.8	130	250	ND	ND	ND	ND
TAL Metals - mg/kg								
Aluminum	--	--	--	--	11300	12600	13000	10500
Antimony	--	--	--	--	0.8 J	0.99 J	0.99 J	0.71 J
Arsenic	13	16	16	16	7.1	7	7.8	8.5
Barium	350	350	400	10000	113	120	119	116 J
Beryllium	7.2	14	590	2700	0.53	0.52	0.56	0.49
Cadmium	2.5	2.5	9.3	60	0.92	0.7	0.63	0.55
Calcium	--	--	--	--	19900 B	11200 B	12500 B	20900 B
Chromium	30	36	1,500	6,800	**31.3 B**	**66.5 B**	**41.6 B**	**72.3 B**
Cobalt	--	--	--	--	11.1	23.7	13.5	15.8
Copper	50	270	270	10000	48.6	41.7	44.3	**74 J**
Iron	--	--	--	--	19000	22000	20200	18700
Lead	63	400	1,000	3,900	**95.8**	**86.1**	**105**	**81.5**
Magnesium	--	--	--	--	5550 B	4440 B	5060 B	5610 B F1
Manganese	1,600	2,000	10,000	10,000	444 B	449 B	469 B	511 B
Mercury	0.18	0.81	2.8	5.7	**0.2**	0.14	0.13	0.1
Nickel	30	140	310	10000	**43.8**	**130**	**65**	**205**
Potassium	--	--	--	--	2190 ^+	2400 ^+	2460 ^+	2290 J
Selenium	3.9	36	1,500	6,800	1.1 J	0.99 J	0.61 J	0.71 J
Sodium	--	--	--	--	114 J	114 J	100 J	114 J
Vanadium	--	--	--	--	22.8	27.3	26.4	22.5
Zinc	109	2,200	10,000	10,000	**144**	**124**	**138**	**121**
Organochlorine Pesticides - mg/kg [3]								
4,4'-DDE	0.0033	1.8	62	120	**0.0085 J**	**0.014 J**	**0.01 J**	**0.011 J**
4,4'-DDT	0.0033	1.7	47	94	**0.014 J**	**0.015 J**	ND	**0.015 J**
delta-BHC	0.04	100	500	1000	ND	0.0088 J	ND	ND
Methoxychlor	--	--	--	--	ND	ND	ND	ND
Herbicides - mg/kg [3]								
	--	--	--	--	ND	ND	ND	ND
Polychlorinated Biphenyls (PCBs) mg/kg								
PCB-1254	--	--	--	--	0.23	0.22 J	0.17 J	ND
Total PCBs	0.1	1	1	25	**0.23**	**0.22 J**	**0.17 J**	ND
Perfluorinated Alkyl Acids - ug/kg								
Perfluoropentanoic Acid (PFPeA)	--	--	--	--	--	0.15 J	--	--
Perfluorohexanoic Acid (PFHxA)	--	--	--	--	--	0.21 EMPC	--	--
Perfluoroheptanoic Acid (PFHpA)	--	--	--	--	--	0.12 J	--	--
Perfluorooctanoic Acid (PFOA)	0.66	6.6	500	600	--	0.4	--	--
Perfluorononanoic Acid (PFNA)	--	--	--	--	--	0.14 J	--	--
Perfluorodecanoic Acid (PFDA)	--	--	--	--	--	ND	--	--
Perfluoroundecanoic Acid (PFUnA)	--	--	--	--	--	ND	--	--
Perfluorododecanoic Acid (PFDoA)	--	--	--	--	--	ND	--	--
Perfluorohexanesulfonic Acid (PFHxS)	--	--	--	--	--	0.069 J	--	--
Perfluorooctanesulfonic Acid (PFOS)	0.88	8.8	440	440	--	**3.1**	--	--
Perfluorodecanesulfonic Acid (PFDS)	--	--	--	--	--	1.1	--	--
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	--	--	--	--	--	0.18 J	--	--

Notes:

1. Only those parameters detected at a minimum of one sample location are presented in this table; all other compounds were reported as non-detect.
2. Values per NYSDEC Part 375 Soil Cleanup Objectives (SCOs) .
3. Sample results were reported by the laboratory in micograms per kilogram (ug/kg) and converted to milligram per kilogram (mg/kg) for comparison to SCOs.

Definitions:

ND = Parameter not detected above laboratory detection limit.
-- = Sample not analyzed for parameter and/or no SCO available.
J = Estimated value; result is less than the sample quantitation limit but greater than zero.
B = Compound was found in the blank and sample.
N = Presumptive evidence of analyte; result should be used with caution as a potential false positive and/or elevated quantitative value.
F1 = MS and/or MSD Recovery is outside acceptance limits.
F2 = MS/MSD RPD exceeds control limits.
T = Result is a tentatively identified compound (TIC) and an estimated value.
^+ = Continuing Calibration Verification (CCV) is outside acceptable limits, high biased.
EMPC = Theresults do not meet all criteria for a confirmed identification. The quantitative value represents a Estimated Maximum Possible Concentration of the analyte in the sample.

Result exceeds Unrestricted SCOs
Result exceeds Restricted-Residential SCOs
Result exceeds Commercial SCOs
Result exceeds Industrial SCOs

BENCHMARK

TABLE 5
SUMMARY OF PHASE II AND RI SUBSURFACE SOIL/FILL ANALYTICAL RESULTS
REMEDIAL INVESTIGATION / ALTERNATIVES ANALYSIS REPORT
MT. OLIVE SENIOR MANOR SITE
BCP SITE NO. C915377
PORTION OF 703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

Parameter [1]	Unrestricted SCOs [2] (mg/kg)	Residential SCOs [2] (mg/kg)	Commercial SCOs [2] (mg/kg)	Industrial SCOs [2] (mg/kg)	Phase II Investigation Locations								RI Investigation Locations										
					TP-1 (0.25-1.5 FT)	TP-2 (0.25-1 FT)	TP-3 (0.25-1 FT)	TP-4 (0.25-1 FT)	TP-5 (0.25-1 FT)	TP-6 (0.25-2 FT)	TP-7 (0.25-1 FT)	TP-8 (0.25-1 FT)	TP-9 (0-2.5 FT)	TP-10 (0-1.6 FT)	TP-11 (0-2.1 FT)	TP-12 (0-2.6 FT)	TP-13 (0-1.3 FT)	TP-14 (0-2.1 FT)	TP-15 (0-2.2 FT)	TP-16 (0-2.2 FT)	TP-17 (0-1.9 FT)	TP-18 (1.2-2.1 FT)	TP-19 (0-1.3 FT)	TP-20 (0-1.6 FT)
					2/24/2021	2/24/2021	2/24/2021	2/24/2021	2/24/2021	2/24/2021	2/24/2021	2/24/2021	8/25/22	8/24/22	8/25/22	8/24/22	8/24/22	8/25/22	8/24/22	8/24/22	8/25/22	8/24/22	8/25/22	8/24/22
TCL Volatile Organic Compounds (VOCs) - mg/kg [3]																							
Total VOCs					--	--	--	--	--	--	--	--	--	ND	--	ND	--	--	ND	ND	--	ND	--	ND
VOC TICs	--	--	--	--	--	--	--	--	--	--	--	--	--	ND	--	ND	--	--	ND	ND	--	ND	--	ND
TCL Semi-Volatile Organic Compounds (SVOCs) - mg/kg [3]																							
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	0.52 J	ND		ND	0.68 J	2.7	ND	1.9 F1	0.93 J	ND	1.4 J	3.3 J
Acenaphthene	20	100	500	1000	0.35 J	0.11 J	1.2	--	--	--	0.52 J	--	1.3 J	0.4 J	0.52 J	ND	2.7	5.3	0.35 J	6.5 F1	2.6	ND	5.1	12
Acenaphthylene	100	100	500	1000	ND	ND	ND	--	--	--	0.12 J	--	0.3 J	0.23 J	0.15 J	ND	0.25 J	0.43 J	ND	0.42 J	0.41 J	ND	0.46 J	0.86 J
Anthracene	100	100	500	1000	0.75 J	0.19 J	1.8	--	--	--	2.7	--	2.6	1	0.96 J	ND	4.6	8.6	0.66 J	11	5.1	ND	9	20
Benzo(a)anthracene	1	1	5.6	11	1.9	0.59	3.7	--	--	--	5.5	--	5.4	3.1	2.8	1.4 J	10	16	1.7 J	20	10	0.066 J	19	41
Benzo(a)pyrene	1	1	1	1.1	2.2	0.65	3.6	--	--	--	5.5	--	5.5	3.1	2.9	1.8 J	11	16	2.1	20	10	0.078 J	18	40
Benzo(b)fluoranthene	1	1	5.6	11	3.1	0.76	4.4	--	--	--	5.7	--	6.5	3.5	3.5	2.1	13	17	2.4	22	12	0.12 J	21	49
Benzo(g,h,i)perylene	100	100	500	1000	4.1	0.51	2.1	--	--	--	3.4	--	3.3	1.7	2.3	0.96 J	4.1	9.8	1.2 J	12	5.8	0.043 J	10	15
Benzo(k)fluoranthene	0.8	1	56	110	1.2	0.38	1.6	--	--	--	3.5	--	2.8	1.7	1.5	1 J	6.2	8.1	1.2 J	12	4.7	0.045 J	7.7	19
Biphenyl	--	--	--	--	--	--	--	--	--	--	--	--	ND	ND	ND	ND	ND	0.54 J	ND	0.58 J	ND	ND	0.3 J	0.99 J
Bis(2-ethylhexyl) phthalate	--	--	--	--	--	--	--	--	--	--	--	--	0.84 J	0.35 J	28	ND	ND	0.72 J	ND	ND	ND	ND	ND	ND
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	1.7 J	0.56 J	0.72 J	ND	3.1	6.2	0.41 J	6.9 F1	3.4	ND	6.6	14
Chrysene	1	1	56	110	2.3	0.63	3.6	--	--	--	5.6	--	5.6	3.2	2.9	1.6 J	11	16	1.9	22	11	0.086 J	19	41
Dibenzo(a,h)anthracene	0.33	0.33	0.56	1.1	0.65 J	0.13 J	0.64 J	--	--	--	1	--	1 J	0.62 J	0.48 J	ND	1.6 J	2.6	0.43 J	4.5 F1	1.7 J	ND	3	6.3
Dibenzofuran	7	14	350	1000	--	--	--	--	--	--	--	--	0.99 J	0.31 J	0.35 J	ND	1.8 J	4.6	0.24 J	5.2 F1	2.2	ND	3.8	8.6
Fluoranthene	100	100	500	1000	4.3	1.2	9.1	--	--	--	12	--	14	7.1	7.2	2.6	26	42	3.8 J	46	26	0.15 J	47	97
Fluorene	30	100	500	1000	0.43 J	0.12 J	1.3	--	--	--	1.4	--	1.5 J	0.46 J	0.47 J	ND	2.7	6	0.38 J	7.1 F1 F2	3	ND	5.4	11
Indeno(1,2,3-cd)pyrene	0.5	0.5	5.6	11	2.2	0.4	1.9	--	--	--	3	--	3.3	1.8	2.1	0.86 J	4.4	9.7	1 J	11	5.9	0.043 J	10	17
Naphthalene	12	100	500	1000	ND	0.03 J	0.89 J	--	--	--	0.43 J	--	1.2 J	0.12 J	0.25 J	ND	1.1 J	7	ND	2.4 F1	1.7 J	ND	2.1	6.2
Phenanthrene	100	100	500	1000	3.2	0.95	7.9	--	--	--	11	--	12	5	5.7	1.1 J	22	43	3.1 J	48	25	0.093 J	44	95
Pyrene	100	100	500	1000	3.6	1.1	9.6	--	--	--	11	--	9.9	5.4	5.2	2	18	30	2.8	36	19	0.097 J	34	70
Total PAHs	--	--	--	--	30.3	7.75	53.3	--	--	--	73.2	--	76.2	38.4	38.9	15.4	139	238	23.0	281	144	0.821	255	540
SVOC TICs	--	--	--	--	--	--	--	--	--	--	--	--	9.40 TJN	7.27 TJN	14.3 TJN	ND	26.9 TJN	75.1 TJN	1.60 TJN	90.6 TJN	43.9 TJN	0.180 TJN	96.2 TJN	143 TJN
1,4-Dioxane - mg/kg																								
1,4-Dioxane	1.8	9.8	130	250	--	--	--	--	--	--	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TAL Metals - mg/kg																								
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	11600	13100	14300	9820	12300	13800	7750	12100	11500	14600	15900	16800
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	6 J	1.8 J	2.3 J	1.4 J	1.3 J	0.82 J	1 J	1.9 J	3.2 J	0.6 J	1.9 J	3.4 J
Arsenic	13	16	16	16	7.6	14.9	5	12.9	14.8	10.2	9.3	14.1	17.9	9.5	10.8	8.4	7.1	8.9	6.4	9.5	30.3	9.2	24	19.1
Barium	350	350	400	10000	106	94.6	74.4	138 F1	101	135	87.9	249	387	146	322	85.6	101	165	84.1	134 J	361	61.6	958	271
Beryllium	7.2	14	590	2700	--	--	--	--	--	--	--	--	0.53	0.53	0.55	0.43	0.49	0.61	0.33	0.55	0.48	0.43	0.66	1.1
Cadmium	2.5	4.3	9.3	60	0.62	ND	0.26	1	0.45	0.45	0.72	1.4	1.3	0.87	0.89	0.66	0.79	1.2	0.61	0.9	1.4	0.39	1.1	1.6
Calcium	--	--	--	--	--	--	--	--	--	--	--	--	5490 B	55700 B	5830 B	12200 B	14300 B	16800 B	8650 B	11000 B F2	7900 B	3260 B	7190 B	27300 B
Chromium	30	36	1,500	6,800	30.6 F1	58	13.2	224 F2	44	33.8	93.6	196	85.1 B	45.3	97.7 B	50.4	52.8	106 B	30.7	96.2 F1	158 B	30.4	110 B	171
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	14.4	8.3	12.7	6	13	34	6.3	21.4	44.4	4.9	24.9	41.8
Copper	50	270	270	10000	--	--	--	--	--	--	--	--	141	60.1	58.6	35.9	41.8	65.7	51.3	83.4	118	24.7	47	116
Iron	--	--	--	--	--	--	--	--	--	--	--	--	57400	24200	37400	21300	20800	20700	14900	24400 F2	50500	18500	21900	42000
Lead	63	400	1,000	3,900	105 F1	216	61.3	273	2570	152	132	337	402	210	183	120	106	274	136	167	211	40.6	195	293
Magnesium	--	--	--	--	--	--	--	--	--	--	--	--	2310 B	2870 B	2820 B	3310 B	3750 B	4870 B	2610 J	3030 B F1	2460 B	2180 B	2830 B	6710 B
Manganese	1,600	2,000	10,000	10,000	--	--	--	--	--	--	--	--	706 B	665 B	996 B	358 B	519 B	672 B	1260 B	675 B	1410 B	348 B	771 B	1450 B
Mercury	0.18	0.81	2.8	5.7	0.19	0.15	0.061	0.15	0.34	0.21	0.18	0.26	0.32	0.15	0.2	0.14	0.27	0.27	0.17	0.18	0.14	0.04	0.33	0.52
Nickel	30	140	310	10000	--	--	--	--	--	--	--	--	107	46.1	92.9	26.7	73.9	219	27.5 J	172 J	216	27.5	138	300
Potassium	--	--	--	--	--	--	--	--	--	--	--	--	1130 ^+	1420	1290 ^+	1580	1950	2280 ^+	1210	1810 J	1260 ^+	1280	1680 ^+	2280
Selenium	3.9	36	1,500	6,800	ND	1.8	1.1 J	4.5 J	6.3 J	3.1 J	0.79 J	4.2 J	1.5 J	1.8 J	1.3 J	0.97 J	1.2 J	1.4 J	1.3 J	1.7 J	2 J	1.3 J	2.1 J	2.6 J
Silver	2	36	1,500	6,800	0.37 J	0.81	ND	0.54 J	0.7 J	0.36 J	0.41 J	0.61J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	114 J	163	127 J	74.3 J	99 J	140 J	107 J	106 J	109 J	95 J	97.7 J	189
Vanadium	--	--	--	--	--	--	--	--	--	--	--	--	30.4	29.3	33.4	20.1	26.7	29.6	17.7	27.8	28.9	36.1	35.3	38.6
Zinc	109	2,200	10,000	10,000	--	--	--	--	--	--	--	--	234	170	195	116	132	177	109	167	204	90	243	315
Organochlorine Pesticides - mg/kg [3]																								
4,4'-DDD	0.0033	2.6	92	180	--	--	--	--	--	--	--	--	--	ND	--	ND	--	--	0.0029 J	0.015 J	--	ND	--	0.016 J
4,4'-DDE	0.0033	1.8	62	120	--	--	--	--	--	--	--	--	--	ND	--	0.021 J	--	--	0.0036 J	0.013 J	--	ND	--	0.016 J
4,4'-DDT	0.0033	1.7	47	94	--	--	--	--	--	--	--	--	--	ND	--	ND	--	--	ND	ND	--	0.012	--	0.07
delta-BHC	0.04	100	500	1000	--	--	--	--	--	--	--	--	--	ND	--	ND	--	--	ND	0.0082 J	--	ND	--	0.0099 J
Dieldrin	0.005	0.039	1.4	2.8	--	--	--	--	--	--	--	--	--	0.0065 J	--	ND	--	--	ND	ND	--	ND	--	ND
Endrin aldehyde	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0061 J	--	ND	--	--	ND	ND	--	ND	--	0.016 J
Endrin ketone	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0081 J	--	ND	--	--	0.0042 J	0.036 J	--	0.0031 J	--	0.033 J
gamma-BHC (Lindane)	0.1	0.28	9.2	23	--	--	--	--	--	--	--	--	--	ND	--	ND	--	--	ND	ND	--	ND	--	ND
Heptachlor	0.042	0.42	15	29	--	--	--	--	--	--	--	--	--	0.0046 J	--	ND	--	--	ND	ND	--	ND	--	ND
Methoxychlor	--	--	--	--	--	--	--	--	--	--	--	--	--		--	ND	--	--	ND	ND	--	ND	--	ND
trans-Chlordane (gamma)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01 J	--	ND	--	--	ND	ND	--	ND	--	ND
Herbicides - mg/kg [3]																								
Herbicides	--	--	--	--	--	--	--	--	--	--	--	--	--	ND	--	ND	--	--	ND	ND	--	ND	--	ND
Polychlorinated Biphenyls (PCBs) mg/kg																								
PCB-1248	--	--	--	--	ND	ND	ND	--	--	--	ND	--	2.4	2.9	3.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1254	--	--	--	--	ND	ND	ND	--	--	--	ND	--	ND	ND	ND	ND	0.3	0.59	ND	0.26	0.68	ND	1.3	0.28
PCB-1260	--	--	--	--	ND	ND	ND	--	--	--	ND	--	ND	ND	ND	0.15 J	ND	ND	ND	ND	ND	ND	ND	ND
Total PCBs	0.1	1	1	25	ND	ND	ND	--	--	--	ND	--	2.4	2.9	3.5	0.15 J	0.3	0.59	ND	0.26	0.68	ND	1.3	0.28
Perfluorinated Alkyl Acids - ug/kg																								
Perfluoropentanoic Acid (PFPeA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15 J	--	0.36	--	--	0.23	0.15 J	--	0.22 J	--	ND
Perfluorohexanoic Acid (PFHxA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.23 EMPC	--	0.31	--	--	0.26	0.25	--	0.19 J	--	0.3 EMPC
Perfluoroheptanoic Acid (PFHpA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.12 J	--	0.18 J	--	--	0.21 J	0.13 J	--	0.089 J	--	0.13 J
Perfluorooctanoic Acid (PFOA)	0.66	6.6	500	600	--	--	--	--	--	--	--	--	--	0.69	--	1	--	--	1	0.43	--	0.3	--	0.52
Perfluorononanoic Acid (PFNA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15 J	--	0.29	--	--	0.11 J	0.11 J	--	0.085 J	--	0.2 J
Perfluorodecanoic Acid (PFDA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15 J	--	0.44	--	--	0.11 J	0.1 J	--	ND	--	0.2 J
Perfluoroundecanoic Acid (PFUnA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.089 J	--	0.081 J	--	--	0.039 J	0.058 J	--	ND	--	0.12 J
Perfluorododecanoic Acid (PFDoA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.065 J	--	0.15 J	--	--	0.051 J	0.038 J	--	ND	--	0.075 J
Perfluorotridecanoic Acid (PFTrDA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.031 J	--	0.038 J	--	--	ND	ND	--	ND	--	0.051 J
Perfluorotetradecanoic Acid (PFTA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.038 J	--	0.057 J	--	--	ND	ND	--	ND	--	0.036 J
Perfluorobutanesulfonic Acid (PFBS)	--	--	--	--	--	--	--	--	--	--	--	--	--	ND	--	ND	--	--	ND	ND	--	ND	--	0.043 J
Perfluorohexanesulfonic Acid (PFHxS)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.056 J	--	0.1 EMPC	--	--	0.073 J	ND	--	ND	--	0.055 EMPC
Perfluoroheptanesulfonic Acid (PFHpS)	--	--	--	--	--	--	--	--	--	--	--	--	--	ND	--	0.046 EMPC	--	--	0.052 EMPC	ND	--	ND	--	ND
Perfluorooctanesulfonic Acid (PFOS)	0.88	8.8	440	440	--	--	--	--	--	--	--	--	--	2.6	--	11	--	--	4.7	1.6	--	0.88	--	1.8
Perfluorodecanesulfonic Acid (PFDS)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.48	--	5	--	--	1.2	0.4	--	0.05 J	--	0.31
Perfluorooctanesulfonamide (FOSA)	--	--	--	--	--	--	--	--	--	--	--	--	--	ND	--	ND	--	--	ND	ND	--	ND	--	0.053 J
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1 J	--	0.32 J	--	--	ND	ND	--	ND	--	0.1 J

Notes:
1. Only those parameters detected at a minimum of one sample location are presented in this table; all other compounds were reported as non-detect.
2. Values per NYSDEC Part 375 Soil Cleanup Objectives (SCOs) and Sampling, Analysis, and Assessment of PFAS Guidance June 2021.
3. Sample results were reported by the laboratory in micograms per kilogram (ug/kg) and converted to milligram per kilogram (mg/kg) for comparison to SCOs.

Definitions:
ND = Parameter not detected above laboratory detection limit.
-- = Sample not analyzed for parameter and/or no SCO available.
J = Estimated value; result is less than the sample quantitation limit but greater than zero.
B = Compound was found in the blank and sample.
F1 = MS and/or MSD Recovery is outside acceptance limits.
F2 = MS/MSD RPD exceeds control limits.
I = Value is EMPC (estimated maximum possible concentration)
N = Presumptive evidence of analyte; result should be used with caution as a potential false positive and/or elevated quantitative value.
T = Result is a tentitively identified compound (TIC) and an estimated value.
^+ = Continuing Calibration Verification (CCV) is outside acceptance limits, high biased.
EMPC = Theresults do not meet all criteria for a confirmed identification. The quantitative value represents a Estimated Maximum Possible Concentration of the analyte in the sample.

Result exceeds Unrestricted SCOs
Result exceeds Restricted-Residential SCOs
Result exceeds Commercial SCOs
Result exceeds Industrial SCOs

TABLE 6
SUMMARY OF PHASE II AND RI GROUNDWATER ANALYTICAL RESULTS
REMEDIAL INVESTIGATION / ALTERNATIVES ANALYSIS REPORT
MT. OLIVE SENIOR MANOR SITE
BCP SITE NO. C915377
PORTION OF 703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

PARAMETER [1]	GWQS [2]	Phase II Results	RI Results			
		MW-1	MW-1	MW-2	MW-3	MW-4
		04/23/21	10/7/22 & 7/10/22	10/07/22	10/07/22	10/07/22
Volatile Organic Compounds (VOCs) - ug/L						
cis-1,2-Dichloroethene	**5**	ND	ND	ND	ND	**40**
Trichloroethene	**5**	0.36 J	ND	ND	0.57 J	**210**
Semi-Volatile Organic Compounds (SVOCs) - ug/L						
	--	--	ND	ND	ND	ND
Semi-Volatile Organic Compounds 8270 (SIM) - ug/L	***Action Level***					
1,4 - Dioxane	**0.35**		ND	--	--	ND
Total Metals - ug/L [3]						
Aluminum	**--**	--	5980	ND	63 J	620 J
Antimony	**3**	--	**6.8 J**	ND	ND	ND
Barium	**1000**	--	56	91 J	110	110
Cadmium	**5**	--	ND	ND	ND	0.5 J
Calcium	**--**	--	100000	118000	70700	114000
Chromium	**50**	--	15	5.9	9.2	1.6 J
Cobalt	**5**	--	4.1	ND	ND	**11**
Copper	**200**	--	10 B	1.9 JB	3.7 JB	25 B
Iron	**300**	--	**3400**	**2000**	120	**430 J**
Lead	**25**	--	6.8 J	ND	ND	ND
Magnesium	**35000**	--	14200	20800	12500	12100
Manganese	**300**	--	45 B	110 B	1.6 JB	90 B
Nickel	**100**	--	10	4.7 J	2.7 J	36
Potassium	**--**	--	4700	8500	3700	4200
Sodium	**20000**	--	**43500**	**34000**	**50700**	**23100**
Vanadium	**14**	--	11	ND	ND	ND
Zinc	**2000**	--	21 B	ND	1.6 JB	59 B
Dissolved Metals - ug/L [3]						
Barium	**1000**	--	--	120 J	--	--
Calcium	**--**	--	--	115000	--	--
Cobalt	**5**	--	--	0.73 J	--	--
Copper	**200**	--	--	4.7 J	--	--
Magnesium	**35000**	--	--	20400	--	--
Manganese	**300**	--	--	82 B	--	--
Nickel	**100**	--	--	4.9 J	--	--
Potassium	**--**	--	--	9500	--	--
Sodium	**20000**	--	--	**39200**	--	--
Zinc	**2000**	--	--	ND	--	--
PCB (ug/L)						
Total PCBs	**0.09**	--	ND	ND	ND	ND
Pesticides - ug/L						
4,4'-DDD	**0.3**	--	ND	ND	ND	ND
4,4'-DDE	**0.2**	--	ND	ND	ND	ND
4,4'-DDT	**0.2**	--	ND	0.024 J	ND	ND
Aldrin	**ND**	--	ND	ND	ND	0.041 J
beta-BHC	**0.01**	--	ND	ND	**0.026 J**	ND
alpha-Chlordane	**0.05**	--	ND	ND	ND	ND
Endosulfan I	**--**	--	ND	ND	ND	0.024 J
Endrin Aldehyde	**5**		ND	ND	ND	ND
Herbicides - ug/L						
Herbicides	**--**	--	ND	ND	ND	ND
Perfluorinated Alkyl Acids - ng/L	***Action Level***					
Perfluorobutanoic Acid (PFBA)	**--**	--	19 J-	--	--	15 J-
Perfluoropentanoic Acid (PFPeA)	**--**	--	36	--	--	53
Perfluorohexanoic Acid (PFHxA)	**--**	--	37	--	--	20
Perfluoroheptanoic Acid (PFHpA)	**--**	--	32	--	--	18
Perfluorooctanoic Acid (PFOA)	**10**	--	**75**	--	--	**20**
Perfluorononanoic Acid (PFNA)	**--**	--	26	--	--	2
Perfluorodecanoic Acid (PFDA)	**--**	--	18	--	--	0.45 J
Perfluorobutanesulfonic Acid (PFBS)	**--**	--	12	--	--	11
Perfluorohexanesulfonic Acid (PFHxS)	**--**	--	40	--	--	2.7
Perfluoroheptanesulfonic Acid (PFHpS)	**--**	--	4.6	--	--	ND
Perfluorooctanesulfonic Acid (PFOS)	**10**	--	**390 D**	--	--	**16**
Perfluorodecanesulfonic Acid (PFDS)	**--**	--	0.41 J	--	--	ND

Notes:

1. Only those parameters detected at a minimum of one sample location are presented in this table; all other compounds or analytes were reported as non-detect.
2. Values per NYSDEC Division of Water Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations - Class GA (TOGS 1.1.1) or NYSDEC Action Levels for emgergent contaminants.
3. Reported by the laboratory in mg/L, converted to ug/L for comparison to GWQS/GV.

Definitions:

ND = Parameter not detected above laboratory detection limit.
"--" = No value available for the parameter; Parameter not analysed for.
J = Estimated value; result is less than the reporting limit but greater than zero.
N = Indicates presumptive evidence of compound.
B = Compound was found in the blank and sample.
T = Result is a tentatively identified compound (TIC) and an estimated value.
BOLD = Result exceeds GWQS.

BENCHMARK

TABLE 7
SUMMARY OF SOIL VAPOR AND OUTDOOR AIR ANALYTICAL RESULTS
REMEDIAL INVESTIGATION/ALTERNATIVES ANALYSIS REPORT
MT. OLIVE SENIOR MANOR SITE
BCP SITE NO. C915377
PORTION OF 703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

Parameter [1,2]	Sample Location			
	SV-1	SV-3	SV-4	OA-1
	8/26/2022			
Volatile Organic Compounds (VOCs, ug/m3)				
1,1,1-Trichloroethane (Matrix B)	ND, <2.2	ND, <4.4	ND, <5.5	ND, <1.1
1,1-Dichloroethene (Matrix A)	ND, <1.6	ND, <3.2	ND, <4	ND, <0.79
1,2,4-Trimethylbenzene	2.5	4.3 J	3.7 J	1.2 J
1,3,5-Trimethylbenzene	ND, <2	ND, <3.9	ND, <4.9	0.34 J
4-Ethyltoluene	ND, <2	ND, <3.9	ND, <4.9	0.32 J
Acetone	160 D	370 DJ	390 DJ	16 J
Benzene	2.8	1.6 J	1.6 J	0.56 J
Carbon Disulfide	1.1 J	56 J	ND, <7.8	0.51 J
Carbon Tetrachloride (Matrix A)	ND, <2.5	ND, <5	ND, <6.3	0.34 J
Chloroform	1.2 J	ND, <3.9	ND, <4.9	ND, <0.98
Chloromethane	2.5	ND, <4.1	ND, <5.2	0.85 J
cis-1,2-Dichlorethene (Matrix A)	ND, <1.6	ND, <3.2	ND, <4	ND, <0.79
Cumene	ND, <2	ND, <3.9	ND, <4.9	0.49 J
Cyclohexane	3	ND, <2.8	ND, <3.4	ND, <0.69
Dichlorodifluoromethane (Freon 12)	2.2 J	ND, <9.9	ND, <12	2 J
Ethylbenzene	2	1.7 J	2.5 J	1.1 J
Freon 22	ND, <3.5	ND, <7.1	ND, <8.8	0.64 J
m,p-Xylene	5.8	3 J	5.3 J	4.4 J
Methyl Butyl Ketone	3.4 J	5.4 J	ND, <10	ND, <2
Methyl Ethyl Ketone	19	29 J	30 J	5.5 J
Methyl Isobutyl Ketone	3.5 J	7.6 J	18 J	1.6 J
Methylene chloride (Matrix B)	ND, <3.5	ND, <6.9	ND, <8.7	ND, <1.7
n-Butane	4.9	ND, <4.8	ND, <5.9	ND, <1.2
n-Heptane	6.5	2.7 J	3.8 J	ND, <0.82
n-Hexane	6.7	ND, <7	ND, <8.8	ND, <1.8
n-Propylbenzene	ND, <2	ND, <3.9	ND, <4.9	0.23 J
o-Xylene	2.4	2.1 J	3.2 J	1.7 J
Styrene	1.1 J	0.56 J	0.81 J	1 J
Tert-Butyl Alcohol	56	120 J	110 J	3.6 J
tert-Butylbenzene	ND, <2.2	120	ND, <5.5	ND, <1.1
Tetrachloroethene (Matrix B)	1.8 J	1.1 J	3.2 J	0.3 J
Toluene	8.9	4.2 J	5.4 J	5.2 J
Trichloroethene (Matrix A)	0.71 J	ND, <4.3	1.2 J	ND, <1.1
Trichlorofluoromethane	1.1 J	ND, <4.5	ND, <5.6	0.8 J
Vinyl chloride (Matrix C)	ND, <1	ND, <2	ND, <2.6	ND, <0.51
Xylenes, Total	8.1	5.2 J	8.5 J	6.1 J

Notes:

1. Only those compounds detected at a minimum of one location are presented.
2. Matrix A, B and C refers to NYSDOH Soil Vapor / Indoor Air Matrices dated May 2017.

Qualifiers:

ND, < = non-detect result and associated reporting limit.
D = Sample results are obtained from a dilution.
J = The analyte was positively identified; the associated numerical value is an approximate concentration of the analyte in the sample.

Color Code:

blue = one of eight compounds regulated by the NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York (May 2017)
ug/m3 = micrograms per cubic meter

APPENDIX B

FIELD OPERATING PROCEDURES

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FIELD OPERATING PROCEDURES

Abandonment of Borehole Procedures

FOP 001.1

ABANDONMENT OF BOREHOLE PROCEDURE

PURPOSE

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

PROCEDURE

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

   Grout Slurry Composition (% Weight)

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

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

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

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

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

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

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

8. Begin mixing the grout to be emplaced.

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

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

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

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

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

14. Clear and clean the surface near the borehole.

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

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

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

ATTACHMENTS

Well Abandonment/Decommissioning Log (sample)

REFERENCES

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

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

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

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

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WELL ABANDONMENT/ DECOMMISSIONING LOG

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

DECOMMISSIONING PROCEDURES

Time	Description of Field Activities

SAMPLE

PREPARED BY: DATE:

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FIELD OPERATING PROCEDURES

Abandonment of Monitoring Wells Procedure

FOP 002.0

ABANDONMENT OF MONITORING WELLS PROCEDURE

PURPOSE

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

PROCEDURE

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

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

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

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

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

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

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

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

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

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

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

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

CEMENT/BENTONITE GROUT MIXTURE

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

Grout Slurry Composition (% Weight)

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

MISCELLANEOUS

All removed well materials (PVC, stainless steel, steel pipe) should be decontaminated (if necessary) as per the project specific **Drilling and Excavation Equipment Decontamination FOP** and removed from the site. The project manager will determine the destination of final disposal for all well materials. All drill cuttings (depending on site protocol) should be placed in DOT-approved 55-gallon drums, labeled and sampled in

accordance with Benchmark's field operating procedure **Management of Investigation-Derived Waste** in order to determine proper removal and disposal procedures. The drilling subcontractor will provide any potable water utilized during this field activity from a known and reliable source (see Notes section).

ATTACHMENTS

Well Abandonment/Decommissioning Log (sample)

REFERENCES

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

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

Benchmark FOPs:

018 Drilling/Excavation Equipment Decontamination Protocols
032 Management of Investigation-Derived Waste

NOTES

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

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

WELL ABANDONMENT / DECOMMISSIONING LOG

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

DECOMMISSIONING PROCE ES

Time	Description of Field Activiti

SAMPLE

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FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Dissolved Oxygen Meter

FOP 007.0

CALIBRATION AND MAINTENANCE OF PORTABLE DISSOLVED OXYGEN METER

PURPOSE

This guideline describes a method for calibration of a portable dissolved oxygen meter. This meter measures the concentration of dissolved oxygen within a water sample. This parameter is of interest both as a general indicator of water quality, and because of its pertinence to fate and transport of organics and inorganics. This guideline presents a method for calibration of this meter, which is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the dissolved oxygen meter will be within ± 1% of full-scale over the temperature range of 23° to 113° F (-5° to +45° C).

PROCEDURE

1. Calibrate the dissolved oxygen meter to ambient air based on probe temperature and true local atmospheric pressure conditions (or feet above sea level). Because procedures vary with different brands and models of meters, refer to the manufacturer's recommended calibration procedures.

2. In the event of a failure to adequately calibrate, follow the corrective action directed by the manufacturer.
3. If calibration cannot be achieved or maintained, obtain a replacement instrument (rental instruments) and/or order necessary repairs/adjustment.

4. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
    - Time, date, and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand and expiration dates of calibration solutions
    - The calibration readings
    - The instrument settings (if applicable)
    - The approximate response time
    - The overall adequacy of calibration including the Pass or fail designation in accordance with the accuracy specifications presented above
    - Corrective action taken (see Step 5 above) in the event of failure to adequately calibrate

MAINTENANCE

- When not in use or between measurements, the dissolved oxygen probe will be kept immersed in or moist with deionized water.

- The meter batteries will be checked prior to each meter's use and will be replaced when the meter cannot be redline adjusted.

- The meter response time and stability will be tracked to determine the need for instrument maintenance. When response time becomes greater than two minutes, probe service is indicated.

ATTACHMENTS

Equipment Calibration Log (sample)

FOP 007.0

CALIBRATION AND MAINTENANCE OF PORTABLE DISSOLVED OXYGEN METER

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: Date:

Project No.:

Client: Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		< 0.4		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		µS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID			open air zero		MIBK re
						____ ppm Iso. Gas		factor =
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/h					background area		
☐								

SAMPLE

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

BENCHMARK
ENVIRONMENTAL
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SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Field pH/Eh Meter

FOP 008.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER

PURPOSE

This guideline describes a method for calibration of a portable pH/Eh meter. The pH/Eh meter measures the hydrogen ion concentration or acidity of a water sample (pH function), and the oxidation/reduction potential of a water sample (Eh function). Calibration is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the pH/Eh meter will be:

pH ± 0.2 pH unit, over the temperature range of ± 0.2 C.

Eh ± 0.2 millivolts (mV) over the range of ± 399.9 mV, otherwise ± 2 mV.

PROCEDURE

Note: Meters produced by different manufacturers may have different calibration procedures. These instructions will take precedence over the procedure provided herein. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

1. Obtain and active the meter to be used. As stated above, initial calibrations will be performed at the beginning of each sampling day.

2. Immerse the sensing probe in a container of certified pH 7.0 buffer solution traceable to the National Bureau of Standards.

3. Measure the temperature of the buffer solution, and adjust the temperature setting accordingly.

4. Compare the meter reading to the known value of the buffer solution while stirring. If the reading obtained by the meter does not agree with the known value of the buffer solution, recalibrate the meter according to the manufacturer's instructions until the desired reading is obtained. This typically involves accessing and turning a dial or adjustment screw while measuring the pH of the buffer solution. The meter is adjusted until the output agrees with the known solution pH.

5. Repeat Steps 2 through 5 with a pH 4.0 and 10.0 buffer solution to provide a three-point calibration. Standards used to calibrate the pH meter will be of concentrations that bracket the expected values of the samples to be analyzed, especially for two-point calibrations (see note below).

Note: Some pH meters only allow two-point calibrations. Two-point calibrations should be within the suspected range of the groundwater to be analyzed. For example, if the groundwater pH is expected to be approximately 8, the two-point calibration should bracket that value. Buffer solutions of 7 and 10 should then be used for the two-point calibration.

6. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:

   - Time, date, and initials of the field team member performing the calibration
   - The unique identifier for the meter, including manufacturer, model, and serial number
   - The brand and expiration dates of buffer solutions
   - The instrument readings
   - The instrument settings (if applicable)

- Pass or fail designation in accordance with the accuracy specifications presented above
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate

MAINTENANCE

- When not in use, or between measurements, keep the pH/Eh probe immersed in or moist with buffer solutions.

- Check the meter batteries at the end of each day and recharge or replace as needed.

- Replace the pH/Eh probe any time that the meter response time becomes greater than two minutes or the meeting system consistently fails to retain its calibrated accuracy for a minimum of ten sample measurements.

- If a replacement of the pH/Eh probe fails to resolve instrument response time and stability problems, obtain a replacement instrument (rental instruments) and/or order necessary repairs/adjustment.

ATTACHMENTS

Equipment Calibration Log (sample)

FOP 008.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: Date:

Project No.:

Client: Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		< 0.4		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		µS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID			open air zero		MIBK re
						____ ppm Iso. Gas		factor =
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/h					background area		
☐								

SAMPLE

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

BENCHMARK
ENVIRONMENTAL
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SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Field Turbidity Meter

FOP 009.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD TURBIDITY METER

PURPOSE

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

ACCURACY

Accuracy shall be ± 2% of reading below 499 NTU or ± 3% of reading above 500 NTU with resolution to 0.01 NTU in the lowest range. The range key provides for automatic or manual range selection for ranges of 0.00 to 9.99, 0.0 to 99.9 and 0 to 1000 NTU. Another key provides for selecting automatic signal averaging. Pressing the key shall toggle signal averaging on or off.

PROCEDURE

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provides long-term stability and minimizes the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. **A formazin recalibration should be performed at least once every three months,** more often if experience indicates the need. During calibration, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

Note: Meters produced by different manufacturers may have different calibration check procedures. These manufacturers' instructions will take precedence over the procedure provided here. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

Note: Because the turbidity meter measures light transmission, it is critical that the meter and standards be cared for as precision optical instruments. Scratches, dirt, dust, etc. can all temporarily or permanently affect the accuracy of meter readings.

Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*.

Note: These instructions do not apply to < 0.1 NTU StablCal Standards; < 0.1 NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to re-suspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the vial of StablCal 5 to 7 times.
4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see *Section 2.3.2 on page 11 of the manual*)

and marking the vial to maintain the same orientation in the sample cell compartment (see *Section 2.3.3 on page 12 of the manual*). This step will eliminate any optical variations in the sample vial.

5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure.

Calibration Procedure

1. Turn the meter on.

2. Shake pre-mixed formazin primary standards in accordance with the above procedure.

3. Wipe the outside of the < 0.1 NTU standard and insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment.

4. Close the lid and press **I/O**.

5. Press the **CAL** button. The **CAL** and **S0** icons will be displayed and the 0 will flash. The four-digit display will show the value of the **S0** standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank. Press the right arrow key (→) to get a numerical display.

6. Press **READ**. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (*see Section 3.6.2.3 on page 31 of the manual*). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment

Note: The turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show "S0 NTU" and the ↑ key must be pressed to continue with the next standard.

7. Repeat steps 1 through 7 for the 20, 100 and 800 standards.

8. Following the 800 NTU standard calibration, the display will increment back to the **S0** display. Remove the sample cell from the cell compartment.

9. Press **CAL** to accept the calibration. The instrument will return to measurement mode automatically.

10. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
    - Time, date, and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand of calibration standards
    - The instrument readings
    - The instrument settings (if applicable)
    - Pass or fail designation in accordance with the accuracy specifications presented above
    - Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

Note: Pressing CAL completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after CAL is pressed. If E 1 or E 2 appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If "CAL?" appears, an error may have

occurred during calibration. If "CAL?" is flashing, the instrument is using the default calibration.

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑ , and →keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2)**. To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If "**CAL?"** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

MAINTENANCE

- **Cleaning**: Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1 on page 11of the manual* for more information about sample cell care.

- **Battery Replacement**: AA alkaline cells typically last for about 300 tests with the signal-averaging mode off, about 180 tests if signal averaging is used. The "battery" icon flashes when battery replacement is needed. Refer to *Section 1.4.2 on page 5 of the manual* for battery installation instructions. If the batteries are changed within 30

seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings. If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

- **Lamp Replacement**: The procedure in *Section 4.0 on page 49 of the manual* explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

ATTACHMENTS

Equipment Calibration Log (sample)

FOP 009.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD TURBIDITY METER

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: Date:

Project No.:

Client: Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		< 0.4		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		µS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID			open air zero		MIBK re
						____ ppm Iso. Gas		factor =
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/h					background area		
☐								

SAMPLE

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Photoionization Detector (PID)

FOP 011.1

CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

PURPOSE

This procedure describes a general method for the calibration and maintenance of a portable photoionization detector (PID). The PID detects and initially quantifies a reading of the volatile organic compound (VOC) concentration in air. The PID is used as a field-screening tool for initial evaluation of soil samples and for ambient air monitoring of compounds with ionization potentials (IP) less than the PID lamp electron voltage (eV) rating. The IP is the amount of energy required to move an electron to an infinite distance from the nucleus thus creating a positive ion plus an electron. It should be noted that all of the major components of air (i.e., carbon dioxide, methane, nitrogen, oxygen etc.) have IP's above 12 eV. As a result, they will not be ionized by the 9.8, 10.6, or 11.7 eV lamps typically utilized in field PIDs. The response of the PID will then be the sum of the organic and inorganic compounds in air that are ionized by the appropriate lamp (i.e., 9.8, 10.6 or 11.7 eV). Attached to this FOP is a table summarizing common organic compounds and their respective IPs.

Calibration is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Compound-specific calibration methods should be selected on a project-by-project basis to increase the accuracy of the instrument. The best way to calibrate a PID to different compounds is to use a standard of the gas of interest. However, correction factors have been determined that enable the user to quantify a large number of chemicals using only a single calibration gas, typically isobutylene. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

Note: The information included below is equipment manufacturer- and model-specific, however, accuracy, calibration, and maintenance procedures for this type of portable equipment are typically similar. The information below pertains to the MiniRAE 2000 Portable VOC Monitor equipped with a 10.6 eV lamp. The actual equipment to be used in the field will be equivalent or similar. The following information is provided for general reference; the equipment-specific manufacturer's manual should be followed with precedence over this FOP.

Note: The PID indicates total VOC concentration readings that are normalized to a calibration standard, so actual quantification of individual compounds is not provided. In addition, the PID response to compounds is highly variable, dependent on ionization potential of the compound, and the presence or absence of other compounds.

ACCURACY

The MiniRAE 2000 is accurate to ± 2 ppm or 10% of the reading for concentrations ranging from 0-2,000 ppm and ± 20% of the reading at concentrations greater than 2,000 ppm. Response time is less than two seconds to 90 percent of full-scale. The operating temperature range is 0 to 45° C and the operating humidity range is 0 to 95 % relative humidity (non-condensing).

CALIBRATION PROCEDURE

The calibration method and correction factor, if applicable, will be selected on a project-by-project basis and confirmed with the Project Manager prior to the start of field work.

1. Calibrate all field test equipment at the beginning of each sampling day. Check and recalibrate the PID according to the manufacture's specifications.

2. Calibrate the PID using a compressed gas cylinder or equivalent containing the calibration standard, a flow regulator, and a tubing assembly. In addition, a compressed gas cylinder containing zero air ("clean" air) may be required if ambient air conditions do not permit calibration to "clean air".

3. Fill two Tedlar® bags equipped with a one-way valve with zero-air (if applicable) and the calibration standard gas.

4. Assemble the calibration equipment and actuate the PID in its calibration mode.

5. Select the appropriate calibration method. Calibration may be completed with two methods: 1) where the calibration standard gas is the same as the measurement gas (no correction factor is applied) or 2) where the calibration standard gas is not the same as the measurement gas and a correction factor will be applied. An isobutylene standard gas must be used as the calibration standard gas for the use of correction factors with the MiniRAE 2000. See below for additional instructions for calibration specific to use with or without correction factors.

Calibrating Without a Correction Factor

Navigate within the menu to select the "cal memory" for the specific calibration standard gas prior to calibration. The default gas selections for the MiniRAE 2000 are as follows:

Cal Memory #0	Isobutylene
Cal Memory #1	Hexane
Cal Memory #2	Xylene
Cal Memory #3	Benzene
Cal Memory #4	Styrene
Cal Memory #5	Toluene
Cal Memory #6	Vinyl Chloride
Cal Memory #7	Custom

The calibration standard gas for Cal Memory #1-7 may be toggled for selection of any of the approximately 100 preprogrammed calibration standard gases for use without an applied correction factor (i.e., the calibration gas must be the same as the measurement gas).

Calibrating With a Correction Factor

Navigate within the menu to select the "Cal Memory".

Select "Cal Memory #0" and toggle for selection of any of the approximately 100 preprogrammed chemicals. During calibration, the unit requests isobutylene gas and displays the isobutylene concentration immediately following calibration, but when the unit is returned to the normal reading mode, it displays the selected chemical and applies the correction factor.

If the pre-programmed list does not include the desired chemical or a user-defined measurement gas and correction factor is desired, toggle Cal Memory #0 to "user defined custom gas". A list of approximately 300 correction factors is attached in Technical Note 106 generated by MiniRAE.

6. Once the PID settings have been verified, connect the PID probe to the zero air calibration bag (or calibrate to ambient air if conditions permit) and wait for a stable indication.

7. Connect the PID probe to the calibration standard bag. Measure an initial reading of the standard and wait for a stable indication.

8. Keep the PID probe connected to the calibration standard bag, calibrate to applicable concentration (typically 100 ppm with isobutylene) with the standard and wait for a stable indication.

9. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample), indicating the meter readings before and after the instrument has been adjusted. This is important, not only for data validation, but also to establish

maintenance schedules and component replacement. Information will include, at a minimum:

- Time, date and initials of the field team member performing the calibration
- The unique identifier for the meter, including manufacturer, model, and serial number
- The calibration standard and concentration
- Correction factors used, if any
- The brand and expiration date of the calibration standard gas
- The instrument readings: before and after calibration
- The instrument settings (if applicable)
- Pass or fail designation in accordance with the accuracy specifications presented above
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

MAINTENANCE

- The probe and dust filter of the PID should be checked before and after every use for cleanliness. Should instrument response become unstable, recalibration should be performed. If this does not resolve the problem, access the photoionization bulb and clean with the manufacturer-supplied abrasive compound, then recalibrate.

- The PID battery must be recharged after each use. Store the PID in its carrying case when not in use. Additional maintenance details related to individual components of the PID are provided in the equipment manufacturer's instruction manual. If calibration or instrument performance is not in accordance with specifications, send the instrument to the equipment manufacturer for repair.

- Maintain a log for each monitoring instrument. Record all maintenance performed on the instrument on this log with date and name of the organization performing the maintenance.

ATTACHMENTS

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

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
A		
2-Amino pyridine	8	
Acetaldehyde	10.21	
Acetamide	9.77	
Acetic acid	10.69	X
Acetic anhydride	10	
Acetone	9.69	
Acetonitrile	12.2	X
Acetophenone	9.27	
Acetyl bromide	10.55	
Acetyl chloride	11.02	X
Acetylene	11.41	X
Acrolein	10.1	
Acrylamide	9.5	
Acrylonitrile	10.91	X
Allyl alcohol	9.67	
Allyl chloride	9.9	
Ammonia	10.2	
Aniline	7.7	
Anisidine	7.44	
Anisole	8.22	
Arsine	9.89	
B		
1,3-Butadiene (butadiene)	9.07	
1-Bromo-2-chloroethane	10.63	X
1-Bromo-2-methylpropane	10.09	
1-Bromo-4-fluorobenzene	8.99	
1-Bromobutane	10.13	
1-Bromopentane	10.1	
1-Bromopropane	10.18	
1-Bromopropene	9.3	
1-Butanethiol	9.14	
1-Butene	9.58	
1-Butyne	10.18	
2,3-Butadione	9.23	
2-Bromo-2-methylpropane	9.89	
2-Bromobutane	9.98	
2-Bromopropane	10.08	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
2-Bromothiophene	8.63	
2-Butanone (MEK)	9.54	
3-Bromopropene	9.7	
3-Butene nitrile	10.39	
Benzaldehyde	9.53	
Benzene	9.25	
Benzenethiol	8.33	
Benzonitrile	9.71	
Benzotrifluoride	9.68	
Biphenyl	8.27	
Boron oxide	13.5	X
Boron trifluoride	15.56	X
Bromine	10.54	
Bromobenzene	8.98	
Bromochloromethane	10.77	X
Bromoform	10.48	
Butane	10.63	X
Butyl mercaptan	9.15	
cis-2-Butene	9.13	
m-Bromotoluene	8.81	
n-Butyl acetate	10.01	
n-Butyl alcohol	10.04	
n-Butyl amine	8.71	
n-Butyl benzene	8.69	
n-Butyl formate	10.5	
n-Butyraldehyde	9.86	
n-Butyric acid	10.16	
n-Butyronitrile	11.67	X
o-Bromotoluene	8.79	
p-Bromotoluene	8.67	
p-tert-Butyltoluene	8.28	
s-Butyl amine	8.7	
s-Butyl benzene	8.68	
sec-Butyl acetate	9.91	
t-Butyl amine	8.64	
t-Butyl benzene	8.68	
trans-2-Butene	9.13	
C		

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
1-Chloro-2-methylpropane	10.66	X
1-Chloro-3-fluorobenzene	9.21	
1-Chlorobutane	10.67	X
1-Chloropropane	10.82	X
2-Chloro-2-methylpropane	10.61	X
2-Chlorobutane	10.65	X
2-Chloropropane	10.78	X
2-Chlorothiophene	8.68	
3-Chloropropene	10.04	
Camphor	8.76	
Carbon dioxide	13.79	X
Carbon disulfide	10.07	
Carbon monoxide	14.01	X
Carbon tetrachloride	11.47	X
Chlorine	11.48	X
Chlorine dioxide	10.36	
Chlorine trifluoride	12.65	X
Chloroacetaldehyde	10.61	X
α -Chloroacetophenone	9.44	
Chlorobenzene	9.07	
Chlorobromomethane	10.77	X
Chlorofluoromethane (Freon 22)	12.45	X
Chloroform	11.37	X
Chlorotrifluoromethane (Freon 13)	12.91	X
Chrysene	7.59	
Cresol	8.14	
Crotonaldehyde	9.73	
Cumene (isopropyl benzene)	8.75	
Cyanogen	13.8	X
Cyclohexane	9.8	
Cyclohexanol	9.75	
Cyclohexanone	9.14	
Cyclohexene	8.95	
Cyclo-octatetraene	7.99	
Cyclopentadiene	8.56	
Cyclopentane	10.53	
Cyclopentanone	9.26	
Cyclopentene	9.01	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Cyclopropane	10.06	
m-Chlorotoluene	8.83	
o-Chlorotoluene	8.83	
p-Chlorotoluene	8.7	
D		
1,1-Dibromoethane	10.19	
1,1-Dichloroethane	11.12	X
1,1-Dimethoxyethane	9.65	
1,1-Dimethylhydrazine	7.28	
1,2-Dibromoethene	9.45	
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	12.2	X
1,2-Dichloroethane	11.12	X
1,2-Dichloropropane	10.87	X
1,3-Dibromopropane	10.07	
1,3-Dichloropropane	10.85	X
2,2-Dimethyl butane	10.06	
2,2-Dimethyl propane	10.35	
2,3-Dichloropropene	9.82	
2,3-Dimethyl butane	10.02	
3,3-Dimethyl butanone	9.17	
cis-Dichloroethene	9.65	
Decaborane	9.88	
Diazomethane	9	
Diborane	12	X
Dibromochloromethane	10.59	
Dibromodifluoromethane	11.07	X
Dibromomethane	10.49	
Dibutylamine	7.69	
Dichlorodifluoromethane (Freon 12)	12.31	X
Dichlorofluoromethane	12.39	X
Dichloromethane	11.35	X
Diethoxymethane	9.7	
Diethyl amine	8.01	
Diethyl ether	9.53	
Diethyl ketone	9.32	
Diethyl sulfide	8.43	
Diethyl sulfite	9.68	
Difluorodibromomethane	11.07	X

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Dihydropyran	8.34	
Diiodomethane	9.34	
Diisopropylamine	7.73	
Dimethoxymethane (methylal)	10	
Dimethyl amine	8.24	
Dimethyl ether	10	
Dimethyl sulfide	8.69	
Dimethylaniline	7.13	
Dimethylformamide	9.18	
Dimethylphthalate	9.64	
Dinitrobenzene	10.71	X
Dioxane	9.19	
Diphenyl	7.95	
Dipropyl amine	7.84	
Dipropyl sulfide	8.3	
Durene	8.03	
m-Dichlorobenzene	9.12	
N,N-Diethyl acetamide	8.6	
N,N-Diethyl formamide	8.89	
N,N-Dimethyl acetamide	8.81	
N,N-Dimethyl formamide	9.12	
o-Dichlorobenzene	9.06	
p-Dichlorobenzene	8.95	
p-Dioxane	9.13	
trans-Dichloroethene	9.66	
E		
Epichlorohydrin	10.2	
Ethane	11.65	X
Ethanethiol (ethyl mercaptan)	9.29	
Ethanolamine	8.96	
Ethene	10.52	
Ethyl acetate	10.11	
Ethyl alcohol	10.48	
Ethyl amine	8.86	
Ethyl benzene	8.76	
Ethyl bromide	10.29	
Ethyl chloride (chloroethane)	10.98	X
Ethyl disulfide	8.27	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Ethyl ether	9.51	
Ethyl formate	10.61	X
Ethyl iodide	9.33	
Ethyl isothiocyanate	9.14	
Ethyl mercaptan	9.29	
Ethyl methyl sulfide	8.55	
Ethyl nitrate	11.22	X
Ethyl propionate	10	
Ethyl thiocyanate	9.89	
Ethylene chlorohydrin	10.52	
Ethylene diamine	8.6	
Ethylene dibromide	10.37	
Ethylene dichloride	11.05	X
Ethylene oxide	10.57	
Ethylenelmine	9.2	
Ethynylbenzene	8.82	
F		
2-Furaldehyde	9.21	
Fluorine	15.7	X
Fluorobenzene	9.2	
Formaldehyde	10.87	X
Formamide	10.25	
Formic acid	11.05	X
Freon 11 (trichlorofluoromethane)	11.77	X
Freon 112 (1,1,2,2-tetrachloro-1,2-difluoroethane)	11.3	X
Freon 113 (1,1,2-trichloro-1,2,2-trifluororethane)	11.78	X
Freon 114 (1,2-dichloro-1,1,2,2-tetrafluoroethane)	12.2	X
Freon 12 (dichlorodifluoromethane)	12.31	X
Freon 13 (chlorotrifluoromethane)	12.91	X
Freon 22 (chlorofluoromethane)	12.45	X
Furan	8.89	
Furfural	9.21	
m-Fluorotoluene	8.92	
o-Fluorophenol	8.66	
o-Fluorotoluene	8.92	
p-Fluorotoluene	8.79	
H		
1-Hexene	9.46	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
2-Heptanone	9.33	
2-Hexanone	9.35	
Heptane	10.08	
Hexachloroethane	11.1	X
Hexane	10.18	
Hydrazine	8.1	
Hydrogen	15.43	X
Hydrogen bromide	11.62	X
Hydrogen chloride	12.74	X
Hydrogen cyanide	13.91	X
Hydrogen fluoride	15.77	X
Hydrogen iodide	10.38	
Hydrogen selenide	9.88	
Hydrogen sulfide	10.46	
Hydrogen telluride	9.14	
Hydroquinone	7.95	
I		
1-Iodo-2-methylpropane	9.18	
1-Iodobutane	9.21	
1-Iodopentane	9.19	
1-Iodopropane	9.26	
2-Iodobutane	9.09	
2-Iodopropane	9.17	
Iodine	9.28	
Iodobenzene	8.73	
Isobutane	10.57	
Isobutyl acetate	9.97	
Isobutyl alcohol	10.12	
Isobutyl amine	8.7	
Isobutyl formate	10.46	
Isobutyraldehyde	9.74	
Isobutyric acid	10.02	
Isopentane	10.32	
Isophorone	9.07	
Isoprene	8.85	
Isopropyl acetate	9.99	
Isopropyl alcohol	10.16	
Isopropyl amine	8.72	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Isopropyl benzene	8.69	
Isopropyl ether	9.2	
Isovaleraldehyde	9.71	
m-Iodotoluene	8.61	
o-Iodotoluene	8.62	
p-Iodotoluene	8.5	
K		
Ketene	9.61	
L		
2,3-Lutidine	8.85	
2,4-Lutidine	8.85	
2,6-Lutidine	8.85	
M		
2-Methyl furan	8.39	
2-Methyl napthalene	7.96	
1-Methyl napthalene	7.96	
2-Methyl propene	9.23	
2-Methyl-1-butene	9.12	
2-Methylpentane	10.12	
3-Methyl-1-butene	9.51	
3-Methyl-2-butene	8.67	
3-Methylpentane	10.08	
4-Methylcyclohexene	8.91	
Maleic anhydride	10.8	X
Mesityl oxide	9.08	
Mesitylene	8.4	
Methane	12.98	X
Methanethiol (methyl mercaptan)	9.44	
Methyl acetate	10.27	
Methyl acetylene	10.37	
Methyl acrylate	9.9	
Methyl alcohol	10.85	X
Methyl amine	8.97	
Methyl bromide	10.54	
Methyl butyl ketone	9.34	
Methyl butyrate	10.07	
Methyl cellosolve	9.6	
Methyl chloride	11.28	X

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Methyl chloroform (1,1,1-trichloroethane)	11	X
Methyl disulfide	8.46	
Methyl ethyl ketone	9.53	
Methyl formate	10.82	X
Methyl iodide	9.54	
Methyl isobutyl ketone	9.3	
Methyl isobutyrate	9.98	
Methyl isocyanate	10.67	X
Methyl isopropyl ketone	9.32	
Methyl isothiocyanate	9.25	
Methyl mercaptan	9.44	
Methyl methacrylate	9.7	
Methyl propionate	10.15	
Methyl propyl ketone	9.39	
α -Methyl styrene	8.35	
Methyl thiocyanate	10.07	
Methylal (dimethoxymethane)	10	
Methylcyclohexane	9.85	
Methylene chloride	11.32	X
Methyl-n-amyl ketone	9.3	
Monomethyl aniline	7.32	
Monomethyl hydrazine	7.67	
Morpholine	8.2	
n-Methyl acetamide	8.9	
N		
1-Nitropropane	10.88	X
2-Nitropropane	10.71	X
Naphthalene	8.12	
Nickel carbonyl	8.27	
Nitric oxide, (NO)	9.25	
Nitrobenzene	9.92	
Nitroethane	10.88	X
Nitrogen	15.58	X
Nitrogen dioxide	9.78	
Nitrogen trifluoride	12.97	X
Nitromethane	11.08	X
Nitrotoluene	9.45	
p-Nitrochloro benzene	9.96	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
O		
Octane	9.82	
Oxygen	12.08	X
Ozone	12.08	X
P		
1-Pentene	9.5	
1-Propanethiol	9.2	
2,4-Pentanedione	8.87	
2-Pentanone	9.38	
2-Picoline	9.02	
3-Picoline	9.02	
4-Picoline	9.04	
n-Propyl nitrate	11.07	X
Pentaborane	10.4	
Pentane	10.35	
Perchloroethylene	9.32	
Pheneloic	8.18	
Phenol	8.5	
Phenyl ether (diphenyl oxide)	8.82	
Phenyl hydrazine	7.64	
Phenyl isocyanate	8.77	
Phenyl isothiocyanate	8.52	
Phenylene diamine	6.89	
Phosgene	11.77	X
Phosphine	9.87	
Phosphorus trichloride	9.91	
Phthalic anhydride	10	
Propane	11.07	X
Propargyl alcohol	10.51	
Propiolactone	9.7	
Propionaldehyde	9.98	
Propionic acid	10.24	
Propionitrile	11.84	X
Propyl acetate	10.04	
Propyl alcohol	10.2	
Propyl amine	8.78	
Propyl benzene	8.72	
Propyl ether	9.27	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Propyl formate	10.54	
Propylene	9.73	
Propylene dichloride	10.87	X
Propylene imine	9	
Propylene oxide	10.22	
Propyne	10.36	
Pyridine	9.32	
Pyrrole	8.2	
Q		
Quinone	10.04	
S		
Stibine	9.51	
Styrene	8.47	
Sulfur dioxide	12.3	X
Sulfur hexafluoride	15.33	X
Sulfur monochloride	9.66	
Sulfuryl fluoride	13	X
T		
o-Terphenyls	7.78	
1,1,2,2-Tetrachloro-1,2-difluoroethane (Freon 112)	11.3	X
1,1,1-Trichloroethane	11	X
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	11.78	X
2,2,4-Trimethyl pentane	9.86	
o-Toluidine	7.44	
Tetrachloroethane	11.62	X
Tetrachloroethene	9.32	
Tetrachloromethane	11.47	X
Tetrahydrofuran	9.54	
Tetrahydropyran	9.25	
Thiolacetic acid	10	
Thiophene	8.86	
Toluene	8.82	
Tribromoethene	9.27	
Tribromofluoromethane	10.67	X
Tribromomethane	10.51	
Trichloroethene	9.45	
Trichloroethylene	9.47	
Trichlorofluoromethane (Freon 11)	11.77	X

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Trichloromethane	11.42	X
Triethylamine	7.5	
Trifluoromonobromo-methane	11.4	X
Trimethyl amine	7.82	
Tripropyl amine	7.23	
V		
o-Vinyl toluene	8.2	
Valeraldehyde	9.82	
Valeric acid	10.12	
Vinyl acetate	9.19	
Vinyl bromide	9.8	
Vinyl chloride	10	
Vinyl methyl ether	8.93	
W		
Water	12.59	X
X		
2,4-Xylidine	7.65	
m-Xylene	8.56	
o-Xylene	8.56	
p-Xylene	8.45	

FOP 011.0

CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

EQUIPMENT CALIBRATION LOG

PROJECT INFORMATION:

Project Name: Date:

Project No.:

Client: Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	POST CAL. READING	SETTINGS
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	9706000145		< 0.4		
						00		
						800		
☐ Sp. Cond. meter	uS mS		Myron L Company Ultra Meter 6P			_____ mS @ 25 °C		
☐ PID	ppm		MinRAE 20			open air zero		MIBK response factor = 1.0
						_____ ppm Iso. Gas		
☐ Dissolved Oxygen	ppm		YSI Model 5					
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/H					background area		
☐								

SAMPLE

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:

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

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

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

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 x 86 x 0.041 equals 15.2.

Correction Factors for Mixtures

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

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

Thus, for example, a vapor phase mixture of 5% benzene and 95% n-hexane would have a CFmix of CFmix = 1 / (0.05/0.53 + 0.95/4.3) = 3.2. A reading of 100 would then correspond to 320 ppm of the total mixture, comprised of 16 ppm benzene and 304 ppm hexane.

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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:

$$TLV\ mix = 1 / (X_1/TLV_1 + X_2/TLV_2 + X_3/TLV_3 + ... Xi/TLVi)$$

In the above example, the 8-h TLV for benzene is 0.5 ppm and for n-hexane 50 ppm. Therefore the TLV of the mixture is TLVmix = 1 / (0.05/0.5 + 0.95/50) = 8.4 ppm, corresponding to 8.0 ppm hexane and 0.4 ppm benzene. For an instrument calibrated on isobutylene, the reading corrsponding to the TLV is:

$$Alarm\ Reading = TLVmix / CFmix = 8.4 / 3.2 = 2.6\ ppm$$

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

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most commonly used for monitoring VOCs in air, in which case the preferred calibration gas matrix is air. For a MiniRAE, methane, methanol, and water vapor reduce the response by about 20% when their concentration is 15,000 ppm and by about 40% at 30,000 ppm. Despite earlier reports of oxygen effects, RAE PID responses with 10.6 eV lamps are independent of oxygen concentration, and calibration gases in a pure nitrogen matrix can be used. H_2 and CO_2 up to 5 volume % also have no effect.

e) Concentration. Although RAE Systems PIDs have electronically linearized output, it is best to calibrate in a concentration range close to the actual measurement range. For example, 100 ppm standard gas for anticipated vapors of 0 to 250 ppm, and 500 ppm standard for expected concentrations of 250 to 1000 ppm. The correction factors in this table were typically measured at 50 to 100 ppm and apply from the ppb range up to about 1000 ppm. Above 1000 ppm the CF may vary and it is best to calibrate with the gas of interest near the concentration of interest.

f) Filters. Filters affect flow and pressure conditions and therefore all filters to be used during sampling should also be in place during calibration. Using a water trap (hydrophobic filter) greatly reduces the chances of drawing water aerosols or dirt particles into the instrument. Regular filter replacements are recommended because dirty filters can adsorb VOCs and cause slower response time and shifts in calibration.

g) Instrument Design. High-boiling ("heavy") or very reactive compounds can be lost by reaction or adsorption onto materials in the gas sample train, such as filters, pumps and other sensors. Multi-gas meters, including EntryRAE, MultiRAE and AreaRAE have the pump and other sensors upstream of the PID and are prone to these losses. Compounds possibly affected by such losses are shown in green in the table, and may give slow response, or in extreme cases, no response at all. In many cases the multi-gas meters can still give a rough indication of the relative concentration, without giving an accurate, quantitative reading. The ppbRAE and MiniRAE series instruments have inert sample trains and therefore do not exhibit significant loss; nevertheless, response may be slow for the very heavy compounds and additional sampling time up to a minute or more should be allowed to get a stable reading.

Table Abbreviations:

CF = Correction Factor (multiply by reading to get corrected value for the compound when calibrated to isobutylene)
NR = No Response
IE = Ionization Energy (values in parentheses are not well established)
C = Confirmed Value indicated by "+" in this column; all others are preliminary or estimated values and are subject to change
ne = Not Established ACGIH 8-hr. TWA
C## = Ceiling value, given where 8-hr.TWA is not available

Disclaimer:

Actual readings may vary with age and cleanliness of lamp, relative humidity, and other factors. For accurate work, the instrument should be calibrated regularly under the operating conditions used. The factors in this table were measured in dry air at room temperature, typically at 50-100 ppm. CF values may vary above about 1000 ppm.

Updates:

The values in this table are subject to change as more or better data become available. Watch for updates of this table on the Internet at **http://www.raesystems.com**

IE data are taken from the CRC Handbook of Chemistry and Physics, 73rd Edition, D.R. Lide (Ed.), CRC Press (1993) and NIST Standard Ref. Database 19A, NIST Positive Ion Energetics, Vers. 2.0, Lias, et.al., U.S. Dept. Commerce (1993). Exposure limits (8-h TWA and Ceiling Values) are from the 2005 ACGIH Guide to Occupational Exposure Values, ACGIH, Cincinnati, OH 2005. Equations for exposure limits for mixtures of chemicals were taken from the 1997 TLVs and BEIs handbook published by the ACGIH (1997).

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Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Acetaldehyde		75-07-0	C_2H_4O	NR	+	6	+	3.3	+	10.23	C25
Acetic acid	Ethanoic Acid	64-19-7	$C_2H_4O_2$	NR	+	22	+	2.6	+	10.66	10
Acetic anhydride	Ethanoic Acid Anhydride	108-24-7	$C_4H_6O_3$	NR	+	6.1	+	2.0	+	10.14	5
Acetone	2-Propanone	67-64-1	C_3H_6O	1.2	+	1.1	+	1.4	+	9.71	500
Acetone cyanohydrin	2-Hydroxyisobutyronitrile	75-86-5	C_4H_7NO					4	+	11.1	C5
Acetonitrile	Methyl cyanide, Cyanomethane	75-05-8	C_2H_3N					100		12.19	40
Acetylene	Ethyne	74-86-2	C_2H_2					2.1	+	11.40	ne
Acrolein	Propenal	107-02-8	C_3H_4O	42	+	3.9	+	1.4	+	10.10	0.1
Acrylic acid	Propenoic Acid	79-10-7	$C_3H_4O_2$			12	+	2.0	+	10.60	2
Acrylonitrile	Propenenitrile	107-13-1	C_3H_3N			NR	+	1.2	+	10.91	2
Allyl alcohol		107-18-6	C_3H_6O	4.5	+	2.4	+	1.6	+	9.67	2
Allyl chloride	3-Chloropropene	107-05-1	C_3H_5Cl			4.3		0.7		9.9	1
Ammonia		7664-41-7	H_3N	NR	+	9.7	+	5.7	+	10.16	25
Amyl acetate	mix of n-Pentyl acetate & 2-Methylbutyl acetate	628-63-7	$C_7H_{14}O_2$	11	+	2.3	+	0.95	+	<9.9	100
Amyl alcohol	1-Pentanol	75-85-4	$C_5H_{12}O$			5		1.6		10.00	ne
Aniline	Aminobenzene	62-53-3	C_7H_7N	0.50	+	0.48	+	0.47	+	7.72	2
Anisole	Methoxybenzene	100-66-3	C_7H_8O	0.89	+	0.58	+	0.56	+	8.21	ne
Arsine	Arsenic trihydride	7784-42-1	AsH_3			1.9	+			9.89	0.05
Benzaldehyde		100-52-7	C_7H_6O					1		9.49	ne
Benzenamine, N-methyl-	N-Methylphenylamine	100-61-8	C_7H_9N			0.7				7.53	
Benzene		71-43-2	C_6H_6	0.55	+	0.53	+	0.6	+	9.25	0.5
Benzonitrile	Cyanobenzene	100-47-0	C_7H_5N			1.6				9.62	ne
Benzyl alcohol	α-Hydroxytoluene, Hydroxymethylbenzene, Benzenemethanol	100-51-6	C_7H_8O	1.4	+	1.1	+	0.9	+	8.26	ne
Benzyl chloride	α-Chlorotoluene, Chloromethylbenzene	100-44-7	C_7H_7Cl	0.7	+	0.6	+	0.5	+	9.14	1
Benzyl formate	Formic acid benzyl ester	104-57-4	$C_8H_8O_2$	0.9	+	0.73	+	0.66	+		ne
Boron trifluoride		7637-07-2	BF_3	NR		NR		NR		15.5	C1
Bromine		7726-95-6	Br_2	NR	+	1.30	+	0.74	+	10.51	0.1
Bromobenzene		108-86-1	C_6H_5Br			0.6		0.5		8.98	ne
2-Bromoethyl methyl ether		6482-24-2	C_3H_7OBr			0.84	+			~10	ne
Bromoform	Tribromomethane	75-25-2	$CHBr_3$	NR	+	2.5	+	0.5	+	10.48	0.5
Bromopropane,1-	n-Propyl bromide	106-94-5	C_3H_7Br	150	+	1.5	+	0.6	+	10.18	ne
Butadiene	1,3-Butadiene, Vinyl ethylene	106-99-0	C_4H_6	0.8		0.85	+	1.1		9.07	2
Butadiene diepoxide, 1,3-	1,2,3,4-Diepoxybutane	298-18-0	$C_4H_6O_2$	25	+	3.5	+	1.2		~10	ne
Butanal	1-Butanal	123-72-8	C_4H_8O			1.8				9.84	
Butane		106-97-8	C_4H_{10}			67	+	1.2		10.53	800
Butanol, 1-	Butyl alcohol, n-Butanol	71-36-3	$C_4H_{10}O$	70	+	4.7	+	1.4	+	9.99	20
Butanol, t-	tert-Butanol, t-Butyl alcohol	75-65-0	$C_4H_{10}O$	6.9	+	2.9	+			9.90	100
Butene, 1-	1-Butylene	106-98-9	C_4H_8			0.9				9.58	ne
Butoxyethanol, 2-	Butyl Cellosolve, Ethylene glycol monobutyl ether	111-76-2	$C_6H_{14}O_2$	1.8	+	1.2	+	0.6	+	<10	25
Butoxyethanol acetate	Ethanol, 2-(2-butoxyethoxy)-, acetate	124-17-4	$C_{10}H_{20}O_4$			5.6				≤10.6	
Butoxyethoxyethanol	2-(2-Butoxyethoxy)ethanol	112-34-5	$C_8H_{18}O_3$			4.6				≤10.6	
Butyl acetate, n-		123-86-4	$C_6H_{12}O_2$			2.6	+			10	150
Butyl acrylate, n-	Butyl 2-propenoate, Acrylic acid butyl ester	141-32-2	$C_7H_{12}O_2$			1.6	+	0.6	+		10
Butylamine, n-		109-73-9	$C_4H_{11}N$	1.1	+	1.1	+	0.7	+	8.71	C5
Butyl cellosolve	see 2-Butoxyethanol	111-76-2									
Butyl hydroperoxide, t-		75-91-2	$C_4H_{10}O_2$	2.0	+	1.6	+			<10	1
Butyl mercaptan	1-Butanethiol	109-79-5	$C_4H_{10}S$	0.55	+	0.52	+			9.14	0.5
Carbon disulfide		75-15-0	CS_2	4	+	1.2	+	0.44		10.07	10
Carbon tetrachloride	Tetrachloromethane	56-23-5	CCl_4	NR	+	NR	+	1.7	+	11.47	5
Carbonyl sulfide	Carbon oxysulfide	463-58-1	COS							11.18	

Cellosolve see 2-Ethoxyethanol
CFC-14 see Tetrafluoromethane
CFC-113 see 1,1,2-Trichloro-1,2,2-trifluoroethane

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Chlorine		7782-50-5	Cl_2					1.0	+	11.48	0.5
Chlorine dioxide		10049-04-4	ClO_2	NR	+	NR	+	NR	+	10.57	0.1
Chlorobenzene	Monochlorobenzene	108-90-7	C_6H_5Cl	0.44	+	0.40	+	0.39	+	9.06	10
Chlorobenzotrifluoride, 4-	PCBTF, OXSOL 100 p-Chlorobenzotrifluoride	98-56-6	$C_7H_4ClF_3$	0.74	+	0.63	+	0.55	+	<9.6	25
Chloro-1,3-butadiene, 2-	Chloroprene	126-99-8	C_4H_5Cl			3					10
Chloro-1,1-difluoroethane, 1-	HCFC-142B, R-142B	75-68-3	$C_2H_3ClF_2$	NR		NR		NR		12.0	ne
Chlorodifluoromethane	HCFC-22, R-22	75-45-6	$CHClF_2$	NR		NR		NR		12.2	1000
Chloroethane	Ethyl chloride	75-00-3	C_2H_5Cl	NR	+	NR	+	1.1	+	10.97	100
Chloroethanol	Ethylene chlrohydrin	107-07-3	C_2H_5ClO					2.9		10.52	C1
Chloroethyl ether, 2-	bis(2-chloroethyl) ether	111-44-4	$C_4H_8Cl_2O$	8.6	+	3.0	+				5
Chloroethyl methyl ether, 2-	Methyl 2-chloroethyl ether	627-42-9	C_3H_7ClO			3					ne
Chloroform	Trichloromethane	67-66-3	$CHCl_3$	NR	+	NR	+	3.5	+	11.37	10
Chloro-2-methylpropene, 3-	Methallyl chloride, Isobutenyl chloride	563-47-3	C_4H_7Cl	1.4	+	1.2	+	0.63	+	9.76	ne
Chloropicrin		76-06-2	CCl_3NO_2	NR	+	~400	+	7	+	?	0.1
Chlorotoluene, o-	o-Chloromethylbenzene	95-49-8	C_7H_7Cl			0.5		0.6		8.83	50
Chlorotoluene, p-	p-Chloromethylbenzene	106-43-4	C_7H_7Cl					0.6		8.69	ne
Chlorotrifluoroethene	CTFE, Chlorotrifluoroethylene Genetron 1113	79-38-9	C_2ClF_3	6.7	+	3.9	+	1.2	+	9.76	5
Chlorotrimethylsilane		75-77-4	C_3H_9ClSi	NR		NR		0.82	+	10.83	ne
Cresol, m-	m-Hydroxytoluene	108-39-4	C_7H_8O	0.57	+	0.50	+	0.57	+	8.29	5
Cresol, o-	o-Hydroxytoluene	95-48-7	C_7H_8O			1.0				8.50	
Cresol, p-	p-Hydroxytoluene	106-44-5	C_7H_8O			1.4				8.35	
Crotonaldehyde	*trans*-2-Butenal	123-73-9 4170-30-3	C_4H_6O	1.5	+	1.1	+	1.0	+	9.73	2
Cumene	Isopropylbenzene	98-82-8	C_9H_{12}	0.58	+	0.54	+	0.4	+	8.73	50
Cyanogen bromide		506-68-3	CNBr	NR		NR		NR		11.84	ne
Cyanogen chloride		506-77-4	CNCl	NR		NR		NR		12.34	C0.3
Cyclohexane		110-82-7	C_6H_{12}	3.3	+	1.4	+	0.64	+	9.86	300
Cyclohexanol	Cyclohexyl alcohol	108-93-0	$C_6H_{12}O$	1.5	+	0.9	+	1.1	+	9.75	50
Cyclohexanone		108-94-1	$C_6H_{10}O$	1.0	+	0.9	+	0.7	+	9.14	25
Cyclohexene		110-83-8	C_6H_{10}			0.8	+			8.95	300
Cyclohexylamine		108-91-8	$C_6H_{13}N$			1.2				8.62	10
Cyclopentane 85% 2,2-dimethylbutane 15%		287-92-3	C_5H_{10}	NR	+	15	+	1.1		10.33	600
Cyclopropylamine	Aminocyclpropane	765-30-0	C_3H_7N	1.1	+	0.9	+	0.9	+		ne
Decamethylcyclopentasiloxane		541-02-6	$C_{10}H_{30}O_5Si_5$	0.16	+	0.13	+	0.12	+		ne
Decamethyltetrasiloxane		141-62-8	$C_{10}H_{30}O_3Si_4$	0.17	+	0.13	+	0.12	+	<10.2	ne
Decane		124-18-5	$C_{10}H_{22}$	4.0	+	1.4	+	0.35	+	9.65	ne
Diacetone alcohol	4-Methyl-4-hydroxy-2-pentanone	123-42-2	$C_6H_{12}O_2$			0.7					50
Dibromochloromethane	Chlorodibromomethane	124-48-1	$CHBr_2Cl$	NR	+	5.3	+	0.7	+	10.59	ne
Dibromo-3-chloropropane, 1,2-	DBCP	96-12-8	$C_3H_5Br_2Cl$	NR	+	1.7	+	0.43	+		0.001
Dibromoethane, 1,2-	EDB, Ethylene dibromide, Ethylene bromide	106-93-4	$C_2H_4Br_2$	NR	+	1.7	+	0.6	+	10.37	ne
Dichlorobenzene, o-	1,2-Dichlorobenzene	95-50-1	$C_6H_4Cl_2$	0.54	+	0.47	+	0.38	+	9.08	25
Dichlorodifluoromethane	CFC-12	75-71-8	CCl_2F_2			NR	+	NR	+	11.75	1000
Dichlorodimethylsilane		75-78-5	$C_2H_6Cl_2Si$	NR		NR		1.1	+	>10.7	ne
Dichloroethane, 1,2-	EDC, 1,2-DCA, Ethylene dichloride	107-06-2	$C_2H_4Cl_2$			NR	+	0.6	+	11.04	10
Dichloroethene, 1,1-	1,1-DCE, Vinylidene chloride	75-35-4	$C_2H_2Cl_2$			0.82	+	0.8	+	9.79	5
Dichloroethene, c-1,2-	*c*-1,2-DCE, *cis*-Dichloroethylene	156-59-2	$C_2H_2Cl_2$			0.8				9.66	200
Dichloroethene, t-1,2-	*t*-1,2-DCE, *trans*-Dichloroethylene	156-60-5	$C_2H_2Cl_2$			0.45	+	0.34	+	9.65	200
Dichloro-1-fluoroethane, 1,1-	R-141B	1717-00-6	$C_2H_3Cl_2F$	NR	+	NR	+	2.0	+		ne
Dichloromethane	see Methylene chloride										

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Dichloropentafluoropropane	AK-225, mix of ~45% 3,3-dichloro-1,1,1,2,2-pentafluoro-propane (HCFC-225ca) & ~55% 1,3-Dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)	442-56-0 507-55-1	$C_3HCl_2F_5$	NR	+	NR	+	25	+		ne
Dichloropropane, 1,2-		78-87-5	$C_3H_6Cl_2$					0.7		10.87	75
Dichloro-1-propene, 1,3-		542-75-6	$C_3H_4C_{12}$	1.3	+	0.96	+			<10	1
Dichloro-1-propene, 2,3-		78-88-6	$C_3H_4Cl_2$	1.9	+	1.3	+	0.7	+	<10	ne
Dichloro-1,1,1-trifluoroethane, 2,2-	R-123	306-83-2	$C_2HCl_2F_3$	NR	+	NR	+	10.1	+	11.5	ne
Dichloro-2,4,6-trifluoropyridine, 3,5-	DCTFP	1737-93-5	$C_5Cl_2F_3N$	1.1	+	0.9	+	0.8	+		ne
Dichlorvos *	Vapona; O,O-dimethyl O-dichlorovinyl phosphate	62-73-7	$C_4H_7Cl_2O_4P$			0.9	+			<9.4	0.1
Dicyclopentadiene	DCPD, Cyclopentadiene dimer	77-73-6	$C_{10}H_{12}$	0.57	+	0.48	+	0.43	+	8.8	5
Diesel Fuel		68334-30-5	m.w. 226			0.9	+				11
Diesel Fuel #2 (Automotive)		68334-30-5	m.w. 216	1.3		0.7	+	0.4	+		11
Diethylamine		109-89-7	$C_4H_{11}N$			1	+			8.01	5
Diethylaminopropylamine, 3-		104-78-9	$C_7H_{18}N_2$			1.3					ne
Diethylbenzene	See Dowtherm J										
Diethylmaleate		141-05-9	$C_8H_{12}O_4$			4					ne
Diethyl sulfide	see Ethyl sulfide										
Diglyme	See Methoxyethyl ether	111-96-6	$C_6H_{14}O_3$								
Diisobutyl ketone	DIBK, 2,2-dimethyl-4-heptanone	108-83-8	$C_9H_{18}O$	0.71	+	0.61	+	0.35	+	9.04	25
Diisopropylamine		108-18-9	$C_6H_{15}N$	0.84	+	0.74	+	0.5	+	7.73	5
Diketene	Ketene dimer	674-82-8	$C_4H_4O_2$	2.6	+	2.0	+	1.4	+	9.6	0.5
Dimethylacetamide, N,N-	DMA	127-19-5	C_4H_9NO	0.87	+	0.8	+	0.8	+	8.81	10
Dimethylamine		124-40-3	C_2H_7N			1.5				8.23	5
Dimethyl carbonate	Carbonic acid dimethyl ester	616-38-6	$C_3H_6O_3$	NR	+	~70	+	1.7	+	~10.5	ne
Dimethyl disulfide	DMDS	624-92-0	$C_2H_6S_2$	0.2	+	0.20	+	0.21	+	7.4	ne
Dimethyl ether	see Methyl ether										
Dimethylethylamine	DMEA	598-56-1	$C_4H_{11}N$	1.1	+	1.0	+	0.9	+	7.74	~3
Dimethylformamide, N,N-	DMF	68-12-2	C_3H_7NO	0.7	+	0.7	+	0.8	+	9.13	10
Dimethylhydrazine, 1,1-	UDMH	57-14-7	$C_2H_8N_2$			0.8	+	0.8	+	7.28	0.01
Dimethyl methylphosphonate	DMMP, methyl phosphonic acid dimethyl ester	756-79-6	$C_3H_9O_3P$	NR	+	4.3	+	0.74	+	10.0	ne
Dimethyl sulfate		77-78-1	$C_2H_6O_4S$	~23		~20	+	2.3	+		0.1
Dimethyl sulfide	see Methyl sulfide										
Dimethyl sulfoxide	DMSO, Methyl sulfoxide	67-68-5	C_2H_6OS			1.4	+			9.10	ne
Dioxane, 1,4-		123-91-1	$C_4H_8O_2$			1.3				9.19	25
Dioxolane, 1,3-	Ethylene glycol formal	646-06-0	$C_3H_6O_2$	4.0	+	2.3	+	1.6	+	9.9	20
Dowtherm A see Therminol® *											
Dowtherm J (97% Diethylbenzene) *		25340-17-4	$C_{10}H_{14}$			0.5					
DS-108F Wipe Solvent	Ethyl lactate/Isopar H/ Propoxypropanol ~7:2:1	97-64-3 64742-48-9 1569-01-3	m.w. 118	3.3	+	1.6	+	0.7	+		ne
Epichlorohydrin	ECH Chloromethyloxirane, 1-chloro2,3-epoxypropane	106-89-8	C_2H_5ClO	~200	+	8.5	+	1.4	+	10.2	0.5
Ethane		74-84-0	C_2H_6			NR	+	15	+	11.52	ne
Ethanol	Ethyl alcohol	64-17-5	C_2H_6O			10	+	3.1	+	10.47	1000
Ethanolamine *	MEA, Monoethanolamine	141-43-5	C_2H_7NO	5.6	+	1.6	+			8.96	3
Ethene	Ethylene	74-85-1	C_2H_4			9	+	4.5	+	10.51	ne
Ethoxyethanol, 2-	Ethyl cellosolve	110-80-5	$C_4H_{10}O_2$			1.3				9.6	5
Ethyl acetate		141-78-6	$C_4H_8O_2$			4.6	+	3.5		10.01	400
Ethyl acetoacetate		141-97-9	$C_6H_{10}O_3$	1.4	+	1.2	+	1.0	+	<10	ne
Ethyl acrylate		140-88-5	$C_5H_8O_2$			2.4	+	1.0	+	<10.3	5
Ethylamine		75-04-7	C_2H_7N			0.8				8.86	5

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Ethylbenzene		100-41-4	C_8H_{10}	0.52	+	0.52	+	0.51	+	8.77	100
Ethyl caprylate	Ethyl octanoate	106-32-1	$C_{10}H_{20}O_2$		+	0.52	+	0.51	+		
Ethylenediamine	1,2-Ethanediamine; 1,2-Diaminoethane	107-15-3	$C_2H_8N_2$	0.9	+	0.8	+	1.0	+	8.6	10
Ethylene glycol *	1,2-Ethanediol	107-21-1	$C_2H_6O_2$			16	+	6	+	10.16	C100
Ethylene glycol, Acrylate	2-hydroxyethyl Acrylate	818-61-1	$C_5H_8O_3$			8.2				≤10.6	
Ethylene glycol dimethyl ether	1,2-Dimethoxyethane, Monoglyme	110-71-4	$C_4H_{10}O_2$	1.1		0.86		0.7		9.2	ne
Ethylene glycol monobutyl ether acetate	2-Butoxyethyl acetate	112-07-2	$C_8H_{16}O_3$			1.3				≤10.6	
Ethylene glycol, monothio	mercapto-2-ethanol	60-24-2	C_2H_6OS			1.5				9.65	
Ethylene oxide	Oxirane, Epoxyethane	75-21-8	C_2H_4O			13	+	3.5	+	10.57	1
Ethyl ether	Diethyl ether	60-29-7	$C_4H_{10}O$			1.1	+	1.7		9.51	400
Ethyl 3-ethoxypropionate	EEP	763-69-9	$C_7H_{14}O_3$	1.2	+	0.75	+				ne
Ethyl formate		109-94-4	$C_3H_6O_2$					1.9		10.61	100
Ethylhexyl acrylate, 2-	Acrylic acid 2-ethylhexyl ester	103-11-7	$C_{11}H_{20}O_2$			1.1	+	0.5	+		ne
Ethylhexanol	2-Ethyl-1-hexanol	104-76-7	C8H18O			1.9				≤10.6	
Ethylidenenorbornene	5-Ethylidene bicyclo(2,2,1)hept-2-ene	16219-75-3	C_9H_{12}	0.4	+	0.39	+	0.34	+	≤8.8	ne
Ethyl (S)-(-)-lactate see also DS-108F	Ethyl lactate, Ethyl (S)-(-)-hydroxypropionate	687-47-8 97-64-3	$C_5H_{10}O_3$	13	+	3.2	+	1.6	+	~10	ne
Ethyl mercaptan	Ethanethiol	75-08-1	C_2H_6S	0.60	+	0.56	+			9.29	0.5
Ethyl sulfide	Diethyl sulfide	352-93-2	$C_4H_{10}S$			0.5	+			8.43	ne
Formaldehyde	Formalin	50-00-0	CH_2O	NR	+	NR	+	1.6	+	10.87	C0.3
Formamide		75-12-7	CH_3NO			6.9	+	4		10.16	10
Formic acid		64-18-6	CH_2O_2	NR	+	NR	+	9	+	11.33	5
Furfural	2-Furaldehyde	98-01-1	$C_5H_4O_2$			0.92	+	0.8	+	9.21	2
Furfuryl alcohol		98-00-0	$C_5H_6O_2$			0.80	+			<9.5	10
Gasoline #1		8006-61-9	m.w. 72			0.9	+				300
Gasoline #2, 92 octane		8006-61-9	m.w. 93	1.3	+	1.0	+	0.5	+		300
Glutaraldehyde	1,5-Pentanedial, Glutaric dialdehyde	111-30-8	$C_5H_8O_2$	1.1	+	0.8	+	0.6	+		C0.05
Glycidyl methacrylate	2,3-Epoxypropyl methacrylate	106-91-2	$C_7H_{10}O_3$	2.6	+	1.2	+	0.9	+		0.5
Halothane	2-Bromo-2-chloro-1,1,1-trifluoroethane	151-67-7	$C_2HBrClF_3$					0.6		11.0	50
HCFC-22 see Chlorodifluoromethane											
HCFC-123 see 2,2-Dichloro-1,1,1-trifluoroethane											
HCFC-141B see 1,1-Dichloro-1-fluoroethane											
HCFC-142B see 1-Chloro-1,1-difluoroethane											
HCFC-134A see 1,1,1,2-Tetrafluoroethane											
HCFC-225 see Dichloropentafluoropropane											
Heptane, n-		142-82-5	C_7H_{16}	45	+	2.8	+	0.60	+	9.92	400
Heptanol, 4-	Dipropylcarbinol	589-55-9	$C_7H_{16}O$	1.8	+	1.3	+	0.5	+	9.61	ne
Hexamethyldisilazane, 1,1,1,3,3,3- *	HMDS	999-97-3	$C_6H_{19}NSi_2$			0.2	+	0.2	+	~8.6	ne
Hexamethyldisiloxane	HMDSx	107-46-0	$C_6H_{18}OSi_2$	0.33	+	0.27	+	0.25	+	9.64	ne
Hexane, n-		110-54-3	C_6H_{14}	350	+	4.3	+	0.54	+	10.13	50
Hexanol, 1-	Hexyl alcohol	111-27-3	$C_6H_{14}O$	9	+	2.5	+	0.55	+	9.89	ne
Hexene, 1-		592-41-6	C_6H_{12}			0.8				9.44	30
HFE-7100 see Methyl nonafluorobutyl ether											
Histoclear (Histo-Clear)	Limonene/corn oil reagent		m.w. ~136	0.5	+	0.4	+	0.3	+		ne
Hydrazine *		302-01-2	H_4N_2	>8	+	2.6	+	2.1	+	8.1	0.01
Hydrazoic acid	Hydrogen azide		HN_3							10.7	
Hydrogen	Synthesis gas	1333-74-0	H_2	NR	+	NR	+	NR	+	15.43	ne
Hydrogen cyanide	Hydrocyanic acid	74-90-8	HCN	NR	+	NR	+	NR	+	13.6	C4.7
Hydrogen iodide *	Hydriodic acid	10034-85-2	HI			~0.6*				10.39	
Hydrogen peroxide		7722-84-1	H_2O_2	NR	+	NR	+	NR	+	10.54	1
Hydrogen sulfide		7783-06-4	H_2S	NR	+	3.3	+	1.5	+	10.45	10
Hydroxypropyl methacrylate		27813-02-1 923-26-2	$C_7H_{12}O_3$	9.9	+	2.3	+	1.1	+		ne
Iodine *		7553-56-2	I_2	0.1	+	0.1	+	0.1	+	9.40	C0.1

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Iodomethane	Methyl iodide	74-88-4	CH_3I	0.21	+	0.22	+	0.26	+	9.54	2
Isoamyl acetate	Isopentyl acetate	123-92-2	$C_7H_{14}O_2$	10.1		2.1		1.0		<10	100
Isobutane	2-Methylpropane	75-28-5	C_4H_{10}			100	+	1.2	+	10.57	ne
Isobutanol	2-Methyl-1-propanol	78-83-1	$C_4H_{10}O$	19	+	3.8	+	1.5		10.02	50
Isobutene	Isobutylene, Methyl butene	115-11-7	C_4H_8	1.00	+	1.00	+	1.00	+	9.24	Ne
Isobutyl acrylate	Isobutyl 2-propenoate	106-63-8	$C_7H_{12}O_2$			1.5	+	0.60	+		Ne
Isoflurane	1-Chloro-2,2,2-trifluoroethyl difluoromethyl ether, forane	26675-46-7	$C_3H_2ClF_5O$	NR	+	NR	+	48	+	~11.7	Ne
Isooctane	2,2,4-Trimethylpentane	540-84-1	C8H18			1.2				9.86	ne
Isopar E Solvent	Isoparaffinic hydrocarbons	64741-66-8	m.w. 121	1.7	+	0.8	+				Ne
Isopar G Solvent	Photocopier diluent	64742-48-9	m.w. 148			0.8	+				Ne
Isopar K Solvent	Isoparaffinic hydrocarbons	64742-48-9	m.w. 156	0.9	+	0.5	+	0.27	+		Ne
Isopar L Solvent	Isoparaffinic hydrocarbons	64742-48-9	m.w. 163	0.9	+	0.5	+	0.28	+		Ne
Isopar M Solvent	Isoparaffinic hydrocarbons	64742-47-8	m.w. 191			0.7	+	0.4	+		Ne
Isopentane	2-Methylbutane	78-78-4	C_5H_{12}			8.2					Ne
Isophorone		78-59-1	$C_9H_{14}O$					3		9.07	C5
Isoprene	2-Methyl-1,3-butadiene	78-79-5	C_5H_8	0.69	+	0.63	+	0.60	+	8.85	Ne
Isopropanol	Isopropyl alcohol, 2-propanol, IPA	67-63-0	C_3H_8O	500	+	6.0	+	2.7		10.12	200
Isopropyl acetate		108-21-4	$C_5H_{10}O_2$			2.6				9.99	100
Isopropyl ether	Diisopropyl ether	108-20-3	$C_6H_{14}O$			0.8				9.20	250
Jet fuel JP-4	Jet B, Turbo B, F-40 Wide cut type aviation fuel	8008-20-6 + 64741-42-0	m.w. 115			1.0	+	0.4	+		Ne
Jet fuel JP-5	Jet 5, F-44, Kerosene type aviation fuel	8008-20-6 + 64747-77-1	m.w. 167			0.6	+	0.5	+		29
Jet fuel JP-8	Jet A-1, F-34, Kerosene type aviation fuel	8008-20-6 + 64741-77-1	m.w. 165			0.6	+	0.3	+		30
Jet fuel A-1 (JP-8)	F-34, Kerosene type aviation fuel	8008-20-6 + 64741-77-1	m.w. 145			0.67					34
Jet Fuel TS	Thermally Stable Jet Fuel, Hydrotreated kerosene fuel	8008-20-6 + 64742-47-8	m.w. 165	0.9	+	0.6	+	0.3	+		30
Limonene, D-	(R)-(+)-Limonene	5989-27-5	$C_{10}H_{16}$			0.33	+			~8.2	Ne
Kerosene C10-C16 petro.distillate – see Jet Fuels		8008-20-6									
MDI – see 4,4'-Methylenebis(phenylisocyanate)											
Maleic anhydride	2,5-Furandione	108-31-6	$C_4H_2O_3$							~10.8	0.1
Mesitylene	1,3,5-Trimethylbenzene	108-67-8	C_9H_{12}	0.36	+	0.35	+	0.3	+	8.41	25
Methallyl chloride – see 3-Chloro-2-methylpropene											
Methane	Natural gas	74-82-8	CH_4	NR	+	NR	+	NR	+	12.61	Ne
Methanol	Methyl alcohol, carbinol	67-56-1	CH_4O	NR	+	NR	+	2.5	+	10.85	200
Methoxyethanol, 2-	Methyl cellosolve, Ethylene glycol monomethyl ether	109-86-4	$C_3H_8O_2$	4.8	+	2.4	+	1.4	+	10.1	5
Methoxyethoxyethanol, 2-	2-(2-Methoxyethoxy)ethanol Diethylene glycol monomethyl ether	111-77-3	$C_7H_{16}O$	2.3	+	1.2	+	0.9	+	<10	Ne
Methoxyethyl ether, 2-	bis(2-Methoxyethyl) ether, Diethylene glycol dimethyl ether, Diglyme	111-96-6	$C_6H_{14}O_3$	0.64	+	0.54	+	0.44	+	<9.8	Ne
Methyl acetate		79-20-9	$C_3H_6O_2$	NR	+	6.6	+	1.4	+	10.27	200
Methyl acrylate	Methyl 2-propenoate, Acrylic acid methyl ester	96-33-3	$C_4H_6O_2$			3.7	+	1.2	+	(9.9)	2
Methylamine	Aminomethane	74-89-5	CH_5N			1.2				8.97	5
Methyl amyl ketone	MAK, 2-Heptanone, Methyl pentyl ketone	110-43-0	$C_7H_{14}O$	0.9	+	0.85	+	0.5	+	9.30	50
Methyl bromide	Bromomethane	74-83-9	CH_3Br	110	+	1.7	+	1.3	+	10.54	1
Methyl t-butyl ether	MTBE, *tert*-Butyl methyl ether	1634-04-4	$C_5H_{12}O$			0.9	+			9.24	40
Methyl cellosolve	see 2-Methoxyethanol										
Methyl chloride	Chloromethane	74-87-3	CH_3Cl	NR	+	NR	+	0.74	+	11.22	50
Methylcyclohexane		107-87-2	C_7H_{14}	1.6	+	0.97	+	0.53	+	9.64	400
Methylene bis(phenyl-isocyanate), 4,4'- *	MDI, Mondur M		$C_{15}H_{10}N_2O_2$	Very slow ppb level response							0.005

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Methylene chloride	Dichloromethane	75-09-2	CH_2Cl_2	NR	+	NR	+	0.89	+	11.32	25
Methyl ether	Dimethyl ether	115-10-6	C_2H_6O	4.8	+	3.1	+	2.5	+	10.03	Ne
Methyl ethyl ketone	MEK, 2-Butanone	78-93-3	C_4H_8O	0.86	+	0.9	+	1.1	+	9.51	200
Methylhydrazine	Monomethylhydrazine, Hydrazomethane	60-34-4	$C_2H_6N_2$	1.4	+	1.2	+	1.3	+	7.7	0.01
Methyl isoamyl ketone	MIAK, 5-Methyl-2-hexanone	110-12-3	$C_7H_{14}O$	0.8	+	0.76	+	0.5	+	9.28	50
Methyl isobutyl ketone	MIBK, 4-Methyl-2-pentanone	108-10-1	$C_6H_{12}O$	0.9	+	0.8	+	0.6	+	9.30	50
Methyl isocyanate	CH3NCO	624-83-9	C_2H_3NO	NR	+	4.6	+	1.5		10.67	0.02
Methyl isothiocyanate	CH3NCS	551-61-6	C_2H_3NS	0.5	+	0.45	+	0.4	+	9.25	ne
Methyl mercaptan	Methanethiol	74-93-1	CH_4S	0.65		0.54		0.66		9.44	0.5
Methyl methacrylate		80-62-6	$C_5H_8O_2$	2.7	+	1.5	+	1.2	+	9.7	100
Methyl nonafluorobutyl ether	HFE-7100DL	163702-08-7, 163702-07-6	$C_5H_3F_9O$			NR	+	~35	+		ne
Methyl-1,5-pentanediamine, 2- (coats lamp) *	Dytek-A amine, 2-Methyl pentamethylenediamine	15520-10-2	C6H16N2			~0.6	+			<9.0	ne
Methyl propyl ketone	MPK, 2-Pentanone	107-87-9	$C_5H_{12}O$			0.93	+	0.79	+	9.38	200
Methyl-2-pyrrolidinone, N-	NMP, N-Methylpyrrolidone, 1-Methyl-2-pyrrolidinone, 1-Methyl-2-pyrrolidone	872-50-4	C_5H_9NO	1.0	+	0.8	+	0.9	+	*9.17*	ne
Methyl salicylate	Methyl 2-hydroxybenzoate	119-36-8	C_8H_8O3	1.3	+	0.9	+	0.9	+	~9	ne
Methylstyrene, α-	2-Propenylbenzene	98-83-9	C_9H_{10}			0.5				8.18	50
Methyl sulfide	DMS, Dimethyl sulfide	75-18-3	C_2H_6S	0.49	+	0.44	+	0.46	+	8.69	ne
Mineral spirits	Stoddard Solvent, Varsol 1, White Spirits	8020-83-5 8052-41-3 68551-17-7	m.w. 144	1.0		0.69	+	0.38	+		100
Mineral Spirits - Viscor 120B Calibration Fluid, b.p. 156-207°C		8052-41-3	m.w. 142	1.0	+	0.7	+	0.3	+		100
Monoethanolamine - see Ethanolamine											
Mustard *	HD, Bis(2-chloroethyl) sulfide	505-60-2 39472-40-7 68157-62-0	$C_4H_8Cl_2S$			0.6					0.0005
Naphtha - see VM & P Naptha											
Naphthalene	Mothballs	91-20-3	$C_{10}H_8$	0.45	+	0.42	+	0.40	+	8.13	10
Nickel carbonyl (in CO)	Nickel tetracarbonyl	13463-39-3	C_4NiO_4			0.18				<8.8	0.001
Nicotine		54-11-5	$C_{10}H_{14}N_2$			2.0				≤10.6	
Nitric oxide		10102-43-9	NO	~6		5.2	+	2.8	+	9.26	25
Nitrobenzene		98-95-3	$C_6H_5NO_2$	2.6	+	1.9	+	1.6	+	9.81	1
Nitroethane		79-24-3	$C_2H_5NO_2$					3		10.88	100
Nitrogen dioxide		10102-44-0	NO_2	23	+	16	+	6	+	9.75	3
Nitrogen trifluoride		7783-54-2	NF_3	NR		NR		NR		13.0	10
Nitromethane		75-52-5	CH_3NO_2					4		11.02	20
Nitropropane, 2-		79-46-9	$C_3H_7NO_2$					2.6		10.71	10
Nonane		111-84-2	C_9H_{20}			1.4				9.72	200
Norpar 12	n-Paraffins, mostly C_{10}-C_{13}	64771-72-8	m.w. 161	3.2	+	1.1	+	0.28	+		ne
Norpar 13	n-Paraffins, mostly C_{13}-C_{14}	64771-72-8	m.w. 189	2.7	+	1.0	+	0.3	+		ne
Octamethylcyclotetrasiloxane		556-67-2	$C_8H_{24}O_4Si_4$	0.21	+	0.17	+	0.14	+		ne
Octamethyltrisiloxane		107-51-7	$C_8H_{24}O_2Si_3$	0.23	+	0.18	+	0.17	+	<10.0	ne
Octane, n-		111-65-9	C_8H_{18}	13	+	1.8	+			9.82	300
Octene, 1-		111-66-0	C_8H_{16}	0.9	+	0.75	+	0.4	+	9.43	75
Pentane		109-66-0	C_5H_{12}	80	+	8.4	+	0.7	+	10.35	600
Peracetic acid *	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	$C_2H_4O_3$	NR	+	NR	+	2.3	+		ne
Peracetic/Acetic acid mix *	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	$C_2H_4O_3$			50	+	2.5	+		ne
Perchloroethene	PCE, Perchloroethylene, Tetrachloroethylene	127-18-4	C_2Cl_4	0.69	+	0.57	+	0.31	+	9.32	25
PGME	Propylene glycol methyl ether, 1-Methoxy-2-propanol	107-98-2	$C_6H_{12}O_3$	2.4	+	1.5	+	1.1	+		100

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PGMEA	Propylene glycol methyl ether acetate, 1-Methoxy-2-acetoxypropane, 1-Methoxy-2-propanol acetate	108-65-6	$C_6H_{12}O_3$	1.65	+	1.0	+	0.8	+		ne
Phenol	Hydroxybenzene	108-95-2	C_6H_6O	1.0	+	1.0	+	0.9	+	8.51	5
Phosgene	Dichlorocarbonyl	75-44-5	CCl_2O	NR	+	NR	+	8.5	+	11.2	0.1
Phosgene in Nitrogen	Dichlorocarbonyl	75-44-5	CCl_2O	NR	+	NR	+	6.8	+	11.2	0.1
Phosphine (coats lamp)		7803-51-2	PH_3	28		3.9	+	1.1	+	9.87	0.3
Photocopier Toner	Isoparaffin mix					0.5	+	0.3	+		ne
Picoline, 3-	3-Methylpyridine	108-99-6	C_6H_7N			0.9				9.04	ne
Pinene, α-		2437-95-8	$C_{10}H_{16}$			0.31	+	0.47		8.07	ne
Pinene, β-		18172-67-3	$C_{10}H_{16}$	0.38	+	0.37	+	0.37	+	~8	100
Piperylene, isomer mix	1,3-Pentadiene	504-60-9	C_5H_8	0.76	+	0.69	+	0.64	+	8.6	100
Propane		74-98-6	C_3H_8			NR	+	1.8	+	10.95	2500
Propanol, n-	Propyl alcohol	71-23-8	C_3H_8O			5		1.7		10.22	200
Propene	Propylene	115-07-1	C_3H_6	1.5	+	1.4	+	1.6	+	9.73	ne
Propionaldehyde	Propanal	123-38-6	C_3H_6O			1.9				9.95	ne
Propyl acetate, n-		109-60-4	$C_5H_{10}O_2$			3.5		2.3		10.04	200
Propylamine, n-	1-Propylamine, 1-Aminopropane	107-10-8	C_3H_9N	1.1	+	1.1	+	0.9	+	8.78	ne
Propylene carbonate *		108-32-7	$C_4H_6O_3$			62	+	1	+	10.5	ne
Propylene glycol	1,2-Propanediol	57-55-6	$C_3H_8O_2$	18		5.5	+	1.6	+	<10.2	ne
Propylene glycol propyl ether	1-Propoxy-2-propanol	1569-01-3	$C_6H_{14}O_2$	1.3	+	1.0	+	1.6	+		ne
Propylene oxide	Methyloxirane	75-56-9 16088-62-3 15448-47-2	C_3H_6O	~240		6.6	+	2.9	+	10.22	20
Propyleneimine	2-Methylaziridine	75-55-8	C_3H_7N	1.5	+	1.3	+	1.0	+	9.0	2
Propyl mercaptan, 2-	2-Propanethiol, Isopropyl mercaptan	75-33-2	C_3H_8S	0.64	+	0.66	+			9.15	ne
Pyridine		110-86-1	C_5H_5N	0.78	+	0.7	+	0.7	+	9.25	5
Pyrrolidine (coats lamp)	Azacyclohexane	123-75-1	C_4H_9N	2.1	+	1.3	+	1.6	+	~8.0	ne
RR7300 (PGME/PGMEA)	70:30 PGME:PGMEA (1-Methoxy-2-propanol:1-Methoxy-2-acetoxypropane)	107-98-2	$C_4H_{10}O_2$ / $C_6H_{12}O_3$			1.4	+	1.0	+		ne
Sarin	GB, Isopropyl methylphosphonofluoridate	107-44-8 50642-23-4	$C_4H_{10}FO_2P$			~3					
Stoddard Solvent - see Mineral Spirits		8020-83-5									
Styrene		100-42-5	C_8H_8	0.45	+	0.40	+	0.4	+	8.43	20
Sulfur dioxide		7446-09-5	SO_2	NR		NR	+	NR	+	12.32	2
Sulfur hexafluoride		2551-62-4	SF_6	NR		NR		NR		15.3	1000
Sulfuryl fluoride	Vikane	2699-79-8	SO_2F_2	NR		NR		NR		13.0	5
Tabun *	Ethyl N, N-dimethylphosphoramidocyanidate	77-81-6	$C_5H_{11}N_2O_2P$			0.8					15ppt
Tetrachloroethane, 1,1,1,2-		630-20-6	$C_2H_2Cl_4$					1.3		~11.1	ne
Tetrachloroethane, 1,1,2,2-		79-34-5	$C_2H_2Cl_4$	NR	+	NR	+	0.60	+	~11.1	1
Tetrachlorosilane		10023-04-7	$SiCl_4$	NR		NR		15	+	11.79	ne
Tetraethyl lead	TEL	78-00-2	$C_8H_{20}Pb$	0.4		0.3		0.2		~11.1	0.008
Tetraethyl orthosilicate	Ethyl silicate, TEOS	78-10-4	$C_8H_{20}O_4Si$			0.7	+	0.2	+	~9.8	10
Tetrafluoroethane, 1,1,1,2-	HFC-134A	811-97-2	$C_2H_2F_4$			NR		NR			ne
Tetrafluoroethene	TFE, Tetrafluoroethylene, Perfluoroethylene	116-14-3	C_2F_4			~15				10.12	ne
Tetrafluoromethane	CFC-14, Carbon tetrafluoride	75-73-0	CF_4			NR	+	NR	+	>15.3	ne
Tetrahydrofuran	THF	109-99-9	C_4H_8O	1.9	+	1.7	+	1.0	+	9.41	200
Tetramethyl orthosilicate	Methyl silicate, TMOS	681-84-5	$C_4H_{12}O_4Si$	10	+	1.9	+			~10	1
Therminol® D-12 *	Hydrotreated heavy naphtha	64742-48-9	m.w. 160	0.8	+	0.51	+	0.33	+		ne
Therminol® VP-1 *	Dowtherm A, 3:1 Diphenyl oxide: Biphenyl	101-84-8 92-52-4	$C_{12}H_{10}O$ $C_{12}H_{10}$			0.4	+				1
Toluene	Methylbenzene	108-88-3	C_7H_8	0.54	+	0.50	+	0.51	+	8.82	50

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Tolylene-2,4-diisocyanate	TDI, 4-Methyl-1,3-phenylene-2,4-diisocyanate	584-84-9	$C_9H_6N_2O_2$	1.4	+	1.4	+	2.0	+		0.002
Trichlorobenzene, 1,2,4-	1,2,4-TCB	120-82-1	$C_6H_3Cl_3$	0.7	+	0.46	+			9.04	C5
Trichloroethane, 1,1,1-	1,1,1-TCA, Methyl chloroform	71-55-6	$C_2H_3Cl_3$			NR	+	1	+	11	350
Trichloroethane, 1,1,2-	1,1,2-TCA	79-00-5	$C_2H_3Cl_3$	NR	+	NR	+	0.9	+	11.0	10
Trichloroethene	TCE, Trichoroethylene	79-01-6	C_2HCl_3	0.62	+	0.54	+	0.43	+	9.47	50
Trichloromethylsilane	Methyltrichlorosilane	75-79-6	CH_3Cl_3Si	NR		NR		1.8	+	11.36	ne
Trichlorotrifluoroethane, 1,1,2-	CFC-113	76-13-1	$C_2Cl_3F_3$			NR		NR		11.99	1000
Triethylamine	TEA	121-44-8	$C_6H_{15}N$	0.95	+	0.9	+	0.65	+	7.3	1
Triethyl borate	TEB; Boric acid triethyl ester	150-46-9	$C_6H_{15}O_3B$			2.2	+	1.1	+	~10	ne
Triethyl phosphate	Ethyl phosphate	78-40-0	$C_6H_{15}O_4P$	~50	+	3.1	+	0.60	+	9.79	ne
Trifluoroethane, 1,1,2-		430-66-0	$C_2H_3F_3$					34		*12.9*	ne
Trimethylamine		75-50-3	C_3H_9N			0.9				7.82	5
Trimethylbenzene, 1,3,5- - see Mesitylene		108-67-8									25
Trimethyl borate	TMB; Boric acid trimethyl ester, Boron methoxide	121-43-7	$C_3H_9O_3B$			5.1	+	1.2	+	10.1	ne
Trimethyl phosphate	Methyl phosphate	512-56-1	$C_3H_9O_4P$			8.0	+	1.3	+	9.99	ne
Trimethyl phosphite	Methyl phosphite	121-45-9	$C_3H_9O_3P$			1.1	+		+	*8.5*	2
Turpentine	Pinenes (85%) + other diisoprenes	8006-64-2	$C_{10}H_{16}$	0.37	+	0.30	+	0.29	+	~8	20
Undecane		1120-21-4	$C_{11}H_{24}$			2				9.56	ne
Varsol – see Mineral Spirits											
Vinyl actetate		108-05-4	$C_4H_6O_2$	1.5	+	1.2	+	1.0	+	9.19	10
Vinyl bromide	Bromoethylene	593-60-2	C_2H_3Br			0.4				9.80	5
Vinyl chloride	Chloroethylene, VCM	75-01-4	C_2H_3Cl			2.0	+	0.6	+	9.99	5
Vinyl-1-cyclohexene, 4-	Butadiene dimer, 4-Ethenylcyclohexene	100-40-3	C_8H_{12}	0.6	+	0.56	+			9.83	0.1
Vinylidene chloride - see 1,1-Dichloroethene											
Vinyl-2-pyrrolidinone, 1-	NVP, N-vinylpyrrolidone, 1-ethenyl-2-pyrrolidinone	88-12-0	C_6H_9NO	1.0	+	0.8	+	0.9	+		ne
Viscor 120B - see Mineral Spirits - Viscor 120B Calibration Fluid											
V. M. & P. Naphtha	Ligroin; Solvent naphtha; Varnish maker's & painter's naptha	64742-89-8	m.w. 111 (C_8-C_9)	1.7	+	0.97	+				300
Xylene, m-	1,3-Dimethylbenzene	108-38-3	C_8H_{10}	0.50	+	0.44	+	0.40	+	8.56	100
Xylene, o-	1,2-Dimethylbenzene	95-47-6	C_8H_{10}	0.56	+	0.46	+	0.43		8.56	100
Xylene, p-	1,4-Dimethylbenzene	106-42-3	C_8H_{10}	0.48	+	0.39	+	0.38	+	8.44	100
None				1		1		1			
Undetectable				1E+6		1E+6		1E+6			

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

Therminol® is a registered Trademark of Solutia, Inc.

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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				

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FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Specific Conductance Meter

FOP 012.0

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

PURPOSE

This guideline describes a method for calibration of a portable specific conductance meter. This meter measures the ability of a water sample to conduct electricity, which is largely a function of the dissolved solids within the water. The instrument has been calibrated by the manufacturer according to factory specifications. This guideline presents a method for checking the factory calibration of a portable specific conductance meter. A calibration check is performed to verify instrument accuracy and function. All field test equipment will be checked at the beginning of each sampling day. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the specific conductance meter will be within ± 1 percent of full-scale, with repeatability of ± 1 percent. The built-in cell will be automatically temperature compensated from at least 32° to 160° F (0° to 71°C).

PROCEDURE

Note: The information included below is equipment manufacturer- and model-specific, however, accuracy, calibration, and maintenance procedures for this type of portable equipment are typically similar. The information below pertains to the Myron L Company Ultrameter Model 6P. The actual equipment to be used in the field will be equivalent or similar.

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

1. Calibrate all field test equipment at the beginning of each sampling day. Check and recalibrate the specific conductance meter according to the manufacture's specifications.

2. Use a calibration solution of known specific conductivity and salinity. For maximum accuracy, use a Standard Solution Value closest to the samples to be tested.

3. Rinse conductivity cell three times with proper standard.

4. Re-fill conductivity cell with same standard.

5. Press **COND** or **TDS**, then press **CAL/MCLR**. The "CAL" icon will appear on the display.

6. Press the **↑/MS** or **MR/↓** key to step the displayed value toward the standard's value or hold a key down to cause rapid scrolling of the reading.

7. Press CAL/MCLR once to confirm new value and end the calibration sequence for this particular solution type.

8. Repeat steps 1 through 7 with additional new solutions, as necessary.

9. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample), indicating the meter readings before and after the instrument has been adjusted. This is important, not only for data validation, but also to establish maintenance schedules and component replacement. Information will include, at a minimum:
    - Time, date and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand and expiration date of the calibration standards
    - The instrument readings: before and after calibration

- The instrument settings (if applicable)
- The overall adequacy of calibration including the Pass or fail designation in accordance with the accuracy specifications presented above.
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

MAINTENANCE

NOTE: Ultrameters should be rinsed with clean water after use. Solvents should be avoided. Shock damage from a fall may cause instrument failure.

Temperature Extremes

Solutions in excess of 160°F/71°C should not be placed in the cell cup area; this may cause damage. Care should be exercised not to exceed rated operating temperature. Leaving the Ultrameter in a vehicle or storage shed on a hot day can easily subject the instrument to over 150°F voiding the warranty.

Battery Replacement

Dry Instrument THOROUGHLY. Remove the four bottom screws. Open instrument carefully; it may be necessary to rock the bottom slightly side to side to release it from the RS-232 connector. Carefully detach battery from circuit board. Replace with 9-volt alkaline battery. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Re-install screws, tighten evenly and securely.

NOTE: Because of nonvolatile EEPROM circuitry, all data stored in memory and all calibration settings are protected even during power loss or battery replacement.

Cleaning Sensors

The conductivity cell cup should be kept as clean as possible. Flushing with clean water following use will prevent buildup on electrodes. However, if very dirty samples — particularly scaling types — are allowed to dry in the cell cup, a film will form. This film reduces accuracy. When there are visible films of oil, dirt, or scale in the cell cup or on the electrodes, use a foaming non-abrasive household cleaner. Rinse out the cleaner and your Ultrameter is ready for accurate measurements.

NOTE: Maintain a log for each monitoring instrument. Record all maintenance performed on the instrument on this log with date and name of the organization performing the maintenance.

ATTACHMENTS

Equipment Calibration Log (sample)

FOP 012.0

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: Date:

Project No.:

Client: Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		< 0.4		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		µS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID			open air zero		MIBK re
						____ ppm Iso. Gas		factor =
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/h					background area		
☐								

SAMPLE

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

BENCHMARK
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FIELD OPERATING PROCEDURES

Documentation Requirements for Drilling and Well Installation

FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

PURPOSE

The purpose of these documentation requirements is to document the procedures used for drilling and installing wells in order to ensure the quality of the data obtained from these operations. Benchmark field technical personnel will be responsible for developing and maintaining documentation for quality control of field operations. At least one field professional will monitor each major operation (e.g. one person per drilling rig) to document and record field procedures for quality control. These procedures provide a description of the format and information for this documentation.

PROCEDURE

Project Field Book

Personnel assigned by the Benchmark Field Team Leader or Project Manager will maintain a Project Field Book for all site activities. These Field Books will be started upon initiation of any site activities to document the field investigation process. The Field Books will meet the following criteria:

- Permanently bound, with nominal 8.5-inch by 11-inch gridded pages.
- Water resistant paper.
- Pages must be pre-numbered or numbered in the field, front and back.

Notations in the field book will be in black or blue ink that will not smudge when wet. Information that may be recorded in the Field Book includes:

- Time and date of all entries.

- Name and location of project site and project job number.
- Listing of key project, client and agency personnel and telephone numbers.
- Date and time of daily arrivals and departures, name of person keeping the log, names and affiliation of persons on site, purpose of visit (if applicable), weather conditions, outline of project activities to be completed.
- Details of any variations to the procedures/protocols (i.e., as presented in the Work Plan or Field Operating Procedures) and the basis for the change.
- Field-generated data relating to implementation of the field program, including sample locations, sample descriptions, field measurements, instrument calibration, etc.
- Record of all photographs taken in the field, including date, time, photographer, site location and orientation, sequential number of photograph, and roll number.

Upon completion of the site activities, all Field Books will be photocopied and both the original and photocopied versions placed in the project files. In addition, all field notes except those presented on specific field forms will be neatly transcribed into Field Activity Daily Log (FADL) forms (sample attached).

Field Borehole/Monitoring Well Installation Log Form

Examples of the Field Borehole Log and Field Borehole/Monitoring Well Installation Log forms are attached to this Field Operating Procedure. One form will be completed for every boring by the Benchmark field person overseeing the drilling. At a minimum, these forms will include:

- Project name, location, and number.
- Boring number.

- Rig type and drilling method.
- Drilling dates.
- Sampling method.
- Sample descriptions, to meet the requirements of the Unified Soil Classification System (USCS) for soils and the Unified Rock Classification System (URCS) for rock.
- Results of photoionization evaluations (scan and/or headspace determinations).
- Blow counts for sampler penetration (Standard Penetration Test, N-Value).
- Drilling rate, rig chatter, and other drilling-related information, as necessary.

All depths recorded on Boring/Monitoring Well Installation Log forms will be expressed in increments tenths of feet, and not in inches.

Well Completion Detail Form

An example of this form is attached to this Field Operating Procedure. One form will be completed for every boring by the Benchmark field person overseeing the well installation. At a minimum, these forms will include:

- Project name, location, and number.
- Well number.
- Installation dates.
- Dimensions and depths of the various well components illustrated in the Well Completion Detail (attached). These include the screened interval, bottom caps or plugs, centralizers, and the tops and bottoms of the various annular materials.

- Drilling rate, rig chatter, and other drilling related information.

All depths recorded on Field Borehole/Monitoring Well Installation Logs will be expressed in tenths of feet, and not in inches.

Daily Drilling Report Form

An example of this form is attached to this Field Operating Procedure. This form should be used to summarize all drilling activities. One form should be completed for each rig for each day. These forms will include summaries of:

- Footage drilled, broken down by diameter (e.g. 200 feet of 6-inch diameter hole, 50 feet of 10-inch diameter hole).
- Footage of well and screen installed, broken down by diameter.
- Quantities of materials used, including sand, cement, bentonite, centralizers, protective casings, traffic covers, etc. recorded by well or boring location.
- Active time (hours), and activity (drilling, decontamination, development, well installation, surface completions, etc.)
- Down-time (hours) and reason.
- Mobilizations and other events.
- Other quantities that will be the basis for drilling invoices.

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

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

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

DAILY LOG				
	DATE			
	NO.			
	SHEET		OF	

FIELD ACTIVITY DAILY LOG

PROJECT NAME:	PROJECT NO.
PROJECT LOCATION:	CLIENT:
FIELD ACTIVITY SUBJECT:	
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:	

TIME	DESCRIPTION

SAMPLE

VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS:
WEATHER CONDITIONS: A.M.: P.M.:	IMPORTANT TELEPHONE CALLS:
BM/TK PERSONNEL ON SITE:	
SIGNATURE	DATE:

(CONTINUED)

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE LOG

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

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

SAMPLE

ABANDONMENT:

Volume of cement/bentonite grout required:	$V = \pi r^2 \times 7.48 =$	gallons	borehole depth =	ft.
Volume of cement/bentonite grout installed:		gallons	borehole diameter =	ft.
Has bridging of grout occurred?	☐ yes ☐ no		borehole radius =	ft.
If yes, explain resolution:				
Method of installation:				

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

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

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

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

SAMPLE

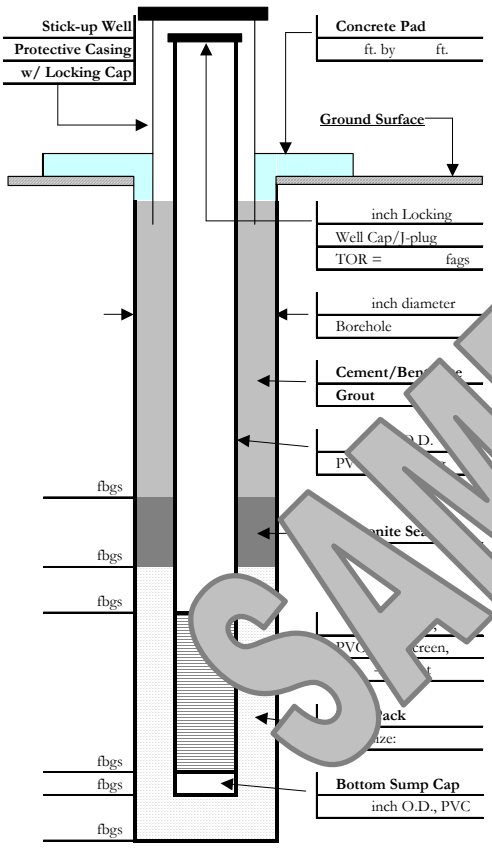
Project No:	Benchmark Environmental Engineering & Science, PLLC	Figure

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

STICK-UP WELL/PIEZOMETER COMPLETION DETAIL

Project Name:	WELL NUMBER:
Client:	Date Installed:
Boring Location:	Project Number:



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

Well Informa	
Land Surfa ation:	fmsl (approximate)
Drilling Meth	
Soil Sample Colle nod:	
Fluid:	
Fl s During Dri	gallons (approximate)

al C Cons io	
C	
S	
Pack:	
Seal:	

Dev pment	
urpose:	
Tec neque(s):	
ate Completed:	
BM/TK Personnel:	
Total Volume Purge:	gallons
Static Water Level:	fbTOR
Pump Depth:	
Purge Duration:	minutes
Yeild:	gpm
Specific Capacity:	gpm/ft

SAMPLE

Comments:

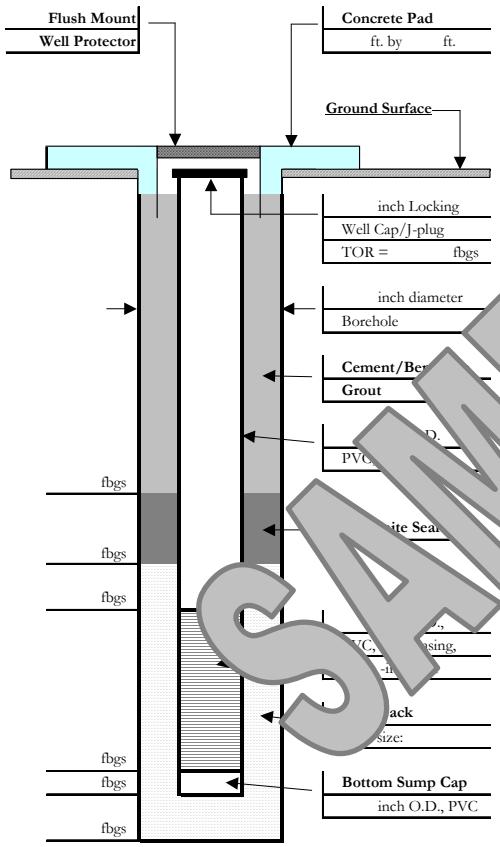
PREPARED BY: DATE:

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FLUSHMOUNT WELL/PIEZOMETER COMPLETION DETAIL

Project Name:	WELL NUMBER:
Client:	Date Installed:
Boring Location:	Project Number:



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

Well Inform	
Land Surfa ation	fmsl (approximate)
Drilling Meth	
S Sample Colle thod:	
Fluid:	
Flu During Dril	gallons (approximate)

l o Con ion	
C	
S	
Pack:	
A Seal:	

Dev opment	
W urpose:	
Technneque(s):	
Date Completed:	
BM/TK Personnel:	
Total Volume Purge:	gallons
Static Water Level:	fbTOR
Pump Depth:	
Purge Duration:	minutes
Yeild:	gpm
Specific Capacity:	gpm/ft

SAMPLE

Comments:

PREAPRED BY: DATE:

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

DAILY DRILLING REPORT

CONTRACTOR:	DATE:
DRILLING EQUIPMENT:	PROJECT:
CREW MEMBERS:	JOB NUMBER:
SITE NAME:	BM PERSONNEL:

CATEGORY	Total Hours	a.m. 6 7 8 9 10 11 12	p.m. 1 2 3 4 5 6 7 8 9 10 11 12	a.m. 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, qu…

ITEM OR SERVICE	QUANTITIES	LOCATION				TOTALS
Starting depth (fbgs)						--
Ending depth (fbgs)						--
Total footage drilled (feet)						
Drilling Method (HSA, air … ble etc.)						--
Auger/Bit size						--
CSSS starting depth (fbg…						--
CSSS ending depth (fbgs)						--
Total CSSS footage						
-inch Schedule 40 PVC screen, slot size =						
-inch Schedule 40 PVC riser						
-inch Schedule 40 PVC screen, sl…						
-inch Schedule 40 PVC riser						
-inch Schedule 40 PVC screen, slot size =						
-inch Schedule 40 PVC riser						
Sand pack, size =						
Bentonite pellets/chips, size =						
Cement/beontonite grout						
☐ Protective casing ☐ Flushmount road box						
Lockable J-plug						
Lock						

PERSONNEL TIME LOG:

POSITION	NAME	HOURS
Observer		
Drillers		

DRILLER (optional):	BM REP.

SAMPLE

BENCHMARK
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FIELD OPERATING PROCEDURES

Drill Site Selection Procedure

FOP 017.0

DRILL SITE SELECTION PROCEDURE

PURPOSE

This procedure presents a method for selecting a site location for drilling. Drill site selection should be based on the project objectives, ease of site access, freedom from obstructions and buried metallic objects (drums) and site safety (appropriate set backs from overhead and buried services).

PROCEDURE

The following procedure outlines procedures prior to drilling activities:

1. Review project objectives and tentatively select drilling locations that provide necessary information for achieving objectives (i.e., Work Plan).

2. Clear locations with property owner/operator to ensure that drilling activities will not interfere with site operations and select appropriate access routes.

3. Stake locations in the field, measure distance from locations to recognizable landmarks, such as building or fence lines and plot locations on site plan. Ensure location is relatively flat, free of overhead wires and readily accessible. Survey location if property ownership is in doubt.

4. Obtain clearances from appropriate utilities and if buried waste/metallic objects are suspected, screen location with appropriate geophysical method.

5. Establish a secure central staging area for storage of drilling supplies and for equipment decontamination. Locate a secure storage area for drilling samples, as necessary.

ATTACHMENTS

none

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FIELD OPERATING PROCEDURES

Drilling and Excavation Equipment Decontamination Procedures

FOP 018.0

DRILLING AND EXCAVATION EQUIPMENT DECONTAMINATION PROCEDURES

PURPOSE

This procedure is to be used for the decontamination of drilling and excavation equipment (i.e., drill rigs, backhoes, augers, drill bits, drill rods, buckets, and associated equipment) used during a subsurface investigation. The purpose of this procedure is to remove chemical constituents associated with a particular drilling or excavation location from this equipment. This prevents these constituents from being transferred between drilling or excavation locations, or being transported out of controlled areas.

PROCEDURE

The following procedure will be utilized prior to the use of drilling or excavation equipment at each location, and prior to the demobilization of such equipment from the site:

1. Remove all loose soil and other particulate materials from the equipment at the survey site.

2. Wrap augers, tools, plywood, and other reusable items with a plastic cover prior to transport from the site of use to the decontamination facility.

3. Transport equipment to the decontamination facility. All equipment must be decontaminated at an established decontamination facility. This facility will be placed within a controlled area, and will be equipped with necessary features to contain and collect wash water and entrained materials.

4. Wash equipment thoroughly with pressurized low-volume water or steam, supplied by a pressure washer or steam cleaner.

5. If necessary, use a brush or scraper to remove visible soils adhering to the equipment, and a non-phosphate detergent to remove any oils, grease, and/or hydraulic fluids adhering to the equipment. Continue pressure washing until all visible contaminants are removed.

6. Allow equipment to air dry.

7. Store equipment in a clean area or wrap the equipment in new plastic sheeting as necessary to ensure cleanliness until ready for use.

8. Manage all wash waters and entrained solids as described in the Benchmark Field Operating Procedure for Management of Investigation-Derived Waste.

ATTACHMENTS

none

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FIELD OPERATING PROCEDURES

Establishing Horizontal and Vertical Control

FOP 021.0

ESTABLISHING HORIZONTAL AND VERTICAL CONTROL

PURPOSE

This guideline presents a method for establishing horizontal and vertical controls at a project site. It is imperative that this procedure be performed accurately, as all topographic and site maps, monitoring well locations and test pit locations will be based on these controls.

PROCEDURE

A. Establishing Horizontal Primary and Project Control

1. Research the State Plan Coordinate, USGS or project site applicable horizontal control monuments.

2. At the project site, recover the above-mentioned monuments, two markers minimum being recovered.

3. Establish control points on the project site by bringing in the primary control points recovered in the field.

4. All control points will be tied into a closed traverse to assure the error of closure.

5. Compute closures for obtaining degree of accuracy to adjust traverse points.

B. Establishing Vertical Primary and Project Control

1. Research project or USGS datum for recovering monument(s) for vertical control if different than those previously found.

2. Recover the monuments in the field, two markers minimum being found.

3. Set the projects benchmarks.

4. Run a level line from the monuments to the set project benchmarks and back, setting turning points on all benchmarks set on site.

5. Reduce field notes and compute error of closure to adjust benchmarks set on site.

6. Prepare the recovery sketches and tabulate a list for horizontal and vertical control throughout project site.

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FIELD OPERATING PROCEDURES

Groundwater Level Measurement

FOP 022.0

GROUNDWATER LEVEL MEASUREMENT

PURPOSE

This procedure describes the methods used to obtain accurate and consistent water level measurements in monitoring wells, piezometers and well points. Water levels will be measured at monitoring wells and, if practicable, in supply wells to estimate purge volumes associated with sampling, and to develop a potentiometric surface of the groundwater in order to estimate the direction and velocity of flow in the aquifer. Water levels in monitoring wells will be measured using an electronic water level indicator (e-line) that has been checked for operation prior to mobilization.

PROCEDURE

1. Decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

2. Unlock and remove the well protective cap or cover and place on clean plastic.

3. Lower the probe slowly into the monitoring well until the audible alarm sounds. This indicates the depth to water has been reached.

4. Move the cable up and down slowly to identify the depth at which the alarm just begins to sound. Measure this depth against the mark on the lip of the well riser used as a surveyed reference point (typically the north side of the riser).

5. Read depth from the graduated cable to the nearest 0.01 foot. Do not use inches. If the e-line is not graduated, use a rule or tape measure graduated in 0.01-foot increments to measure from the nearest reference mark on the e-line cable.

6. Record the water level on a Water Level Monitoring Record (sample attached).

7. Remove the probe from the well slowly, drying the cable and probe with a clean paper wipe. Be sure to repeat decontamination before use in another well.

8. Replace well plug and protective cap or cover. Lock in place as appropriate.

ATTACHMENTS

Water Level Monitoring Record (sample)

REFERENCES

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

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

WATER LEVEL MONITORING RECORD

Project Name:	Client:
Project No.:	Location:
Field Personnel:	Date:
Weather:	

Well No.	Time	Top of Riser Elevation (fmsl)	Static Depth to Water (fbTOR)	Groundwater Elevation (fmsl)	Total Depth (fbTOR)	Last Total Depth Measurement (fbTOR)

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FIELD OPERATING PROCEDURES

Groundwater Purging Procedures Prior to Sample Collection

FOP 023.1

GROUNDWATER PURGING PROCEDURES PRIOR TO SAMPLE COLLECTION

PURPOSE

This procedure describes the methods for monitoring well/piezometer purging prior to groundwater sample collection in order to collect representative groundwater samples. The goal of purging is to remove stagnant, non-representative groundwater from the well and/or prevent stagnant water from entering collected samples. Purging involves the removal of at least three to five volumes of water in wells with moderate yields and at least one well volume from wells with low yields (slow water level recovery).

Purge and sample wells in order of least-to-most contaminated (this is not necessary if dedicated or disposable equipment is used). If you do not know this order, sample the upgradient wells first, then the furthest down-gradient or side-gradient wells, and finally the wells closest to, but down-gradient of the most contaminated area. Sampling should commence immediately following purging or as soon as the well has adequately recharged and not more than 24-hours following end time of evacuation.

PROCEDURE

1. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark Field Operating Procedure for Groundwater Level Measurement and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-disposable and Non-dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

2. Inspect the interior and exterior of the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Field Form and/or Groundwater Well Inspection Form (samples attached). Specifically, inspect

the integrity of the following: concrete surface seal, lock, protective casing and well cover, well riser and J-plug/cap. Report any irregular findings to the Project Manager.

3. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

4. Calibrate the photoionization detector (PID) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of Portable Photoionization Detector.

5. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging.

6. Lower the e-line probe slowly into the monitoring well and record the initial water level in accordance with the procedures referenced in the Benchmark Field Operating Procedure for Groundwater Level Measurement.

7. Following static water level determinations, slowly lower the e-line to the bottom of the well/piezometer. Record the total depth to the nearest 0.01-foot and compare to the previous total depth measurement. If a significant discrepancy exists, re-measure the total depth. Continue with purging activities observing purge water to determine whether the well/piezometer had become silted due to inactivity or damaged (i.e., well sand within purge water). Upon confirmation of the new total depth and determination of the cause (i.e., siltation or damage), notify the Project Manager following field activities.

8. Calculate the volume of water in the well based on the water level below the top of riser and the total depth of the well using the following equation:

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

Where,

A = Total Depth of Well (feet below measuring point)
B = Casing diameter (inches)
C = Static Water Level (feet below measuring point)

9. **For wells where the water level is 20 feet or less below the top of riser**, a peristaltic pump may be used to purge the well. Measure the purged volume using a calibrated container (i.e., graduated 5-gallon bucket) and record measurements on the attached Groundwater Well Development and Purge Log. Use new and dedicated tubing for each well. During the evacuation of shallow wells, the intake opening of the pump tubing should be positioned just below the surface of the water. As the water level drops, lower the tubing as needed to maintain flow. For higher yielding wells, the intake level should not be lowered past the top of the screen. Pumping from the top of the water column will ensure proper flushing of the well. Continue pumping until the required volumes are removed (typically three well volumes). For higher yielding wells, adjust the purging rate to maintain the water level above the screen. For lower yielding wells or wells where the screen straddles the water table, maintain purging at a rate that matches the rate of recovery of the well (well yield). If the well purges to dryness and is slow to recharge (greater than 15 minutes), terminate evacuation. **A peristaltic pump and dedicated tubing cannot be used to collect VOC or SVOC project-required samples; only non-organic compounds may be collected using this type of pump.**

10. **For wells where the water level is initially below 20 feet,** or drawn down to this level because of slow recharge rate, conduct purging using one of three devices listed below:

- Bailer – A bottom filling dedicated polyethylene bailer attached to a length of dedicated hollow-braid polypropylene rope. Purging a well utilizing a bailer should be conducted smoothly and slowly as not to agitate the groundwater or damage the well.

- Well Wizard Purge Pump (or similar) – This pneumatic bladder pump uses compressed air to push water to the surface. Groundwater is not in contact

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

- Submersible Pump (12 or 24 volt, or similar) – These submersible pumps are constructed of PVC or stainless steel and are capable of pumping up to 70 feet from ground surface using a 12 volt battery (standard pump) and standard low flow controller. For depths up to 200 feet from ground surface, a high performance power booster controller is used with a 12 volt battery. Unless these pumps are dedicated to the monitoring well location, decontamination between locations is necessary and an equipment blank may be required.

- Waterra™ Pump – This manually operated pump uses dedicated polyethylene tubing and a check valve that can be used as an optional method for purging deeper wells. The pump utilizes positive pressure to evacuate the well, therefore the pump may be used for sample collection, and however over-agitation groundwater should be avoided.

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

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

Field Parameter	Stabilization Criteria
Dissolved Oxygen	± 0.3 mg/L
Turbidity	± 10 %
Specific Conductance	± 3 %
Eh	± 10 mV
PH	± 0.1 unit

Stabilization criteria presented within the project Work Plan will take precedence.

DOCUMENTATION AND SAMPLE COLLECTION

This section pertains to the documentation of collected field data during and following purging activities and sample collection.

1. Record all data including the final three stable readings for each indicator parameter on the attached Groundwater Well Purge & Sample Log.

2. Record, at a minimum, the "volume purged," "purging stop-time," "purged dry (Y/N)," "purged below sand pack (Y/N)," and any problems purging on the attached Groundwater Well Purge & Sample Log.

3. Collect groundwater samples in accordance with the Benchmark Field Operating Procedure for Groundwater Sample Collection. Record "sample flow rate" as an average, "time sample collected," and any other pertinent information related to the sampling event on the attached Groundwater Well Purge & Sample Log.

4. Restore the well to its capped/covered and locked condition.

ALTERNATIVE METHODS

Alternative purging and sampling methods and equipment, other than those described herein are acceptable if they provide representative groundwater samples. The purging and sampling method and equipment must not adversely affect sample integrity, chemistry, temperature, and turbidity. In addition, alternative equipment must have minimal or no effect on groundwater geochemistry, aquifer permeability and well materials. Equipment materials must also minimize sorption and leaching. The field team is responsible for documenting and describing any alternative equipment and procedures used to purge a well and collect samples.

ATTACHMENTS

Groundwater Field Form
Groundwater Well Inspection Form

REFERENCES

Benchmark FOPs:

011 *Calibration and Maintenance of Portable Photoionization Detector*
022 *Groundwater Level Measurement*
024 *Groundwater Sample Collection Procedures*
040 *Non-disposable and Non-dedicated Sampling Equipment Decontamination*

GROUNDWATER PURGING PROCEDURES PRIOR TO SAMPLE COLLECTION

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

GROUNDWATER FIELD FORM

Project Name: Date:

Location: Project No.: Field Team:

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

SAMPLE

REMARKS:

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

Volume Calculation

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

Stabilization Criteria

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

PREPARED BY:

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

GROUNDWATER WELL INSPECTION FORM

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

EXTERIOR INSPECTION

Protective Casing:
Lock:
Hinge/Lid:
Concrete Surface Seal:
Bollards:
Label/I.D.:
Other:

INTERIOR INSPECTION

Well Riser:
Annular Space:
Well Cap:
Water Level (fbTOR):
Total Depth (fbTOR):
Other:

Comments/Corrective Actions:

PREPARED BY: DATE:

SAMPLE

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FIELD OPERATING PROCEDURES

Groundwater Sample Collection Procedures

FOP 024.1

GROUNDWATER SAMPLE COLLECTION PROCEDURES

PURPOSE

This procedure describes the methods for collecting groundwater samples from monitoring wells and domestic supply wells following purging and sufficient recovery. This procedure also includes the preferred collection order in which water samples are collected based on the volatilization sensitivity or suite of analytical parameters required.

PROCEDURE

Allow approximately 3 to 10 days following well development before performing purge and sample activities at any well location. Conversely, perform sampling as soon as practical after sample purging at any time after the well has recovered sufficiently to sample, or within 24 hours after evacuation, if the well recharges slowly. If the well does not yield sufficient volume for all required laboratory analytical testing (including quality control), a decision should be made to prioritize analyses based on contaminants of concern at the site. If the well takes longer than 24 hours to recharge, the Project Manager should be consulted. The following two procedures outline sample collection activities for monitoring and domestic type wells.

Monitoring Wells

1. Purge the monitoring well in accordance with the Benchmark FOPs for Groundwater Purging Procedures Prior to Sample Collection or Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedures. Perform sampling as soon as practical after purging at any time after the well has recovered sufficiently to sample, or within 24 hours after evacuation, if the well recharges slowly. If the well does not yield sufficient volume for all required laboratory analytical testing (including quality control), a decision should be made to prioritize analyses based on contaminants of concern at the site. Analyses will be prioritized in the order of the parameters volatilization sensitivity. After volatile organics have been collected, field parameters

must be measured from the next sample collected. If a well takes longer than 24 hours to recharge, the Project Manager should be consulted.

2. Sampling equipment that is not disposable or dedicated to the well will be decontaminated in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

3. Calibrate all field meters (i.e., pH/Eh, turbidity, specific conductance, dissolved oxygen, PID etc.) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of the specific field meter.

4. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark Field Operating Procedure for Groundwater Level Measurement and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-disposable and Non-dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

5. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Field Form (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.

6. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

7. Calibrate the photoionization detector (PID) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of Portable Photoionization Detector.

8. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging. Record PID measurements on a well-specific Groundwater Field Form (sample attached).

9. Lower the e-line probe slowly into the monitoring well and record the measurement on a well-specific Groundwater Field Form (sample attached).

10. Groundwater samples will be collected directly from the sampling valve on the flow through cell (low-flow), discharge port of a standard pump assembly (peristaltic, pneumatic, submersible, or Waterra™ pump) or bailer (stainless steel, PVC or polyethylene) into appropriate laboratory provided containers. In low-yielding wells at which the flow through cell is not used, the samples may be collected using a disposable bailer. **A peristaltic pump and dedicated tubing cannot be used to collect VOC or SVOC project-required samples; only non-organic compounds may be collected using this type of pump.**

11. If disposable polyethylene bailers are used, the bailer should be lowered *slowly* below the surface of the water to minimize agitation and volatilization. For wells that are known to produce turbid samples (values greater than 50 NTU), the bailer should be lowered and retrieved at a rate that limits surging of the well.

12. Sampling data will be recorded on a Groundwater Field Form (sample attached).

13. Pre-label all sample bottles in the field using a waterproof permanent marker in accordance with the Benchmark Sample Labeling, Storage, and Shipment FOP. The following information, at a minimum, should be included on the label:

    - Project Number;
    - Sample identification code (as per project specifications);
    - Date of sample collection (mm, dd, yy);
    - Time of sample collection (military time only) (hh:mm);
    - Specify "grab" or "composite" sample type;
    - Sampler initials;
    - Preservative(s) (if applicable); and
    - Analytes for analysis (if practicable).

14. Collect a separate sample of approximately 200 ml into an appropriate container prior to collecting the first and following the last groundwater sample collected to measure the following field parameters:

Parameter	Units
Dissolved Oxygen	parts per million (ppm)
Specific Conductance	μmhos/cm or μS or mS
pH	pH units
Temperature	^{o}C or ^{o}F
Turbidity	NTU
Eh (*optional*)	mV
PID VOCs (*optional*)	ppm

Record all field measurements on a Groundwater Field Form (sample attached).

15. Collect samples into pre-cleaned bottles provided by the analytical laboratory with the appropriate preservative(s) added based on the volatilization sensitivity or suite of analytical parameters required, as designated in the **Sample Collection Order** section below.

16. Lower the e-line probe slowly into the monitoring well and record the measurement on a well-specific Groundwater Field Form (sample attached).

17. The samples will be labeled, stored, and shipped in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage, and Shipment Procedures.

Domestic Supply Wells

1. Calculate or estimate the volume of water in the well. It is desirable to purge at least one casing volume before sampling. This is controlled, to some extent, by the depth of the well, well yield and the rate of the existing pump. If the volume of water in the well cannot be calculated, the well should be purged continuously for no less than 15 minutes.

2. Connect a sampling tap to an accessible fitting between the well and the pressure tank where practicable. A hose will be connected to the device and the hose discharge located 25 to 50 feet away. The well will be allowed to pump until the lines and one

well volume is removed. Flow rate will be measured with a container of known volume and a stopwatch.

3. Place a clean piece of polyethylene or Teflon™ tubing on the sampling port and collect the samples in the order designated below and in the sample containers supplied by the laboratory for the specified analytes. ***DO NOT*** use standard garden hose to collect samples.

4. Sampling results and measurements will be recorded on a Groundwater Field Form (sample attached) as described in the previous section.

5. Collect samples into pre-cleaned bottles provided by the analytical laboratory with the appropriate preservative(s) added based on the volatilization sensitivity or suite of analytical parameters required, as designated in the **Sample Collection Order** section below.

6. The samples will be labeled, stored, and shipped in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage, and Shipment Procedures.

SAMPLE COLLECTION ORDER

All groundwater samples, from monitoring wells and domestic supply wells, will be collected in accordance with the following.

1. Samples will be collected preferentially in recognition of volatilization sensitivity. The preferred order of sampling if no free product is present is:

    - Field parameters
    - Volatile Organic Compounds (VOCs)
    - Purgeable organic carbons (POC)
    - Purgeable organic halogens (POH)
    - Total Organic Halogens (TOX)
    - Total Organic Carbon (TOC)
    - Extractable Organic Compounds (i.e., BNAs, SVOCs, etc.)
    - Total petroleum hydrocarbons (TPH) and oil and grease

- PCBs and pesticides
- Total metals (Dissolved Metals)
- Total Phenolic Compounds
- Cyanide
- Sulfate and Chloride
- Turbidity
- Nitrate (as Nitrogen) and Ammonia
- Preserved inorganics
- Radionuclides
- Unpreserved inorganics
- Bacteria
- Field parameters

2. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Field Form (sample attached).
3. 1,4-dioxane will be analyzed via the 8270 SIM method.

DOCUMENTATION

The three words used to ensure adequate documentation for groundwater sampling are accountability, controllability, and traceability. Accountability is undertaken in the sampling plan and answers the questions who, what, where, when, and why to assure that the sampling effort meets its goals. Controllability refers to checks (including QA/QC) used to ensure that the procedures used are those specified in the sampling plan. Traceability is documentation of what was done, when it was done, how it was done, and by whom it was done, and is found in the field forms, Project Field Book, and chain-of-custody forms. At a minimum, adequate documentation of the sampling conducted in the field consists of an entry in the Project Field Book (with sewn binding), field data sheets for each well, and a chain-of-custody form.

As a general rule, if one is not sure whether the information is necessary, it should nevertheless be recorded, as it is impossible to over-document one's fieldwork. Years may go by before the documentation comes under close scrutiny, so the documentation must be capable of defending the sampling effort without the assistance or translation of the sampling crew.

The minimum information to be recorded daily with an indelible pen in the Project Field Book and/or field data sheets includes date and time(s), name of the facility, name(s) of the sampling crew, site conditions, the wells sampled, a description of how the sample shipment was handled, and a QA/QC summary. After the last entry for the day in the Project Field Book, the Field Team Leader should sign the bottom of the page under the last entry and then draw a line across the page directly under the signature.

PRECAUTIONS/RECOMMENDATIONS

The following precautions should be adhered to prior to and during sample collection activities:

- Field vehicles should be parked downwind (to avoid potential sample contamination concerns) at a minimum of 15 feet from the well and the engine turned off prior to PID vapor analysis and VOC sample collection.

- Ambient odors, vehicle exhaust, precipitation, or windy/dusty conditions can potentially interfere with obtaining representative samples. These conditions should be minimized and should be recorded in the field notes. Shield sample bottles from strong winds, rain, and dust when being filled.

- The outlet from the sampling device should discharge below the top of the sample's air/water interface, when possible. The sampling plan should specify

how the samples will be transferred from the sample collection device to the sample container to minimize sample alterations.

- The order of sampling should be from the least contaminated to the most contaminated well to reduce the potential for cross contamination of sampling equipment (see the Sampling Plan or Work Plan).

- Samples should not be transferred from one sampling container to another.

- Sampling equipment must not be placed on the ground, because the ground may be contaminated and soil contains trace metals. Equipment and supplies should be removed from the field vehicle only when needed.

- Smoking and eating should not be allowed until the well is sampled and hands are washed with soap and water, due to safety and possibly sample contamination concerns. These activities should be conducted beyond a 15-foot radius of the well.

- No heat-producing or electrical instruments should be within 15 feet of the well, unless they are intrinsically safe, prior to PID vapor analysis.

- Minimize the amount of time that the sample containers remain open.

- Do not touch the inside of sample bottles or the groundwater sample as it enters the bottle. Disposable gloves may be a source of phthalates, which could be introduced into groundwater samples if the gloves contact the sample.

- Sampling personnel should use a new pair of disposable gloves for each well sampled to reduce the potential for exposure of the sampling personnel to contaminants and to reduce sample cross contamination. In addition, sampling personnel should change disposable gloves between purging and sampling operations at the same well.

- Sampling personnel should not use perfume, insect repellent, hand lotion, etc., when taking groundwater samples. If insect repellent must be used, then sampling personnel should not allow samples or sampling equipment to contact the

repellent, and it should be noted in the documentation that insect repellent was used.

- Complete the documentation of the well. A completed assemblage of paperwork for a sampling event includes the completed field forms, entries in the Project Field Book (with a sewn binding), transportation documentation (if required), and possibly chain-of-custody forms.

ATTACHMENTS

Groundwater Field Form (sample)

REFERENCES

1. Wilson, Neal. *Soil Water and Ground Water Sampling*, 1995

Benchmark FOPs:

007 Calibration and Maintenance of Portable Dissolved Oxygen Meter
008 Calibration and Maintenance of Portable Field pH/Eh Meter
009 Calibration and Maintenance of Portable Field Turbidity Meter
011 Calibration and Maintenance of Portable Photoionization Detector
012 Calibration and Maintenance of Portable Specific Conductance Meter
022 Groundwater Level Measurement
023 Groundwater Purging Procedures Prior to Sample Collection (optional)
031 Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedures (optional)
040 Non-Disposable and Non-Dedicated Sampling Equipment Decontamination
046 Sample Labeling, Storage and Shipment Procedures

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

GROUNDWATER FIELD FORM

Project Name: Date:

Location: Project No.: Field Team:

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

SAMPLE

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

REMARKS:

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

Volume Calculation

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

Stabilization Criteria

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

PREPARED BY:

Benchmark Environmental Engineering & Science, PLLC

Field Operating Procedures

PFAS Groundwater/Surface Water Sample Collection Procedures

FOP 024.3

PFAS GROUNDWATER/ SURFACE WATER SAMPLE COLLECTION PROCEDURES

PURPOSE

This procedure describes the methods for collecting per-and polyfluoroalkyl substances (PFAS) groundwater samples from monitoring wells, following purging and sufficient recovery, and surface water locations. This procedure is specific to sites where PFAS sample analysis is required, and analysis specific collection and handling procedures are needed. PFAS sample analysis will be completed when Site analysis requires sampling of the full TAL/TCL analyte list. This field operating procedure (FOP) describes the personal protective equipment (PPE) and sampling equipment/materials appropriate for PFAS sample collection. PFAS laboratory analysis is performed using extremely low detection limits (parts per trillion). Therefore, cross contamination from potential sources (i.e., field equipment, consumer products) must be minimized to the extent possible.

PROCEDURE

Prior to sampling, discuss with the Site's Project Manager whether the monitoring wells that are to be sampled for the PFAS analytical parameters are new monitoring wells or existing monitoring wells. The specific handing and collection procedures for PFAS sampling are solely based on job preparation and sampling equipment used for the job. The standard practice of a 10 volume surge and purge of a newly installed monitoring well for development as discussed in Benchmark's FOP 036.0 – Monitoring Well Development Procedures and three volume well purge and/or low flow sampling that are discussed in Benchmark's FOP 023.1 – Groundwater Procedures Prior to Sample Collection remain the same. FOP 064.0 – Surface Water Sampling Procedures remains the same with the exceptions made in this FOP for PFAS sampling. The field sampling personnel must be prepared with appropriate clothing, equipment, and sampling containers for PFAS sampling as discussed below.

FIELD CLOTHING

Unacceptable Field Clothing

- No Gore-Tex®, this includes but not limited to boots, gloves, coveralls, hats, and coats.
- No Tyvex®, this includes but not limited to coveralls, boots, hoods and head coverings. Tyvex® is also found in everyday items such as envelopes, receipts, and adhesives.
- No clothes, jackets, boots, or gloves that have been pretreated with Teflon® water proofing. Teflon® can be found in everyday items such as scissors, plumbers' tape, adhesive tapes, Teflon ® paper for crafting and cookware utensils.
- No clothing that has been waterproofed with PFAS materials
- No brand-new unwashed cotton clothing.
- Clothing that has been washed with fabric softeners prior to sampling.

Acceptable Field Clothing

- Well-worn, washed clothes, jackets, hats, and coveralls without fabric softener usage.
- Rain Gear made from PVC, polyurethane, or rubber only (it cannot contain any of the products listed above).
- Disposable powder free nitrile gloves.

FIELD EQUIPMENT

Unacceptable Field Equipment

- Sampling Equipment containing Teflon® or Low-Density Polyethylene (LDPE). Sampling equipment that may contain these materials include submersible pumps, bailers, tubing, braided poly rope or cord, fishing line.

- No LDPE or glass lined sampling containers, or Teflon®-lined caps.
- Waterproof field books, binders, plastic clip boards, spiral hard cover notebooks.
- No adhesives or permanent makers can be used (i.e., Post-It® notes and Sharpies).
- No Aluminum foil or sampling tins.
- No blue ice packs
- Avoid using paper towels

Acceptable Field Equipment

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

Acceptable Field Equipment (continued)

- Sampling Equipment (i.e. bailers) made from Poly Vinyl Chloride (PVC)
- Nylon rope/twine
- Ice
- Alconox

ADDITIONAL PROCEDURES

- Keep all bottle ware in a dedicated cooler containing only PFAS sample containers.
- Avoid consumption of food or drink prior to and during the sampling event.
- Do not apply cosmetics or moisturizers prior to sampling.

- Do not use standard commercial sunscreen or insect repellents. Use only all natural or organic products.
- Collect PFAS sample from each location prior to collecting other samples for analysis to avoid contact with other sample containers and packing materials.
- New disposable nitrile gloves will be donned at each sampling location.
- Don new disposable nitrile gloves while handling empty sample containers, filling sampling containers, sealing sample containers, and placing containers into sampling coolers.
- Single use (dedicated) or disposable sampling equipment is preferred when multiple locations are sampled.
- Perform a standard two-step decontamination using Alconox detergent and laboratory provided PFAS-free water for all non-dedicated sampling equipment.
- Equipment blanks should be comprised of laboratory provided PFAS-free water. The water should be poured over and/or brought into direct contact with all sampling equipment (bailer, rope, tubing, gloves, water level meter, etc.). The equipment blank will then be sealed and returned to the sample cooler. One equipment blank will be collected each day PFAS samples are collected, or once every 20 samples, whichever is more frequent. Additional equipment blanks may be collected as needed.
- One field duplicate and one matrix spike/matrix spike duplicate (MS/MSD) will be collected for every 20 samples.
- Field blanks should be comprised of laboratory provided PFAS-free water. The field blank should be uncapped and placed near the field crew while purging/sampling preparations take place (i.e. prepare bottle set, calibrate groundwater quality meters, prepare bailers for sampling, etc.). The intent of the uncapped blank is to capture any ambient PFAS compounds that may emanate from the field crew or equipment during typical preparations associated with groundwater/surface water sampling. The field blank will then be capped and returned to the sample cooler.

ATTACHMENTS

Groundwater Field Form (sample)
Surface Water Quality Field Collection Log (Sample)

REFERENCES

Benchmark FOPs:
036.0 Monitoring Well Development Procedures
023.1 Groundwater Purging Procedures Prior to Sample Collection
064.0 Surface Water Sampling Procedures

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

GROUNDWATER FIELD FORM

Project Name: Date:

Location: Project No.: Field Team:

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

SAMPLE

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

REMARKS:

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

Volume Calculation

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

Stabilization Criteria

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

PREPARED BY:

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

SURFACE WATER QUALITY FIELD COLLECTION LOG

PROJECT INFORMATION

Project Name:

Project No.:

Client:

SAMPLE DESCRIPTION

I.D.:

Matrix:

Location:

SAMPLE INFORMATION

Date Collected:

Time Collected:

Date Shipped to Lab:

Collected By:

Sample Collection Method:

LABORATORY ANALYSIS

SAMPLING INFORMATION

Weather:

Air Temperature:

Depth of Sample:

LOCATION SKETCH

(not to scale, dimensions are approximate)

Parameter	First	Last	Units
pH			units
Temp.			°C
Cond.			mS
Turbidity			NTU
Eh			mV
D.O.			ppm
Odor			olfactory
Appearance			visual

EXACT LOCATION (if applicable)

Northing (ft)	Easting (ft)	Surface Elevation (fmsl)

ADDITIONAL LABORATORY ANALYSIS:

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

SAMPLE

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
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FIELD OPERATING PROCEDURES

Hollow Stem Auger Drilling Procedures

FOP 026.1

HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES

PURPOSE

This guideline presents a method for drilling a borehole through unconsolidated materials, including soils or overburden, and consolidated materials, including bedrock.

PROCEDURE

The following procedure will be used to drill a borehole for sampling and/or well installation, using hollow-stem auger methods and equipment.

1. Follow Benchmark's Field Operating Procedure for Drill Site Selection Procedure prior to implementing any drilling activity.

2. Perform drill rig safety checks with the driller by completing the Drilling Safety Checklist form (sample attached).

3. Conduct tailgate health and safety meeting with project team and drillers by completing the Tailgate Safety Meeting Form.

4. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures (i.e., PID, FID, combustible gas meter) or manufacturer's recommendations for calibration of field meters (i.e., DataRAM 4 Particulate Meter).

5. Ensure all drilling equipment (i.e., augers, rods, split-spoons) appear clean and free of soil prior to initiating any subsurface intrusion. Decontamination of drilling equipment should be in accordance with Benchmark's FOP: Drilling and Excavation Equipment Decontamination Procedures.

6. Mobilize the auger rig to the site and position over the borehole.

7. Level and stabilize the rig using the rig jacks, and recheck the rig location against the planned drilling location. If necessary, raise the jacks and adjust the rig position.

8. Place a metal or plywood auger pan over the borehole location to collect the auger cuttings. This auger pan will be equipped with a 12-inch nominal diameter hole for auger passage. As an alternative, a piece of polyethylene tarp may be used as a substitute.

9. Advance augers into the subsurface. For sampling or pilot-hole drilling, nominal 8-inch outside diameter (OD) augers should be used. The boring diameter will be approved by the Benchmark field supervisor.

10. Collect soil samples via split spoon sampler in accordance with Benchmark's Field Operating Procedure for Split Spoon Sampling.

11. Check augers periodically during drilling to ensure the boring is plumb. Adjust rig position as necessary to maintain plumb.

12. Continue drilling until reaching the assigned total depth, or until auger refusal occurs. Auger refusal is when the drilling penetration drops below 0.1 feet per 10 minutes, with the full weight of the rig on the auger bit, and a center bit (not center plug) in place.

13. Plug and abandon boreholes not used for well installation in accordance with Benchmark's Field Operating Procedure for Abandonment of Borehole.

OTHER PROCEDURAL ISSUES

- Slip rings may be used for lifting a sampling or bit string. The string will not be permitted to extend more than 15 feet above the mast crown.

- Borings will not be over drilled (rat holed) without the express permission of the Benchmark field supervisor. All depth measurements should be accurate to the nearest 0.1 foot, to the extent practicable.

- Potable water may be placed in the auger stem if critically necessary for borehole control or to accomplish sampling objectives and must be approved by the Benchmark Project Manager and/or NYSDEC Project Manager. Upon approval,

the potable water source and quantity used will be documented in the Project Field Book and subsequent report submittal.

ATTACHMENTS

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

REFERENCES

Benchmark FOPs:

001 *Abandonment of Borehole Procedures*
010 *Calibration and Maintenance of Portable Flame Ionization Detector*
011 *Calibration and Maintenance of Portable Photoionization Detector*
017 *Drill Site Selection Procedure*
018 *Drilling and Excavation Equipment Decontamination Procedures*
058 *Split Spoon Sampling Procedures*

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**	Date:
Project No.: **0041-009-500**	Drilling Company:
Client: **RealCo., Inc.**	Drill Rig Type:

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

SAMPLE

ITEMS TO CHECK	OK	ACTION NEEDED

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**	Date:
Project No.: **0041-009-500**	Drilling Company:
Client: **RealCo., Inc.**	Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
The work area around the borehole shall be kept clear of trip hazards and walking surfaces should be free of slippery material.		
Workers shall not proceed higher than the drilling deck without a fall restraining device and must attach the device in a manner to restrict fall to less than 6 feet.		
A fire extinguisher of appropriate size shall be immediately available to the drill crew. The drill crew shall have received annual training on proper use of the fire extinguisher.		
29 CFR 1910.333 © (3) Except where electrical distribution and transmission lines have been de-energized and visibly grounded, drill rigs will be operated proximate to, under, by, or near power lines only in accordance with the following: .333 © (3) (ii) 50 kV or less -minimum clearance is 10 ft. For 50 kV or over - 10ft. Plus ½ in. For each additional kV **Benchmark Policy: Maintain 20 feet clearance**		
29 CFR 1910.333 © (3) (iii) While the rig is in transit with the boom in the down position, clearance from energized power lines will be maintained as follows: Less than 50 kV - 4 feet 50 to 365 kV - 10 feet 365 to 720 kV - 16 feet		

SAMPLE

Name: _____ (printed)

Signed: _____ Date: _____

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

TAILGATE SAFETY MEETING FORM

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

HOSPITAL INFORMATION:

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

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

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

New Equipment:

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

SAMPLE

ATTENDEES

Name Printed	Signatures

Meeting conducted by:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

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

FOP 031.2

LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

PURPOSE

This procedure describes the methods used for performing low flow (minimal drawdown) purging, also referred to as micro-purging, at a well prior to groundwater sampling to obtain a representative sample from the water-bearing zone. This method of purging is used to minimize the turbidity of the produced water. This may increase the representativeness of the groundwater samples by avoiding the necessity of filtering suspended solids in the field prior to preservation of the sample.

Well purging is typically performed immediately preceding groundwater sampling. The sample should be collected as soon as the parameters measured in the field (i.e., pH, specific conductance, dissolved oxygen, Eh, temperature, and turbidity) have stabilized.

PROCEDURE

Allow approximately 3 to 10 days following well development for groundwater to return to static conditions before performing low-flow purge and sample activities at any well location. Conversely, perform low-flow sampling as soon as purged groundwater has stabilized. If the well does not yield sufficient volume (i.e., cannot maintain a constant water level during purging) for low-flow purge and sampling, then an alternative method must be performed in accordance with Benchmark's Groundwater Purging Procedures Prior to Sample Collection FOP.

1. Water samples should not be taken immediately following well development. Sufficient time should be allowed to stabilize the groundwater flow regime in

the vicinity of the monitoring well. This lag time will depend on site conditions and methods of installation but may exceed one week.

2. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark's Groundwater Level Measurement FOP and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

3. Calibrate all sampling devices and monitoring equipment in accordance with manufacturer's recommendations, the site Quality Assurance Project Plan (QAPP) and/or Field Sampling Plan (FSP). Calibration of field instrumentation should be followed as specified in Benchmark's Calibration and Maintenance FOP for each individual meter.

4. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Field Form (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.

5. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

6. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging.

7. Lower the e-line probe slowly into the monitoring well and record the initial water level in accordance with the procedures referenced in Benchmark's Groundwater Level Measurement FOP. Refer to the construction diagram for the well to identify the screened depth.

8. Decontaminate all non-dedicated pump and tubing equipment following the procedures referenced in the Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP.

9. Lower the purge pump or tubing (i.e., low-flow electrical submersible, peristaltic, etc.) slowly into the well until the pump/tubing intake is approximately in the middle of the screened interval. Rapid insertion of the pump will increase the turbidity of well water, and can increase the required purge time. This step can be eliminated if dedicated tubing is already within the well.

   Placement of the pump close to the bottom of the well will cause increased entrainment of solids, which may have settled in the well over time. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval. The objective of low-flow purging is to maintain a purging rate, which minimizes stress (drawdown) of the water level in the well. Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen.

10. Lower the e-line back down the well as water levels will be frequently monitored during purge and sample activities.

11. Begin pumping to purge the well. The pumping rate should be between 100 and 500 milliliters (ml) per minute (0.03 to 0.13 gallons per minute) depending on site hydrogeology. Periodically check the well water level with the e-line adjusting the flow rate as necessary to stabilize drawdown within the well. If possible, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 feet or less). If the water level exceeds 2 feet below static and declining, slow the purge rate until the water level generally stabilizes. Record each pumping rate and water level during the event. If the water level continues to drop and will not stabilize, the monitoring location is not conducive to low-flow sampling and conventional purge and sample methods should be performed.

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

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

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

13. Purging will continue until parameters of water quality have stabilized or at least a minimum of three (3) well volumes have been removed. Record measurements for field indicator parameters (including water levels) at regular intervals during purging. The stability of these parameters with time can be used to guide the decision to discontinue purging. Proper adjustments must be made to stabilize the flow rate as soon as possible.

14. Record well purging and sampling data in the Project Field Book or on the Groundwater Field Form (sample attached). Measurements should be taken approximately every three to five minutes, or as merited given the rapidity of change.

15. Purging is complete when field indicator parameters stabilize. Stabilization is achieved after all field parameters have stabilized for three successive readings. Three successive readings should be within ± 0.1 units for pH, ± 3% for specific conductance, ± 10 mV for Eh, and ± 10% for turbidity and dissolved oxygen. These stabilization guidelines are provided for rough estimates only, actual site-specific knowledge may be used to adjust these requirements higher or lower.

    An in-line water quality measurement device (e.g., flow-through cell) should be used to establish the stabilization time for several field parameters on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

16. Collect all project-required samples from the discharge tubing at the flow rate established during purging in accordance with Benchmark's Groundwater Sample Collection Procedures FOP. **A peristaltic pump and dedicated tubing cannot be used to collect VOC or SVOC project-required samples; only non-organic compounds may be collected using this type of pump.** Continue to maintain a constant flow rate such that the water level is not drawn down as described above. Fill sample containers with minimal turbulence by allowing the ground water to flow from the tubing along the inside walls of the container.

17. If field filtration is recommended as a result of increased turbidity greater than 50 NTU, an in-line filter equipped with a 0.45-micron filter should be utilized. Collection of a filtered sample must be accompanied by an unfiltered sample.

18. Replace the dedicated tubing down the well taking care to avoid contact with the ground surface.

19. Restore the well to its capped/covered and locked condition.

20. Upon purge and sample collection completion, slowly lower the e-line to the bottom of the well/piezometer. Record the total depth to the nearest 0.01-

foot and compare to the previous total depth measurement. If a significant discrepancy exists, re-measure the total depth. Record observations of purge water to determine whether the well/piezometer had become silted due to inactivity or damaged (i.e., well sand within purge water). Upon confirmation of the new total depth and determination of the cause (i.e., siltation or damage), notify the Project Manager following project field activities.

ATTACHMENTS

Groundwater Field Form (sample)

REFERENCES

United States Environmental Protection Agency, 540/S-95/504, 1995. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.*

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*

LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

GROUNDWATER FIELD FORM

Project Name: Date:

Location: Project No.: Field Team:

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

SAMPLE

REMARKS:

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

Volume Calculation

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

Stabilization Criteria

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

PREPARED BY:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Management of Investigative-Derived Waste (IDW)

FOP 032.2

MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

PURPOSE

The purpose of these guidelines is to ensure the proper holding, storage, transportation, and disposal of materials generated from field investigation activities that may contain hazardous wastes. Investigation-derived waste (IDW) includes the following:

- Drill cuttings, discarded soil samples, drilling mud solids, and used sample containers.
- Well development and purge waters and discarded groundwater samples.
- Decontamination waters and associated solids.
- Soiled disposable personal protective equipment (PPE).
- Used disposable sampling equipment.
- Used plastic sheeting and aluminum foil.
- Other equipment or materials that either contain or have been in contact with potentially impacted environmental media.

Because these materials may contain regulated chemical constituents, they must be managed as a solid waste. This management may be terminated if characterization analytical results indicate the absence of these constituents.

PROCEDURE

1. Contain all investigation-derived wastes in Department of Transportation (DOT)-approved 55-gallon drums, roll-off boxes, or other containers suitable for the wastes.

2. Contain wastes from separate borings or wells in separate containers (i.e. do not combine wastes from several borings/wells in a single container, unless it is a container used specifically for transfer purposes, or unless specific permission to do so has been provided by the 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 NYSDEC Project Manager approval, dispose of investigation-derived wastes as follows:

- Soil, water, and other environmental media for which analysis does not detect organic constituents, and for which inorganic constituents are at levels that meet the Site's cleanup objectives, may be spread on the Property or otherwise treated as a non-waste material. Disposal quantity and on-site location will be documented on Project Field Books and in the project report submittal.

- Soil, water, and other environmental media in which organic compounds are detected or metals are present above the Site's cleanup objectives will be disposed off-site in accordance with applicable state and federal regulations. Disposal quantity and off-site location will be documented on Project Field Books and in the project report submittal.

- Personal protective equipment, disposable bailers, and similar equipment may be disposed as municipal waste, unless waste characterization results mandate otherwise.

WASTE STORAGE MANAGEMENT

Hazardous materials generated on site should be temporarily stored in a secure location that is under the control of the owner/operator or does not allow for vandalism (i.e., within a locked building structure or within a locked fenced in area). A waste-staging area should be designated on-site by the Project Manager in conjunction with the owner/operator.

ATTACHMENTS

Investigation Derived Waste Container Log (sample)
Investigation Derived Waste Container Label (sample)

REFERENCES

None

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INVESTIGATION DERIVED WASTE CO

Project Name: Location:

Project Number: Personnel:

Container		Contents	Date		Staging Location	Date Sampled	Co
Number	Description		Started	Ended			

SAMPLE

Prepared By:

Signed:

IDW Container Label (sample):

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Project Name:
Project Number:

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

Contact Name:
Contact Phone Number:

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FIELD OPERATING PROCEDURES

Monitoring Well Construction in Bedrock

FOP 035.0

MONITORING WELL CONSTRUCTION IN BEDROCK

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.

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. <u>Screened Installations</u>

a. Ream NX core hole to nominal 4-inch diameter with 3 ⅞-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 co0mplete, 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.

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

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.)

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 s4eal 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 though 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

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

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

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

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

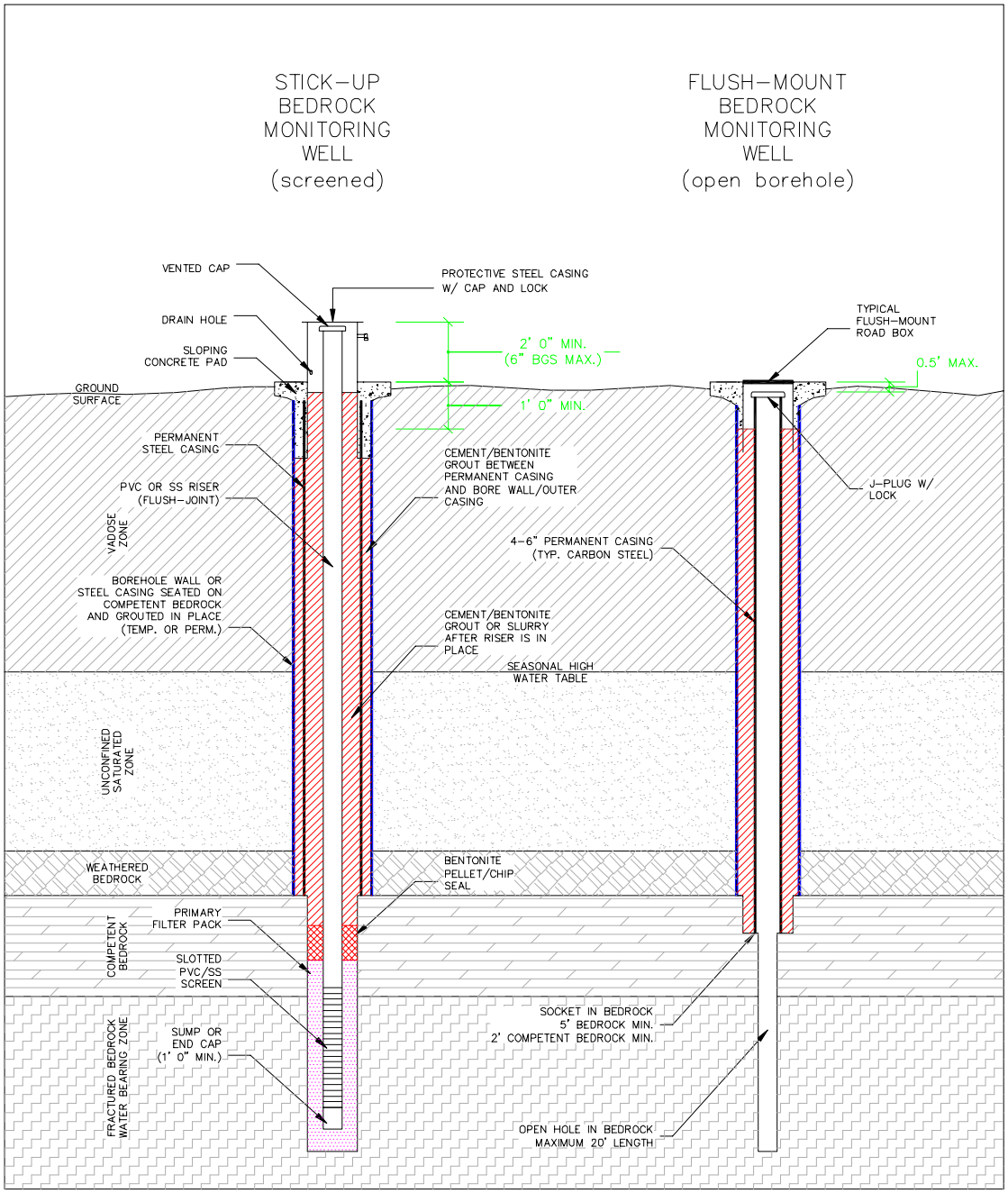
Depth (fbgs)	SAMPLES: Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Plasti Fabric, Bedding, Weathering/Fracturing, Odor, Oth SURFACE ELEVATION (FMSL):	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS

SAMPLE

Project No:	Benchmark Environmental Engineering & Science, PLLC	Figure

MONITORING WELL CONSTRUCTION IN BEDROCK

FIGURE 1



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FIELD OPERATING PROCEDURES

Monitoring Well Development Procedures

FOP 036.0

MONITORING WELL DEVELOPMENT PROCEDURES

PURPOSE

This procedure describes the methods for the development of newly installed monitoring wells and re-development of existing monitoring wells that have been inactive for an extended period of time (i.e., one year or more). Monitoring wells are developed after installation in order to remove introduced water and drilling fluids, reduce the turbidity of the water, and improve the hydraulic communication between the well and the water-bearing formation. Well development will not commence until the annular grout seal has cured, but will be performed within ten calendar days of well installation.

PROCEDURE

1. All well development will include surge blocking or false bailing with one or more of the following fluid removal methods. Well development activities may include:

    - Bailing
    - Air Lifting
    - Submersible Pumping
    - Other methods as approved by the Benchmark Field Team Leader.
    - The appropriate water removal method will be selected based on water level depth and anticipated well productivity.

2. Assemble and decontaminate equipment (if necessary), and place in the well. Reference the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

3. Alternate the use of agitation methods with water removal methods, using the former to suspend solids in the well water, and the latter to remove the turbid water. For example, use a vented surge block to agitate the well, moving up and down within the screened interval and then use a pump to clear the well. A bailer may be used for both purposes, by surging with the bailer (false

bailing) for a period within the screened interval, then bailing a volume of water from the well.

4. When using surging methods, initiate this activity gradually, with short (2 to 3 feet) strokes. After several passes across the screened interval, increase the speed and length of the surge strokes.

5. Continue development until the following objectives are achieved:

   - Field parameters stabilize to the following criteria:
     - Dissolved Oxygen: ± 0.3 mg/L
     - Turbidity: ± 10%
     - Specific Conductance: ± 3%
     - ORP: ± 10 mV
     - pH: ± 0.1 units
   - The well will generate non-turbid water during continued pumping typically less than 50 NTU.
   - A minimum of 10 well volumes has been evacuated from the well.
   - In the case of lost water during drilling activities, the volume of water removed exceeds twice the volume of water lost to the formation during the drilling process, as indicated by the water balance.

6. Document the development methods, volumes, field parameter measurements, and other observations on the attached Benchmark Groundwater Well Development Log (sample attached).

ATTACHMENTS

Groundwater Well Development Log (sample)

REFERENCES

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

MONITORING WELL DEVELOPMENT PROCEDURES

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

GROUNDWATER WELL DEVELOPMENT LOG

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

WELL DATA:

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

PURGING DATA:

DATE:	START TIME:	END TIME:

VOLUME CALCULATION:

(A) Total Depth of Well (fbTOR):	
(B) Casing Diameter (inches):	
(C) Static Water Level (fbTOR):	
One Well Volume (V, gallons): V = 0.0408 [$(B)^2$ x { (A) - (C) }]	

*Use the table to the right to calculate one well volum

Volume Calculation

Well Diameter	Volume gal/ft
	.041
3"	0.
"	0.653
	1.020
6	1.469
8"	2.611

Stabilization Criteria

er	Criteria
DO	+/- 0.3 mg/L
Turbidity	+/- 10%
SC	+/- 3%
ORP	+/- 10 mV
pH	+/- 0.1 unit

Field Personnel:

EVACUATION STABILI TION A:

Time	Water Level (fbTOR)	Accumulated Volume		Tempe rees	Co tance S/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor

REMARKS:

PREPARED BY:

SAMPLE

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FIELD OPERATING PROCEDURES

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

FOP 039.1

NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE

PURPOSE

This procedure describes the methods to detect the presence and sample collection of Non-Aqueous Phase Liquid (NAPL) in groundwater monitoring wells prior to purging activities. If NAPL is suspected, all activities should be performed with proper personnel protective equipment (PPE).

DETECTION PROCEDURE

Groundwater monitoring wells suspected of containing NAPL will be sounded with an interface probe, or similar device, in accordance with the following.

1. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Field Form (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.

2. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

3. Calibrate the photoionization detector (PID) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of Portable Photoionization Detector.

4. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging. Record PID measurements on the Groundwater Field Form (sample attached).

5. Slowly lower the interface probe down the well, avoiding contact with the well casing. Upon contact with the static liquid level in the well, the interface

probe will signal contact with an audible tone and/or a visible light mounted inside the reel.

Note:

- If the signal is constant, the probe is in contact with groundwater; and
- If the signal oscillates, the probe is in contact with NAPL.

6. Record the depth, type of liquid encountered (if applicable) and any other related information in the Project Field Book and on a Groundwater Field Form (sample attached).

7. Slowly lower the interface probe to the well bottom. Record the depth(s) and type(s) of any additional phases encountered.

8. Slowly raise the interface probe to the surface, avoiding contact with the well casing.

9. Place the interface probe and storage reel in a plastic bag for subsequent decontamination in accordance with the Benchmark's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

SAMPLE COLLECTION PROCEDURE

All NAPL samples collected from groundwater monitoring wells will be collected in accordance with the following.

1. Place plastic sheeting on the ground around the well to prevent equipment from coming in contact with soil and also to prevent the surface transmission of NAPL.

2. All sampling personnel will don the appropriate PPE in accordance with the site health and safety plan.

3. Measure the static water level and NAPL level(s) using an interface probe as described in the previous section.

4. Determine depth to NAPL layer and thickness. Record appropriate data in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).

DNAPL SAMPLE COLLECTION

The following procedure should be used in sampling dense, heavier than water NAPL (i.e., with a high specific gravity) (DNAPL).

1. Collect samples using a translucent double check valve bailer (i.e., a bailer with a ball valve on both the top and bottom) constructed of Teflon, polyethylene or PVC which is connected to polypropylene rope for lowering into the well. All non-dedicated equipment shall be decontaminated in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

2. Remove wrapping (i.e., aluminum foil, manufacturers packaging etc.), attach bailer to new polypropylene rope and slowly lower the bailer until it contacts the well bottom.

3. Slowly raise and lower the bailer to create a gentle surging action thereby inducing DNAPL into the bailer past the bottom ball valve.

4. Slowly raise the bailer to the surface. Avoid contact of the bailer line with the well casing and/or ground surface.

5. Observe the DNAPL through the translucent wall of the bailer and check if the immiscible phases have separated. If not, allow the bailer to stand upright until the phases have separated.

6. Carefully attach a bottom-emptying device with stopcock to the bottom of the bailer and discharge the DNAPL gently down the side of the sample bottle to minimize turbulence.

7. Repeat steps 2 through 6 until a sufficient sample volume is obtained.

8. Cap the sample bottle and label, preserve and ship samples in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

9. Place the used plastic sheeting, bailer and polyethylene rope in a plastic bag for subsequent decontamination or disposal.

10. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).

LNAPL SAMPLE COLLECTION

The following procedure should be used in sampling lighter than water NAPL (i.e., with a low specific gravity) (LNAPL).

1. Collect samples using a translucent double check valve bailer (i.e., a bailer with a ball valve on both the top and bottom) constructed of Teflon, polyethylene or PVC which is connected to polypropylene rope for lowering into the well. All non-dedicated equipment shall be decontaminated in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

2. Remove wrapping (i.e., aluminum foil, manufacturers packaging etc.), attach bailer to new polypropylene rope and slowly lower the bailer down the well into the immiscible phase of LNAPL. Care should be taken to lower the bailer just through the LNAPL layer, but not significantly down into the underlying groundwater.

3. Slowly raise the bailer to the surface. Avoid contact of the bailer line with the well casing and/or ground surface.

4. Observe the LNAPL through the translucent wall of the bailer and check if the immiscible phases have separated. If not, allow the bailer to stand upright until the phases have separated.

5. Carefully attach a bottom-emptying device with stopcock to the bottom of the bailer and decant the denser groundwater portion of the bailer contents into a DOT-approved 55-gallon drum for proper disposal.

6. Discharge the LNAPL gently down the side of the sample bottle to minimize turbulence.

7. Repeat steps 2 through 6 until a sufficient sample volume is obtained.

8. Cap the sample bottle and label, preserve and ship samples in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

9. Place the used plastic sheeting, bailer and polyethylene rope in a plastic bag for subsequent decontamination or disposal.

10. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).

ATTACHMENTS

Groundwater Well Purge & Sample Collection Log (sample)

REFERENCES

Benchmark FOPs:

010 *Calibration and Maintenance of Portable Flame Ionization Detector*
011 *Calibration and Maintenance of Portable Photoionization Detector*
040 *Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*
046 *Sample Labeling, Storage and Shipment Procedures*

NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

GROUNDWATER WE
PURGE & SAMPLE COLLECTION L

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

WELL DATA: DATE: | TIME:

Casing Diameter (inches):	Casing Material:
Screened interval (fbTOR):	Screen Material:
Static Water Level (fbTOR):	Bottom Depth (fbTOR):
Elevation Top of Well Riser (fmsl):	Ground Surface Elevation (fmsl):
Elevation Top of Screen (fmsl):	Stick-up (feet):

PURGING DATA: DATE: | START TIME: | END TIME:

Method:	Is purge equipement dedicated to sample location? yes
No. of Well Volumes Purged:	Was well purged to dryness? yes
Standing Volume (gallons):	Was well purged below top of sand pack? yes
Volume Purged (gallons):	Condition of Well:
Purge Rate (gal/min):	Field Personnel:

VOLUME CALCULATION:

(A) Total Depth of Well (fbTOR):	
(B) Casing Diameter (inches):	
(C) Static Water Level (fbTOR):	
One Well Volume (V, gallons): V = 0.0408 [$(B)^2$ x { (A) - (C) }]	

* Use the table to the right to calculate one well volume by subtracting C from A, then multiplying by the volume calculation in the table per well diamter

Volume Calculation

Well Diameter	Volume gal/ft
1"	0.041
2"	0.163
3"	0.367
4"	0.653
5"	1.020
6"	1.469

Stabilization Criteria

Parameter	Criteria
pH	+/- 0.1 un
SC	+/- 3%
Turbidity	+/- 10%
DO	+/- 0.3 m
ORP	+/- 10 mV

EVACUATION STABILIZATION TEST DATA:

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

SAMPLING DATA: DATE: | START TIME: | END TIME:

Method:	Is sampling equipement dedicated to sample location? yes
Initial Water Level (fbTOR):	Was well sampled to dryness? yes
Final Water Level (fbTOR):	Was well sampled below top of sand pack? yes
Air Temperature (°F):	Field Personnel:
Source and type of water used in the field for QC purposes:	

PHYSICAL & CHEMICAL DATA:

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

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

REMARKS:

PREPARED BY:

SAMPLE

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FIELD OPERATING PROCEDURES

Non-Disposable and Non-Dedicated Sampling Equipment Decontamination

FOP 040.1

NON-DISPOSABLE AND NON-DEDICATED SAMPLING EQUIPMENT DECONTAMINATION

PURPOSE

This procedure is to be used for the decontamination of non-disposable and non-dedicated equipment used in the collection of environmental samples. The purpose of this procedure is to remove chemical constituents from previous samples from the sampling equipment. This prevents these constituents from being transferred to later samples, or being transported out of controlled areas.

HEALTH AND SAFETY

Nitric acid is a strong oxidizing agent as well as being extremely corrosive to the skin and eyes. Solvents such as acetone, methanol, hexane and isopropanol are flammable liquids. Limited contact with skin can cause irritation, while prolonged contact may result in dermatitis. Eye contact with the solvents may cause irritation or temporary corneal damage. Safety glasses with protective side shields, neoprene or nitrile gloves and long-sleeve protective clothing must be worn whenever acids and solvents are being used.

PROCEDURE – GENERAL EQUIPMENT

Bailers, split-spoons, steel or brass split-spoon liners, Shelby tubes, submersible pumps, soil sampling knives, and similar equipment will be decontaminated as described below.

1. Wash equipment thoroughly with non-phosphate detergent and potable-quality water, using a brush where possible to remove any particulate matter or surface film. If the sampler is visibly coated with tars or other phase-separated hydrocarbons, pre-wash with acetone or isopropanol, or by steam cleaning. Decontamination will adhere to the following procedure:

a. Rinse with potable-quality water; if the sampling equipment is very oily and use of a solvent is necessary, rinse with pesticide-grade isopropanol.

b. Rinse with potable-quality water;

c. Rinse with deionized water demonstrated analyte-free, such as distilled water;

d. Air dry; and

e. Store in a clean area or wrap in aluminum foil (shiny side out) or new plastic sheeting as necessary to ensure cleanliness.

2. All non-dedicated well evacuation equipment, such as submersible pumps and bailers, which are put into the well, must be decontaminated following the procedures listed above. All evacuation tubing must be dedicated to individual wells (i.e., tubing cannot be reused). However, if submersible pump discharge tubing must be reused, the tubing and associated sample valves or flow-through cells used in well purging or pumping tests will be decontaminated as described below:

a. Pump a mixture of potable water and a non-phosphate detergent through the tubing, sample valves and flow cells, using the submersible pump.

b. Steam clean or detergent wash the exterior of the tubing, sample valves, flow cells and pump.

c. Pump potable water through the tubing, sample valve, and flow cell until no indications of detergent (e.g. foaming) are observed.

d. Double rinse the exterior of the tubing with potable water.

e. Rinse the exterior of the tubing with distilled water.

f. Store in a clean area or wrap the pump and tubing assembly in new plastic sheeting as necessary to ensure cleanliness until ready for use.

3. All unused sample bottles and sampling equipment must be maintained in such a manner that there is no possibility of casual contamination.

4. Manage all waste materials generated during decontamination procedures as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.

PROCEDURE – SUBMERSIBLE PUMPS

Submersible pumps used in well purging or purging tests will be decontaminated thoroughly each day before use as well as between well locations as described below:

Daily Decontamination Procedure:

1. Pre-rinse: Operate the pump in a basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

2. Wash: Operate the pump in 8 to 10 gallons of non-phosphate detergent solution (i.e., Alconox) for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes.

3. Rinse: Operate the pump in a basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

4. Disassemble pump.

5. Wash pump parts with a non-phosphate detergent solution (i.e., Alconox). Scrub all pump parts with a test tube brush or similar device.

6. Rinse pump with potable water.

7. Rinse the inlet screen, the shaft, the suction interconnection, the motor lead assembly, and the stator housing with distilled/deionized water.

8. Rinse the impeller assembly with 1% nitric acid (HNO_3).

9. Rinse the impeller assembly with isopropanol.

10. Rinse the impeller assembly with distilled/deionized water.

Between Wells Decontamination Procedure:

1. Pre-rinse: Operate the pump in a basin containing 8 to 10 gallons of potable water for 5 minutes.

2. Wash: Operate the pump in 8 to 10 gallons of non-phosphate detergent solution (i.e., Alconox) for 5 minutes.

3. Rinse: Operate the pump in a basin of potable water for 5 minutes.

4. Final rinse the pump in distilled/deionized water.

ATTACHMENTS

None

REFERENCES

Benchmark FOPs:
032 Management of Investigation-Derived Waste

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Rock Core Classification Procedure

FOP 043.0

ROCK CORE CLASSIFICATION PROCEDURE

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 3⅞-inch tri-cone roller bit

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):

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:

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:

    - ***Sandstone*** – Made up predominantly of granular materials ranging between 1/16 and 2 inches in diameter.
    - ***Siltstone*** – Made up of granular materials less than 1/16 inch in diameter. Fractures irregularly. Medium thick to thick bedded.
    - ***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.
    - ***Shale*** – A fissile very fine-grained rock. Fractures along bedding planes.
    - ***Limestone*** – Rock made up predominantly of calcite ($CaCO_3$). effervesces upon the application of hydrochloric acid.
    - ***Coal*** – Rock consisting mainly of organic remains.
    - ***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

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

- 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)

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.

    - ***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.
    - ***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.
    - ***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.
    - ***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.
    - ***Residual Soil*** (note pedogenic development, pertaining to soil formation) – can be crumbled by hand (and in near-surface position).

8. **DISINTIGRATION**

    - ***Competent*** – no mineralization or dissolution (to either bedrock or cementation)
    - ***Slightly Disintegrated*** – trace mineralization or dissolution
    - ***Moderately Disintegrated*** – some mineralization or dissolution
    - ***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).

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:

    - ***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).
    - ***Medium soft*** – Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.
    - ***Medium hard*** – No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.
    - ***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.

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

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

- *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**
   - ***Joint*** – structural break where little or no differential movement has occurred
   - ***Shear*** – structural break where differential movement has occurred
   - ***Bedding Plane Joint*** – division plane that separates successive layers or beds
   - ***Microjoint*** – tight, often discontinuous plane, may be separated by hand along plane
   - ***Fracture Zone*** – numerous intersecting joints
   - ***Shear Zone*** – width of fracture zone indicating numerous joints, shears, or fault
   - ***Mechanical Break*** – break due to drilling, blasting, or handling

3. **DIP ANGLE** – degrees from horizontal

4. **APERTURE FOR OPENINGS**
   - ***Wide*** – greater than 200 mm
   - ***Moderately Wide*** – 60 to 200 mm

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

5. APPERTURE FOR VOIDS

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

6. HEALING

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

7. INFILLING

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

- ***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

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

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

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE LOG

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

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

SAMPLE

ABANDONMENT:			
Volume of cement/bentonite grout required:	$V = \pi r^2 \times 7.48 =$	gallons	borehole depth = ft.
Volume of cement/bentonite grout installed:		gallons	borehole diameter = ft.
Has bridging of grout occurred?	☐ yes ☐ no		borehole radius = ft.
If yes, explain resolution:			
Method of installation:			
Project No:	**Benchmark Environmental Engineering & Science, PLLC**		Figure

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

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

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

SAMPLE

Project No:	Benchmark Environmental Engineering & Science, PLLC	Figure

TABLE 1

GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
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

TABLE 2

BEDDING THICKNESS CLASSIFICATION

Thickness (Metric)	Approx. English Equivalent	Classification
> 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. –0 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

FIGURE 1

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

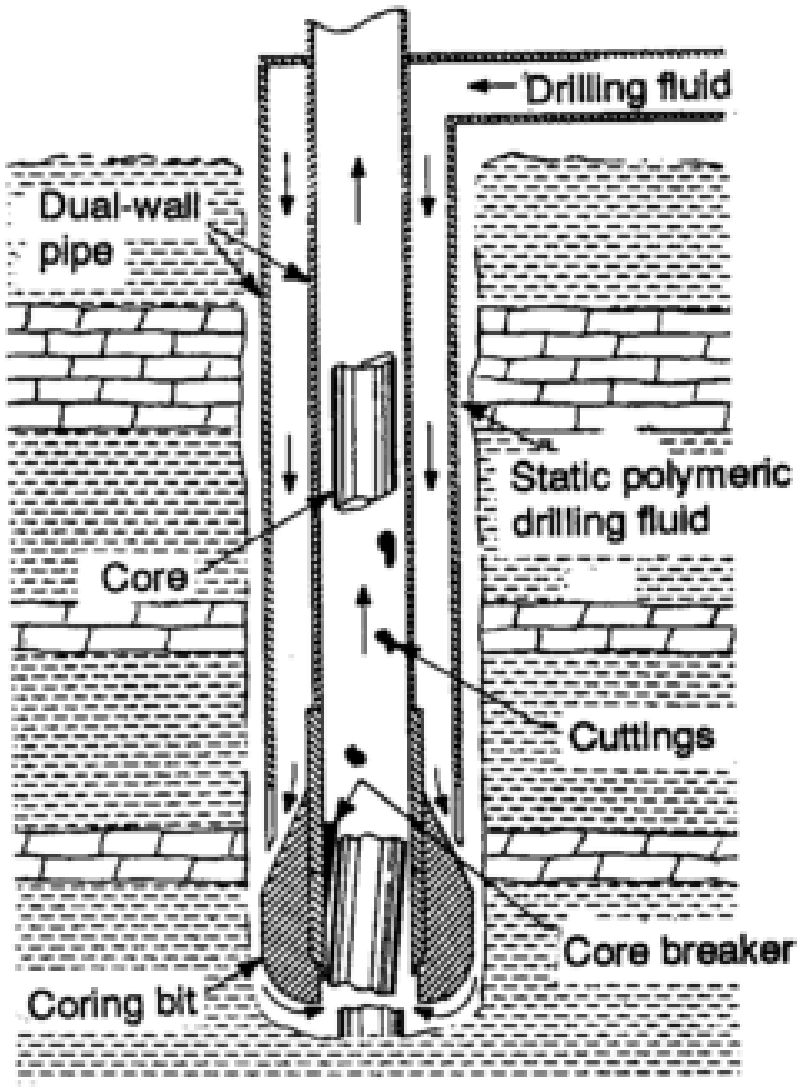


FIGURE 2

CORE PLACEMENT & CORE BOX LABELING

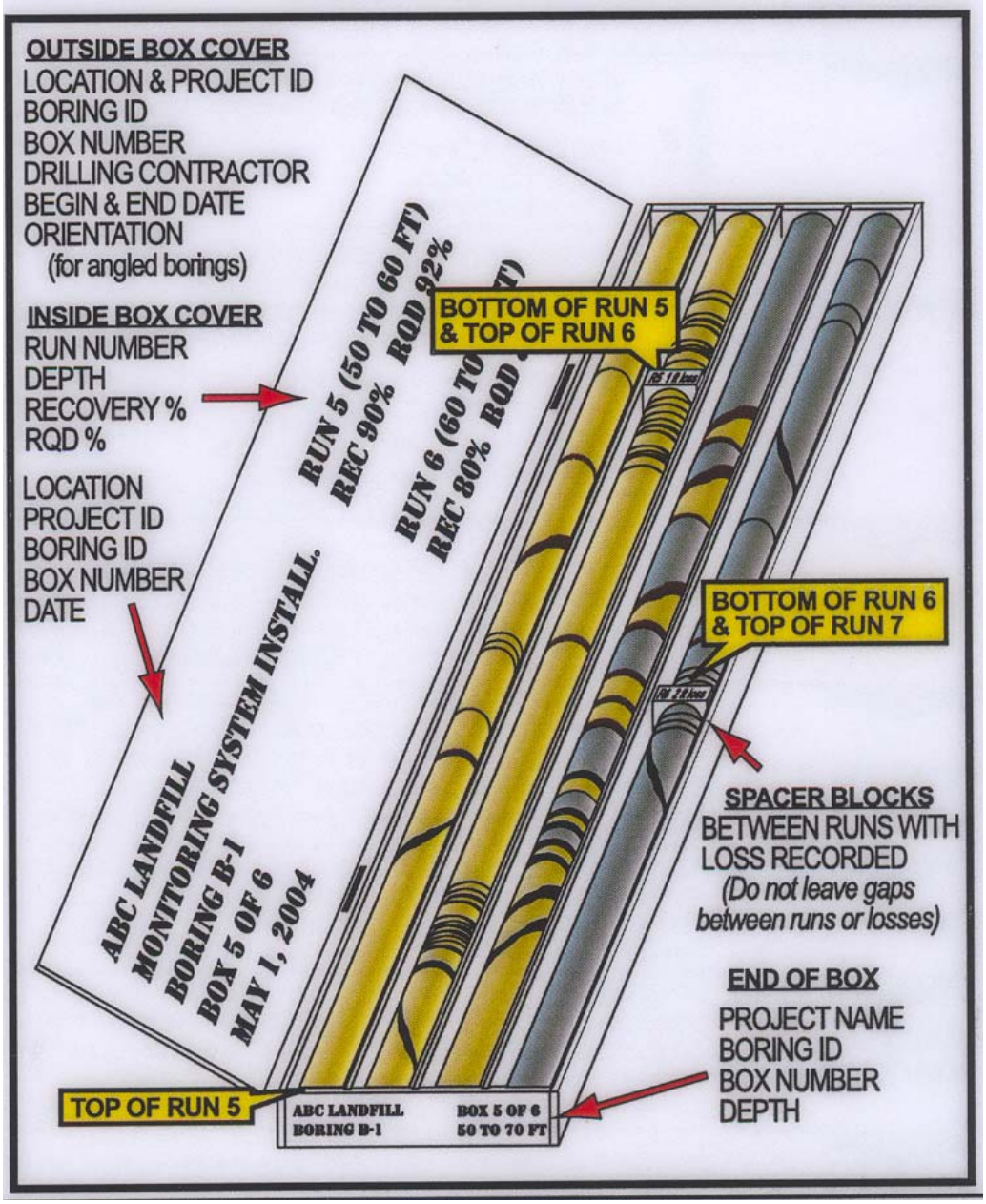
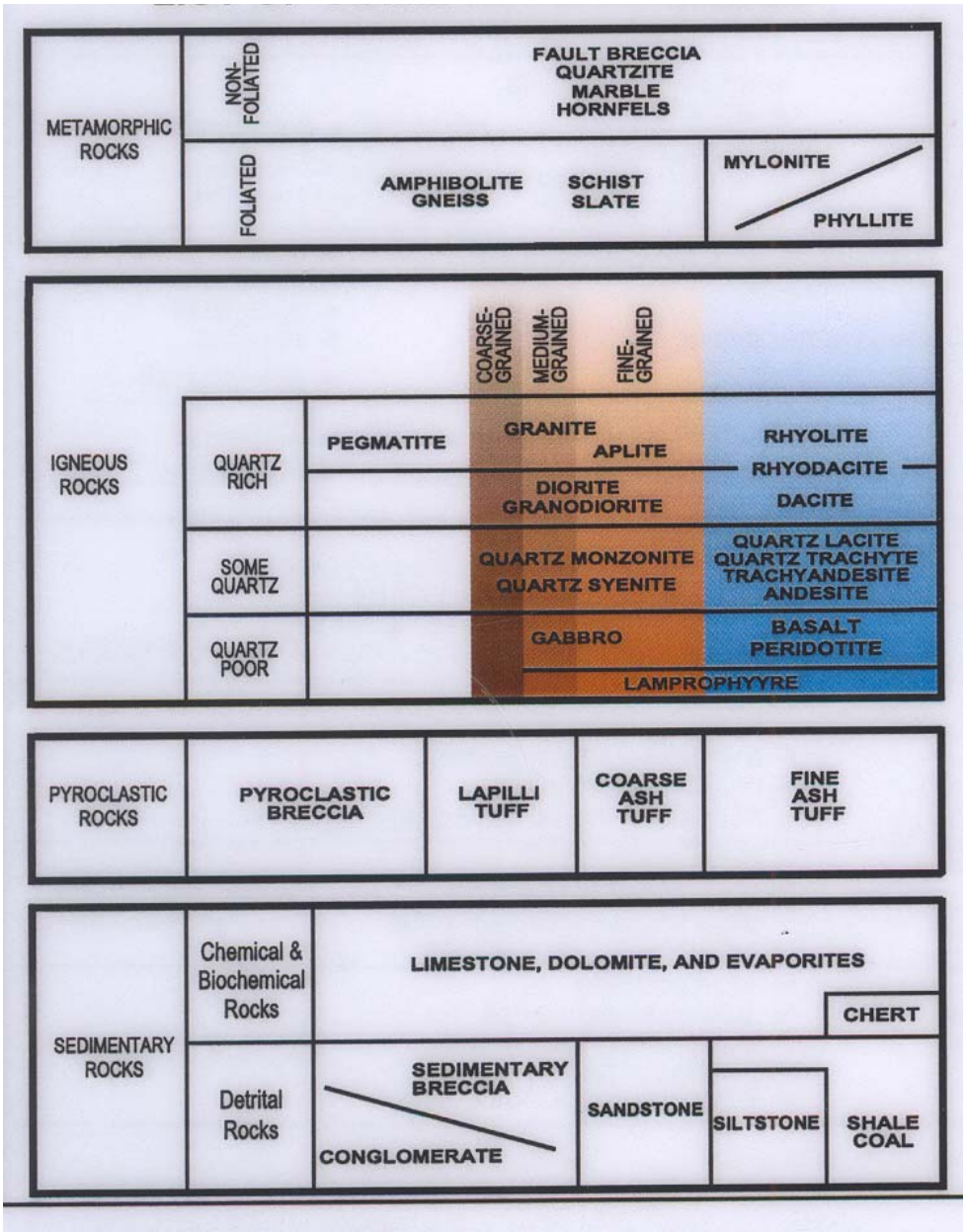


FIGURE 3

LIST OF COMMON ROCK NAMES



BENCHMARK
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FIELD OPERATING PROCEDURES

Rock Quality Designation (RQD) Procedure

FOP 044.0

ROCK QUALITY DESIGNATION (RQD) PROCEDURE

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.

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

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

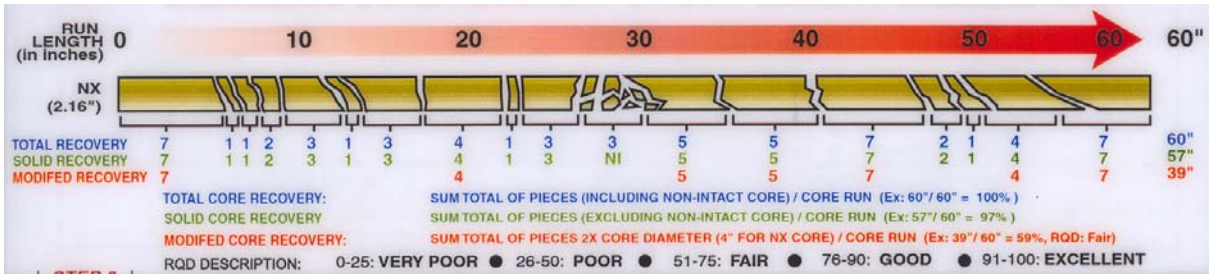
none

REFERENCES

none

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

NOTES:

60 inches = length of run.
Core Recovery = (60"/60") x 100 = 100%
RQD = (39"/60") x 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."

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FIELD OPERATING PROCEDURES

Sample Labeling, Storage, and Shipment Procedures

FOP 046.0

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

PURPOSE

The collection and analysis of samples of environmental media, including soils, groundwater, surface water, and sediment, are the central activities of the field investigation. These samples must be properly labeled to preserve its identity, and properly stored and shipped in a manner that preserves its integrity and chain of custody. This procedure presents methods for these activities.

SAMPLE LABELING PROCEDURE

1. Assign each sample retained for analysis a unique 9-digit alphanumeric identification code or as indicated in the Project Work Plan. Typically, this code will be formatted as follows:

Sample I.D. Example: GW051402047	
GW	**Sample matrix** GW = groundwater; SW = surface water; SUB = subsurface soil; SS = surface soil; SED = sediment; L = leachate; A = air
05	Month of sample collection
14	Day of sample collection
02	Year of sample collection
047	Consecutive sample number

2. Consecutive sample numbers will indicate the individual sample's sequence in the total set of samples collected during the investigation/sampling event. The sample number above, for example, would indicate the 47th sample retained for analysis during the field investigation, collected on May 14, 2002.

3. Affix a non-removable (when wet) label to each sample container. The following information will be written on the label with black or blue ink that will not smudge when wet:

   - Project number
   - Sample ID (see Step 1 above)
   - Date of sample collection
   - Time of sample collection (military time only)
   - Specify "grab" or "composite" sample with an "X"
   - Sampler initials
   - Preservative(s) (if applicable)
   - Analytes for analysis (if practicable)

4. Record all sample label information in the Project Field Book and on a Sample Summary Collection Log (see attached samples), keyed to the sample identification number. In addition, add information regarding the matrix, sample location, depth, etc. to provide a complete description of the sample.

SAMPLE STORAGE PROCEDURE

1. Immediately after collection, placement in the proper container, and labeling, place samples to be retained for chemical analysis into resealable plastic bags.

2. Place bagged samples into an ice chest filled approximately half-full of double bagged ice. Blue ice is not an acceptable substitute for ice.

3. Maintain samples in an ice chest or in an alternative location (e.g. sample refrigerator) as approved by the Benchmark Field Team Leader until time of shipment. Periodically drain melt-water off coolers and replenish ice as necessary.

4. Ship samples on a daily basis, unless otherwise directed by the Benchmark Field Team Leader.

5. Maintain appropriate custody procedures on coolers and other sample storage containers at all times. These procedures are discussed in detail in the Project Quality Assurance Project Plan, Monitoring Plan or Work Plan.

6. Samples shall be kept in a secure location locked and controlled (i.e., locked building or fenced area) so that only the Project Field Team Leader has access to the location or under the constant visual surveillance of the same.

SAMPLE SHIPPING PROCEDURE

1. Fill out the chain-of-custody form completely (see attached sample) with all relevant information. The white original goes with the samples and should be placed in a resealable plastic bag and taped inside the sample cooler lid; the sampler should retain the copy.

2. Place a layer of inert cushioning material such as bubble pack in the bottom of cooler.

3. Place each bottle in a bubble wrap sleeve or other protective wrap. To the extent practicable, then place each bottle in a resealable plastic bag.

4. Open a garbage bag (or similar) into a cooler and place sample bottles into the garbage bag (or similar) with volatile organic analysis (VOA) vials near the center of the cooler.

5. Pack bottles with ice in plastic bags. At packing completion, cooler should be at least 50 percent ice, by volume. Coolers should be completely filled, so that samples do not move excessively during shipping.

6. Duct tape (or similar) cooler drain closed and wrap cooler completely in two or more locations to secure lid, specifically covering the hinges of the cooler.

7. Place laboratory label address identifying cooler number (i.e., 1 of 4, 2 of 4 etc.) and overnight delivery waybill sleeves on cooler lid or handle sleeve (Federal Express).

8. Sign the custody seal tape with an indelible soft-tip marker and place over the duct tape across the front and back seam between the lid and cooler body.

9. Cover the signed custody seal tape with an additional wrap of transparent strapping tape.

10. Place "Fragile" and "This Side Up" labels on all four sides of the cooler. "This Side Up" labels are yellow labels with a black arrow with the arrowhead pointing toward the cooler lid.

11. For coolers shipped by overnight delivery, retain a copy of the shipping waybill, and attach to the chain-of-custody documentation.

ATTACHMENTS

Soil/Sediment Sample Summary Collection Log (sample)
Groundwater/Surface Water Sample Summary Collection Log (sample)
Wipe Sample Summary Collection Log (sample)
Air Sample Summary Collection Log (sample)
Chain-Of-Custody Form (sample)

REFERENCES

None

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

AIR SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, important observations or descriptions, etc.)

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. SC - Summa Canister.
3. TB - Tedlar Bag (quantity).
4. No Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blanks, Field Duplicates, Field Blanks or Rinsates collected for air samples.

SAMPLE

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

CHAIN OF CUSTODY RECORD

Project No.	Project Name					Number of Containers	VOCs	SVOCs	Metals						REMARKS
Samplers (Signature)															
No.	Date	Time	comp	grab	Sample Identification										

Possible Hazard Identification:
☐ Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal:
☐ Return to Client ☐ Disposal by Lab ☐ Archive _____(mos.)

Turnaround Time Required:
Normal ☐ Rush ☐

QC Level:
I. ☐ II. ☐ III. ☐ Project Specific (specify):_____

Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	REMARKS:
Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	

SAMPLE

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

WIPE SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, important observations or descriptions, etc.)

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. FD - Field Duplicate.
4. FB - Field Blank.
5. RS - Rinsate.
6. No Matrix Spike, Matrix Spike Duplicate or Matrix Spike Blanks for wipe samples.
7. Rinsates should be taken at a rate of 1 per day during wipe sampling. Only take when reusable equipment is used.
8. Wipe sample FB collected by wiping unused glove and any other sampling equipment coming into contact with sampled surface) with prepared gauze pad and place in sample jar. Take at a rate of 1 FB per 20 samples.
9. Wipe sample FDs taken adjacent to original sample at a rate of 1 FD per 20 samples.
10. **EH :** Extract and Hold

SAMPLE

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

AIR SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, important observations or descriptions, etc.)

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. SC - Summa Canister.
3. TB - Tedlar Bag (quantity).
4. No Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blanks, Field Duplicates, Field Blanks or Rinsates collected for air samples.

SAMPLE

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

CHAIN OF CUSTODY RECORD

Project No.	Project Name					Number of Containers	VOCs	SVOCs	Metals						REMARKS
Samplers (Signature)															
No.	Date	Time	comp	grab	Sample Identification										

Possible Hazard Identification:
☐ Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal:
☐ Return to Client ☐ Disposal by Lab ☐ Archive _____(mos.)

Turnaround Time Required:
Normal ☐ Rush ☐

QC Level:
I. ☐ II. ☐ III. ☐ Project Specific (specify):_____

Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	REMARKS:
Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	

SAMPLE

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FIELD OPERATING PROCEDURES

Screening of Soil Samples for Organic Vapors During Drilling Activities

FOP 047.0

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING DRILLING ACTIVITIES

PURPOSE

This procedure is used to screen soil samples for the presence of volatile organic constituents (VOCs) using a field organic vapor meter. These meters will be either photoionization detector (PID) or flame-ionization detector (FID) type. This screening is performed at the drilling and sampling location as a procedure for ensuring the health and safety of personnel at the site and to identify potentially contaminated soil samples for laboratory analysis. All soil samples will be field screened to provide a vertical profile of soil contamination by volatile organic substances.

PROCEDURE

1. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

2. Collect split-spoon (or other sampler) samples in accordance with Benchmark's Split Spoon Sampling Procedure FOP.

3. When the split-spoon or other sampler is opened or accessed, shave a thin layer of material from the entire length of the core.

4. Scan the core visually and with the PID or FID noting stratification, visible staining, or other evidence of contamination.

5. Based on this initial scan of the sample, collect approximately 100 milliliters (ml) of soil using a decontaminated or dedicated stainless steel spatula, scoop, or equivalent. Place this soil into a labeled wide-mouth glass jar approximately ½ to ¾ full and seal with aluminum foil and a screw top cap. Alternatively, the soil may be placed into a clean, re-sealable plastic bag and sealed. Be sure to leave some headspace above the soil sample within the sealed container.

6. Place field screening sample (i.e., jar or bag) in a location where the ambient temperature is at least 70° Fahrenheit.

7. Leave the field screening sample bag for at least 30 minutes, but no more than 60 minutes.

8. Carefully remove the screw top cap from the jar and slowly insert the tip of the organic vapor meter (PID or FID) through the aluminum foil seal making the smallest hole possible. Alternatively, unseal a portion of the plastic bag just big enough to insert the probe of a calibrated PID.

9. Record the maximum reading in parts per million by volume (ppmv) on the Field Borehole Log or Field Borehole/Monitoring Well Installation Log form (see attached samples) (see Documentation Requirements for Drilling and Well Installation FOP), at the depth interval corresponding to the depth of sample collection.

ATTACHMENTS

Field Borehole Log (sample)
Field Borehole/Monitoring Well Installation Log (sample)

REFERENCES

Benchmark FOPs:

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

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING DRILLING ACTIVITIES

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE LOG

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

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

SAMPLE

ABANDONMENT:			
Volume of cement/bentonite grout required:	$V = \pi r^2 \times 7.48 =$	gallons	borehole depth = ft.
Volume of cement/bentonite grout installed:		gallons	borehole diameter = ft.
Has bridging of grout occurred?	☐ yes ☐ no		borehole radius = ft.
If yes, explain resolution:			
Method of installation:			
Project No:	**Benchmark Environmental Engineering & Science, PLLC**		Figure

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING DRILLING ACTIVITIES

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

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

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

SAMPLE

Project No:	Benchmark Environmental Engineering & Science, PLLC	Figure

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FIELD OPERATING PROCEDURES

Screening of Soil Samples for Organic Vapors During Impacted Soil Removal Activities

FOP 048.0

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING IMPACTED SOIL REMOVAL ACTIVITIES

PURPOSE

This procedure is used to screen soil samples for the presence of volatile organic constituents (VOCs) using a field organic vapor meter. The field meter should either be a photoionization detector (PID) or flame-ionization detector (FID) type. This type of screening is generally performed during underground storage tank (UST) and/or impacted soil removal activities as a procedure for ensuring the health and safety of the community and personnel at the site as well as to identify potential VOC-impacted soil samples for laboratory analysis (i.e., confirmatory or verification samples). Soil samples are also screened in the field to provide assessment criteria to determine horizontal and vertical extents of VOC-impacts in order to ensure soils that may have been impacted by volatile organic substances are removed.

PROCEDURE

1. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

2. Perform community air monitoring in accordance with the Project Work Plan and/or Benchmark's FOP: Real-Time Air Monitoring During Intrusive Activities.

3. Upon proper removal of any identified UST in accordance with NYSDEC Division of Environmental Remediation, Spill Response Unit or Bulk Storage Unit guidelines and/or Benchmark's FOP: Underground Storage Tank Removal Procedures; examine the four sidewalls and bottom of the excavation for visually impacted (i.e., stained) soils.

4. If visually impacted soils are identified, direct the excavating equipment operator to scrape the impacted area (i.e., sidewall or bottom of the excavation) and present the scraped soil for evaluation. NOTE: Under no circumstances should anyone enter an excavation greater than 4 feet in depth, unless absolutely necessary. Excavation entry may only occur under strict confined space entry procedures following implementation of specific engineering controls (i.e., continuous air monitoring, excavation shoring, trench box installation, benching).

5. Visually inspect and perform an open air PID/FID scan of the scraped soil sample noting stratification, visible staining, or other evidence of impact (i.e., presence of non-aqueous phase liquid, NAPL).

6. Collect a representative sample (approximately 100 milligrams (mg)) of soil using a decontaminated or dedicated stainless steel sampling tool (i.e., spoon, spatula, scoop, or approved equivalent), for field headspace determination of VOC-impact. Place the representative soil sample into a labeled wide-mouth glass jar approximately ½ to ¾ full and seal with aluminum foil and a screw top cap. Alternatively, the soil sample may be placed into a clean, re-sealable plastic bag and sealed. Be sure to leave adequate headspace above the soil sample within either sealed container.

7. Place the field screening sample (i.e., jar or bag) in a location where the ambient temperature is at least 70^{o} Fahrenheit for at least 15 minutes, but no more than 60 minutes.

8. Carefully remove the screw top cap from the jar and slowly insert the tip of the organic vapor meter (PID or FID) through the aluminum foil seal making the smallest hole possible. Alternatively, unseal a portion of the plastic bag just big enough to insert the probe of a calibrated PID.

9. Record the depth, sample location (i.e., sidewall, bottom) and <u>maximum</u> reading in parts per million by volume (ppmv) in the Project Field Book and Impacted Soil Excavation Log (sample attached), at the depth interval corresponding to the depth of sample collection.

10. The representative soil samples collected from the excavation will be used to assess the vertical and horizontal limits of VOC-impact and guide the impacted soil removal activities in accordance with project requirements (i.e., PID scans less than 20 ppm will not require removal unless laboratory analytical results exceed regulatory limits).

11. Collect verification/confirmation samples in accordance with NYSDEC Division of Environmental Remediation, Spill Response Unit or Bulk Storage Unit guidelines and/or Benchmark's FOP: Surface and Subsurface Soil Sampling Procedures.

ATTACHMENTS

Impacted Soil Excavation Log (sample)

REFERENCES

Benchmark FOPs:

010 *Calibration and Maintenance of Portable Flame Ionization Detector*
011 *Calibration and Maintenance of Portable Photoionization Detector*
063 *Surface and Subsurface Soil Sampling Procedures*
073 *Real-Time Air Monitoring During Intrusive Activities*
074 *Underground Storage Tank Removal Procedures*

FOP 048.0

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING IMPACTED SOIL REMOVAL ACTIVITIES

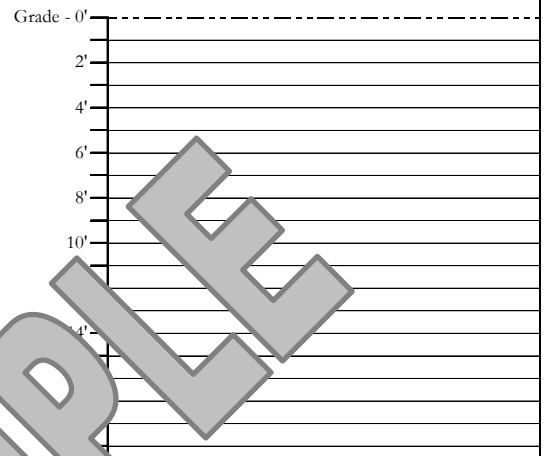
BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

IMPACTED SOIL EXCAVATION LOG

Project:	EXCAVATION I.D.:
Project No.:	Excavation Date:
Client:	Excavation Method:
Location:	CQA Observer:

Excavation Location: *NOT TO SCALE* *(approximate)*

Excavation Cross Section:



SAMPLE

TIME	Length:					
Start:	Width:					
End:	Depth:					

Verification Sample I.D.	D… (ft…	…ca… (sid…	…hi…	PID Scan (ppm)	PID Headspace (ppm)	Photos Y / N	

COMMENTS:

UST ENCOUNTERED:	☐ yes	☐ no	If yes, Describe (type, material, size, capacity etc.):
GROUNDWATER ENCOUNTERED:	☐ yes	☐ no	If yes, depth to GW:
VISUAL IMPACTS:	☐ yes	☐ no	Describe:
OLFACTORY OBSERVATIONS:	☐ yes	☐ no	Describe:
NON-NATIVE FILL ENCOUNTERED:	☐ yes	☐ no	
OTHER OBSERVATIONS:	☐ yes	☐ no	Describe:
QUANTITY OF IMPACTED SOIL REMOVED:			
FINAL DESTINATION OF IMPACTED SOIL:			
TYPE OF BACKFILL:			
SURFACE COMPLETION:			

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FIELD OPERATING PROCEDURES

Soil Description Procedures Using The Visual-Manual Method

FOP 054.2

SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

PURPOSE

This guideline presents a means for insuring consistent and proper field identification and description of collected soils during a project (via, split-spoon (barrel) sampler, hand auger, test pit etc.). The lithology and moisture content of each soil sample will be physically characterized by visual-manual observation in accordance with ASTM Method D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). When precise classification of soils for engineering purposes is required, the procedures prescribed in ASTM Method D2487 (Standard Practice for Classification of Soils for Engineering Purposes [Unified Soil Classification System, USCS]) will be used. The method of soil characterization presented herein describes soil types based on grain size, liquid and plastic limits, and moisture content based on visual examination and manual tests. When using this FOP to classify soil, the detail of description provided for a particular material should be dictated by the complexity and objectives of the project. However, more often than not, "after the fact" field information is required later in the project, therefore, every attempt to describe the soil as completely as possibly should be made.

Intensely weathered or decomposed rock that is friable and can be reduced to gravel size or smaller by normal hand pressure should be classified as a soil. The soil classification would be followed by the parent rock name in parenthesis. Projects requiring depth to bedrock determinations should always classify weathered or decomposed bedrock as bedrock (i.e., landfill siting). The project manager should always be consulted prior to making this determination.

PROCEDURE

Assemble necessary equipment and discuss program requirements with drilling contractor.

1. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

2. Collect desired soil sample in accordance with appropriate Benchmark FOP (i.e., split-spoon sampling, hand augering, test pitting etc.).

3. Shave a thin layer off the entire length of the sample to expose fresh sample.

4. Photograph and scan the sample with a photoionization detector (PID) at this time, if applicable, in accordance with Benchmark's Screening of Soil Samples for Organic Vapors During Drilling Activities FOP.

5. Describe the sample using terminology presented in the Descriptive Terms section below.

6. Record all pertinent information in the Project Field Book and Field Borehole Log (sample attached) or Field Borehole/Monitoring Well Installation Log (sample attached).

7. After the sample has been described, place a representative portion of the sample in new, precleaned jars or self-sealing plastic bags for archival purposes (if required). Label the jar or bag with the sample identification number, sample interval, date, project number and store in a secure location.

8. If the soil is to be submitted to a laboratory for analysis, collect the soil sample with a dedicated stainless steel sampling tool, place the sample into the appropriate laboratory-supplied containers, and store in an ice-chilled cooler staged in a secure location in accordance with Benchmark's Sample Labeling, Storage and Shipment Procedures FOP.

9. All remaining soil from soil sample collection activities shall be containerized in accordance with Benchmark's Management of Investigative-Derived Waste (IDW) FOP and/or the Project Work Plan.

DESCRIPTIVE TERMS

All field soil samples will be described using the Unified Soil Classification System (USCS) presented in Figures 1 and 2 (attached). In addition to ASTM Method D2488, Method D1586, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils (a.k.a., Standard Penetration Test, STP), when implemented, can also be used to classify the resistance of soils. In certain instances, it is desirable to supplement the USCS classification with a geologic interpretation of the soil sample that is supported by the soil descriptive terms presented in this section. The project manager should be consulted when making any geologic interpretation. Field test methods are provided to assist field personnel in classifying soil and are identified by a bold blue **FTM** and shaded. Classification of sampled soils will use the following ASTM descriptive terms and criteria:

- **Group Name** (USCS, see Figure 2)
- **Group Symbol** (USCS, see Figure 2) – only use if physical laboratory testing has been performed to substantiate. The USCS can be applied to most unconsolidated materials, and is represented by a two-letter symbol, except Peat (Pt).
  - The first letter includes: G (gravel), S (sand), M (silt), C (clay), and O (organic).
  - The second letter includes: P (poorly graded or uniform particle sizes), W (well graded or diversified particle sizes), H (high plasticity), and L (low plasticity).
  - Examples:
    - GW = well graded gravels and gravel-sand mixtures, little or no fines
    - GP = poorly graded gravels and gravel-sand mixtures, little or no fines
    - GM = silty gravels, gravel-sand-silt mixtures

- GC = clayey gravels, gravel-sand-clay mixtures
- SW = well graded sands and gravelly sands, little or no fines
- SP = poorly graded sands and gravelly sands, little or no fines
- SM = silty sand, sand-silt mixtures
- SC = clayey sand sand-clay mixtures
- ML = inorganic silts, very fine sands, rock flour, silty or clayey fine sands
- CL = inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays
- OL = organic silts and organic silty clays of low plasticity
- MH = inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts (very rare)
- CH = inorganic clays of high plasticity, fat clays
- OH = organic clays of medium to high plasticity
- Pt = peat, muck, and other highly organic soils

- **Angularity** (ASTM D2488; Table 1)
  - Angular – particles have sharp edges and relatively planar sides with unpolished surfaces
  - Subangular – particles are similar to angular description but have rounded edges
  - Subrounded – particles have nearly planar sides but have well-rounded corners and edges
  - Rounded – particles have smoothly curved sides and no edges
- **Particle Shape** (ASTM D2488; Table 2)
  - Flat – particles with width/thickness > 3
  - Elongated – particles with length/width > 3
  - Flat and Elongated – particles meet criteria for both flat and elongated
- **Moisture Condition** (ASTM D2488; Table 3)
  - Dry – absence of moisture, dusty, dry to the touch
  - Moist – damp, but no visible water
  - Wet – visible free water, usually soil is below water table
- **Reaction with Hydrochloric Acid (HCL)** (ASTM D2488; Table 4)
  - None – no visible reaction

- Weak – some reaction, with bubbles forming slowly
- Strong – violent reaction, with bubbles forming immediately

- **Consistency of Cohesive Soils** (ASTM D2488; Table 5)
  - Very soft – squeezes between fingers when fist is closed; easily penetrated several inches by fist (SPT = 2 or less)
  - Soft – easily molded by fingers; easily penetrated several inches by thumb (SPT = 2 to 4)
  - Firm – molded by strong pressure of fingers; can be penetrated several inches by thumb with moderate effort (SPT = 4 to 8)
  - Stiff – dented by strong pressure of fingers; readily indented by thumb but can be penetrated only with great effort (SPT = 8 to 15)
  - Very stiff – readily indented by thumbnail (SPT = 15 to 30)
  - Hard – indented with difficultly by thumbnail (SPT >30)
- **Cementation** (ASTM D2488; Table 6)
  - Weak – crumbles or breaks with handling or slight finger pressure
  - Moderate – crumbles or breaks with considerable finger pressure
  - Strong – will not crumble or break with finger pressure
- **Structure (Fabric)** (ASTM D2488; Table 7)
  - Varved – alternating 1 mm to 12 mm (0.04 – 0.5 inch) layers of sand, silt and clay
  - Stratified – alternating layers of varying material or color with the layers less than 6 mm (0.23 inches) thick; note thickness
  - Laminated – alternating layers of varying material or color with the layers less than 6 mm (0.23 inches) thick; note thickness
  - Fissured – contains shears or separations along planes of weakness
  - Slickensided – shear planes appear polished or glossy, sometimes striated

- Blocky – cohesive soil that can be broken down into small angular lumps which resist further breakdown
- Lensed – inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
- Homogeneous or Massive – same color and appearance throughout

- **Inorganic Fine-Grained Soil Characteristics** (ASTM D2488; Table 12)

  Several field tests can be performed to determine the characteristics of fine-grained soils (material passing the No. 40 sieve), such as dry strength, dilatency, and toughness. These field testing methods are described below.

  - **Dry Strength** (ASTM D2488; Table 8)

    FTM (Dry Strength): Select enough material and moisten with water until it can be molded or shaped without sticking to your fingers (slightly below the sticky limit) into a ball about 1 inch in diameter. From this ball, form three balls about ½ inch in diameter and allow to dry in air, or sun, or by artificial means (temperature not to exceed 60° C (140° F). Soil containing natural dry lumps about ½ inch in diameter may be used in place of molded balls, however the dry strengths are usually lower. Test the strength by crushing the dry balls or lumps between your fingers using the descriptions below.

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

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

    FTM (Dilatency): Place enough material in your hand to form a ball approximately ½ inch in diameter and moisten with water until it can be

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

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

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

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

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

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

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

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

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

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

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

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

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

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

- Fine Gravel – pea
- Coarse Sand – rock salt
- Medium Sand – opening in window screen
- Fine Sand – sugar, table salt
- Fines (silt and clay) – cannot visually determine size (unaided)

- **Gradation**
  - Well Graded (GW, SW) – full range and even distribution of grain sizes present
  - Poorly-graded (GP, SP) – narrow range of grain sizes present
  - Uniformly-graded (GP, SP) – consists predominantly of one grain size
  - Gap-graded (GP-SP) – within the range of grain sizes present, one or more sizes are missing

- **Organic Material** – Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread of the toughness test will be spongy.
  - PEAT – 50 to 100 percent organics by volume, primary constituent
  - Organic (soil name) – 15 to 50 percent organics by volume, secondary organic constituent
  - (Soil name) with some organics – 5 to 15 percent organics by volume, additional organic constituents

- **Fill Materials** – All soils should be examined to see if they contain materials indicative of man-made fills. Man-made fill items should be listed in each of the soil descriptions. Common fill indicators include glass, brick, dimensioned lumber, concrete, pavement sections, asphalt, metal, plastics, plaster etc. Other items that could suggest fill include buried vegetation mats, tree limbs, stumps etc. The soil description for a fill material should be followed by the term "FILL", i.e., for a sandy silt with some brick fragments the description would be "SANDY

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

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

SOIL DESCRIPTIONS

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

characteristics, and should be given in a consistent order and format. The following order is recommended:

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

  - White to pink may indicate considerable silica, calcium carbonate, or aluminum compounds.

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

The first step when describing soil is to determine if the sample is predominantly fine-grained or coarse-grained (see Figures 3 and 4). Coarse-grained soils are relatively easy to identify, however descriptions of fine-grained soils can be more difficult, requiring additional field tests to assist the field geologist arrive at the proper soils classification (see **FTMs** under Descriptive Terms above). These tests are explained in detail in the ASTM Standard D2488 and briefly herein. Generally, the differentiation between silt and clay is based on plasticity and "texture". However, tests for dry strength and dilatency, along with plasticity,

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

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

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

Coarse-grained Soil

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

Fine-grained Soil

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

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

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

Soil/Fill (option 2) – no visual evidence of fill, suspected reworked material

FILL (reworked): Black, moist, mostly fines with some fine sand and few coarse angular gravel, non-plastic, hard, loose when disturbed, mild odor

BORING AND MONITORING WELL INSTALLATION LOGS

Currently, Benchmark utilizes WinLoG software to construct subsurface logs and a template of the log is included in this FOP as an example. One of the most important functions of a boring/monitoring well installation log, besides transmitting the soil description, is to indicate where the "data" (soil samples) were collected, giving the reader an idea of how reliable or representative the description is. On each sample log, depths of attempted and recovered or non-recovered interval are shown. Odor, if noted, should be considered subjective and not necessarily indicative of specific compounds or concentrations.

Remember: all field logs should be NEAT, ACCURATE, and LEGIBLE. Don't forget that the well completion diagram completed for each well requires details of the surface completion (i.e., flush-mount, stick-up etc.). It is the responsibility of the field staff to double-check each log (i.e., soil names, classifications, well construction details etc.) prior to implementing into a final report. A registered professional (i.e., professional engineer, PE or professional geologist, PG) must review each log and will be ultimately responsible for its content and accuracy.

REQUIRED EQUIPMENT

- Knife
- Engineer's rule/measuring tape

- Permanent marker
- Pre-cleaned wide-mouth sample jars (typically provided by the driller)
- Pre-cleaned wide-mouth laboratory sample jars (provided by the laboratory)
- Stainless steel sampling equipment (i.e., spoons, spatulas, bowls etc.)
- 10x hand lens
- Hydrochloric acid
- ASTM D2488 flow charts (preferably laminated)
- ASTM D2488 test procedures (Tables 1 through 12) (preferably laminated)
- Camera (disposable, 35 mm or digital)
- Munsell soil color chart (as necessary)
- Project Field Book/field forms

ATTACHMENTS

Figure 1; Field Guide for Soil and Stratigraphic Analysis
Figure 2; USCS Soil Classification Flow Chart (modified from ASTM D2488)
Figure 3; Illustration of Particle Sizes
Figure 4; Grain-Size Scale (Modified Wentworth Scale)

Field Borehole Log (sample)

REFERENCES

American Society for Testing and Materials, 2008a. *ASTM D1586: Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.*

American Society for Testing and Materials, 2010. *ASTM D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).*

American Society for Testing and Materials, 2009a. *ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).*

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

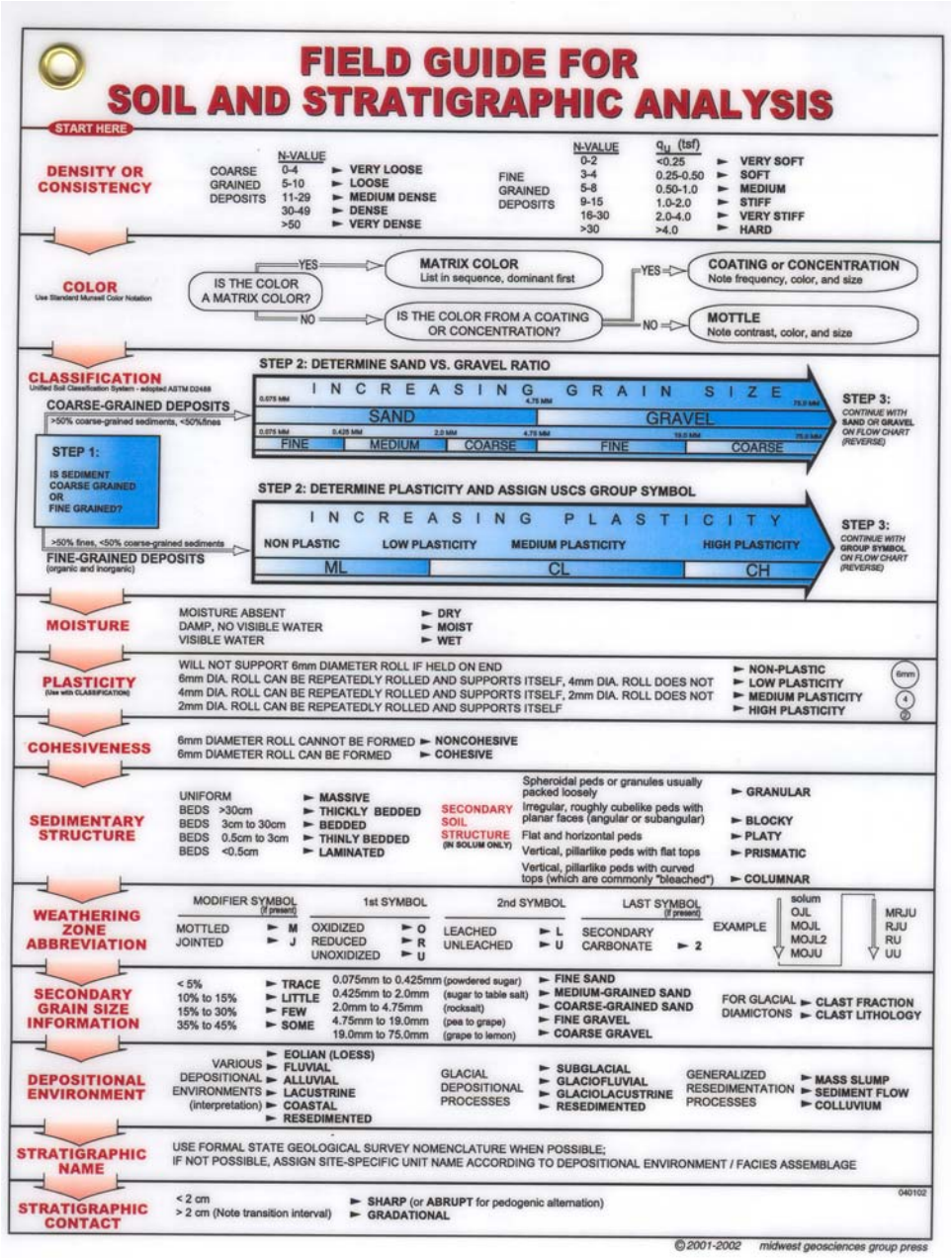
Benchmark FOPs:

010 Calibration and Maintenance of Portable Flame Ionization Detector
011 Calibration and Maintenance of Portable Photoionization Detector
015 Documentation Requirements for Drilling and Well Installation
025 Hand Augering Procedures
032 Management of Investigation-Derived Waste
046 Sample Labeling, Storage and Shipment Procedures
047 Screening of Soil Samples for Organic Vapors During Drilling Activities
058 Split-Spoon Sampling Procedures
065 Test Pit Excavation and Logging Procedures

SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

FIGURE 1

FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS



SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

FIGURE 2

USCS SOIL CLASSIFICATION FLOW CHART (MODIFIED FROM ASTM D2488)

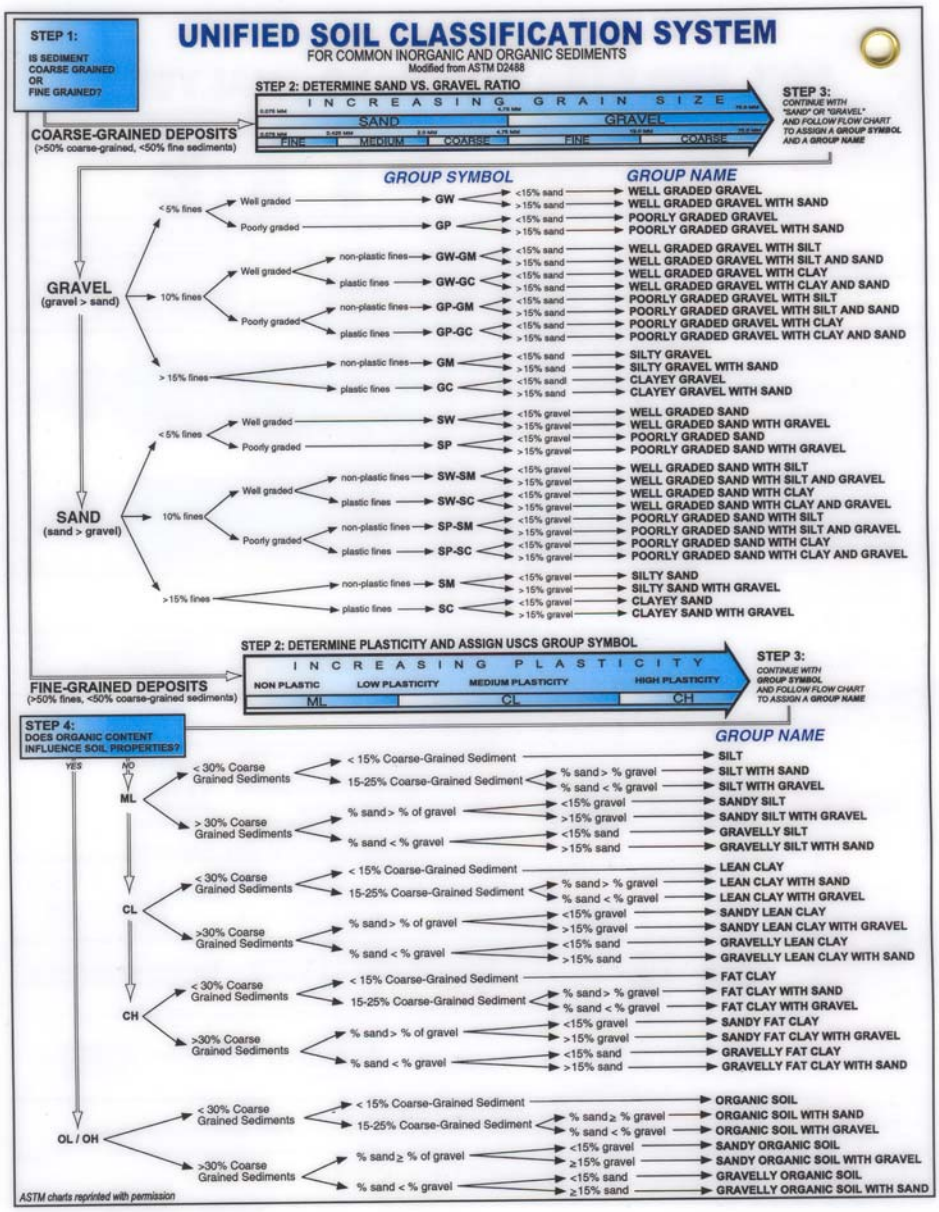


FIGURE 3

ILLUSTRATION OF PARTICLE SIZES

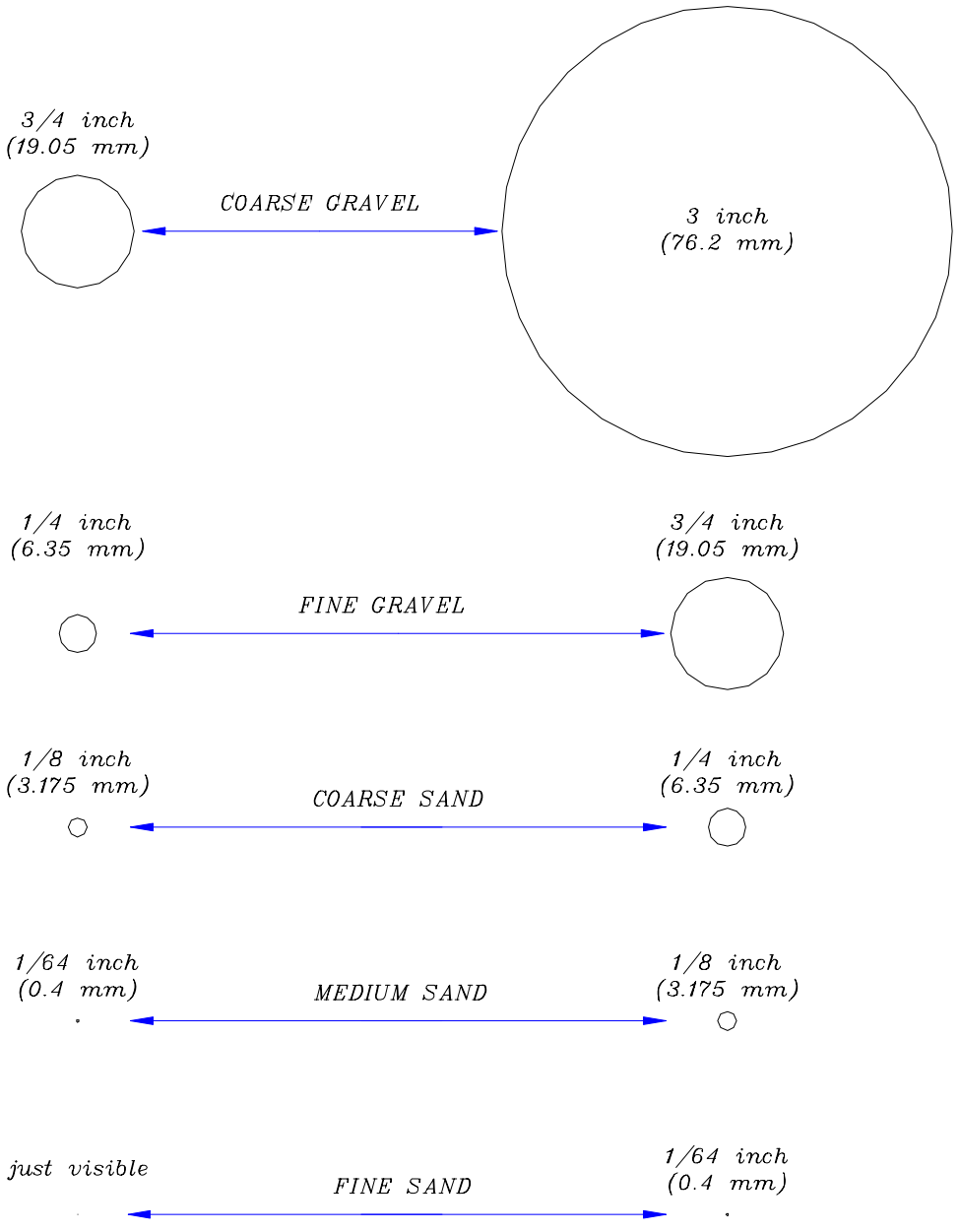


FIGURE 4

GRAIN-SIZE SCALE (MODIFIED WENTWORTH SCALE)

Grain size refers to the physical dimensions of particles of rock or other solid. This is different from the crystallite size, which is the size of a single crystal inside the solid (a grain can be made of several single crystals). Grain sizes can range from very small colloidal particles, through clay, silt, sand, and gravel, to boulders. Size ranges define limits of classes that are given names in the Wentworth scale used in the United States. The Krumbein *phi* (φ) scale, a modification of the Wentworth scale created by W. C. Krumbein, is a logarithmic scale computed by the equation: $\varphi = -\log_2(\text{grain size in mm})$.

φ scale	Size range (metric)	Size range (approx. inches)	Aggregate name (Wentworth Class)
< −8	> 256 mm	> 10.1 in	Boulder
−6 to −8	64–256 mm	2.5–10.1 in	Cobble
−5 to −6	32–64 mm	1.26–2.5 in	Very coarse gravel
−4 to −5	16–32 mm	0.63–1.26 in	Coarse gravel
−3 to −4	8–16 mm	0.31–0.63 in	Medium gravel
−2 to −3	4–8 mm	0.157–0.31 in	Fine gravel
−1 to −2	2–4 mm	0.079–0.157 in	Very fine gravel
0 to −1	1–2 mm	0.039–0.079 in	Very coarse sand
1 to 0	½–1 mm	0.020–0.039 in	Coarse sand
2 to 1	¼–½ mm	0.010–0.020 in	Medium sand
3 to 2	125–250 µm	0.0049–0.010 in	Fine sand
4 to 3	62.5–125 µm	0.0025–0.0049 in	Very fine sand
8 to 4	3.90625–62.5 µm	0.00015–0.0025 in	Silt
> 8	< 3.90625 µm	< 0.00015 in	Clay
<10	< 1 µm	< 0.000039 in	Colloid

In some schemes "gravel" is anything larger than sand (>2.0 mm), and includes "granule", "pebble", "cobble", and "boulder" in the above table. In this scheme, "pebble" covers the size range 4 to 64 mm (−2 to −6 φ).

FOP 054.2

SOIL DESCRIPTION PROCEDURES
USING THE VISUAL-MANUAL METHOD

Project No: **Borehole Number:**

Project:

Client: *Logged By:*

Site Location: *Checked By:*

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

Benchmark Environmental Engineering & Science, PLLC
726 Exchange Street, Suite 624
Buffalo, NY
(716) 856-0599

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

SAMPLE

Drilled By: *Hole Size:*
Drill Rig Type: *Stick-up:*
Drill Method: *Datum:*

Drill Date(s): *Sheet: 1 of 1*

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Soil Sample Collection for VOC Analysis (EnCore Sampling)

FOP 057.0

SOIL SAMPLE COLLECTION FOR VOC ANALYSIS – ENCORE SAMPLING

BACKGROUND AND PURPOSE

This procedure describes the methods for collecting soil samples for VOC analysis to ensure that the sample adequately represents the VOC concentrations in the soil in accordance with SW-846 Method 5035A (effective July 1, 2002). These compounds tend to volatilize from the soil after disturbance or introduction to the atmosphere. Therefore, care must be exercised to ensure that the sample collected is not altered during the collection and storage procedures. A variety of sampling options are allowed and Appendix A of Method 5035A provides details regarding the many options available for sample collection. The collection and preservation procedures are intended to prevent loss of VOCs during sample transport, handling and analysis.

Method 5035A is a method designed for volatile sample collection and analysis of soils and solid wastes for volatile organic compounds. This method is described in Update III to the Third Edition of SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, and is required for all analytical methods using purge and trap techniques (8021, 8015B, and 8260B). Alternative protocols may be used in some states (including New York), however this method is strongly recommended.

The volatile analysis is performed over two ranges:

	GC/MS (µg/kg)	GC (µg/kg)
Low Level	5 – 300	Not Available
High Level	>250	>20

The different levels require different sampling techniques. The low level method can only handle samples within a specific concentration range (these samples CANNOT be diluted), therefore a high level sample MUST be collected to ensure that all the target analytes can be quantified.

Naturally occurring carbonates in some soils may cause effervescence (foaming) on contact with the sodium bisulfate (NaHSO4) solution used as preservative for the low-level preparation. This interference makes it necessary for the laboratory to use the high-level prep or an alternative technique for low level. Check with the NYSDEC to discuss acceptable options.

Typically, analytical laboratories will support the following options for the two levels:

Option	No. of Containers	Sample Size (g)	Holding Time (days)
A – Low Level EnCore™ Samplers	3*	5	14**
B – High Level EnCore™ Sampler	1*	5	14**
C – High Level Methanol vial w/syringe	1	10	14

* Additional EnCore™ Samplers are required for MS/MSD.

** The sample MUST be extracted and preserved in sodium bisulfate or methanol within 48 hours of collection.

NOTE: The EnCore™ Sampler is disposable – it can only be used ONCE. It CANNOT be cleaned and/or reused. The samplers MUST be used in conjunction with an EnCore™ T-handle.

PROCEDURE

The preferred method for collecting and storing a soil sample for VOC analysis is using the EnCore™ method. This field procedure is described in this FOP.

1. The sampling team should reference the manufacturers' directions prior to sample collection (attached).

    a. Ensure that the EnCore™ Sampler is present at the sampling location before collecting the sample from the borehole or surface sample location. The necessary parts of the EnCore™ Sampler will consist of three disposable coring bodies, three disposable caps, and a reusable stainless steel T-handle.

    b. Retrieve the sampling tool from the borehole or sample location.

    c. Expose a surface of the soil sample. For Shelby tube samples, this would require the extrusion of the sample. For split spoon samples, this would require the spoon be disassembled and opened. If liners are being used in conjunction with a split spoon or solid barrel sampler, this would require the removal of the liners from the sampler, so that the soil at the liner's end is exposed.

    d. Following the manufacturer's directions for the use of the EnCore™ Sampler (attached), collect three aliquots of soil from the exposed soil surface, using the three coring bodies. After the collection of each aliquot, cap and label each aliquot. The manufacturer's direction for use of the EnCore™ Sampler are attached

2. If the use of the EnCore™ Sampler is not possible due to soil texture (e.g. gravels) the sample must be field preserved with acid and methanol in accordance with SW-846 Method 5035A.

3. If the soil material is too coarse for sampling with the EnCore™ Sampler and contains excessive calcium carbonate material that reacts with the acid preservative, the sample will be retained in the brass or stainless steel liner of the split-spoon sampler or similar device. The ends of these liners will be covered with Teflon™ rounds, capped and sealed with tape.

4. Record all information associated with sample collection in the Project Field Book.

5. The samples will be labeled, stored and shipped in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

ATTACHMENTS

EnCore™ Sampling Procedure (manufacturers instructions)

REFERENCES

Benchmark FOPs:
046 Sample Labeling, Storage and Shipment Procedures

ATTACHMENT

EnCore™ Sampling Procedure (manufacturers instructions)

Disposable En Core® Sampler

Sampling Procedures

Using The En Core® T-Handle

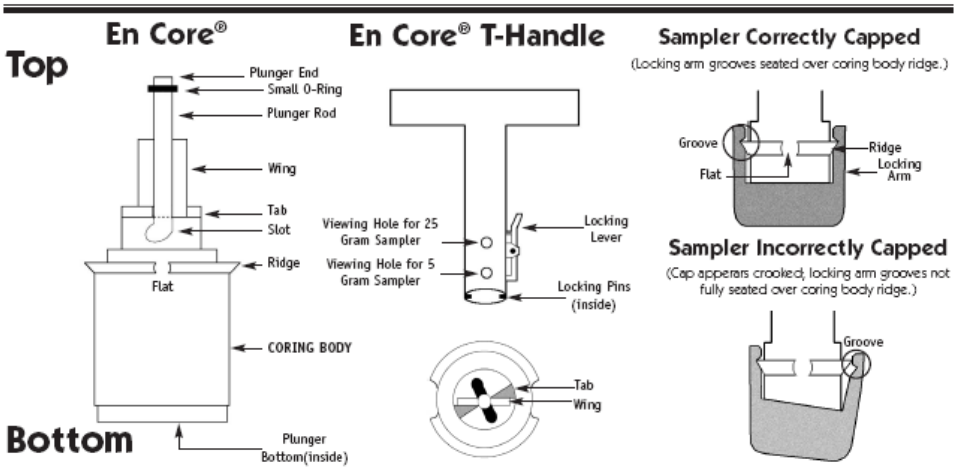
En Novative Technologies, Inc.
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Green Bay, WI 54302
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Toll Free: 888-411-0757
www.ennovativetech.com

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.

Disposable En Core® Sampler

EXTRUSION PROCEDURES

USING THE En Core® EXTRUSION TOOL

CAUTION! Always use the Extrusion Tool to extrude soil from the En Core Sampler. If the Extrusion Tool is not used, the Sampler may fragment, causing injury.

1. Use a pliers to break locking arms on cap of En Core Sampler. Do not remove cap at this time. **(CAUTION: Broken edges will be sharp.)**

2. To attach En Core Sampler to En Core Extrusion Tool: Depress locking lever on Extrusion Tool and place Sampler, plunger end first, into open end of Extrusion Tool, aligning slots on coring body with pins in Extrusion Tool. Turn coring body clockwise until it locks into place. Release locking lever.

3. Rotate and gently push Extrusion Tool plunger knob clockwise until plunger slides over wings of coring body. (When properly positioned plunger will not rotate further.)

4. Hold Extrusion Tool with capped Sampler pointed upward so soil does not fall out when cap is removed. To release soil core, remove cap from Sampler and push down on plunger knob of En Core Extrusion Tool. Remove and properly dispose of En Core Sampler.

Warranty and Disclaimers

IMPORTANT: FAILURE TO USE THE EN CORE* SAMPLER IN COMPLIANCE WITH THE WRITTEN INSTRUCTIONS PROVIDED HEREIN VOIDS ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

PRINCIPLE OF USE. The En Core Sampler Cartridge System is a volumetric sampling system designed to collect, store and deliver a soil sample. The En Core Sampler comes in two sizes for sample volumes of approximately 25 or 5 grams. There are four components: the cartridge with a movable plunger; a cap with two locking arms; a T-handle (purchased separately); and an extrusion handle (purchased separately). NOTE: The En Core Sampler is designed to store soil. It is not designed to store solvent or free product.

The soil is stored in a sealed headspace-free state. The seals are achieved by three special Viton® * o-rings, two located on the plunger and one on the cap of the Sampler. At no time and under no condition should these o-rings be removed or disturbed.

QUALITY CONTROL. The cartridge is sealed in an airtight package to prevent contamination prior to use. Due to the stringent quality control requirements associated with the use of this system, the disposable cartridge is designed to be used only once.

WARRANTY. En Novative Technologies, Inc. ("En Novative Technologies") warrants that the En Core Sampler shall perform consistent with the research conducted under En Novative Technologies' approval, within thirty (30) days from the date of delivery, provided that the Customer gives En Novative Technologies prompt notice of any defect or failure to perform and satisfactory proof thereof. THIS WARRANTY DOES NOT APPLY TO THE FOLLOWING, AS SOLELY DETERMINED BY EN NOVATIVE TECHNOLOGIES: (a) Damage caused by accident, abuse, mishandling or dropping; (b)Samplers that have been opened, taken apart or mishandled; (c)Samplers not used in accordance with the directions; and (d)Damages exceeding the cost of the sampler. Seller warrants that all En Core Samplers shall be free from defects in title. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY INFORMATION PROVIDED BY SALES REPRESENTATIVES OR IN MARKETING LITERATURE. IMPLIED WARRANTIES OF FITNESS AND MERCHANTABILITY SHALL NOT APPLY. En Novative Technologies' warranty obligations and Customer's remedies, except as to title, are solely and exclusively as stated herein.

LIMITATION OF LIABILITY. IN NO EVENT SHALL EN NOVATIVE TECHNOLOGIES BE LIABLE FOR ANTICIPATED PROFITS, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF REVENUE, DOWN TIME, REMEDIATION ACTIVITIES, REMOBILIZATION OR RESAMPLING, COST OF CAPITAL, SERVICE INTERRUPTION OR FAILURE OF SUPPLY, LIABILITY OF CUSTOMER TO A THIRD PARTY, OR FOR LABOR, OVERHEAD, TRANSPORTATION, SUBSTITUTE SUPPLY SOURCES OR ANY OTHER EXPENSE, DAMAGE OR LOSS, INCLUDING PERSONAL INJURY OR PROPERTY DAMAGE. En Novative Technologies' liability on any claim of any kind shall be replacement of the En Core Sampler or refund of the purchase price. En Novative Technologies shall not be liable for penalties of any description whatsoever. In the event the En Core Sampler will be utilized by Customer on behalf of a third party, such third party shall not occupy the position of a third-party beneficiary of the obligation or warranty provided by En Novative Technologies, and no such third party shall have the right to enforce same. All claims must be brought within one (1) year of shipment, regardless of their nature.

En Novative Technologies, Inc.
1241 Bellevue Street
Green Bay, WI 54302
Phone: 920-465-3960 • Fax: 920-465-3963
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www.ennovativetech.com

The En Core™ Sampler is covered by One or More of the Following U.S. Patents: 5,343,771; 5,505,098; 5,517,868; 5,522,271. Other U.S. and Foreign Patents Pending.

* Viton® is a registered trademark of DuPont Dow Elastomers.

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FIELD OPERATING PROCEDURES

Split-Spoon Sampling Procedures

FOP 058.0

SPLIT-SPOON SAMPLING PROCEDURES

PURPOSE

This guideline presents the methods for using a split-spoon sampler for collecting soil samples from a boring and for estimating the relative in-situ compressive strength of subsurface materials (ASTM D 1586). Representative samples for lithologic description, geochemical analysis, and geotechnical testing will be collected from the subsurface materials using the split-spoon sampler.

PROCEDURE

1. Place plastic sheeting on a sturdy surface to prevent the split-spoon and its contents from coming in contact with the surface (several layers of sheeting may be placed on the surface so that they may be removed between each sample or as needed).

2. Lower the sampling string to the base of the borehole. Measure the portion of the sampling string that extends above surrounding grade (i.e. the stickup). The depth of sampling will equal the total length of the string (sampler plus rods) minus the stickup length.

3. Measure sampling depths to an accuracy of 0.1 feet. If field measurements indicate the presence of more than 0.3 feet of disturbed materials in the base of the borehole (i.e. slough), the sampler will be used to remove this material, after which a second sampling trip will be made.

4. Select additional sampler components as required (i.e., leaf spring core retainer for clays or a sand trap for non-cohesive sands). If a retainer or trap is not used, a spacer ring will be used to hold the liners in position inside the sampler.

5. For driving samples, attach the drive head sub and hammer to the drill rods without the weight resting on the rods. For pushing samples using the rig hydraulics, skip to Step 9.

6. Mark four 6-inch intervals on the drill rods relative to a reference point on the drill rig. With the sampler resting on the bottom of the hole, drive the sampler with the 140 lb. hammer falling freely over a 30-inch fall until 24 inches have been penetrated or 50 blows applied.

7. Record the number of blows per 6 inches. Determine the "N" value by adding the blows for the 6 to 12-inch and 12 to 18-inch intervals of each sample drive.

8. After penetration is complete, remove the sampling string. Avoid removing sampling string by hitting up on the string with the hammer as this can cause the sample to fall from the bottom of the split-spoon sampler. The sampling string should be removed via cable lifting or rig hydraulics. If sample retention has been poor, let the sampling string rest in place for at least 3 minutes, then rotate clockwise at least 3 times before removing from the borehole.

9. For pushed samples (i.e., using rig hydraulics), mark four 6-inch intervals on the drill rods relative to a reference point on the rig. Use the rig pull-down to press the sampler downward until 24 inches have been penetrated or no further progress can be made with the full weight of the rig on the sampler.

10. Remove the split-spoon sampler from the sampling string and place on the plastic-covered surface.

11. Open the split-spoon sampler only when the Benchmark field geologist is prepared to describe and manage the sample.

12. Describe the sample in accordance with the Unified Soil Classification System in accordance with the Benchmark FOP: Soil Description Procedures Using the Unified Soil Classification System (USCS).

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

14. Collect a portion of the sample for field screening as described in the Benchmark FOP: Screening of Soil Samples for Organic Vapors During Drilling Activities.

15. If applicable, collect soil samples for volatile organic constituents (VOCs). If applicable, collect sample for semi-volatile, metals, geotechnical, or other off-site analysis.

16. The samples will be labeled, stored and shipped in accordance with the Benchmark's FOP: Sample Labeling, Storage and Shipment Procedures.

ATTACHMENTS

none

REFERENCES

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)

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FIELD OPERATING PROCEDURES

Surface and Subsurface Soil Sampling Procedures

FOP 063.2

SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

PURPOSE

This procedure describes the methods for sampling surface soil and subsurface soil samples for physical and chemical laboratory analysis during intrusive activities such as test pitting, hand augering, drilling, surface soil sampling etc. Typical health and safety related issues should be addressed in the Project Health and Safety Plan.

PRE-SAMPLING PROCEDURES

1. Review project objectives and the Project Health and Safety Plan (HASP).

2. Conduct tailgate health and safety meeting with project team and/or subcontractor(s) by completing the Tailgate Safety Meeting Form (sample attached).

3. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

4. Commence intrusive activities in accordance with specific Benchmark FOPs (test pitting, hand augering, drilling etc.) or as directed by the Project Work Plan.

5. Conduct air monitoring as required by the HASP, Project Work Plan or Benchmark's FOP Real-Time Air Monitoring During Intrusive Activities. Record all results on the Real Time Air Monitoring Log (sample attached).

6. Decontaminate all non-dedicated stainless steel (or Pyrex glass) equipment in accordance with Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination procedures.

7. Collect soil samples in accordance with the following sections.

SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

SURFACE SOIL/FILL SAMPLING PROCEDURES

Collection of surface soil/fill samples facilitates the evaluation of potential health risks to current site receptors that may be exposed to soil/fill via direct contact, incidental ingestion, or inhalation of airborne particulates. The following procedure is in accordance with NYSDEC sampling protocol of surface soil/fill material.

1. Collect all soil samples using dedicated (or decontaminated non-dedicated) sampling tools (i.e., spoons, trowels, bowls etc.), preferably constructed of stainless steel.

2. If the sample area is vegetated, then collect the surface soil sample from 0 to 2 inches below ground surface (bgs) following removal of the sod.

3. If there is no soil present within the sample area (i.e., only slag, concrete, mixed with fines), excavate an area 12 inches by 12 inches by 6 inches deep, screen the material to less than 1/8 inch (No. 4 sieve), and submit the screened material for analysis. If there is not enough material to completely fill the sample jar, then expand the excavation 3 inches in all four directions screening the additional material. Expand the excavation in this manner until sufficient sample volume is obtained. Volatile organic analysis of surface soil/fill utilizing this method will yield negatively biased results and should not be performed.

SURFACE/SUBSURFACE SOIL SAMPLING PROCEDURES

1. Collect all soil samples using dedicated (or decontaminated non-dedicated) sampling tools (i.e., spoons, trowels, bowls etc.), preferably constructed of stainless steel.

   Surface soil samples are typically collected from 0 to 6 inches below ground surface (bgs). Subsurface soils are typically sampled from varying depths greater than 6-inches bgs based on field observations and as directed by the Project Work Plan.

2. Transfer samples for chemical (VOC, SVOC, Metals etc.) and physical (i.e., Atterberg Limits, Grain Size, Permeability etc.) analytical testing by direct grab (i.e., directly from the bucket of the excavation equipment, split-spoon sampler, hand auger etc.) using the dedicated (or decontaminated non-dedicated) sampling tools into appropriate laboratory-supplied containers and seal. The chemical or physical laboratory selected to perform the analysis should determine minimum sample volume for analysis.

3. Prepare collected samples in accordance with Benchmark's FOP: Sample Labeling, Storage and Shipment Procedures. Do not allow the chemical soil samples to freeze during storage and shipping. It should be noted, ice is not required for physical soil samples and all physical soil samples should be kept at the collected soil moisture by securing with a tight sealing lid. Do not allow physical soil samples to gain or lose moisture from the collected soil moisture prior to analysis.

4. Record all sampling details (i.e., depth and location) in the Project Field Book; appropriate Benchmark log sheets depending on method of intrusion (i.e., drilling, test pitting, hand augering etc.); and on the Soil/Sediment Sample Collection Summary Log (sample attached).

PARAMETER-SPECIFIC PROCEDURES

1. Volatile Organic Compound (VOCs): Transfer sufficient soil volume to fill the laboratory-supplied container (typically 4 ounces) by packing the soil sample with the sampling tool to the top of the container leaving no headspace. At no time should a gloved hand (i.e., latex, nitrile etc.) be used to pack the sample into the sample container as the sample may be compromised via cross-contamination.

2. All Other Parameters: All other parameters include, but are not limited to, Semi-VOCs (SVOCs), polychlorinated biphenyls (PCBs), herbicides, pesticides, total metals etc. Transfer sufficient soil volume to fill the laboratory-supplied container by packing the soil sample with the sampling

tool to the top of the container. Unless otherwise indicated by the laboratory or the Project Work Plan, the sample jar for all other parameters does not have to be packed completely leaving no headspace as with the VOC containers.

ATTACHMENTS

Tailgate Safety Meeting Form (sample)
Soil/Sediment Sample Collection Summary Log (sample)
Real Time Air Monitoring Log (sample)

REFERENCES

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*

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

TAILGATE SAFETY MEETING FORM

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

HOSPITAL INFORMATION:

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

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

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

New Equipment:

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

SAMPLE

ATTENDEES

Name Printed	Signatures

Meeting conducted by:

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

SOIL/SEDIMENT
SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Depth (feet)		Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, depth changes, important matrix observations or description, gravel thickness, etc.)
			from	to						

Equipment Rinsate Blanks - Pour clean deionized water over or through decontaminated sampling equipment into sample containers. Collect at a frequency of 1 per sampling method per day. Analyze for all those parameters analyzed for in the samples collected the same day. HSL Metals can be substituted by only the Metals analyzed for that day (except Hexavalent Chromium which needs a separate container). Match equipment used for constituents of concern to rinsate analyte. Note deionized water lot # or distilled water manufacturers info on label.

MS/MSD/MSB - Collect at a frequency of 1 per 20 samples of each matrix per day. Analyze for all those parameters analyzed for the samples collected the same day.

Field Blank - Pour clean deionized water (used as final decon rinse water) into sample containers while at the sampling site. Collect field blanks at a frequency of 1 per lot of deionized water. Note water lot number and dates in use for decon in 'Comments' section.

Investigation Derived Waste (IDW) Characterization samples - One composite sample from all drums of decon fluids and soil. Please note number of drums and labels on collection log.

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. HDPE - high density polyethylene bottle.
4. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank
5. BD - Blind Duplicate - indicate location of duplicate.

SAMPLE

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

REAL TIME AIR MONITORING LOG

Date:
Project Name:
Project Number:
Project Location:
Client:
Purpose of Air Monitoring:

WEATHER CONDITIONS:

Time of Day:	A.M.	P.M.
Ambient Air Temp.:		
Wind Direction:		
Wind Speed:		
Precipitation:		

Date	Personnel	Time	Air Monitoring Meter Measurement (Units)							Location/Activity/Comments
			PID (ppm)	LEL (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Particulates (mg/m^3)	Other	

SAMPLE

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:

BENCHMARK
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FIELD OPERATING PROCEDURES

Real-Time Air Monitoring During Intrusive Activities

FOP 073.2

REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

PURPOSE

This guideline presents requirements for real-time community air monitoring and required responses during all project required intrusive activities, such as drilling, test pitting, earthwork construction etc. This procedure is consistent with the requirements for community air monitoring for all intrusive projects, including projects conducted at remediation sites, as established by the New York State Department of Health (NYSDOH) and the New York State Department of Environmental Conservation (NYSDEC). Accordingly, it follows procedures and practices outlined under NYSDEC's DER-10 (May 2010) Appendix 1A (NYSDOH's Generic Community Air Monitoring Plan) and Appendix 1B (Fugitive Dust and Particulate Monitoring).

This FOP requires real-time monitoring for constituents of concern (COC) (i.e., volatile organic compounds (VOCs), lower explosive limit (% LEL), particulates (i.e., dust) etc.) at the upwind and downwind perimeter as well as the exclusion zone of a project site during all intrusive activities. This FOP is not intended for use in establishing action levels for worker respiratory protection (see Project Health and Safety Plan (HASP) for worker protection action levels). Rather, its intent is to provide a measure of protection for the surrounding community from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The community, as referenced in this document, includes any off-site residences, public buildings/grounds and commercial or industrial establishments adjacent to the project site. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, this FOP helps to confirm that work activities did not spread contamination off-site through via air transport mechanisms. Community air monitoring shall be integrated with the construction

worker personal exposure-monitoring program contained in the project and site-specific HASP.

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for volatile organic compounds (VOCs) and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate NYSDEC/NYSDOH staff.

MONITORING & MITIGATION PROCEDURE

Real-time air monitoring perimeter locations for monitoring stations will be established based on the location of the exclusion zone (i.e., immediate work area) and wind direction. Where wind direction is shifting or winds are calm, the downwind monitoring location will default to the perimeter location nearest the most sensitive receptor (i.e., residential property). All downwind receptors being equal, the downwind monitoring location will default to the perimeter location downwind of the prevailing winds at the site. Although additional site specific COCs may be monitored during real-time air monitoring activities, the most common COCs are discussed in this FOP, including organic vapors (i.e., VOCs), airborne particulates (i.e., fugitive dust) and combustible gases (i.e., methane) and oxygen.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. "Periodic" monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence

ORGANIC VAPORS

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be

capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

- If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

- If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

- If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

- All 15-minute readings must be recorded and be available for State (DEC and DOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

o **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/m3, work activities should be suspended until controls are implemented and are successful in reducing the total particulate concentration to 150 mcg/m3 or less at the monitoring point.

- Depending upon the nature of contamination and remedial activities, other parameters (e.g., explosivity, oxygen, hydrogen SUlfide, carbon monoxide) may also need to be monitored Response levels and actions should be pre-determined, as necessary, for each site.

Additionally, if following the cessation of work and efforts to abate the emission source are unsuccessful, and if sustained organic vapor levels exceed 25 ppm above background within the 20-foot zone for more than 30 minutes, then the **Major Vapor Emission Response Plan** (see below) will automatically be placed into effect.

Major Vapor Emission Response Plan

Upon activation of Major Vapor Emission Response Plan, the following activities will be undertaken:

1. All Emergency Response Contacts as listed below and in the Site-Specific Health and Safety Plan will be contacted.

2. The local police authorities will immediately be contacted by the Site Safety and Health Officer and advised of the situation.

3. The Site Safety and Health Officer will determine if site workers can safely undertake source abatement measures. Abatement measures may include covering the source area with clean fill or plastic sheeting, or consolidating contaminated materials to minimize surface area. The Site Safety and Health Officer will adjust worker personal protective equipment as necessary to protect workers from over-exposure to organic vapors.

The following personnel are to be notified by the Site Safety and Health Officer in the listed sequence if the Major Vapor Emission Response Plan is activated:

Contact	Phone
Police/Fire Department	911
New York State DOH	(518) 402-7860
New York State DEC Region 8	(585) 226-2466, switchboard

New York State DEC Region 9	(716) 851-7220
State Emergency Response Hotline	(800) 457-7362

In addition, the Site Safety and Health Officer will provide these authorities with a description of the apparent source of the contamination and abatement measures being taken by the contractor, if any.

AIRBORNE PARTICULATES

Fugitive dust suppression and airborne particulate monitoring shall be performed during any intrusive activities involving disturbance or handling of site soil/fill materials. Fugitive dust suppression techniques will include the following minimum measures:

- Spraying potable water on all excessively dry work areas and roads.
- All fill materials leaving the site will be hauled in properly covered containers or haul trailers.
- Additional dust suppression efforts may be required as discussed below.

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance

of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (μg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 μg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

- If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 μg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 μg/m^3 of the upwind level and in preventing visible dust migration.

- All readings must be recorded and be available for State (DEC and DOH) personnel to review.

Visual Assessment

In conjunction with the real-time monitoring program, TurnKey personnel and any subcontractors thereof will be responsible for visually assessing fugitive dust migration from the site. If airborne dust is observed leaving the site, the work will be stopped until supplemental dust suppression techniques are employed in those areas.

Supplemental Dust Suppression

Supplemental dust suppression techniques may include but are not necessarily limited to the

following measures:

- Reducing the excavation size, number of excavations or volume of material handled.
- Restricting vehicle speeds.
- Applying water on buckets during excavation and dumping.
- Wetting equipment and excavation faces.
- Wetting haul roads.
- Restricting work during extreme wind conditions.
- Use of a street sweeper on paved haul roads, where feasible.

Work can resume using supplemental dust suppression techniques provided that the measures are successful in reducing the sustained downwind particulate concentration to below 150 ug/m^3 of the upwind level, and in preventing visible dust migration off-site.

COMBUSTIBLE GASES & OXYGEN

Ambient combustible gas and oxygen concentrations should be measured prior to commencing intrusive activities each workday and a minimum of every 30-minutes thereafter. Air monitoring activities should be performed using equipment appropriate to measure combustible gases in percent lower explosive limit (LEL) and percent oxygen and calibrated daily. All combustible gas and oxygen readings must be recorded in the Project Field Book and/or Real-Time Air Monitoring Logs (sample attached) and, if applicable, be made available for State (DEC and DOH) personnel to review.

Mitigation upon the detection of various action levels of organic vapors are presented below:

Combustible Gas:

- If the sustained ambient air concentration of combustible gas at the downwind perimeter of the site exceeds a reading of 10 to 25% LEL, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 10% LEL, work activities can resume with continued monitoring.

- If sustained combustible gas levels at the downwind perimeter of the site persist at levels in excess of 25% LEL, work activities must be halted, the source of explosion hazards identified, corrective actions taken to abate emissions and monitoring continued. Following combustible gas mitigation, work activities can resume provided that the sustained total organic vapor level 200 feet downwind of the exclusions zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less, (but in no case less than 20 feet) is below a sustained value of 10% LEL.

Oxygen:

- If the sustained ambient oxygen concentration at the downwind perimeter of the site measures a reading between 19.5% - 21% oxygen, work activities can continue with extreme caution, however attempts to determine the potential source of oxygen displacement must be conducted.

- If the sustained oxygen level readily decreases below 19.5% LEL, work activities should be discontinued and all personnel must leave the area immediately.

- If the sustained oxygen level at the downwind perimeter of the site persists at levels between 21-25%, work activities can resume with caution.

- If the sustained oxygen level at the downwind perimeter of the site persists at levels exceeding 25% (fire hazard potential), work activities should be discontinued and all personnel must leave the area immediately.

ATTACHMENTS

Real-Time Air Monitoring Log (sample)

REFERENCES

TurnKey FOPs:

006 *Calibration and Maintenance of Combustible Gas/Oxygen Meter*
010 *Calibration and Maintenance of Flame Ionization Detector*
011 *Calibration and Maintenance of Portable Photoionization Detector*
084 *Calibration and Maintenance of Portable Particulate Meter*

REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, P.C.

REAL TIME AIR MONITORING LOG

Date:
Project Name:
Project Number:
Project Location:
Client:
Purpose of Air Monitoring:

WEATHER CONDITIONS:

Time of Day:	A.M.	P.M.
Ambient Air Temp.:		
Wind Direction:		
Wind Speed:		
Precipitation:		

Date	Personnel	Time	Air Monitoring Meter Measurement (Units)							Location/Activity/Comments
			PID (ppm)	LEL (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Particulates (mg/m^3)	Other	

SAMPLE

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:

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FIELD OPERATING PROCEDURES

"Before Going Into The Field" Procedure

FOP 076.0

"BEFORE & AFTER" PROJECT PROCEDURES FOR FIELD PERSONNEL

PURPOSE

This procedure describes the required field and office activities to be preformed "before and after" project assignments by field personnel. Field activities may include, but are not limited to, drilling oversight, excavation contractor oversight, matrix sample collection (e.g., soil, sediment, groundwater, surface water, wipe, and/or air), third party oversight, and site reconnaissance to name a few. Office activities may include, but are not limited to, photocopying field book entries, completing all field forms, tabulating collected field and laboratory data, and preparation of report text.

The primary goal of this procedure is to eliminate delays and unnecessary budgetary "strain" due to a lack of preparedness and knowledge of the site by the field team members. This procedure also seeks to streamline the preparation and transfer of field information/data from field personnel to the Project Manager upon field work completion.

PROJECT ASSIGNMENT

During the initial meeting with the Project Manager, several questions should be raised by the field team member and answered by the Project Manager. A pad of paper and pen should be in hand to record all pertinent job information. At a minimum, the following questions should be answered:

1. *What is the job number?*
2. *Who is the client and the on-site representative (if applicable)?*
3. *What is the name of the project?*
4. *What are the job responsibilities and how should they be accomplished?*
5. *How much time do I have to complete the assigned tasks?*
6. *Are there any project required documents? What are they?*

Any deviation from the above questions should be approved by the Project Manager prior to contravention, not at the end of the day or following the project completion.

"BEFORE" CHECKLISTS

Checklists should be developed and used so that all of the required steps prior to going into the field are undertaken. A good checklist will include:

- Adequate review of the documents listed in this FOP
- Any documents, equipment, and supplies presented in this FOP
- Providing adequate notification to the laboratory (so that holding times are not exceeded) and to the owner of the site and the primary regulatory agency (usually in writing) that a round of sampling is to commence in order to facilitate sampling and allow for a sampling audit or split sampling.
- Specifying and documenting the equipment maintenance and calibration undertaken prior to going into the field relative to the sampling event.
- Checking and calibrating the equipment.
- Listing the documents, equipment, and supplies required to collect samples at the site as presented in this FOP.

Prior to going into the field, sampling personnel should reacquaint themselves with the sampling plan. The review is undertaken so that the required specific protocol such as sampling from the least to the most contaminated wells, knowing where quality control samples are to be taken, knowing the disposition of purge water, etc., is understood and followed.

The amount of equipment maintenance and calibration required prior to going into the field should be clearly specified in the presampling equipment maintenance and calibration checklists, which are based on the manufacturer's recommendations, sampling objectives, and prior experience. Maintenance and calibration performed before sampling must be

documented to provide evidence that the equipment was adequately maintained and calibrated and to keep a permanent record of equipment servicing and performance.

A list of all the documents, equipment, and supplies required for the sampling event should be prepared and used. It can be frustrating and time consuming to forget equipment and supplies, so some up-front preparation is warranted. The following sections provide a list of the documentation, equipment, and supplies, which should assist in preparing a site-specific equipment and supply checklist. Once prepared, the checklist and project requirements should be reviewed with the Project Manager.

"BEFORE" DOCUMENTATION SUMMARY

Prior to going into the field, the field team should review and understand all of the project documents including, but not limited to:

- The Health and Safety Plan (HASP)
- The Site Analytical Plan (SAP), Sampling Plan, or similar document
- The Quality Assurance Project Plan (QAPP)
- The Work Plan
- Project specific Field Operating Procedures and field forms
- Site Maps
- Equipment operation manuals
- Chain-of-Custody forms
- Shipping labels and custody seals
- Any reference materials (i.e., conversion tables, volume calculation, etc.). The Pocket Ref, Third Edition by Thomas Glover is a great source for the field.

If at any time, the field team does not understand the project required protocol, procedures, sample locations, etc.; the Project Manager should be consulted for clarification.

"BEFORE" EQUIPMENT SUMMARY

Prior to going into the field, the field team should review the following equipment checklist, noting that project specific equipment may not be included in this list:

- Water level indicator
- Pumps, sample tubing, flow controllers, power cord(s), batteries, compressors, generators, etc.
- Bailers (disposable, PVC, stainless steel, glass), rope
- Flow-through cell
- Field meters with adequate calibration solutions (pH/Eh meter, conductivity meter, dissolved oxygen meter, turbidity meter, batteries, etc.)
- Garden hose
- Explosive gas meter and/or photoionization detector (PID) with calibration supplies
- Complete set of hand tools including a sharp knife, screw drivers, pliers, hacksaw, flashlight, large pipe wrench, hammer, bolt cutters, and replacement locks
- Fish hook with weight and string
- Field filtering equipment and supplies
- Decontamination supplies, such as scrub brushes, Alconox®, distilled water, potable water, 5-gallon bucket, paper towels, aluminum foil
- 5-gallon bucket(s)
- Measuring cup
- Sample bottles/containers (with extras) and preservatives
- Stainless steel spoons, trowels, shovels
- Shipping containers (i.e., coolers)
- Clipboard
- Calculator
- Water resistant clock or watch with second hand
- First aid kit

"BEFORE" SUPPLIES SUMMARY

Prior to going into the field, the field team should review the following supplies checklist, noting that project specific supplies may not be included in this list:

- Laboratory grade non-phosphate detergent (Alconox®)
- Appropriate personal protective equipment appropriate to the contaminants of concern, such as nitrile gloves, Tyvek, boots, hardhat, safety glasses, hearing protection, etc.
- Bags of ice
- Plastic garbage bags
- Plastic sheeting
- Sufficient quantities of potable and laboratory grade deionized water for cleaning and equipment blanks
- Methanol
- Isopropyl alcohol
- Clean rags and paper towels
- Electrical tape, duct tape, and wide transparent tape
- Hand soap
- Regular, ballpoint, and indelible pens
- Hollow braid polyethylene rope

After providing adequate notification (lab, state and/or federal agencies), performing the presampling maintenance and calibration, obtaining the site and well keys, and packing the supplies and equipment, the field activities are ready to be performed.

"AFTER" – PROJECT FILE REVIEW & CREATION

It is the responsibility of each field crew member to review his/her own field notes and time sheet for accuracy and completeness. All errors to the field notes should be corrected, dated, and initialed for Project Manager review. Once reviewed by the field team member, the Project Field Book, all field forms, photographs, chain-of-custodies etc. must be

photocopied, scanned (if required), downloaded, etc. and then given to the Project Manager in an organized file folder in a timely manner. Avoiding delay during this step is critical, especially when there are severe time constraints for the project.

REFERENCES

1. Wilson, Neal. *Soil Water and Ground Water Sampling*, 1995

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FIELD OPERATING PROCEDURES

Stockpile Sampling Procedures for Chemical Analysis

FOP 079.0

STOCKPILE SAMPLING PROCEDURES FOR CHEMICAL ANALYSIS

PURPOSE

This guideline presents a method for collecting representative soil samples from stockpiled borrow source material for chemical analysis.

GENERAL

In general, off-site soil that is brought to a Site for use as supplemental fill is subject to Quality Assurance sampling and analysis. If QA is required, all off-site soil proposed for use as Site backfill shall be documented by the subcontractor in writing to have originated from locations having no evidence of disposal or release of hazardous, toxic or radioactive substances, wastes or petroleum products. If the subcontractor designates a source as "virgin" soil, it shall be further documented in writing to be native soil material having not supported any known past industrial or commercial development or agricultural use. Borrow soils can be used as backfill once concentrations are confirmed to meet project designated criteria for the Constituents of Primary Concern (COPCs) and NYSDEC TAGM HWR-94-4046 recommended soil cleanup objectives (SCOs) or NYSDEC 6NYCRR Part 375 SCOs.

Sample collection equipment will include stainless steel mixing bowls, stainless steel mixing spoons, and a stainless steel hand auger with extension rods or a stainless steel spade or equivalent. It may be necessary to use a backhoe or drilling rig to facilitate sample collection.

FOP 079.0

STOCKPILE SAMPLING PROCEDURES FOR CHEMICAL ANALYSIS

SAMPLING PLAN

1. Virgin Sources – Virgin borrow sources will be confirmed acceptable for use as site backfill through collection of a single composite soil sample representative of the borrow pit or stockpile.

2. Non-Virgin Sources – Prior to sampling, determine the amount of soil that will be sampled. The soil will be tested via collection of one composite sample per 250 cubic yards of material from each source area. If more than 1,000 cubic yards of soils are excavated from a given off-site source area and all samples of the first 1,000 cubic yards meet project designated criteria, the sample collection frequency may be reduced to one composite for each additional 1,000 cubic yards of soils from the same source area, up to 5,000 cubic yards. For borrow sources greater than 5,000 cubic yards, sampling frequency may be reduced to one sample per 5,000 cubic yards, providing all earlier samples meet project designated criteria. Sampling procedure for non-virgin sources is described in the next section.

SAMPLE COLLECTION AND HANDLING

The following procedure will be used to collect representative soil samples from a non-virgin soil stockpile.

1. Using a stainless steel spade (or hand auger), a backhoe, or drilling rig, penetrate the pile to a depth of approximately 2 to 3 feet and collect four (4) representative grab samples of approximate equal volume from the top, middle, and bottom.

2. Transfer each grab into a small stainless steel mixing bowl.

3. **VOC Analysis:** Using a clean stainless steel spoon, transfer equal amounts from each small mixing bowl into a laboratory-supplied, 4 oz. VOC sample jar. This should be performed by randomly transferring several small aliquots from each bowl, taking care to minimize disturbance of the soil.

4. **Other COPCs:** Transfer equal aliquots from each small bowl into a large mixing bowl and homogenize the sample. Fill the remaining laboratory-supplied jars with the homogenized soil for all other project required COPCs (i.e., SVOCs, PCBs, Pesticides, Herbicides, inorganics, etc.).

5. Label each set of jars with the following information:
   - Project and site name
   - Sample Code
   - Project Number
   - Date/Time
   - Sample type (soil composite or grab)
   - Sampler's initials
   - Sample Preservation
   - Required analysis

   The sample code will consist of a unique, alphanumeric identification code keyed to the sampling location. Identify the sampling location on a field sketch.

6. Record all information associated with sample collection in the Project Field Book.

7. Label, store, and ship the samples in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

8. Clean the sampling and mixing equipment with Alconox and deionized water and repeat steps 1 through 7 for the remaining samples.

REFERENCES

Benchmark FOPs:
046 Sample Labeling, Storage and Shipment Procedures

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FIELD OPERATING PROCEDURES

Stockpile & Borrow Source Sampling Procedures for Physical Analysis

FOP 080.0

STOCKPILE & BORROW SOURCE SAMPLING PROCEDURES FOR PHYSICAL ANALYSIS

PURPOSE

This guideline presents a method for collecting representative soil samples from stockpiled borrow source material for physical analysis.

GENERAL

Generally, one of two methods will be utilized to collect soil samples for analysis. One method is to collect the samples by digging a series of representative test pits at the borrow source area and obtaining samples from those test pits. The other method involves collecting samples from representative stockpiles (normally after the material has been mechanically screened). Both procedures are discussed within this method.

Sample collection equipment will include stainless steel mixing bowls, stainless steel mixing spoons, and a stainless steel hand auger with extension rods or a stainless steel spade or equivalent. It may be necessary to use a backhoe or drilling rig to facilitate sample collection.

STOCKPILED SOIL SAMPLING METHOD

As shown in the attached Figure 1, twelve (12) samples of approximate equal volume should be collected from the top, middle and bottom of each 1000 CY stockpile by CQA personnel and composited in the field to give one representative aliquot per 1000 CY.

Stockpile Sampling Procedure

1. Using a shovel or backhoe, penetrate the pile to a depth of about two to three feet.
2. Collect a sample using the shovel.

3. Transfer the sample to a specially prepared mixing area.
4. Repeat Steps 1 through 3 at each 1,000 CY stockpile.
5. Mix subsamples using shovel into one homogenous mass and place in a properly labeled 5-gallon bucket. Fill each bucket completely and cover.
6. Attach a label to each container and record location referencing the stockpile identification number. The label may be made with permanent marker on the side (not top) of the container or using adhesive-back paper labels affixed to the side of the container. At a minimum, the labels should be identified with the following information:
    - Project Name
    - Sample number.
    - Initials of CQA inspector or sample collection personnel.
    - Date of collection.
    - Location of collection (i.e. stockpile I.D.)
7. Return remaining contents of composite sample to stockpile.
8. Deliver the samples to the laboratory for analysis as soon as possible.
9. All information pertinent to each sampling event should be recorded by sampling personnel in the field at the time of sample collection. Each report should correspond to each stockpile and will contain the following information:
    - Project Name
    - Sample number or numbers collected
    - Field observations.
    - Climatologic conditions.
    - Date and time of collection.
    - Approximate location of test pit.
    - Name of person who collected sample.

BORROW AREA TEST PIT SAMPLING METHOD

Prior to obtaining representative soil samples, test holes should be excavated at the borrow area to determine the actual depth and lateral extent of the borrow source soil material. A base line should then be established and a grid system staked in the field. Five samples

should be collected at equidistant locations for each 5000 cubic yards (CY) of soil designated for use in the borrow areas (at approximately mid-depth).

Borrow Area Sampling Procedure

1. Using a shovel, collect a representative sample at approximately mid-depth at each of the sampling locations representing 1000 CY of the proposed excavation area.
2. Transfer each sample into a labeled separate 5-gallon bucket. Fill each bucket completely and cover.
3. Attach a label to each container and record location referencing the established grid system in the borrow area. The label may be made with permanent marker on the side (not top) of the container or using adhesive-back paper labels affixed to the side of the container. At a minimum, the labels should be identified with the following information:
    - Project Name
    - Sample number.
    - Initials of CQA inspector or sample collection personnel.
    - Date of collection.
    - Location of collection (i.e. location of borrow area grid system location)
4. Deliver the samples to the laboratory for analysis as soon as possible.
5. All information pertinent to each sampling event should be recorded by sampling personnel in the field at the time of sample collection. Each report should correspond to each test pit and will contain the following information:
    - Project Name
    - Sample number or numbers collected
    - Field observations.
    - Climatologic conditions.
    - Date and time of collection.
    - Approximate location of test pit.
    - Name of person who collected sample.

ATTACHMENTS

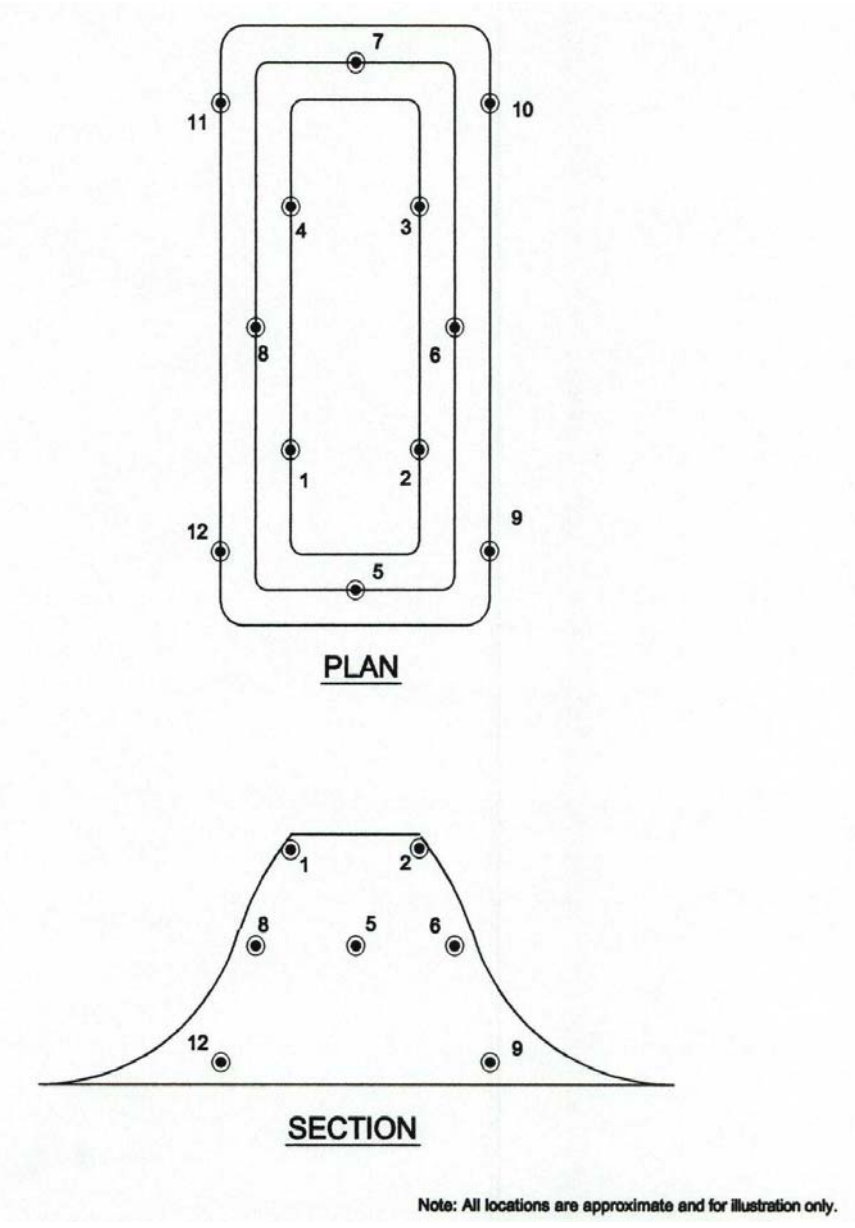
Figure 1; Stockpile Sampling Methodology

REFERENCES

None

FIGURE 4

1,000 CY STOCKPILE SAMPLING METHODOLOGY



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FIELD OPERATING PROCEDURES

Waste Sampling Procedures

FOP 082.0

WASTE SAMPLING PROCEDURES

PURPOSE

This guideline describes the equipment and procedures that can safely be used to collect waste samples from open and closed units.

INTRODUCTION

Hazardous wastes are regulated by the USEPA under 40 CFR Parts 260-265. Therefore, many of the methods that are used to manage, store, treat, and dispose hazardous wastes and potential hazardous wastes are of concern to both the regulators and the regulated community. Samples are often required of regulated or potentially regulated materials. While it is understood that each facility and waste stream may present its own unique sampling and analytical challenges, this procedure will list equipment and enumerate procedures that have been used by the USEPA to safely and successfully sample specific waste units.

SAFETY

Sampling of waste units should be assessed for potential hazards by both the Project Manager (PM) and the site safety officer (SSO). It is the SSOs responsibility to enforce the site Health and Safety Plan (HASP), and to ensure that procedures used during waste sampling are in accordance with current company protocol. Sampling equipment contaminated during waste sampling investigations should be cleaned with laboratory detergent and rinsed with tap water prior to returning the equipment from the field. Contaminated sampling equipment that is to be discarded must be disposed of properly in accordance with the site-specific Work Plan.

It should be noted that although Benchmark does not readily perform field activities with highly hazardous materials, we do occasionally oversee contractors who do. Therefore, it is prudent on our part to recognize those situations and be prepared to ensure the activities of

our subcontractors comply with the site-specific HASP as well as those procedures discussed herein. Any reference within this procedure to personal protective equipment (PPE) upgrades above a modified level C (i.e., Tyvek, nitrile gloves, and full-face respirator) relates solely to our subcontractors.

QUALITY CONTROL PROCEDURES

In some instances, special decontamination procedures will be necessary and should be developed on a case-by-case basis according to the specific material encountered. Any cleaning procedures and equipment repairs conducted in the field deviating from those specified in the associated FOPs or the site-specific Work Plan, should be discussed with the Project Manager, and thoroughly documented in the Project Field Book.

All air monitoring and field analytical/screening equipment (i.e., photoionization detectors) should be checked and calibrated per manufacturer's specifications before being used to collect any waste stream unit sample (open or closed). The Field Team Leader should record all calibration results on appropriate field forms.

WASTE UNIT TYPES

Waste management units can be generally categorized into two types: open and closed. In general, open units are larger than closed units and include waste piles and surface impoundments whereas closed units include containers and tanks as well as ancillary tank equipment. Besides containers and tanks, sumps may also be considered closed units because they are designed to collect the spillage of liquid wastes and are sometimes configured as a confined space.

Although both may pose hazards, units that are open to the environment are generally less hazardous than closed units. Sampling of closed units is considered a higher hazard risk

because of the potential of exposure to toxic gases and flammable/explosive atmospheres. Because closed units prevent the dilution of the wastes by environmental influences, they are more likely to contain materials that have concentrated levels of hazardous constituents. While opening closed units for sampling purposes, investigators/contractor's shall use Level B PPE, air monitoring instruments to ensure that the working environment does not contain hazardous levels of flammable/explosive gasses or toxic vapors, and follow the appropriate safety requirements stipulated in the site-specific HASP.

Buried waste materials should be located and excavated with extreme caution. Once the buried waste is uncovered, the appropriate safety and sampling procedures utilized will depend on the type of waste unit.

Open Units

While open units may contain many types of wastes and come in a variety of shapes and sizes, they can be generally regarded as either waste piles or surface impoundments.

Definitions of these two types of open units from 40 CFR Part 260.10 are:

- Waste pile -- any non-containerized accumulation of solid, non-flowing hazardous waste that is used for treatment or storage and that is not a containment building.

- Surface impoundment -- "...a facility or part of a facility which is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), which is designed to hold the accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling and aeration pits, ponds, and lagoons."

One of the distinguishing features between waste piles and surface impoundments is the state of the waste. Waste piles typically contain solid or non-flowing materials whereas liquid wastes are usually contained in surface impoundments. The nature of the waste will also determine the mode of delivering the waste to the unit. Wastes are commonly pumped

or gravity fed into impoundments while heavy equipment or trucks may be used to dump wastes in piles. Once the waste has been placed in an open unit, the state of the waste may be altered by environmental factors (e.g., temperature, precipitation, etc.).

Surface impoundments may contain several phases such as floating solids, liquid phase(s), and sludges. Waste piles are usually restricted to solids and semi-solids. All of the potential phases contained in a waste unit should be considered in developing the sample design to meet the study's objective.

Closed Units

There are a variety of designs, shapes, sizes, and functions of closed units. In addition to the challenges of the various designs and the safety requirements for sampling them, closed units are difficult to sample because they may contain liquid, solid, semi-solid/sludge, or any combination of phases. Based on the study's design, it may be necessary to obtain a cross sectional profile of the closed unit in an attempt to characterize the unit. The following are definitions of types of closed waste units described in 40 CFR Part 260.10:

- Container -- any portable device in which a material is stored, transported, treated, disposed, or otherwise handled. Examples of containers are drums, overpacks, pails, totes, and roll-offs.

- Tank -- a stationary device, designed to contain an accumulation of hazardous waste constructed primarily of non-earthen materials, which provide structural support.

Portable tanks, tank trucks, and tank cars vary in size and may range from simple to extremely complex designs. Depending on the unit's design, it may be convenient to consider some of these storage units as tanks for sampling purposes even though they meet the definition of a container.

- Ancillary equipment (tank) -- any device including, but not limited to, such devices as piping, fittings, flanges, valves, and pumps that is used to distribute, meter, or control the flow of hazardous waste from its point of generation to a storage or treatment tank(s), between hazardous waste storage and treatment tanks to a point of disposal on-site, or to a point of shipment for disposal off-site.

- Sump -- any pit or reservoir that meets the definition of a tank and those troughs/trenches connected to it that serve to collect hazardous wastes.

Note: some outdoor sumps may be considered open units/surface impoundments.

Although any of the closed units may not be completely sealed and may be partially open to the environment, the unit needs to be treated as a closed unit for sampling purposes until a determination can be made. Once a closed unit is opened, a review of the proposed sampling procedures and level of protection can be performed to determined if the (PPE) is suitable for the site conditions.

Samples collected from different waste units should not be composited into one sample container without additional analytical and/or field screening data to determine if the materials are compatible and will not cause an inadvertent chemical reaction.

EQUIPMENT

Selecting appropriate equipment to sample wastes is a challenging task due to the uncertainty of the physical characteristics and nature of the wastes. It may be difficult to separate, homogenize and/or containerize a waste due to its physical characteristics (viscosity, particle size, etc.). In addition, the physical characteristics of a waste may change with temperature, humidity, or pressure. Waste streams may vary depending on how and when a waste was generated, how and where it was stored/disposed, and the conditions under which it was

stored/disposed. Also, the physical location of the wastes or the unit configuration may prevent the use of conventional sampling equipment.

Given the uncertainties that a waste may present, it is desirable to select sampling equipment that will facilitate the collection of samples that will meet the study's objective, and that will not unintentionally bias the sample by excluding some of the sample population that is under consideration. However, due to the nature of some waste matrices or the physical constraints of some waste units, it may be necessary to collect samples knowing that a portion of the desired population was omitted due to limitations of the equipment. Any deviations from the study plan or difficulties encountered in the field concerning sample collection that may have an effect on the study's objective should be documented in a log book, reviewed with the analytical data, and presented in the report.

WASTE SAMPLING EQUIPMENT

Waste sampling equipment should be made of non-reactive materials that will neither add to nor alter the chemical or physical properties of the material that is being sampled. The attached Table 1 lists some conventional equipment for sampling waste units/phases and some potential limitations of the equipment. Another reference for selecting sampling equipment is the ASTM, Standard Guide for Selection of Sampling Equipment for Wastes and Contaminated Media Data Collection Activities, D6232-98.

WASTE SAMPLING PROCEDURES

Waste Piles

Waste piles vary in size, shape, composition, and compactness, and may vary in distribution of hazardous constituents and characteristics (strata). These variables will affect safety and access considerations. The number of samples, the type of sample(s), and the sample location(s) should be based on the study's objectives. Commonly used equipment to collect

samples from waste piles are listed in Table 1. All equipment should be compatible with the waste and should have been cleaned to prevent any cross contamination of the sample.

Surface Impoundments

Surface impoundments vary in size, shape, and waste content, and may vary in distribution of hazardous constituents and characteristics (strata). The number of samples, the type of sample(s), and the sample location(s) should be based on the study's objectives. Commonly used equipment to collect samples from surface impoundments are listed in Table 1. All equipment should be compatible with the waste and should have been cleaned to prevent any cross contamination of the sample.

Because of the potential danger of sampling waste units suspected of containing elevated levels of hazardous constituents, personnel should never attempt to sample surface impoundments used to manage potentially hazardous wastes from a boat. All sampling should be conducted from the banks or piers of surface impoundments. Any exception must be approved by the appropriate site safety officer and/or the Occupational Health and Safety Designee (OHSD).

Drums

Drums are the most frequent type of containers sampled by field investigators for chemical analyses and/or physical testing. Caution should be exercised by the field investigators when sampling drums because of the potential presence of explosive/flammable gases and/or toxic vapors. Therefore, the following procedures should be used when collecting samples from drums of unknown material:

1. Visually inspect all drums that are being considered for sampling for the following:
    - pressurization (bulging/dimples);
    - crystals formed around the drum opening;
    - leaks, holes, stains;

- labels, markings;
- composition and type (steel/poly and open/bung);
- condition, age, rust
- sampling accessibility

Drums showing evidence of pressurization and crystals should be furthered assessed to determine if remote drum opening is needed. If drums cannot be accessed for sampling, heavy equipment is usually necessary to stage drums for the sampling activities. Adequate time should be allowed for the drum contents to stabilize after a drum is handled.

2. Identify each drum that will be opened (e.g., paint sticks, spray paint, cones, etc).

LEVEL "B" PROTECTION IS REQUIRED FOR THE FOLLOWING PROCEDURES.

3. Before opening, ground each metal drum that is not in direct contact with the earth using grounding wires, alligator clips, and a grounding rod or metal structure. If a metal drum is in an overpack drum, the metal drum should be grounded.

4. Touch the drum opening equipment to the bung or lid and allow an electrical conductive path to form. Slowly remove the bung or drum ring and/or lid with spark resistant tools (brass/beryllium).

5. Screen drums for explosive gases and toxic vapor with air monitoring instruments as bung or drum lid is removed. Depending on site conditions screen for one or more of the following:
   - radioactivity
   - cyanide fumes
   - halogen vapors
   - pH
   - flash point (requires sample for testing)

   Note the state, quantity, phases, and color of the drum contents. Record all relevant results, observations, and information in a logbook.

6. Select the appropriate sampling equipment based on the state of the material and the type of container. Sampling equipment should be made of non-reactive materials that will meet the study's objective(s).

7. Place oil wipe (as necessary), sampling equipment, and sample containers near drum(s) to be sampled.

AIR MONITORING FOR TOXIC VAPORS AND EXPLOSIVE GASES AND OXYGEN DEFICIENT ATMOSPHERES SHOULD BE CONDUCTED DURING DRUM SAMPLING.

Liquids -- Slowly lower the COLIWASA or drum thief to the bottom of the container. Close the COLIWASA with the inner rod or create a vacuum with the sampler's gloved thumb on the end of the thief and slowly remove the sampling device from the drum. Release the sample from the device into the sample container. Repeat the procedure until a sufficient sample volume is obtained.

Solids/Semi-Solids -- Use a push tube, bucket auger, or screw auger or if conditions permit a pneumatic hammer/drill to obtain the sample. Carefully use a clean stainless steel spoon to place the sample into container(s) for analyses.

8. Close the drums when sampling is complete. Segregate contaminated sampling equipment and investigative derived wastes (IDW) containing incompatible materials as determined by the drum screening procedure (Step #5). At a minimum, contaminated equipment should be cleaned with laboratory detergent and rinsed with tap water prior to returning it from the field.

Tanks

Sampling tanks is considered hazardous due to the potential for them to contain large volumes of hazardous materials and therefore, appropriate safety protocols must be followed. Unlike drums, tanks may be compartmentalized or have complex designs.

Preliminary information about the tank's contents and configuration should be reviewed prior to the sampling operation to ensure the safety of sampling personnel and that the study's objectives can be achieved.

In addition to having discharge valves near the bottom of tanks and bulk storage units, most tanks have hatches at the top. It is desirable to collect samples from the top hatch because of the potential for the tank's contents to be stratified. Additionally, when sampling from the discharge valve, there is a possibility of a stuck or broken valve which could cause an uncontrolled release. Investigators should not utilize valves on tanks or bulk storage devices unless they are operated by the owner or operator of the facility, or a containment plan is in place should the valve stick or break. If the investigator must sample from a tank discharge valve, the valving arrangement of the particular tank must be clearly understood to insure that the compartment(s) of interest is sampled.

Because of the many different types of designs and materials that may be encountered, only general sampling procedures that outline sampling a tank from the top hatch are listed below:

1. All relevant information concerning the tank such as the type of tank, the tank capacity, markings, condition, and suspected contents should be documented in a logbook.

2. The samplers should inspect the ladder, stairs, and catwalk that will be used to access the top hatch to ensure that they will support the samplers and their equipment.

LEVEL "B" PROTECTION IS REQUIRED FOR THE FOLLOWING PROCEDURES.

3. Before opening, ground each metal tank using grounding wires, alligator clips, and a grounding rod or metal structure.

4. Any vents or pressure release valves should be slowly opened to allow the unit to vent to atmospheric pressure. Air monitoring for explosive/flammable gases and toxic vapors should be conducted during the venting with the results recorded in a log book. If dangerous concentrations of gases evolve from the vent or the pressure is too great, leave the area immediately.

5. Touch tank opening equipment to the bolts in the hatch lid and allow electrical conductive path to form. Slowly remove bolts and/or hatch with spark resistant tools (brass/beryllium). If a pressure build up is encountered or detected, cease opening activities and leave the area.

6. Screen tanks for explosive/flammable gases and toxic vapors with air monitoring instruments. Depending on the study objectives and site conditions, conduct characteristic screening (e.g., pH, halogen, etc.) as desired. Collect a small volume of sample for flash point testing, if warranted. Note the state, quantity, number of phases, and color of the tank contents. Record all relevant results, observations, and information in a logbook. Compare the screening results with any pre-existing data to determine if the tank should be sampled.

7. Select the appropriate sampling equipment based on the state of the material and the type of tank. Sampling equipment should be constructed of non-reactive materials that will meet the study's objective(s).

8. Place oil wipe (as necessary), sampling equipment, and sample containers near tanks(s) to be sampled.

AIR MONITORING FOR TOXIC VAPORS, EXPLOSIVE GASES AND OXYGEN DEFICIENT ATMOSPHERES SHOULD BE CONTINUOUS DURING TANK SAMPLING.

Liquids -- Slowly lower the bailer, bacon bomb, DipstickTM, COLIWASA, or Teflon® tubing to the desired sampling depth. (NOTE: In work areas where explosive/flammable atmospheres could occur, peristaltic pumps powered by 12 V. batteries should not be used.) Close the sampling device or create a vacuum and slowly remove the sampling device from

the tank. Release the sample from the device into the sample container. Repeat the procedure until a sufficient sample volume is obtained.

Solids/Semi-Solids - Use a push tube, bucket auger, screw auger, MucksuckerTM, or if conditions permit a pneumatic hammer/drill to obtain the sample. Carefully extrude the sample from the sampling device or use a clean stainless steel spoon to place the sample into containers for analyses.

9. Close the tank when sampling is complete. Segregate contaminated sampling equipment and investigative derived wastes (IDW) containing incompatible materials as determined by the screening procedure (Step #6). At a minimum, contaminated equipment should be cleaned with laboratory detergent and rinsed with tap water prior to returning it from the field. IDW should be managed according to Section 5.15, and Region 4's Contaminated Media Policy.

Miscellaneous Contaminated Materials

Sampling may be required of materials or equipment (e.g., documents, building materials, equipment, etc.) to determine whether or not various surfaces are contaminated by hazardous constituents, or to evaluate the effectiveness of decontamination procedures.

Wipe or swab samples may be taken on non-absorbent, smooth surfaces such as metal, glass, plastic, etc. The wipe materials must be compatible with the solvent used and the analyses to be performed, and should not come apart during use. The wipes are saturated with a solvent; methylene chloride, hexane, isopropanol or analyte free water depending on the parameters to be analyzed. The laboratory performing the analyses can provide the appropriate solvent. Wipe samples should not be collected for volatile organic compounds analysis. Sampling personnel should be aware of hazards associated with the selected solvent and should take appropriate precautions to prevent any skin contact or inhalation of these solvents. All surfaces and areas selected for sampling should be based on the study's

objectives. Typically, 10 cm by 10 cm templates are prepared from aluminum foil which are secured to the surface of interest. The prepared (saturated with solvent) wipe(s) is removed from its container with tongs or gloves, and used to wipe the entire area with firm strokes using only one side of the wipe. The goal is to systematically wipe the whole area. The wipe is then folded with the sample side inward and placed into the sample container. This procedure is repeated until the area is free of visible contamination or no more wipes remain. Care should be taken to keep the sample container tightly sealed to prevent evaporation of the solvent. Samplers must also take care to not touch the used side of the wipe.

For items with porous surfaces such as documents (usually business records), insulation, wood, etc., actual samples of the materials are required. It is therefore important, that during the collection and/or analyses of the sample that evidentiary material is not destroyed.

All secondary containing pails will be secured in the vehicles while transporting the samples from the field to the laboratory for analyses. In addition, each pail should indicate when protective equipment is recommended to handle the actual waste/sample material

REFERENCEs

United States Environmental Protection Agency. November 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.*

Benchmark FOPs:

011 Calibration and Maintenance of Portable Photoionization Detector

046 Sample Labeling, Storage and Shipment Procedures

TABLE 1

SAMPLING EQUIPMENT for VARIOUS WASTE UNITS

Equipment	Waste Units/Phases	Limitations
scoop with bracket/conduit	impoundments, piles, containers, tanks/liquids, solids, sludges	Can be difficult to collect deeper phases in multiphase wastes. Depth constraints.
spoon	impoundments, piles, containers/solids, sludges	Similar limitations as the scoop. Generally not effective in sampling liquids.
push tube	piles, containers/cohesive solids, sludges	Should not be used to sample solids with dimensions >'/2 the diameter of the tube. Depth constraints
auger	impoundments, piles, containers / solids	Can be difficult to use in an impoundment or a container, or for solidified wastes.
sediment sampler	impoundments, piles/solids, sludges	Should not be used to sample solids with dimensions >'/2 the diameter of the tube.
ponar dredge	impoundments/solids, sludges	Must have means to position equipment to desired sampling location. Difficult to decon.
COLIWASA or drum	impoundments, containers,	Not good with viscous wastes. Devices >_ 7'
thief	tanks/liquids	Require 2 samplers to use effectively.
DipstickTM /	impoundments, containers,	Not recommended for tanks >11 feet deep.
MucksuckerTM	tanks/liquids, sludges	Devices _> 7' require 2 samplers to use effectively
bacon bomb	impoundments, tanks/ liquids	Not good with viscous wastes.
bailer	impoundments, tanks/ liquids	Only if waste is homogeneous. Not good with viscous wastes
peristaltic pump with vacuum jug assembly	impoundments, tanks/liquids	Cannot be used in flammable atmospheres. Not good with viscous wastes
back-hoe bucket	piles/solids, sludges	May be difficult to access desired sampling location. Difficult to decon. Can lose volatiles.
split-spoon	piles/solids	Requires drill rig or direct push equipment.
roto-hammer	piles, containers/solids	Physically breaks up sample. May release volatiles. Not for flammable atmospheres.

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FIELD OPERATING PROCEDURES

Active Subslab Depressurization Pre-Design Testing Procedure

FOP 083.0

ACTIVE SUBSLAB DEPRESSURIZATION PRE-DESIGN TESTING PROCEDURE

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/). 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 Sate 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.

FOP 083.0

ACTIVE SUBSLAB DEPRESSURIZATION PRE-DESIGN TESTING PROCEDURE

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 ¾ 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.

FOP 083.0

ACTIVE SUBSLAB DEPRESSURIZATION PRE-DESIGN TESTING PROCEDURE

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.

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FIELD OPERATING PROCEDURES

Calibration & Maintenance of Portable Particulate Meter

FOP 084.0

CALIBRATION AND MAINTENANCE OF PORTABLE PARTICULATE METER

PURPOSE

This guideline describes a method for calibration of a portable particulate meter, specifically the Thermo Electron Corporation MIE DataRAM 4 (Model DR-4000). The DataRAM 4 measures the concentration of airborne particulate matter (liquid or solid), as well as mean particle size, air temperature, and humidity, providing direct and continuous readout as well as electronic recording of the information. This parameter is of interest both as a general indicator of air quality, and because of its pertinence to community air monitoring typically required at most construction/remediation/investigation sites. The DataRAM covers a wide measurement range from 0.0001 mg/m^3 to 400 mg/m^3. With its large capacity internal data logging capabilities with data retrieval on screen or downloaded, the DataRAM can store up to 50,000 data points, including individual point averages, particle size, temperature, and humidity with time stamp as well as overall average and maximum concentration.

Because the DataRAM meter must be factory calibrated once a year, this guideline presents a method for start-up, operation, and maintenance, which is performed to verify instrument function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each year. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter. The user should reference the manufacturer's instruction manual prior to operating this unit.

ACCURACY & PRECISION

The calibrated accuracy of the DataRAM 4 particulate meter is within ± 2% of reading ± precision over the temperature range of -4° to 158° F (-10° to 50° C) and 10 to 95% relative humidity (non-condensing). The precision is ± 1% of reading or ± 0.001 mg/m^3, whichever

is greater (1-second averaging) and ± 0.3% of reading or ± 0.0003 mg/m^3, whichever is greater (10-second averaging).

INSTRUMENT PANEL VIEW

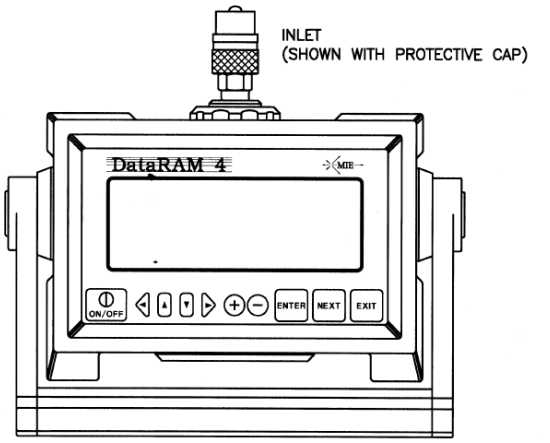


FIGURE 1. FRONT–PANEL VIEW OF DataRAM

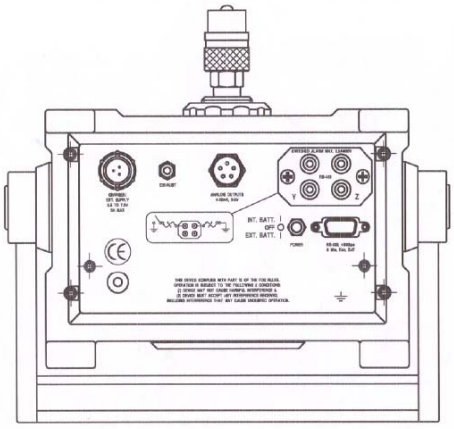


FIGURE 2. BACK–PANEL VIEW OF DataRAM

MAINTENANCE

General Guidelines

The DataRAM 4 is designed to be repaired at the factory. No user serviceable components are inside the metal enclosure of the DataRAM 4 with exception of the filter cartridge or the analytic filter holder. Access to the internal components of the unit by others than authorized MIE personnel voids warranty.

Unless a MALFUNCTION message is displayed, or other operational problems occur, the DataRAM 4 should be returned to the factory once every two years for routine check out, test, cleaning and calibration check.

Battery Charging and Cycling

If the DataRAM 4 is to be operated without its charger/power supply, i.e., deriving power from its internal battery, this battery should be fully charged before initiating a run. The

DataRAM 4 charger/power supply can be connected continuously to the instrument whether the DataRAM 4 is on or off. If the charger/power supply is not connected, the internal battery will discharge very slowly depending on storage temperature. Low storage temperature reduces battery capacity. High storage temperatures, however, reduce battery life which is of the order of 8 years at 20°C (68°F), and only 2 years at 40°C (104°F).

In general, the user should maintain the battery charge as high as possible in order to extend its charge/discharge cycling capacity (this characteristic differs from that of nickel-cadmium batteries).

Instrument Storage

If the DataRAM 4 is to be stored for an extended period of time (i.e., 3 months or more), place the 3-position switch on the back panel in its OFF position (mid-position), in order to minimize gradual battery discharge. This will have no effect on data retention or internal clock function. It is recommended, however, that the battery be recharged every 3 months in order to prolong battery life.

During storage always snap on quick-connect cap over the instrument inlet to protect the sensing optics from gradual dust contamination. Store DataRAM 4 in a dry environment.

Filter Replacement

To replace either of two types of filters used with DataRAM 4, place the instrument on its back rubber feet (front panel facing upward). On the bottom surface of the DataRAM, locate the large threaded plastic filter cover and holding the cross bar, rotate this cover counterclockwise. Remove cover and the filter holder within the open cavity.

HEPA Filter Cartridge Replacement

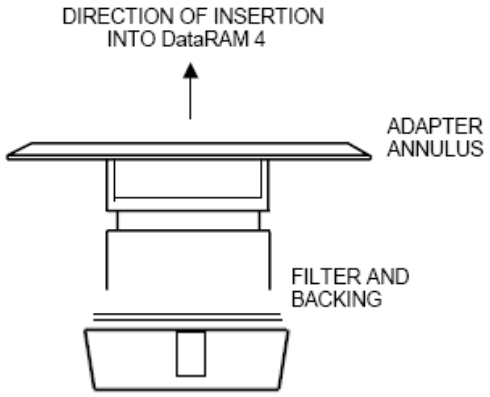
The DataRAM 4 is shipped from the factory with the HEPA filter cartridge installed. This cartridge can be identified by its metallic cover. Remove this cartridge. Clean the internal black rubber gasket against which the cartridge is normally compressed. Install new HEPA-type cartridge (MIE part no. MSA-95302) by inserting its wider ridged end first. Reposition threaded plastic cover engaging threads carefully; rotate cover clockwise, hand tightening firmly. Properly dispose of used cartridge to prevent inadvertent re-use.

Analytic Filter Installation/Replacement

In order to install or replace the analytical filter holder, proceed as follows. Remove the HEPA cartridge normally in place. Remove (separate) the inlet cover (with the blue plug) of the Millipore plastic filter holder from the rest of that holder assembly containing the white membrane filter. Insert firmly the gray plastic adapter annulus into the open face of the filter holder assembly. Remove the red plastic plug from the exhaust nipple of the filter holder assembly. Ensure that all three components of the holder assembly are fully compressed to preclude any leafage. Insert the assembly into the filter cavity of the DataRAM 4 with the gray plastic adapter annulus bearing against the internal black gasket (adapter annulus inserted first). Reposition threaded plastic cover and hand-tighten carefully and firmly. Set aside HEPA cartridge for future use.

In order to remove and/or to replace the membrane filter within its holder, remove the gray plastic adapter annulus and separate (pry apart) the two transparent plastic rings that compress the membrane filter. Make sure to remove and replace only the membrane filter (using tweezers), leaving the white backing disc in the holder. A new membrane filter should then be placed over that backing and the sealing ring should then be inserted to trap and compress the filter and backing discs. For storage, the inlet cap with the blue plug should be inserted as well as the red plug on the back of the filter holder.

Analytical filter holder with adapter annulus inserted



Cleaning of Optical Sensing Chamber

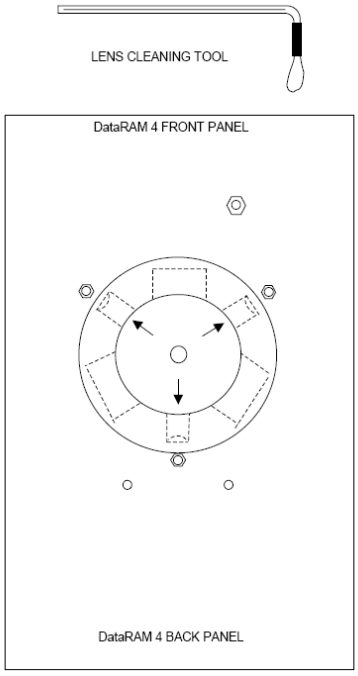
Although the DataRAM 4 incorporates filtered air shielding of the critical optical sensing surfaces, continued sampling of airborne particles at high concentrations may result in gradual build-up of contamination on those interior surfaces of the sensing chamber components. This may cause an excessively high optical background level. If this background level does becomes excessive, the DataRAM 4 will alert the user at the completion of the zeroing sequence by the display of a BACKGROUND HIGH message. If this message is presented, the DataRAM 4 can continue to be operated providing accurate measurements. However, it is then advisable to clean the front surfaces of the optical lenses within the sensing chamber at the first convenient opportunity, as described below. The tools required for this cleaning are: an intense concentrated light source (e.g., flash light) to view the inside of the sensing chamber, denatured alcohol, a soft lint-free cloth, and the special cleaning tool provided with the DataRAM 4 consisting of a cut-off cotton swab inserted in a plastic sleeve and held by a right-angle Allen wrench.

Proceed as follows to clean the lens surfaces within the sensing chamber:

- **Make sure to shut off power completely before proceeding with cleaning**
- Install the stainless steel cover on the inlet of the DataRAM 4 to protect this fitting.
- Place the DataRAM 4 upside down on a table, resting the instrument on the inlet cover and the rear protective bumper.
- Unscrew the gray plastic cover of the filter cavity on the bottom surface of the DataRAM 4.
- Remove the filter cartridge from its cavity.
- Carefully clean the black soft filter-sealing gasket within the filter cavity by wiping it with the lint-free soft cloth. Use alcohol if necessary.
- Shine the concentrated light source into the sensing chamber located about 3 cm (1¼ in.) beyond the soft-sealing gasket in the filter cavity.
- Locate the three smaller side cavities inside the sensing chamber, identified by the arrows on that figure (see page 6). These three cavities contain the lenses of the two sources and the common detector of the DataRAM 4. The frontal surfaces of these lenses are likely to require cleaning if the instrument indicates BACKGROUND HIGH.
- Wet the cotton swab of the lens-cleaning tool with alcohol (e.g., methanol, ethanol, or rubbing alcohol).

- Holding the cleaning tool by its long handle, insert this tool into the sensing chamber without touching the walls of this chamber.
- Direct the cotton swab tip towards the opening of one of the three smaller cavities as indicated by the arrows of the figure below, and insert the cotton tip into this cavity as far as it will go. Gently wipe that internal surface touched by the swab tip by a rotating motion. Carefully withdraw the swab tip from the cavity.
- Repeat previous cleaning step for the other two small cavities.
- Carefully remove the cleaning tool from the sensing chamber. Allow the alcohol to dry leaving the filter cavity open for about 15 minutes.
- Re-insert the filter cartridge into its cavity and close it with its gray plastic cover, hand-tightening it firmly. Remove the inlet cap and store on its pod on the back panel.
- Place the DataRAM 4 right side up and key ON. Proceed to check its optical background by running the ZERO/INITIALIZE check as. The message READY! should appear at the end of this check indicating that the lens contamination has been eliminated. Should the message BACKGROUND HIGH persist after completion of the above-described lens cleaning procedure, please contact the factory.

Lens cleaning tool and bottom view of open filter cavity showing location of sensor chamber lens cavities (arrows).



FACTORY CALIBRATION

For mass concentration measurements, each DataRAM 4 is factory calibrated against a set of reference monitors that, in turn, are periodically calibrated against a gravimetric standard traceable to the National Institute of Standards and Testing (NIST).

The primary factory reference method consists of generating a dust aerosol by means of a fluidized bed generator, and injecting continuously the dust into a mixing chamber from which samples are extracted concurrently by two reference filter collectors and by two master real-time monitors that are used for the routine calibration of every DataRAM 4.

The primary dust concentration reference value is obtained from the weight increase of the two filters due to the dust collected over a measured period of time, at a constant and known flow rate. The two master real-time monitors are then adjusted to agree with the reference mass concentration value (obtained from averaging the measurements of the two gravimetric filters) to within ±1%.

Three primary, NIST traceable, measurements are involved in the determination of the reference mass concentration: the weight increment from the dust collected on the filter, the sampling flow rate, and the sampling time. Additional conditions that must be met are: a) suspended dust concentration uniformity at all sampling inlets of the mixing chamber; b) identical sample transport configurations leading to reference and instrument under calibration; and c) essentially 100% collection efficiency of filters used for gravimetric reference for the particle size range of the test dust.

The test dust used for the MIE factory calibration of the DataRAM 4 is SAE Fine (ISO Fine) supplied by Powder Technology, Inc. It has the following physical characteristics (as dispersed into the mixing chamber):

- Mass median aerodynamic particle diameter: 2 to 3 μm
- Geometric standard deviation of lognormal size distribution: 2.5
- Bulk density: 2.60 to 2.65 g/cm3
- Refractive index: 1.54

In addition to the mass calibration described above, the DataRAM 4 is factory calibrated using a gas with known scattering coefficient in order to adjust the relative scattering irradiance at the two source wavelengths.

ATTACHMENTS

None

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FIELD OPERATING PROCEDURES

Field Quality Control Procedures

FOP 085.0

FIELD QUALITY CONTROL PROCEDURES

PURPOSE

In addition to traditional environmental samples (e.g., soil, groundwater, wipe, vapor etc.) described in each project work plan, site-specific field quality assurance/quality control (QA/QC) samples are typically collected and analyzed to support the required third-party data usability assessment effort of a project. Site-specific QA/QC samples generally include matrix spikes, matrix spike duplicates, blind duplicates (where appropriate), and trip blanks which accompany aqueous volatile organic compound (VOC) samples only.

The number of QA/QC field samples (blind duplicate, matrix spike/matrix spike duplicate, trip blank, field blank, or equipment blank) will be designated prior to field mobilization, but final QC sample locations will be contingent upon field conditions. This procedure outlines and discusses each QA/QC sample that may be required during a project.

PROCEDURE

A brief summary of each QA/QC sample identified above is presented below. Where appropriate, the procedure to be used to collect these samples is also presented.

- **Trip Blanks** – A sufficient number of trip blanks for VOC analysis must be prepared by the laboratory and delivered to the sampling team prior to a sampling event, typically two or three 40-ml VOA vials with organic free reagent water. One sealed blank will be carried into the field per day along with the sample containers for each day that water matrix volatile organic samples are collected. Trip blanks will be transported and handled in the same manner as the actual samples. The results of the trip blank analysis will be reviewed to evaluate if the potential for sample contamination during transportation and handling exists. The trip blanks will be analyzed for the same VOCs (and method) as the project groundwater samples.

- **Blind Duplicate** – One blind duplicate must be collected and analyzed per 20 samples collected per matrix (i.e., soil, groundwater, soil vapor, etc.). The location

of the sample collection point will not be disclosed to the analytical laboratory, therefore the field sample containers will be returned to the laboratory identified only as the "blind duplicate." The well or sample location will be recorded in the Project Field Book or handheld RuggedReader® Pocket PC and on the field data sheets, and the results will be compared to review analytical precision. Sample analysis will be identical to the original sample per the project work plan. The Blind Duplicate sample must be collected simultaneously from the same source under identical conditions as the original sample.

- **Matrix Spike/Matrix Spike Duplicate (MS/MSD)** – A sufficient volume of sample will be collected at one sampling location per sampling event for MS/MSD analysis per matrix (i.e., soil and groundwater only). The laboratory will report the results of the MS/MSD analysis, which will be reviewed for sampling and analysis precision and accuracy. Sample analysis will be identical to the original sample per the project work plan. The MS/MSD sample must be collected simultaneously from the same source under identical conditions as the original sample.

- **Equipment (Rinsate) Blank** – In general, dedicated sampling equipment is used to minimize field decontamination time and avoid the need for equipment blanks; however there may be instances where the use of non-dedicated equipment cannot be avoided. An equipment blank will be collected for each day of sampling activity when non-dedicated sampling equipment is used. These equipment blank samples will be used as a QC check of the decontamination procedures for sampling equipment. Sample analysis for the equipment blank will consist of the most comprehensive parameter list used for risk assessment in which the non-dedicated equipment was used for environmental sample collection. During most projects, every effort to use dedicated sampling equipment should be made in order to minimize field decontamination time and avoid the need for equipment blanks. Equipment Blank sampling procedure is as follows:
    - Non-dedicated equipment are to be decontaminated in accordance with Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination procedures prior to use in the field. If organic-free

deionized water (generally provided by the laboratory) is not available for decontamination, equipment will be allowed to thoroughly air dry.
  - Once properly rinsed or allowed to air dry, analyte-free water (provided by the laboratory) is poured appropriately over or through the decontaminated sample collection device, collected in a sample container, and returned to the laboratory as a sample.

- **Field Blank** – A field blank is a sample of the unused final decontamination rinse water that is collected at the sampling site and returned to the laboratory as a sample. Sample analysis for the field blank will consist of the most comprehensive parameter list used during the investigation.

- **Split Sample** – A split sample is a sample that has been portioned into two or more containers from a single sample container or sample mixing container. Samples for VOC analysis should never be mixed prior to splitting.

- **Blank Wipe Samples** – There are two types of blank wipe samples, an equipment blank and a field blank that may be required per the project work plan, both are described below:
  - Equipment Blank – Required only if reusable templates are used for wipe sample collection. The decontaminated template is wiped with a hexane saturated swab. The swab is placed in the appropriate sample container and returned to the laboratory as a sample.
  - Field Blank – Clean disposable gloves are wiped with a hexane saturated swab. The swab is placed in the appropriate sample container and returned to the laboratory as a sample.

REFERENCES

Benchmark FOPs:

040 Non-disposable and Non-dedicated Sampling Equipment Decontamination

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FIELD OPERATING PROCEDURES

Outdoor Ambient Air VOC Sample Collection Procedure

FOP 090.0

OUTDOOR AMBIENT AIR VOC SAMPLE COLLECTION PROCEDURE

PURPOSE

This procedure describes the methods for collecting outdoor ambient air samples for volatile organic compound (VOC) analysis via USEPA Method TO-15 using Summa® canisters (or approved other). Typically, outdoor air samples are collected to characterize and document site-specific VOCs that may be present in outdoor ambient air. For sample collection associated with intrusive activities that may potentially release VOCs to the ambient air, sample location(s) typically are collected downwind of the intrusive activity at the perimeter of the work area and/or exclusion zone for the Site. Upwind sample location(s) may be utilized if regional facilities (e.g. gasoline service station, factories) are located proximate to the Site to assess off-site ambient VOC contributions (background).

SAMPLE COLLECTION PROCEDURES

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

- A site map should be prepared to indicate the outdoor ambient air sample locations including all site improvements (e.g., buildings, access roads, etc.), public roads/streets (if applicable), the location of potential VOC contributors (e.g., gasoline stations, factories, lawn movers, etc.), compass orientation (north), and scale.

- Weather conditions (e.g., precipitation, wind speed, outdoor temperature, and barometric pressure) should be reported on the Air Canister Field Record (sample attached); and

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

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.

7. Ship the canisters to the laboratory under chain-of-custody command within three days of sample collection so that no sample will exceed the 30-day holding time (since receipt from the lab) per USEPA TO-15.

8. Air samples will be analyzed by Gas Chromatography/Mass Spectroscopy (GC/MS) in accordance with EPA Method TO-15, or as specified. Analytical results will be reported as concentrations of each VOC at each location during each sampling event, typically in parts per billion by volume (ppbv).

9. Sample collection should take place on warm, dry days. If rain or high humidity conditions develop during sampling, the sampling event should be suspended. Temperature, barometric pressure, and wind speed should be monitored during the sampling event, for use in analysis of the results. The combination of sampling location, height, and meteorological conditions will assure that sampling will measure VOCs at their highest concentrations.

QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

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

Some methods require collecting samples in duplicate to assess errors. Duplicate and/or split samples should be collected in accordance with the requirements of the sampling and analytical methods being implemented.

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

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

ATTACHMENTS

Air Canister Field Record (sample)

REFERENCES

United States Environmental Protection Agency. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. Second Addition (EPA/625/R-96/010b). January 1999.

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

AIR CANISTER FIELD RECORD

PROJECT INFORMATION:

Project:
Job No:
Location:
Field Staff:
Client:

SAMPLE I.D.:

Size of Canister:
Canister Serial No.:
Flow Controller No.:
Sample Date(s):
Shipping Date:
Sample Type: ☐ Indoor Air ☐ Outdoor Air
☐ Subslab, complete section below ☐ Soil Gas
Soil Gas Probe Depth:

WEATHER CONDITIONS:

Ambient Air Temp. - A.M.:
Ambient Air Temp. - P.M.:
Wind Direction:
Wind Speed:
Precipitation:

FIELD SAMPLING INFORMATION:

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

LABORATORY CANISTER PRESSURIZATION:

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

SUBSLAB SHROUD:

Shroud Helium Concentration:
Calculated tubing volume: x 3 =
Purged Tubing Volume Concentration:
Is the purged volume concentration less than or equal to 10% in shroud?
☐ YES, continue sampling
☐ NO, improve surface seal and retest

COMPOSITE TIME (hours)	FLOW RATE RANGE (ml/min)
15 Min.	316 - 333
0.5 Hours	158 - 166.7
1	79.2 - 83.3
2	39.6 - 41.7
4	19.8 - 20.8
6	13.2 - 13.9
8	9.9 - 10.4
10	7.92 - 8.3
12	6.6 - 6.9
24	3.5 - 4.0

NOTES:

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

Signed:

APPENDIX C

HEALTH AND SAFETY PLAN

SITE HEALTH AND SAFETY PLAN
for
BROWNFIELD CLEANUP PROGRAM
REMEDIAL ACTION ACTIVITIES

MT OLIVE SENIOR MANOR SITE
BUFFALO, NEW YORK
(SITE NO. C915377)

January 2023 0670-022-001-005

Prepared for:

Mt. Olive Senior Manor LLC

Prepared by:

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

MT. OLIVE SENIOR MANOR SITE
HEALTH AND SAFETY PLAN FOR RA ACTIVITIES

ACKNOWLEDGEMENT

Plan Reviewed by (initial):

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

Project Manager: Christopher Z. Boron

Designated Site Safety and Health Officer: Christopher Z. Boron

Acknowledgement:
I acknowledge that I have reviewed the information contained in this site-specific Health and Safety Plan, and understand the hazards associated with performance of the field activities described herein. I agree to comply with the requirements of this plan.

NAME (PRINT)	SIGNATURE	DATE

BENCHMARK

MT. OLIVE SENIOR MANOR SITE
HEALTH AND SAFETY PLAN FOR RA ACTIVITIES

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MT. OLIVE SENIOR MANOR SITE
HEALTH AND SAFETY PLAN FOR RA ACTIVITIES

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1.0 INTRODUCTION

1.1 General

In accordance with OSHA requirements contained in 29 CFR 1910.120, this Health and Safety Plan (HASP) describes the specific health and safety practices and procedures to be employed by Benchmark Civil/Environmental Engineering & Geology, PLLC (Benchmark) employees during Remedial Action (RA) activities at the Mt. Olive Senior Manor Site located at 703 East Delavan Avenue, City of Buffalo, Erie County, New York (see Figure 1). This HASP presents procedures for Benchmark employees who will be involved with RA field activities; it does not cover the activities of other contractors, subcontractors, or other individuals on the Site. These firms will be required to develop and enforce their own HASPs as discussed in Section 2.0. Benchmark accepts no responsibility for the health and safety of contractor, subcontractor, or other personnel.

This HASP presents information on known Site health and safety hazards using available historical information, and identifies the equipment, materials and procedures that will be used to eliminate or control these hazards. Environmental monitoring will be performed during the course of field activities to provide real-time data for on-going assessment of potential hazards.

1.2 Background

The Site is a ±1.3-acre parcel addressed as a portion of 703 East Delavan Avenue, Buffalo, Erie County, New York. The Site is located in a mixed residential, commercial, and former industrial area of the City of Buffalo. The Site does not contain any structures and primarily used as a playing field.

It is unknown what the actual Site was used for prior to use as an athletic field. Mt Olive Baptist Church purchased the Site from an adjacent facility (Hard Manufacturing Company) in 1988. Review of historic aerials and Sanborn maps to not indicate the presence of structures on the Site.

1.3 Summary of Environmental Conditions

Based on the Phase II investigation and Remedial Investigation (RI), the following environmental conditions exist at the Site:

Soil/Fill

- Based on the Phase II and RI activities, semi-volatile organic compounds (SVOCs), metals, polychlorinated biphenyls (PCBs), pesticides, and/or per- and polyfluoroalkyl substance (PFAS) concentrations were observed exceeding 6 NYCRR Part 375 Unrestricted Soil Cleanup Objectives (USCOs) in the surface and subsurface soil/fill material across the Site at depths ranging from below the vegetative cover to approximately 6 fbgs.
- No volatile organic compounds (VOCs) were detected in soil/fill samples collected as part of the RI, nor were elevated photoionization detector (PID) measurements noted in the soil/fill. The potential source of the VOCs detected in the groundwater discussed below is unknown.
- Waste characterization samples collected during the RI indicate non-hazardous waste disposal.

Groundwater

- No SVOCs, PCBs, herbicides, or 1,4-dioxane were detected above their respective TOGS 1.1.1 Groundwater Quality Standards/Guidance Values (GWQS/GV) at the groundwater monitoring locations at the Site. Beta-BHC was the only pesticide detected slightly above its respective GWQS at one (1) location, MW-3. Antimony and cobalt were each detected at one (1) location slightly above their respective GWQS, and the presence of iron and sodium in the groundwater are not uncommon in urban environments. PFAS were detected above the NYSDEC action levels for perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) at MW-1 and MW-4.
- Cis-1,2-dichloroethene (DCE) and trichloroethene (TCE) were detected at MW-4 above their respective GWQS. VOCs were not detected in soil/fill samples analyzed from the Site, nor were PID measurements noted in on-Site soil/fill. They may be attributed to an upgradient off-site source, based on groundwater flow direction.

Soil Vapor

- The New York State Department of Health (NYSDOH) Decision Matrices for evaluating soil vapor intrusion (SVI) have guidance for eight (8) compounds. Of

those eight (8) compounds, tetrachloroethene (PCE) and TCE were the only compounds detected in the soil vapor samples. PCE was detected in in the three (3) soil vapor samples and the outdoor air sample and TCE was detected in SV-1 and SV-4. Based on the concentrations detected in the soil vapor, it does not appear to be a concern. However, a formal soil vapor intrusion assessment would need to be completed after building construction to confirm.

1.4 Primary Constituents of Concern (COCs)

Based on the previous investigations and RI, the constituents of concern (COCs) for an unrestricted use are presented below:

Soil/Fill: SVOCs, metals, pesticides, PCBs, PFAS

Groundwater: cVOCs

Sub-slab Vapor/Indoor Air: impact of cVOCs to be assessed

1.5 Overview of RA Activities

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

Pre-Design Investigation Activities

1. **Injection Well Installation/Development and Sampling:** Benchmark will observe the installation of three (3) groundwater injection wells, develop the wells, and collect groundwater samples for the purpose of determining the nature and extent of COC impacts.
2. S**ubsurface Soil/Fill Sampling:** Benchmark will oversee the collection subsurface soil samples during well drilling for the purpose of determining the nature and extent of COC impacts.

Remedial Action Activities

1. **Excavation of Overburden Soil/Fill**
2. **Verification Sampling**
3. **Backfilling**
4. **In-Situ Groundwater Treatment**
5. **Groundwater Monitoring**
6. **Sub-Slab Depressurization System Piping Installation**
7. **SVI Assessment**

2.0 ORGANIZATIONAL STRUCTURE

This section of the HASP describes the lines of authority, responsibility, and communication as they pertain to health and safety functions at the Site. The purpose of this chapter is to identify the personnel who impact the development and implementation of the HASP and to describe their roles and responsibilities. This chapter also identifies other contractors and subcontractors involved in work operations and establish the lines of communications among them for health and safety matters. The organizational structure described in this chapter is consistent with the requirements of 29 CFR 1910.120(b)(2). This section will be reviewed by the Project Manager and updated as necessary to reflect the current organizational structure at this Site.

2.1 Roles and Responsibilities

All Benchmark personnel on the Site must comply with the minimum requirements of this HASP. The specific responsibilities and authority of management, safety and health, and other personnel on this Site are detailed in the following paragraphs.

2.1.1 Corporate Health and Safety Director

The Benchmark-TurnKey Corporate Health and Safety Director is ***Mr. Thomas H. Forbes, P.E.*** The Corporate Health and Safety Director is responsible for developing and implementing the Health and Safety program and policies for Benchmark Environmental Engineering & Science, PLLC and TurnKey Environmental Restoration, LLC, and consulting with corporate management to ensure adequate resources are available to properly implement these programs and policies. The Corporate Health and Safety Director coordinates Benchmark'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 Officer

The Project Officer for the Site is ***Mr. Thomas Forbes, P.E.*** The Project Officer has the responsibility for ensuring conformance with the BCP program requirements. The Project Officer will report directly to the Applicant and the NYSDEC/NYSDOH Project Coordinators and is responsible for project oversight. The Project Officer will:

- Define project objectives, oversee detailed work plan development and project schedule.

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

2.1.3 Project Manager

The Project Manager for this Site is ***Mr. Christopher Boron.*** The Project Manager has the responsibility and authority to direct Benchmark work operations at the Site. The Project Manager coordinates safety and health functions with the Site Safety and Health Officer and bears ultimate responsibility for proper implementation of this HASP. He may delegate authority to expedite and facilitate any application of the program, including modifications to the overall project approach as necessary to circumvent unsafe work conditions. Specific duties of the Project Manager include:

- Preparing and coordinating the Site work plan.
- Providing Benchmark workers with work assignments and overseeing their performance.
- Coordinating health and safety efforts with the Site Safety and Health Officer (SSHO).
- Reviewing the emergency response coordination plan to assure its effectiveness.
- Serving as the primary liaison with Site contractors and the property owner.

2.1.4 Site Safety and Health Officer

The Site Safety and Health Officer (SSHO) for this Site is ***Mr. Christopher Z. Boron***. The qualified alternate SSHO is ***Mr. Nathan Munley***. The SSHO reports to the Project Manager. The SSHO is on-site or readily accessible to the Site during all work operations and has the authority to halt Site work if unsafe conditions are detected. The specific responsibilities of the SSHO are:

- Managing the safety and health functions for Benchmark 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 29 CFR Part 1910.120(e)), that they have obtained medical clearance to wear respiratory protection (per 29 CFR Part 1910.134), and that they

are properly trained in the selection, use and maintenance of personal protective equipment, including qualitative respirator fit testing.

- Performing or overseeing Site monitoring as required by the HASP.
- Assisting in the preparation and review of the HASP.
- Maintaining site-specific safety and health records as described in this HASP.
- Coordinating with the Project Manager, Site Workers, and Contractor's SSHO as necessary for safety and health efforts.

2.1.5 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.

2.1.6 Other Site Personnel

Other Site personnel who will have health and safety responsibilities will include the Drilling Contractor, who will be responsible for developing, implementing and enforcing a Health and Safety Plan equally stringent or more stringent than Benchmark'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 performing Site inspection work (i.e., the New York State Department of Environmental Conservation). The Contractor shall be responsible for ensuring that these individuals have received OSHA-required training (29 CFR 1910.120(e)), including initial, refresher and site-specific training, and shall be responsible for the safety and health of these individuals while they are on-Site.

3.0 HAZARD EVALUATION

Due to the presence of certain contaminants at the Site, the possibility exists that workers will be exposed to hazardous substances during field activities. The principal points of exposure would be through direct contact with and incidental ingestion of soil, and through the inhalation of contaminated particles or vapors. Other points of exposure may include direct contact with groundwater. In addition, the use of drilling and/or medium to large-sized construction equipment (e.g., drill rig, excavator) will also present conditions for potential physical injury to workers. Further, since some of the work will be performed outdoors, the potential exists for heat/cold stress to impact workers, especially those wearing protective equipment and clothing. Adherence to the medical evaluations, worker training relative to chemical hazards, safe work practices, proper personal protection, environmental monitoring, establishment work zones and Site control, appropriate decontamination procedures and contingency planning outlined herein will reduce the potential for chemical exposures and physical injuries.

3.1 Chemical Hazards

As discussed in Section 1.3, historic activities have potentially resulted in impacts to Site soil/fill and groundwater. Soil/fill sample results indicate that SVOC (PAHs), PCBs, and metals impact to Site soil/fill. 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 COCs and related health and safety guidance and criteria are provided below.

- **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.
- **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.
- **Polycyclic Aromatic Hydrocarbons (PAHs)** are formed as a result of the pyrolysis and incomplete combustion of organic matter such as fossil fuel. PAH aerosols formed during the combustion process disperse throughout the atmosphere, resulting in the deposition of PAH condensate in soil, water and on

vegetation. In addition, several products formed from petroleum processing operations (e.g., roofing materials and asphalt) also contain elevated levels of PAHs. Hence, these compounds are widely dispersed in the environment. PAHs are characterized by a molecular structure containing three or more fused, unsaturated carbon rings. Seven of the PAHs are classified by USEPA as probable human carcinogens (USEPA Class B2). These are: benzo(a)pyrene; benzo(a)anthracene; benzo(b)fluoranthene; and dibenzo(a,h)anthracene. The primary route of exposure to PAHs is through incidental ingestion and inhalation of contaminated particulates. PAHs are characterized by an organic odor, and exist as oily liquids in pure form. Acute exposure symptoms may include acne-type blemishes in areas of the skin exposed to sunlight.

- **Polychlorinated Biphenyls (PCBs)** are a series of compounds that were commonly used in transformer oil and are suspected carcinogens. PCBs may vary in form from oily liquids to white solids. Exposure may cause nausea, vomiting, weight loss, jaundice, edema, and abdominal pain.
- **4,4'-DDD (CAS #72-54-8)** is a white crystalline solid and is a metabolite of 4,4'-DDT. 4,4'-DDT was commonly used as an insecticide, but now has limited use. 4,4'-DDT is very soluble in organics solvents, fat, and oils, and accumulates quickly in ecosystems. Exposure to 4,4'-DDT is known to impact the nervous system, causing tremors, dizziness, nausea, incoordination, convulsions, and seizures and is likely a carcinogen in humans.
- **4,4'-DDE (CAS #72-55-9)** is a white crystalline solid or white powder and is a metabolite of 4,4'-DDT. 4,4'-DDT was commonly used as an insecticide, but now has limited use. 4,4'-DDT is very soluble in organics solvents, fat, and oils, and accumulates quickly in ecosystems. Exposure to 4,4'-DDT is known to impact the nervous system, causing tremors, dizziness, nausea, incoordination, convulsions, and seizures and is likely a carcinogen in humans.
- **4,4'-DDT (CAS #50-29-3)** is a white, odorless, tasteless crystalline hydrocarbon and was commonly used as an insecticide, however its use is now limited. 4,4'-DDT is very soluble in organics solvents, fat, and oils, and accumulates quickly in ecosystems. Exposure to 4,4'-DDT is known to impact the nervous system, causing tremors, dizziness, nausea, incoordination, convulsions, and seizures and is likely a carcinogen in humans.
- **Dieldrin (CAS #60-57-1)** is a light-tan flaked solid and is a metabolite of aldrin. Dieldrin was commonly used as an insecticide, however its use has been cancelled/suspended. It is toxic by inhalation, skin absorption, and ingestion and can penetrate skin. Exposure to dieldrin is known to cause irritability, convulsions, coma, nausea, vomiting, headache, fainting, and tremors, and it is a known carcinogen in humans.
- **Arsenic (CAS #7440-38-2)** is a naturally occurring element and is usually found

combined with one or more elements, such as oxygen or sulfur. Inhalation is a more important exposure route than ingestion. First phase exposure symptoms include nausea, vomiting, diarrhea, and pain in the stomach. Prolonged contact is corrosive to the skin and mucus membranes. Arsenic is considered a Group A human carcinogen by the USEPA. Exposure via inhalation is associated with an increased risk of lung cancer. Exposure via the oral route is associated with an increased risk of skin cancer.

- **Barium (CAS # 7440-39-3)** is a silver white metal, produced by the reduction of barium oxide. Local effects and symptoms of exposure to barium compounds, such as the hydroxide or carbonate, may include irritation of the eyes, throat, nose and skin. Systemic effects from ingestion include increased muscle contractility, reduction of heart rate/potential arrest, intestinal peristalsis, and vascular constriction.
- **Chromium (CAS #7440-47-3)** is used in the production of stainless steel, chrome plated metals, and batteries. Two forms of chromium, hexavalent (CR+6) and trivalent (CR+3) are toxic. Hexavalent chromium is an irritant and corrosive to the skin and mucus membranes. Chromium is a potential occupational carcinogen. Acute exposures to dust may cause coughing, wheezing, headaches, and fever.
- **Copper (CAS #7440-50-8)** is a naturally occurring metal in the environment in rocks, soil, water and air. The most common use of copper is to make wire, pipes, and sheet metal. High levels of copper exposure may cause irritation of the nose, mouth, and eyes, vomiting, diarrhea, stomach cramps, and death.
- **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.
- **Mercury (CAS #7439-97-6)** is used in industrial applications for the production of caustic and chlorine, and in electrical control equipment and apparatus. Over-exposure to mercury may cause coughing, chest pains, bronchitis, pneumonia, indecision, headaches, fatigue and salivation. Mercury is a skin and eye irritant.
- **Nickel (CAS # 7440-02-0)** is a metal, commonly used to make coins, magnets, jewelry, stainless steel, electronics, and components of industrial machines. It is widely used in industry, primarily refining, electroplating, and welding. Nickel is a carcinogenic metal, that with chronic exposure has been connected with increased risk of lung cancer, cardiovascular disease, neurological deficits, developmental deficits in childhood, and high blood pressure.
- **Zinc (CAS #7440-66-6)** is a naturally occurring inorganic element and is usually

found combined with one or more elements, such as oxygen, chlorine and chrome. Inhalation of zinc compounds such as zinc chloride, zinc chromate or zinc oxide is a more common exposure route than inhalation of pure zinc. The effects of inhalation exposure symptoms for these compounds vary but may include nausea, fatigue and muscle/joint pain. Prolonged contact is corrosive to the skin and mucus membranes and lungs.

- **PFOA (CAS #335-67-1)** is a white solid with a pungent odor. PFOA is a skin, eye, and respiratory tract irritant, and can cause chemical pneumonitis. PFOA is a known environmental contaminant and suspected carcinogen.
- **PFOS (CAS #1763-23-1)** is an off-white to grey liquid. PFOS is likely a skin, eye, and respiratory tract irritant. PFOS is a persistent organic pollutant and suspected carcinogen.

With respect to the anticipated RA 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. Exposure to contaminants through dermal and other routes will also be minimized through the use of protective clothing (Section 7.0), safe work practices (Section 6.0), and proper decontamination procedures (Section 12.0).

3.2 Physical Hazards

RA field activities at the Mt. Olive Senior Manor Site may present the following physical hazards:

- The potential for physical injury during heavy construction equipment use, such as excavator and/or 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 RA operations and sampling activities at the Site. Since it is impossible to list all potential sources of injury, it shall be the responsibility of each individual to exercise proper care and caution during all phases of the work.

4.0 TRAINING

4.1 Site Workers

All personnel performing RA activities at the Site (such as, but not limited to, equipment operators, general laborers, and drillers) and who may be exposed to hazardous substances, health hazards, or safety hazards and their supervisors/managers responsible for the Site shall receive training in accordance with 29 CFR 1910.120(e) before they are permitted to engage in operations in the exclusion zone or contaminant reduction zone. This training includes an initial 40-hour Hazardous Waste Site Worker Protection Course, an 8-hour Annual Refresher Course subsequent to the initial 40-hour training, and 3 days of actual field experience under the direct supervision of a trained, experienced supervisor. Additional site-specific training shall also be provided by the SSHO prior to the start of field activities. A description of topics to be covered by this training is provided below.

4.1.1 Initial and Refresher Training

Initial and refresher training is conducted by a qualified instructor as specified under OSHA 29 CFR 1910.120(e)(5) and is specifically designed to meet the requirements of OSHA 29 CFR 1910.120(e)(3) and 1910.120(e)(8). The training covers, as a minimum, the following topics:

- OSHA HAZWOPER regulations.
- Site safety and hazard recognition, including chemical and physical hazards.
- Medical monitoring requirements.
- Air monitoring, permissible exposure limits, and respiratory protection level classifications.
- Appropriate use of personal protective equipment (PPE), including chemical compatibility and respiratory equipment selection and use.
- Work practices to minimize risk.
- Work zones and Site control.
- Safe use of engineering controls and equipment.
- Decontamination procedures.
- Emergency response and escape.
- Confined space entry procedures.
- Heat and cold stress monitoring.

- Elements of a Health and Safety Plan.
- Spill containment.

Initial training also incorporates workshops for PPE and respiratory equipment use (Levels A, B and C), and respirator fit testing. Records and certification received from the course instructor documenting each employee's successful completion of the training identified above are maintained on file at Benchmark's Buffalo, NY office. Contractors and Subcontractors are required to provide similar documentation of training for all their personnel who will be involved in on-site work activities.

Any employee who has not been certified as having received health and safety training in conformance with 29 CFR 1910.120(e) is prohibited from working in the exclusion and contamination reduction zones, or to engage in any on-site work activities that may involve exposure to hazardous substances or wastes.

4.1.2 Site Training

Site workers are given a copy of the HASP and provided a site-specific briefing prior to the commencement of work to ensure that employees are familiar with the HASP and the information and requirements it contains. The Site briefing shall be provided by the SSHO prior to initiating field activities and shall include:

- Names of personnel and alternates responsible for Site safety and health.
- Safety, health and other hazards present on the Site.
- The site lay-out including work zones and places of refuge.
- The emergency communications system and emergency evacuation procedures.
- Use of PPE.
- Work practices by which the employee can minimize risks from hazards.
- Safe use of engineering controls and equipment on the site.
- Medical surveillance, including recognition of symptoms and signs of over-exposure as described in Chapter 5 of this HASP.
- Decontamination procedures as detailed in Chapter 12 of this HASP.
- The emergency response plan as detailed in Chapter 15 of this HASP.
- Confined space entry procedures, if required, as detailed in Chapter 13 of this HASP.
- The spill containment program as detailed in Chapter 9 of this HASP.
- Site control as detailed in Chapter 11 of this HASP.

Supplemental health and safety briefings will also be conducted by the SSHO on an as-needed basis during the course of the work. Supplemental briefings are provided as necessary to notify employees of any changes to this HASP as a result of information gathered during ongoing Site characterization and analysis. Conditions for which the SSHO may schedule additional briefings include but are not limited to: a change in Site conditions (e.g., based on monitoring results); changes in the work schedule/plan; newly discovered hazards; and safety incidents occurring during Site work.

4.2 Supervisor Training

On-site safety and health personnel who are directly responsible for or who supervise the safety and health of workers engaged in hazardous waste operations (i.e., SSHO) shall receive, in addition to the appropriate level of worker training described in Section 4.1, above, 8 additional hours of specialized supervisory training, in compliance with 29 CFR 1910.120(e)(4).

4.3 Emergency Response Training

Emergency response training is addressed in Appendix A of this HASP, Emergency Response Plan.

4.4 Site Visitors

Each Contractor's SSHO will provide a site-specific briefing to 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 29 CFR Part 1910.120(f). These exams include initial employment, annual and employment termination physicals for 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 located in Seneca Square Plaza, 1900 Ridge Road, West Seneca, New York 14224. The facility can be reached at (716) 823-5050 to schedule routine appointments or post-exposure examinations.

Medical evaluations are conducted according to the Benchmark Medical Monitoring Program and include an evaluation of the workers' ability to use respiratory protective equipment. The examinations include:

- Occupational/medical history review.
- Physical exam, including vital sign measurement.
- Spirometry testing.
- Eyesight testing.
- Audio testing (minimum baseline and exit, annual for employees routinely exposed to greater than 85db).
- EKG (for employees >40 yrs age or as medical conditions dictate).
- Chest X-ray (baseline and exit, and every 5 years).
- Blood biochemistry (including blood count, white cell differential count, serum multiplastic screening).
- Medical certification of physical requirements (i.e., sight, musculoskeletal, cardiovascular) for safe job performance and to wear respiratory protection equipment.

The purpose of the medical evaluation is to determine an employee's fitness for duty on hazardous waste sites; and to establish baseline medical data.

In conformance with OSHA regulations, Benchmark 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

Benchmark employees shall conform to the following safe work practices during 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 personnel entering the Site as required by the HASP or as modified by the Site safety officer. Excessive facial hair (i.e., beards, long mustaches or sideburns) that interferes with the satisfactory respirator-to-face seal is prohibited.
- Contact with surfaces/materials either suspected or known to be contaminated will be avoided to minimize the potential for transfer to personnel, cross contamination and need for decontamination.
- Medicine and alcohol can synergize the effects of exposure to toxic chemicals. Due to possible contraindications, use of prescribed drugs should be reviewed with the Benchmark occupational physician. Alcoholic beverage and illegal drug intake are strictly forbidden during the workday.
- Personnel shall be familiar with standard operating safety procedures and additional instructions contained in this Health and Safety Plan.
- On-site personnel shall use the "buddy" system. No one may work alone (i.e., out of earshot or visual contact with other workers) in the exclusion zone.
- Personnel and equipment in the contaminated area shall be minimized, consistent with effective Site operations.
- 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 at all times in the vicinity of heavy equipment. Hearing protection is also recommended.
- The work Site should be kept neat. This will prevent personnel from tripping and will allow for fast emergency exit from the Site.
- Proper lighting must be provided when working at night.
- Construction activities should be discontinued during an electrical storm or severe weather conditions.
- The presence of combustible gases should be checked before igniting any open flame.
- Personnel shall stand upwind of any construction operation when not immediately involved in sampling/logging/observing activities.
- Personnel will not approach the edge of an unsecured trench/excavation closer than 2 feet.

7.0 PERSONAL PROTECTIVE EQUIPMENT

7.1 Equipment Selection

Personal protective equipment (PPE) will be donned when work activities may result in exposure to physical or chemical hazards beyond acceptable limits, and when such exposure can be mitigated through appropriate PPE. The selection of PPE will be based on an evaluation of the performance characteristics of the PPE relative to the requirements and limitations of the Site, the task-specific conditions and duration, and the hazards and potential hazards identified at the Site.

Equipment designed to protect the body against contact with known or suspect chemical hazards are grouped into four categories according to the degree of protection afforded. These categories designated A through D consistent with United States Environmental Protection Agency (USEPA) Level of Protection designation, are:

- **Level A:** Should be selected when the highest level of respiratory, skin and eye protection is needed.
- **Level B:** Should be selected when the highest level of respiratory protection is needed, but a lesser level of skin protection is required. Level B protection is the minimum level recommended on initial Site entries until the hazards have been further defined by on-site studies. Level B (or Level A) is also necessary for oxygen-deficient atmospheres.
- **Level C:** Should be selected when the types of airborne substances are known, the concentrations have been measured and the criteria for using air-purifying respirators are met. In atmospheres where no airborne contaminants are present, Level C provides dermal protection only.
- **Level D:** Should not be worn on any Site with elevated respiratory or skin hazards. This is generally a work uniform providing minimal protection.

OSHA requires the use of certain PPE under conditions where an immediate danger to life and health (IDLH) may be present. Specifically, OSHA 29 CFR 1910.120(g)(3)(iii) requires use of a positive pressure self-contained breathing apparatus, or positive pressure air-line respirator equipped with an escape air supply when chemical exposure levels present a substantial possibility of immediate serious injury, illness or death, or impair the ability to escape. Similarly, OSHA 29 CFR 1910.120(g)(3)(iv) requires donning totally-encapsulating chemical protective suits (with a protection level equivalent to Level A protection) in conditions where skin absorption of a hazardous substance may result in a substantial

possibility of immediate serious illness, injury or death, or impair the ability to escape.

In situations where the types of chemicals, concentrations, and possibilities of contact are unknown, the appropriate level of protection must be selected based on professional experience and judgment until the hazards can be further characterized. The individual components of clothing and equipment must be assembled into a full protective ensemble to protect the worker from site-specific hazards, while at the same time minimizing hazards and drawbacks of the personal protective gear itself. Ensemble components are detailed below for levels A/B, C, and D protection.

7.2 Protection Ensembles

7.2.1 Level A/B Protection Ensemble

Level A/B ensembles include similar respiratory protection, however Level A provides a higher degree of dermal protection than Level B. Use of Level A over Level B is determined by: comparing the concentrations of identified substances in the air with skin toxicity data, and assessing the effect of the substance (by its measured air concentrations or splash potential) on the small area of the head and neck unprotected by Level B clothing.

The recommended PPE for level A/B is:

- Pressure-demand, full-face piece self-contained breathing apparatus (MSHA/-NIOSH approved) or pressure-demand supplied-air respirator with escape self-contained breathing apparatus (SCBA).
- Chemical-resistant clothing. For Level A, clothing consists of totally-encapsulating chemical resistant suit. Level B incorporates hooded one-or two-piece chemical splash suit.
- Inner and outer chemical resistant gloves.
- Chemical-resistant safety boots/shoes.
- Hardhat.

7.2.2 Level C Protection Ensemble

Level C protection is distinguished from Level B by the equipment used to protect the respiratory system, assuming the same type of chemical-resistant clothing is used. The main selection criterion for Level C is that conditions permit wearing an air-purifying device. The device (when required) must be an air-purifying respirator (MSHA/NIOSH approved) equipped with filter cartridges. Cartridges must be able to remove the substances

encountered. Respiratory protection will be used only with proper fitting, training and the approval of a qualified individual. In addition, an air-purifying respirator can be used only if: oxygen content of the atmosphere is at least 19.5% in volume; substances are identified and concentrations measured; substances have adequate warning properties; the individual passes a qualitative fit-test for the mask; and an appropriate cartridge/canister is used, and its service limit concentration is not exceeded.

Recommended PPE for Level C conditions includes:

- Full-face piece, air-purifying respirator equipped with MSHA and NIOSH approved organic vapor/acid gas/dust/mist combination cartridges or as designated by the SSHO.
- Chemical-resistant clothing (hooded, one or two-piece chemical splash suit or disposable chemical-resistant one-piece suit).
- Inner and outer chemical-resistant gloves.
- Chemical-resistant safety boots/shoes.
- Hardhat.

An air-monitoring program is part of all response operations when atmospheric contamination is known or suspected. It is particularly important that the air be monitored thoroughly when personnel are wearing air-purifying respirators. Continual surveillance using direct-reading instruments is needed to detect any changes in air quality necessitating a higher level of respiratory protection.

7.2.3 Level D Protection Ensemble

As indicated above, Level D protection is primarily a work uniform. It can be worn in areas where only boots can be contaminated, where there are no inhalable toxic substances and where the atmospheric contains at least 19.5% oxygen.

Recommended PPE for Level D includes:

- Coveralls.
- Safety boots/shoes.
- Safety glasses or chemical splash goggles.
- Hardhat.
- Optional gloves; escape mask; face shield.

7.2.4 Recommended Level of Protection for Site Tasks

Based upon current information regarding both the contaminants suspected to be present at the Site and the various tasks that are included in the remedial activities, the minimum required levels of protection for these tasks shall be as identified in Table 3.

8.0 EXPOSURE MONITORING

8.1 General

Based on the results of historic sample analysis and the nature of the proposed work activities at the Site, the possibility exists that organic vapors and/or particulates may be released to the air during intrusive construction activities. Ambient breathing zone concentrations may at times, exceed the permissible exposure limits (PELs) established by OSHA for the individual compounds (see Table 1), in which case respiratory protection will be required. Respiratory and dermal protection may be modified (upgraded or downgraded) by the SSHO based upon real-time field monitoring data.

8.1.1 On-Site Work Zone Monitoring

Benchmark personnel will conduct routine, real-time air monitoring during intrusive construction phases such as excavation, backfilling, drilling, etc. The work area will be monitored at regular intervals using a photo-ionization detector (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 down-wind portion of the Site perimeter will be conducted. This will provide a real-time method for determination of vapor and/or particulate releases to the surrounding community as a result of ground intrusive investigation work.

Ground intrusive activities are defined in the Generic Community Air Monitoring Plan and attached as Appendix C. Ground intrusive activities include soil/fill excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells. Non-intrusive activities include the collection of surface soil/fill samples or the collection of groundwater samples from installed monitoring wells. Continuous monitoring is required for

ground intrusive activities and periodic monitoring is required for non-intrusive activities. Periodic monitoring consists of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring while bailing a well, and taking a reading prior to leaving a sampling location. This may be upgraded to continuous if the sampling location is in close proximity to individuals not involved in the Site activity (i.e., on a curb of a busy street). The action levels below will be used during periodic monitoring.

8.2 Monitoring Action Levels

8.2.1 On-Site Work Zone Action Levels

The PID, or other appropriate instrument(s), will be used by Benchmark 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 (well/boring installation) using a real-time particulate monitor as specified in this plan. In the absence of such monitoring, appropriate respiratory protection for particulates shall be donned. Sustained readings obtained in the breathing zone may be interpreted (with regard to other Site conditions) as follows for Benchmark personnel:

- Total atmospheric concentrations of unidentified (vapors or gases ranging from 0 to 1 ppm above background on the PID) - Continue operations under Level D (see Appendix A).
- Total atmospheric concentrations of unidentified vapors or gases yielding sustained readings from >1 ppm to 5 ppm above background on the PID (vapors not suspected of containing high levels of chemicals toxic to the skin) - Continue operations under Level C (see Appendix A).
- Total atmospheric concentrations of unidentified vapors or gases yielding sustained readings of >5 ppm to 50 ppm above background on the PID - Continue operations under Level B (see Attachment 1), re-evaluate and alter (if possible) construction methods to achieve lower vapor concentrations.
- Total atmospheric concentrations of unidentified vapors or gases above 50 ppm on the PID - Discontinue operations and exit the work zone immediately.

The particulate monitor will be used to monitor respirable dust concentrations during intrusive activities and during handling of Site soil/fill. Action levels based on the instrument readings shall be as follows:

- Less than 50 mg/m^3 - Continue field operations.
- 50-150 mg/m^3 - Don dust/particulate mask or equivalent
- Greater than 150 mg/m^3 - Don dust/particulate mask or equivalent. Initiate engineering controls to reduce respirable dust concentration (viz., wetting of excavated soils or tools at discretion of Site Health and Safety Officer).

Readings from the field equipment will be recorded and documented on the appropriate Project Field Forms. Instruments will be calibrated before use on a daily basis and the procedure will be documented on the appropriate Project Field Forms.

8.2.2 Community Air Monitoring Action Levels

In addition to the action levels prescribed in Section 8.2.1 for Benchmark personnel on-site, the following criteria shall also be adhered to for the protection of downwind receptors consistent with NYSDOH requirements (Appendix C):

- **ORGANIC VAPOR PERIMETER MONITORING:**
  - If the sustained ambient air concentration of organic vapors at the downwind perimeter of the exclusion zone exceeds 5 ppm above background for the 15-minute average, work activities will be temporarily halted and monitoring continued. If the sustained organic vapor decreases below 5 ppm over background, work activities can resume with continued monitoring.
  - If the sustained ambient air concentration of organic vapors at the downwind perimeter of the exclusion zone are greater than 5 ppm over background but less than 25 ppm for the 15-minute average, activities can resume provided that: the organic vapor level 200 feet downwind of the working site or half the distance to the nearest off-site residential or commercial structure, whichever is less, but in no case less than 20 feet, is below 5 ppm over background; and more frequent intervals of monitoring, as directed by the Site Health and Safety Officer, are conducted.
  - If the sustained organic vapor level is above 25 ppm at the perimeter of the exclusion zone for the 15-minute average, the Site Health and Safety Officer must be notified and work activities shut down. The Site Health and Safety Officer will determine when re-entry of the exclusion zone is possible and will

implement downwind air monitoring to ensure vapor emissions do not impact the nearest off-site residential or commercial structure at levels exceeding those specified in the ***Organic Vapor Contingency Monitoring Plan*** below. All readings will be recorded and will be available for New York State Department of Environmental Conservation (DEC) and Department of Health (DOH) personnel to review.

- **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 Health and Safety Plan and the Emergency Response Plan (Appendix A) will be advised.
  2. The local police authorities will immediately be contacted by the Site Health and Safety Officer and advised of the situation.
  3. Frequent air monitoring will be conducted at 30-minute intervals within the 20-foot zone. If two sustained successive readings below action levels are measured, air monitoring may be halted or modified by the Site Health and Safety Officer.

  The following personnel are to be notified in the listed sequence in the event that a Major Vapor Emission Plan is activated:

Responsible Person	Contact	Phone Number
SSHO	Police	911
SSHO	State Emergency Response Hotline	(800) 457-7362

Additional emergency numbers are listed in the Emergency Response Plan included as Appendix A.

- **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 (ug/m^3) greater than the background (upwind perimeter) reading for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression provided that the downwind PM-10 particulate levels do not exceed 150 ug/m^3 above the upwind level and that visible dust is not migrating from the work area.
  - If, after implementation of dust suppression techniques downwind PM-10 levels are greater than 150 ug/m^3 above the upwind level, work activities must be stopped and dust suppression controls re-evaluated. Work can resume provided that supplemental dust suppression measures and/or other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 ug/m^3 of the upwind level and in preventing visible dust migration.

Pertinent emergency response information including the telephone number of the Fire Department is included in the Emergency Response Plan (Appendix A).

9.0 SPILL RELEASE/RESPONSE

This chapter of the HASP describes the potential for and procedures related to spills or releases of known or suspected petroleum and/or hazardous substances on the Site. The purpose of this Section of the HASP is to plan appropriate response, control, counter-measures and reporting, consistent with OSHA requirements in 29 CFR 1910.120(b)(4)(ii)(J) and (j)(1)(viii). The spill containment program addresses the following elements:

- Potential hazardous material spills and available controls.
- Initial notification and evaluation.
- Spill response.
- Post-spill evaluation.

9.1 Potential Spills and Available Controls

An evaluation was conducted to determine the potential for hazardous material and oil/petroleum spills at this Site. For the purpose of this evaluation, hazardous materials posing a significant spill potential are considered to be:

- CERCLA Hazardous Substances as identified in 40 CFR Part 302, where such materials pose the potential for release in excess of their corresponding Reportable Quantity (RQ).
- Extremely Hazardous Substances as identified in 40 CFR Part 355, Appendix A, where such materials pose the potential for release in excess of their corresponding Reportable Quantity (RQ).
- Hazardous Chemicals as defined under Section 311(e) of the Emergency Planning and Community Right-To-Know Act of 1986, where such chemicals are present or will be stored in excess of 10,000 lbs.
- Toxic Chemicals as defined in 40 CFR Part 372, where such chemicals are present or will be stored in excess of 10,000 lbs.
- Chemicals regulated under 6NYCRR Part 597, where such materials pose the potential for release in excess of their corresponding Reportable Quantity (RQ).

Oil/petroleum products are considered to pose a significant spill potential whenever the following situations occur:

- The potential for a "harmful quantity" of oil (including petroleum and non-petroleum-based fuels and lubricants) to reach navigable waters of the U.S. exists (40 CFR Part 112.4). Harmful quantities are considered by USEPA to be volumes

that could form a visible sheen on the water or violate applicable water quality standards.

- The potential for any amount of petroleum to reach any waters of NY State, including groundwater, exists. Petroleum, as defined by NY State in 6NYCRR Part 612, is a petroleum-based heat source, energy source, or engine lubricant/maintenance fluid.
- The potential for any release, to soil or water, of petroleum from a bulk storage facility regulated under 6NYCRR Part 612. A regulated petroleum storage facility is defined by NY State as a site having stationary tank(s) and intra-facility piping, fixtures and related equipment with an aggregate storage volume of 1,100 gallons or greater.

The evaluation indicates that, based on Site history and decommissioning records, a hazardous material spill and/or a petroleum product spill is not likely to occur during RI efforts.

9.2 Initial Spill Notification and Evaluation

Any worker who discovers a hazardous substance or oil/petroleum spill will immediately notify the Project Manager and SSHO. The worker will, to the best of his/her ability, report the material involved, the location of the spill, the estimated quantity of material spilled, the direction/flow of the spill material, related fire/explosion incidents, if any, and any associated injuries. The Emergency Response Plan presented in Appendix A of this HASP will immediately be implemented if an emergency release has occurred.

Following initial report of a spill, the Project Manager will make an evaluation as to whether the release exceeds RQ levels. If an RQ level is exceeded, the Project Manager will notify the Site owner and NYSDEC at 1-800-457-7362 within 2 hours of spill discovery. The Project Manager will also determine what additional agencies (e.g., USEPA) are to be contacted regarding the release, and will follow-up with written reports as required by the applicable regulations.

9.3 Spill Response

For all spill situations, the following general response guidelines will apply:

- Only those personnel involved in overseeing or performing containment operations will be allowed within the spill area. If necessary, the area will be roped, ribboned, or otherwise blocked off to prevent unauthorized access.

- Appropriate PPE, as specified by the SSHO, will be donned before entering the spill area.
- Ignition points will be extinguished/removed if fire or explosion hazards exist.
- Surrounding reactive materials will be removed.
- Drains or drainage in the spill area will be blocked to prevent inflow of spilled materials or applied materials.

For minor spills, the Contractor will maintain a Spill Control and Containment Kit in the Field Office or other readily accessible storage location. The kit will consist of, at a minimum, a 50 lb. bag of "speedy dry" granular absorbent material, absorbent pads, shovels, empty 5-gallon pails and an empty open-top 55-gallon drum. Spilled materials will be absorbed, and shoveled into a 55-gallon drum for proper disposal (NYSDEC approval will be secured for on-site treatment of the impacted soils/absorbent materials, if applicable). Impacted soils will be hand-excavated to the point that no visible signs of contamination remains, and will be drummed with the absorbent.

In the event of a major release or a release that threatens surface water, a spill response contractor will be called to the Site. The response contractor may use heavy equipment (e.g., excavator, backhoe, etc.) to berm the soils surrounding the spill Site or create diversion trenching to mitigate overland migration or release to navigable waters. Where feasible, pumps will be used to transfer free liquid to storage containers. Spill control/cleanup contractors in the Western New York area that may be contacted for assistance include:

- The Environmental Service Group of NY, Inc.: (716) 695-6720
- Environmental Products and Services, Inc.: (716) 447-4700
- Op-Tech: (716) 873-7680

9.4 Post-Spill Evaluation

If a reportable quantity of hazardous material or oil/petroleum is spilled as determined by the Project Manager, a written report will be prepared as indicated in Section 9.2. The report will identify the root cause of the spill, type and amount of material released, date/time of release, response actions, agencies notified and/or involved in cleanup, and procedures to be implemented to avoid repeat incidents. In addition, all re-useable spill cleanup and containment materials will be decontaminated, and spill kit supplies/disposable items will be replenished.

10.0 HEAT/COLD STRESS MONITORING

Since some of the work activities at the Site will be scheduled for both the summer and winter months, measures will be taken to minimize heat/cold stress to Benchmark employees. The Site Safety and Health Officer 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

Personal protective equipment may place an employee at risk of developing heat stress, a common and potentially serious illnesses often encountered at construction, landfill, waste disposal, industrial or other unsheltered sites. The potential for heat stress is dependent on a number of factors, including environmental conditions, clothing, workload, physical conditioning and age. Personal protective equipment may severely reduce the body's normal ability to maintain temperature equilibrium (via evaporation and convection), and require increased energy expenditure due to its bulk and weight.

Proper training and preventive measures will mitigate the potential for serious illness. Heat stress prevention is particularly important because once a person suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat related illness. To avoid heat stress, the following steps should be taken:

- Adjust work schedules.
- Modify work/rest schedules according to monitoring requirements.
- Mandate work slowdowns as needed.
- Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided.
- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.
- Maintain worker's body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat (i.e., eight fluid ounces must be ingested for approximately every 1 lb of weight lost). The normal thirst mechanism is not sensitive enough to ensure that enough water will be consumed to replace lost perspiration. When heavy sweating occurs, workers should be encouraged to drink more.
- Train workers to recognize the symptoms of heat related illness.

Heat-Related Illness - Symptoms:

- Heat rash may result from continuous exposure to heat or humid air.
- Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include: muscle spasms; pain in the hands, feet and abdomen.
- Heat exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include: pale, cool, moist skin; heavy sweating; dizziness; nausea; fainting.
- Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are: red, hot, usually dry skin; lack of or reduced perspiration; nausea; dizziness and confusion; strong, rapid pulse; coma.

The monitoring of personnel wearing protective clothing should commence when the ambient temperature is 70 degrees Fahrenheit or above. For monitoring the body's recuperative ability to excess heat, one or more of the following techniques should be used as a screening mechanism.

- Heart rate may be measured by the radial pulse for 30 seconds as early as possible in the resting period. The rate at the beginning of the rest period should not exceed 100 beats per minute. If the rate is higher, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest periods stay the same. If the pulse rate is 100 beats per minute at the beginning of the nest rest period, the following work cycle should be further shortened by 33%.
- Body temperature may be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period should not exceed 99.6 degrees Fahrenheit. If it does, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period remains the same. However, if the oral temperature exceeds 99.6 degrees Fahrenheit at the beginning of the next period, the work cycle may be further shortened by 33%. Oral temperature should be measured at the end of the rest period to make sure that it has dropped below 99.6 degrees Fahrenheit. No Benchmark employee will be permitted to continue wearing semi-permeable or impermeable garments when his/her oral temperature exceeds 100.6 degrees Fahrenheit.

10.2 Cold Stress Monitoring

Exposure to cold conditions may result in frostbite or hypothermia, each of which progresses in stages as shown below.

- **Frostbite** occurs when body tissue (usually on the extremities) begins to freeze. The three states of frostbite are:
  1) **Frost nip** - This is the first stage of the freezing process. It is characterized by a whitened area of skin, along with a slight burning or painful sensation. Treatment consists of removing the victim from the cold conditions, removal of boots and gloves, soaking the injured part in warm water (102 to 108 degrees Fahrenheit) and drinking a warm beverage. Do not rub skin to generate friction/ heat.
  2) **Superficial Frostbite** - This is the second stage of the freezing process. It is characterized by a whitish gray area of tissue, which will be firm to the touch but will yield little pain. The treatment is identical for Frost nip.
  3) **Deep Frostbite** - In this final stage of the freezing process the affected tissue will be cold, numb and hard and will yield little to no pain. Treatment is identical to that for Frost nip.
- **Hypothermia** is a serious cold stress condition occurring when the body loses heat at a rate faster than it is produced. If untreated, hypothermia may be fatal. The stages of hypothermia may not be clearly defined or visible at first, but generally include:
  1) Shivering
  2) Apathy (i.e., a change to an indifferent or uncaring mood)
  3) Unconsciousness
  4) Bodily freezing

  Employees exhibiting signs of hypothermia should be treated by medical professionals. Steps that can be taken while awaiting help include:
  1) Remove the victim from the cold environment and remove wet or frozen clothing. (Do this carefully as frostbite may have started.)
  2) Perform active re-warming with hot liquids for drinking (Note: do not give the victim any liquid containing alcohol or caffeine) and a warm water bath (102 to 108 degrees Fahrenheit).
  3) Perform passive re-warming with a blanket or jacket wrapped around the victim.

In any potential cold stress situation, it is the responsibility of the Site Health and Safety Officer to encourage the following:

- Education of workers to recognize the symptoms of frostbite and hypothermia.
- Workers should dress warmly, with more layers of thin clothing as opposed to one thick layer.
- Personnel should remain active and keep moving.
- Personnel should be allowed to take shelter in a heated areas, as necessary.
- Personnel should drink warm liquids (no caffeine or alcohol if hypothermia has set in).
- For monitoring the body's recuperation from excess cold, oral temperature recordings should occur:
    - At the Site Safety Technicians discretion when suspicion is based on changes in a worker's performance or mental status.
    - At a worker's request.
    - As a screening measure, two times per shift, under unusually hazardous conditions (e.g., wind chill less than 20 degrees Fahrenheit or wind chill less than 30 degrees Fahrenheit with precipitation).
    - As a screening measure, whenever anyone worker on-site develops hypothermia.

Any person developing moderate hypothermia (a core body temperature of 92 degrees Fahrenheit) will not be allowed to return to work for 48 hours without the recommendation of a qualified medical doctor.

11.0 WORK ZONES AND SITE CONTROL

Work zones around the areas designated for construction activities will be established on a daily basis and communicated to all employees and other Site users by the SSHO. It shall be each Contractor's Site Safety and Health Officer's responsibility to ensure that all Site workers are aware of the work zone boundaries and to enforce proper procedures in each area. The zones will include:

- Exclusion Zone ("Hot Zone") - The area where contaminated materials may be exposed, excavated or handled and all areas where contaminated equipment or personnel may travel. Flagging tape will delineate the zone. All personnel entering the Exclusion Zone must wear the prescribed level of personal protective equipment identified in Section 7.
- Contamination Reduction Zone - The zone where decontamination of personnel and equipment takes place. Any potentially contaminated clothing, equipment, and samples must remain in the Contamination Reduction Zone until decontaminated.
- Support Zone - The part of the site that is considered non-contaminated or "clean." Support equipment will be located in this zone, and personnel may wear normal work clothes within this zone.

In the absence of other task-specific work zone boundaries established by the SSHO, the following boundaries will apply to all investigation and construction activities involving disruption or handling of Site soils or groundwater:

- Exclusion Zone: 50 foot radius from the outer limit of the sampling/construction activity.
- Contaminant Reduction Zone: 100 foot radius from the outer limit of the sampling/construction activity.
- Support Zone: Areas outside the Contaminant Reduction Zone.

Access of non-essential personnel to the Exclusion and Contamination Reduction Zones will be strictly controlled by the SSHO. Only personnel who are essential to the completion of the task will be allowed access to these areas and only if they are wearing the prescribed level of protection. Entrance of all personnel must be approved by the SSHO.

The SSHO will maintain a Health and Safety Logbook containing the names of Benchmark workers and their level of protection. The zone boundaries may be changed by

the SSHO as environmental conditions warrant, and to respond to the necessary changes in work locations on-site.

12.0 DECONTAMINATION

12.1 Decontamination for Benchmark Employees

The degree of decontamination required is a function of a particular task and the environment within which it occurs. The following decontamination procedure will remain flexible, thereby allowing the decontamination crew to respond appropriately to the changing environmental conditions that may arise at the Site. 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 exclusive zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot cover donned, and worker returns to duty.

Station 5 - Outer Garment/Face Piece Removal: Protective suit removed and deposited in separate container provided by Contractor. Face piece or goggles are removed if used. Avoid touching face with fingers. Face piece and/or goggles deposited on plastic sheet. Hard hat removed and placed on plastic sheet.

Station 6 - Inner Glove Removal: Inner gloves are the last personal protective equipment to be removed. Avoid touching the outside of the gloves with bare fingers. Dispose of these gloves in waste disposal container.

Following PPE removal, personnel shall wash hands, face and forearms with absorbent wipes. If field activities proceed for duration of 6 consecutive months or longer, shower facilities will be provided for worker use in accordance with OSHA 29 CFR 1910.120(n).

12.2 Decontamination for Medical Emergencies

In the event of a minor, non-life threatening injury, personnel should follow the decontamination procedures as defined, and then administer first-aid.

In the event of a major injury or other serious medical concern (e.g., heat stroke), immediate first-aid is to be administered and the victim transported to the hospital in lieu of further decontamination efforts unless exposure to a Site contaminant would be considered "Immediately Dangerous to Life or Health."

12.3 Decontamination of Field Equipment

The Contractor, in accordance with their Health and Safety Plan in the Contamination Reduction Zone will conduct decontamination of heavy equipment. As a minimum, this will include manually removing heavy soil contamination, followed by steam cleaning on an impermeable pad.

Benchmark personnel will conduct decontamination of all tools used for sample collection purposes. It is expected that all tools will be constructed of nonporous, nonabsorbent materials (i.e., metal), which will aid in the decontamination effort. Any tool or part of a tool made of porous, absorbent material (i.e., wood) will be placed into suitable containers and prepared for disposal.

Decontamination of bailers, split-spoons, spatula knives, and other tools used for environmental sampling and examination shall be as follows:

- Disassemble the equipment.
- Water wash to remove all visible foreign matter.
- Wash with detergent.
- Rinse all parts with distilled-deionized water.
- Allow to air dry.
- Wrap all parts in aluminum foil or polyethylene.

13.0 CONFINED SPACE ENTRY

OSHA 29 CFR 1910.146 identifies a confined space as a space that is large enough and so configured that an employee can physically enter and do assigned work, has limited or restricted means for entry and exit, and is not intended for continuous employee occupancy. Confined spaces include, but are not limited to, trenches, storage tanks, process vessels, pits, sewers, tunnels, underground utility vaults, pipelines, sumps, wells, and excavations.

Confined space entry by Benchmark employees is not anticipated to be necessary to complete the RA activities identified in Section 2.0. In the event that the scope of work changes or confined space entry appears necessary, the Project Manager will be consulted to determine if feasible engineering alternatives to confined space entry can be implemented. If confined space entry by Benchmark 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 National Fire Protection Association.

14.4 Hot Work

If the scope of work necessitates welding or blowtorch operation, the hot work permit presented in Appendix B will be completed by the SSHO and reviewed/issued by the Project Manager.

15.0 EMERGENCY INFORMATION

In accordance with OSHA 29 CFR Part 1910, an Emergency Response Plan is attached to this HASP as Appendix A. The hospital route map is presented within Appendix A as Figure 1.

TABLES

BENCHMARK

TABLE 1

TOXICITY DATA FOR CONSTITUENTS OF POTENTIAL CONCERN

SITE HEALTH AND SAFETY PLAN
MT. OLIVE SENIOR MANOR SITE
BUFFALO, NEW YORK

Parameter	Synonyms	CAS No.	Code	Concentration Limits [1]		
				PEL	TLV	IDLH
Semi-volatile Organic Compounds (SVOCs) [2] : ppm						
Benzo(a)anthracene	*none*	56-55-3	*none*	--	--	--
Benzo(a)pyrene	*none*	50-32-8	*none*	--	--	--
Benzo(b)fluoranthene	*none*	205-99-2	*none*	--	--	--
Benzo(k)fluoranthene	*none*	207-08-9	*none*	--	--	--
Chrysene	*none*	218 01 9	*none*	--	--	--
Dibenzo(a,h)anthracene	*none*	53-70-3	*none*	--	--	--
Dibenzofuran	*none*	132-64-9	*none*	--	--	--
Indeno(1,2,3-cd)pyrene	*none*	193-39-5	*none*	--	--	--
Inorganic Compounds: mg/m [2]						
Arsenic	*As*	7440-38-2	*none*	0.5	0.5	50
Barium	*Ba*	7440-39-3	*none*	0.5	0.5	50
Chromium	*Cr*	7440-47-3	*Ca*	1	0.5	250
Copper	*Cu*	7440-50-8	*none*	1	1	100
Lead	*Pb*	7439-92-1	*none*	0.05	0.15	100
Mercury	*Hg*	7439-97-6	C-0.1	0.1	0.05	10
Nickel	*Ni*	7440-02-0	Ca	1	1	10
Zinc	*Zn*	7440-66-6	none	--	--	--
Volatile Organic Compounds (VOCs): ppm						
cis-1,2-dichloroethene	Cis-DCE	156-59-2	*none*	200	200	1000
Trichloroethene	TCE	79-01-6	*Ca*	100	50	1000
Total PCBs: mg/m [3]						
Aroclor 1248	*Chlorodiphenyl, 48% chlorine*	12672-29-6	*Ca*	0.5	0.5	5
Aroclor 1254	*Chlorodiphenyl, 54% chlorine*	11097-69-1	*Ca*	0.5	0.5	5
Aroclor 1260	*Chlorodiphenyl, 60% chlorine*	11096-82-5	*Ca*	0.5	0.5	5
Pesticides: mg/m [3]						
4,4'-DDD	*p,p-DDD, dichlorodiphenyldichloroethane*	72-54-8	*Ca*	--	--	--
4,4'-DDE	*p,p-DDE, dichlorodiphenyldichloroethene*	72-55-9	*Ca*	--	--	--
4,4'-DDT	*p,p-DDT, dichlorodiphenyltrichloroethane, clefenotane*	50-29-3	*Ca*	1	1	500
Dieldrin	*Octalox*	60-57-1	*Ca*	0.25	0.25	50
Total PCBs: mg/m [3]						
PFOA	*Perfluorooctanoic acid*	335-67-1	*Ca*	--	--	--
PFOS	*Perfluorooctanesulfonic acid*	1763-23-1	*Ca*	--	--	--

Notes:

1. Concentration limits as reported by NIOSH Pocket Guide to Chemical Hazards, February 2004 (NIOSH Publication No. 97-140, fourth printing with chages and updates).
2. " -- " = concentration limit not available; exposure should be minimized to the extent feasible through appropriate engineering controls & PPE.

Explanation:

C-## = Ceiling Level equals the maximum exposure concentration allowable during the work day.

IDLH = Immediately Dangerous to Life or Health.

TLV = Threshold Limit Value, established by American Conference of Industrial Hygienists (ACGIH), equals the maximum exposure concentration allowable for 8 hours/day @ 40 hr

TLVs are the amounts of chemicals in the air that almost all healthy adult workers are predicted to be able to tolerate without adverse effects. There are three types.

TLV-TWA (TLV-Time-Weighted Average) which is averaged over the normal eight-hour day/forty-hour work week. (Most TLVs.)

TLV-C or Ceiling limits are the concentration that should not be exceeded during any part of the working exposure.

Unless the initials "STEL" or "C" appear in the Code column, the TLV value should be considered to be the eight-hour TLV-TWA.

PEL = Permissible Exposure Limit, established by OSHA, equals the maximium exposure conconcentration allowable for 8 hours per day @ 40 hours per week

BENCHMARK

TABLE 2

POTENTIAL ROUTES OF EXPOSURE TO THE CONSTITUENTS OF POTENTIAL CONCERN

SITE HEALTH AND SAFETY PLAN
MT OLIVE SENIOR MANOR SITE
BUFFALO, NEW YORK

Activity [1]	Direct Contact with Soil/Fill	Inhalation of Vapors or Dust	Direct Contact with Groundwater
Pre-Design Investigation Tasks			
1. Monitoring Well Installation/Development and Sampling	x	x	x
2. Subsurface Soil Sampling	x	x	
Remedial Action Tasks			
1. Excavation of Overburden Soil/Fill	x	x	
2. Verification Sampling	x	x	
3. Backfilling	x	x	
4. In-Situ Groundwater Treatment			x
5. Groundwater Monitoring			x
6. Sub-Slab Depressurization System Piping Installation		x	
7. SVI Assessment		x	

Notes:
1. Activity as described in Section 1.5 of the Health and Safety Plan.

BENCHMARK

TABLE 3

REQUIRED LEVELS OF PROTECTION
FOR REMEDIAL INVESTIGATION TASKS

SITE HEALTH AND SAFETY PLAN
MT OLIVE SENIOR MANOR SITE
BUFFALO, NEW YORK

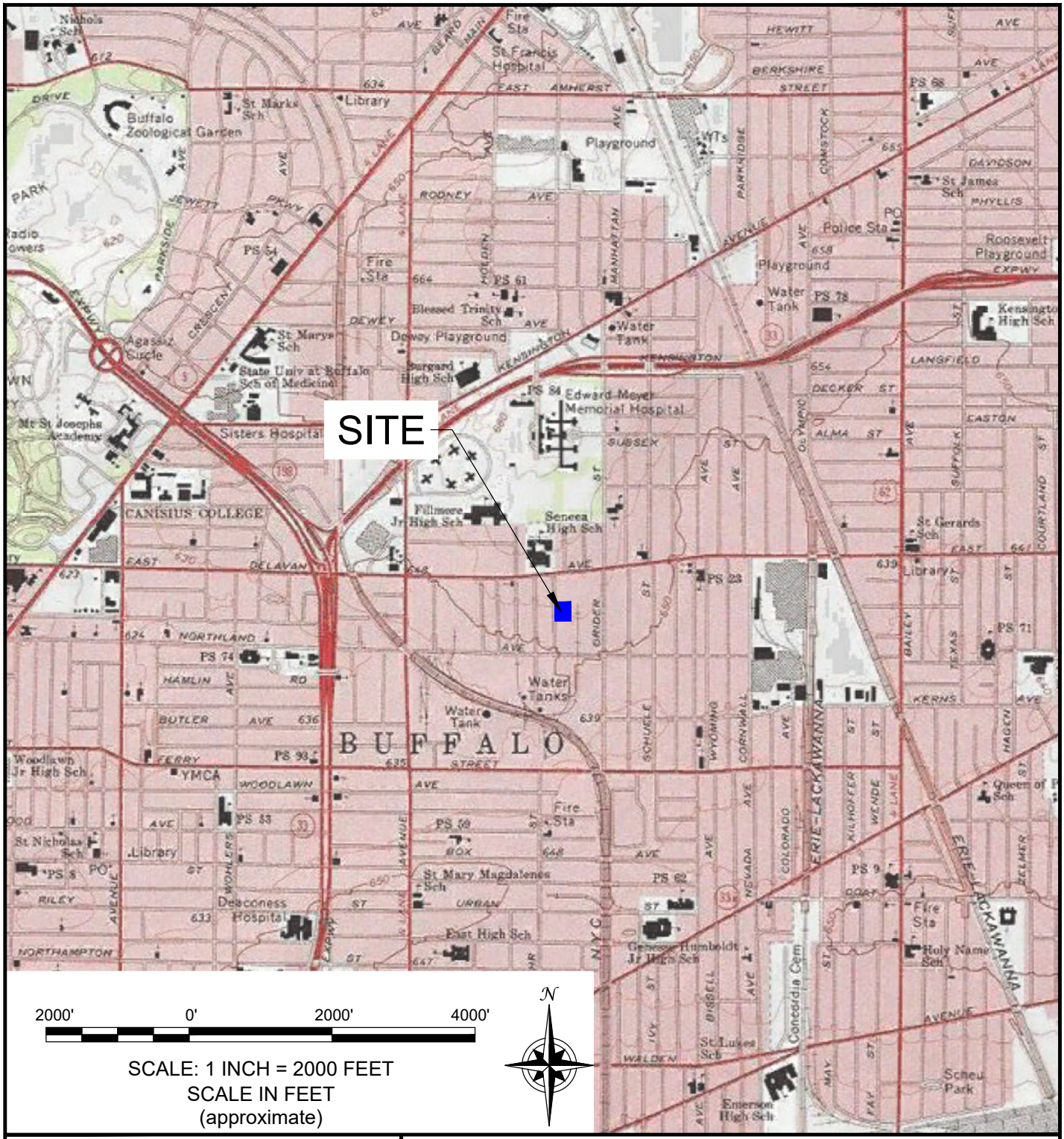
Activity	Respiratory Protection [1]	Clothing	Gloves [2]	Boots [2, 3]	Other Required PPE/Modifications [2, 4]
Pre-Design Investigation Tasks					
1. Monitoring Well Installation/Development and Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
2. Subsurface Soil Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
Remedial Action Tasks					
1. Excavation of Overburden Soil/Fill	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
2. Verification Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
3. Backfilling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
4. In-Situ Groundwater Treatment	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
5. Groundwater Monitoring	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
6. Sub-Slab Depressurization System Piping Installation	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
7. SVI Assessment	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS

Notes:
1. Respiratory equipment shall conform to guidelines presented in Section 7.0 of this HASP. The Level C requirement is an air-purifying respirator equiped with organic compound/acid
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

F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\HASP\Figure 1; Site Location and Vicinity Map.dwg, 12/30/2022 2:30:56 PM, DWG To PDF.pc3

FIGURE 1



SITE LOCATION AND VICINITY MAP

HEALTH AND SAFETY PLAN

MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

PREPARED FOR

MT. OLIVE SENIOR MANOR LLC

BENCHMARK

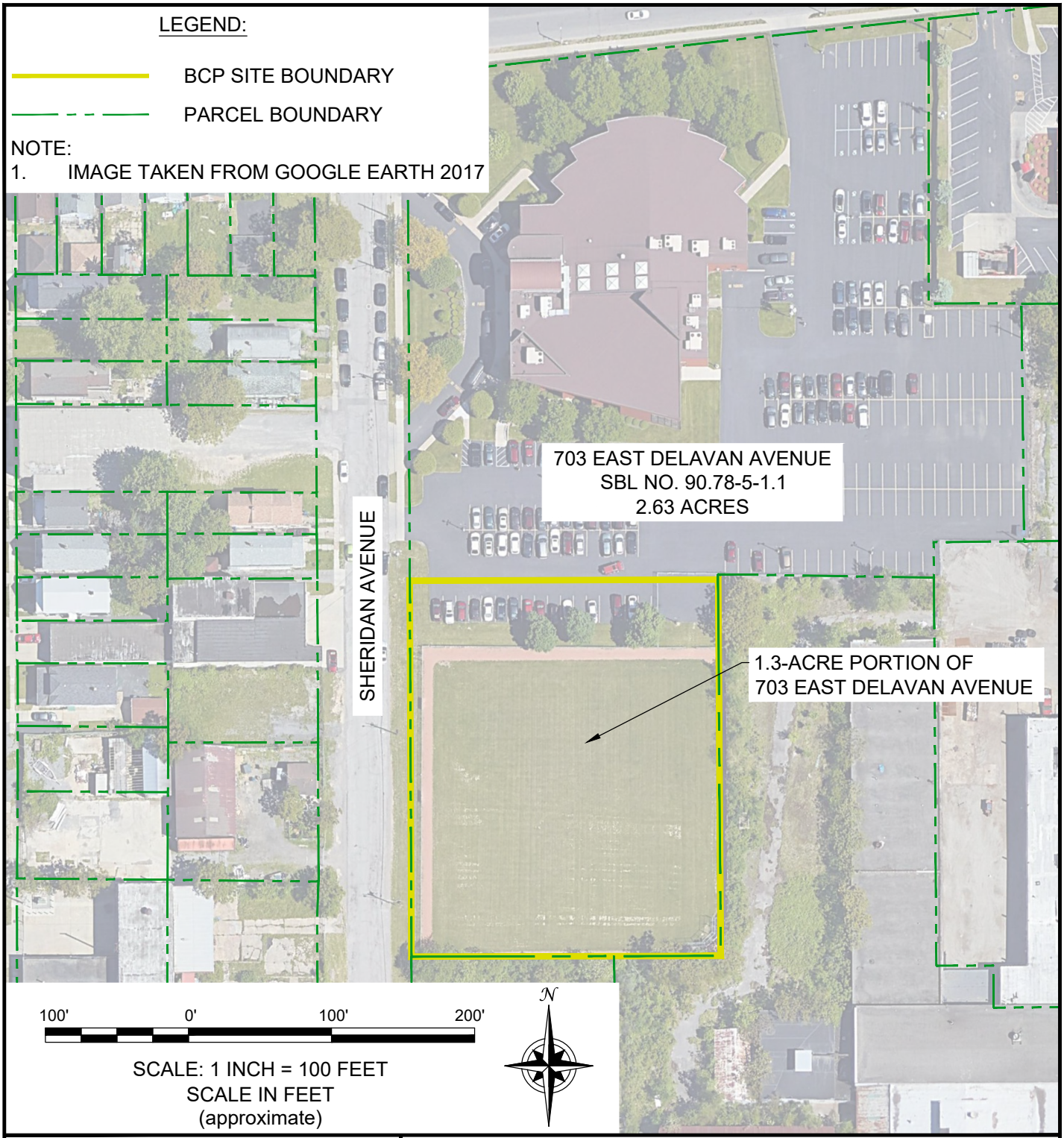
2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218, (716) 856-0599

PROJECT NO.:	B0670-022-001
DATE:	JANUARY 2023
DRAFTED BY:	CEH

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F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\HASP\Figure 2; Site Plan (Aerial).dwg, 12/30/2022 2:30:20 PM, DWG To PDF.pc3

FIGURE 2



SITE PLAN (AERIAL)

HEALTH AND SAFETY PLAN

MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

PREPARED FOR

MT. OLIVE SENIOR MANOR LLC

BENCHMARK

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

PROJECT NO.: B0670-022-001

DATE: JANUARY 2023

DRAFTED BY: CNK

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ATTACHMENT A

EMERGENCY RESPONSE PLAN

BENCHMARK

EMERGENCY RESPONSE PLAN
for
BROWNFIELD CLEANUP PROGRAM
RA ACTIVITIES

MT. OLIVE SENIOR MANOR SITE
BUFFALO, NEW YORK
(SITE NO. C915377)

January 2023 0670-022-001-005

Prepared for:

MT. OLIVE SENIOR MANOR LLC

Prepared by:

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

MT. OLIVE SENIOR MANOR SITE
HEALTH AND SAFETY PLAN FOR RA ACTIVITIES
APPENDIX A: EMERGENCY RESPONSE PLAN

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Figure E-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 Action (RA) activities at the Mt. Olive Senior Manor Site located at 703 East Delavan, in Buffalo, New York. This appendix of the HASP describes potential emergencies that may occur at the Site; procedures for responding to those emergencies; roles and responsibilities during emergency response; and training all workers must receive in order to follow emergency procedures. This ERP also describes the provisions this Site has made to coordinate its emergency response planning with other contractors on-site and with off-site emergency response organizations.

This ERP is consistent with the requirements of 29 CFR 1910.120(l) and provides the following site-specific information:

- Pre-emergency planning.
- Personnel roles, lines of authority, and communication.
- Emergency recognition and prevention.
- Safe distances and places of refuge.
- Evacuation routes and procedures.
- Decontamination procedures.
- Emergency medical treatment and first aid.
- Emergency alerting and response procedures.
- Critique of response and follow-up.
- Emergency personal protective equipment (PPE) and equipment.

2.0 PRE-EMERGENCY PLANNING

This Site has been evaluated for potential emergency occurrences, based on site hazards, the required work tasks, the site topography, and prevailing weather conditions. The results of that evaluation indicate the potential for the following site emergencies to occur at the locations indicated.

Type of Emergency:

1. Medical, due to physical injury

Source of Emergency:

1. Slip/trip/fall

Location of Source:

1. Non-specific

3.0 ON-SITE EMERGENCY RESPONSE EQUIPMENT

Emergency procedures may require specialized equipment to facilitate worker rescue, contamination control and reduction, or post-emergency clean up. Emergency response equipment available on the Site is listed below. The equipment inventory and storage locations are based on the potential emergencies described above. This equipment inventory is designed to meet on-site emergency response needs and any specialized equipment needs that off-site responders might require because of the hazards at this Site but not ordinarily stocked.

Any additional personal protective equipment (PPE) required and stocked for emergency response is also listed in below. During an emergency, the Emergency Response Coordinator (ERC) is responsible for specifying the level of PPE required for emergency response. At a minimum, PPE used by emergency responders will comply with Section 7.0, Personal Protective Equipment, of this HASP. Emergency response equipment is inspected at regular intervals and maintained in good working order. The equipment inventory is replenished as necessary to maintain response capabilities.

Emergency Equipment	Quantity	Location
First Aid Kit	1	Site Vehicle
Chemical Fire Extinguisher	2 (minimum)	All heavy equipment and Site Vehicle

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

4.0 EMERGENCY PLANNING MAPS

An area-specific map of the Site will be developed on a daily basis during performance of field activities. The map will be marked to identify critical on-site emergency planning information, including: emergency evacuation routes, a place of refuge, an assembly point, and the locations of key site emergency equipment. Site zone boundaries will be shown to alert responders to known areas of contamination. There are no major topographical features, however the direction of prevailing winds/weather conditions that could affect emergency response planning are also marked on the map. The map will be posted at site-designated place of refuge and inside the Benchmark personnel field vehicle.

5.0 EMERGENCY CONTACTS

The following identifies the emergency contacts for this ERP.

Emergency Telephone Numbers:

Project Officer: ***Thomas H Forbes, P.E.***
Work: (716) 856-0599
Mobile: (716) 864-1730

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

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

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

Alternate SSHO: ***Nathan Munley***
Work: (716) 856-0599
Mobile: (716) 289-1072

ECMC HOSPITAL (ER):	(716) 898-3000
FIRE:	911
AMBULANCE:	911
BUFFALO POLICE:	911
STATE EMERGENCY RESPONSE HOTLINE:	(800) 457-7362
NATIONAL RESPONSE HOTLINE:	(800) 424-8802
NYSDOH:	(716) 847-4385
NYSDEC:	(716) 851-7220
NYSDEC 24-HOUR SPILL HOTLINE:	(800) 457-7252

The Site location is:
703 East Delavan Avenue
Buffalo, New York 14215
Site Phone Number: Benchmark Staff Cell Phones to be used.

6.0 EMERGENCY ALERTING & EVACUATION

Internal emergency communication systems are used to alert workers to danger, convey safety information, and maintain site control. Any effective system can be employed. Two-way radio headsets or field telephones are often used when work teams are far from the command post. Hand signals and air-horn blasts are also commonly used. Every system must have a backup. It shall be the responsibility of each contractor's Site Health and Safety Officer to ensure all personnel entering the site understand an adequate method of internal communication. Unless all personnel are otherwise informed, the following signals shall be used.

1) Emergency signals by portable air horn, siren, or whistle: two short blasts, personal injury; continuous blast, emergency requiring site excavation.

2) Visual signals: hand gripping throat, out of air/cannot breathe; hands on top of head, need assistance; thumbs up, affirmative/ everything is OK; thumbs down, no/negative; grip partner's wrist or waist, leave area immediately.

If evacuation notice is given, site workers leave the worksite with their respective buddies, if possible, by way of the nearest exit. Emergency decontamination procedures detailed in Section 12.0 of the HASP are followed to the extent practical without compromising the safety and health of site personnel. The evacuation routes and assembly area will be determined by conditions at the time of the evacuation based on wind direction, the location of the hazard source, and other factors as determined by rehearsals and inputs from emergency response organizations. Wind direction indicators are located so that workers can determine a safe up wind or cross wind evacuation route and assembly area if not informed by the emergency response coordinator at the time the evacuation alarm sounds. Since work conditions and work zones within the site may be changing on daily basis, it shall be the responsibility of the construction Site Health and Safety Officer to review evacuation routes and procedures as necessary and to inform all Benchmark-TurnKey workers of any changes.

Personnel exiting the site will gather at a designated assembly point. To determine that everyone has successfully exited the site, personnel will be accounted for at the assembly site. If any worker cannot be accounted for, notification is given to the SSHO (***Christopher***

Boron or ***Nathan Munley***) so that appropriate action can be initiated. Contractors and subcontractors on this site have coordinated their emergency response plans to ensure that these plans are compatible, and that source(s) of potential emergencies are recognized, alarm systems are clearly understood, and evacuation routes are accessible to all personnel relying upon them.

7.0 EXTREME WEATHER CONDITIONS

In the event of adverse weather conditions, the Site Safety and Health Officer in conjunction with the Contractor's SSHO will determine if engineering operations can continue without sacrificing the health and safety of site personnel. Items to be considered prior to determining if work should continue include but are not limited to:

- Potential for heat/cold stress.
- Weather-related construction hazards (e.g., flooding or wet conditions producing undermining of structures or sheeting, high wind threats, etc).
- Limited visibility.
- Potential for electrical storms.
- Limited site access/egress (e.g., due to heavy snow)

8.0 EMERGENCY MEDICAL TREATMENT & FIRST AID

Personnel Exposure:

The following general guidelines will be employed in instances where health impacts threaten to occur acute exposure is realized:

- Skin Contact: Use copious amounts of soap and water. Wash/rinse affected area for at least 15 minutes. Decontaminate and provide medical attention. Eyewash stations will be provided on site. If necessary, transport to Buffalo General Hospital.
- Inhalation: Move to fresh air and, if necessary, transport to Hospital.
- Ingestion: Decontaminate and transport to Hospital.

Personal Injury:

Minor first-aid will be applied on-site as deemed necessary. In the event of a life-threatening injury, the individual should be transported to Hospital via ambulance. The Site Health and Safety Officer will supply available chemical specific information to appropriate medical personnel as requested.

First aid kits will conform to Red Cross and other applicable good health standards and shall consist of a weatherproof container with individually sealed packages for each type of item. First aid kits will be fully equipped before being sent out on each job and will be checked weekly by the SSHO to ensure that the expended items are replaced.

Directions to ECMC Hospital Emergency Room (see Figure 1):

The following directions describe the best route from the Site to ECMC Hospital which is less than 1 mile away:

- Head north on Sheridan Avenue toward East Delavan Avenue.
- Turn Right onto East Delavan Avenue.
- Head west on East Delavan Avenue for 0.1 miles.
- Turn Left onto Grider Street for 0.3 miles.
- Turn Left at the 1st hospital entrance for the Emergency Room, following signs. Head East along hospital road for 0.1 to reach emergency room.

9.0 EMERGENCY RESPONSE CRITIQUE & RECORD KEEPING

Following an emergency, the SSHO and Project Manager shall review the effectiveness of this Emergency Response Plan (ERP) in addressing notification, control and evacuation requirements. Updates and modifications to this ERP shall be made accordingly. It shall be the responsibility of each contractor to establish and assure adequate records of the following:

- Occupational injuries and illnesses.
- Accident investigations.
- Reports to insurance carrier or State compensation agencies.
- Reports required by the client.
- Records and reports required by local, state, federal and/or international agencies.
- Property or equipment damage.
- Third party injury or damage claims.
- Environmental testing logs.
- Explosive and hazardous substances inventories and records.
- Records of inspections and citations.
- Safety training.

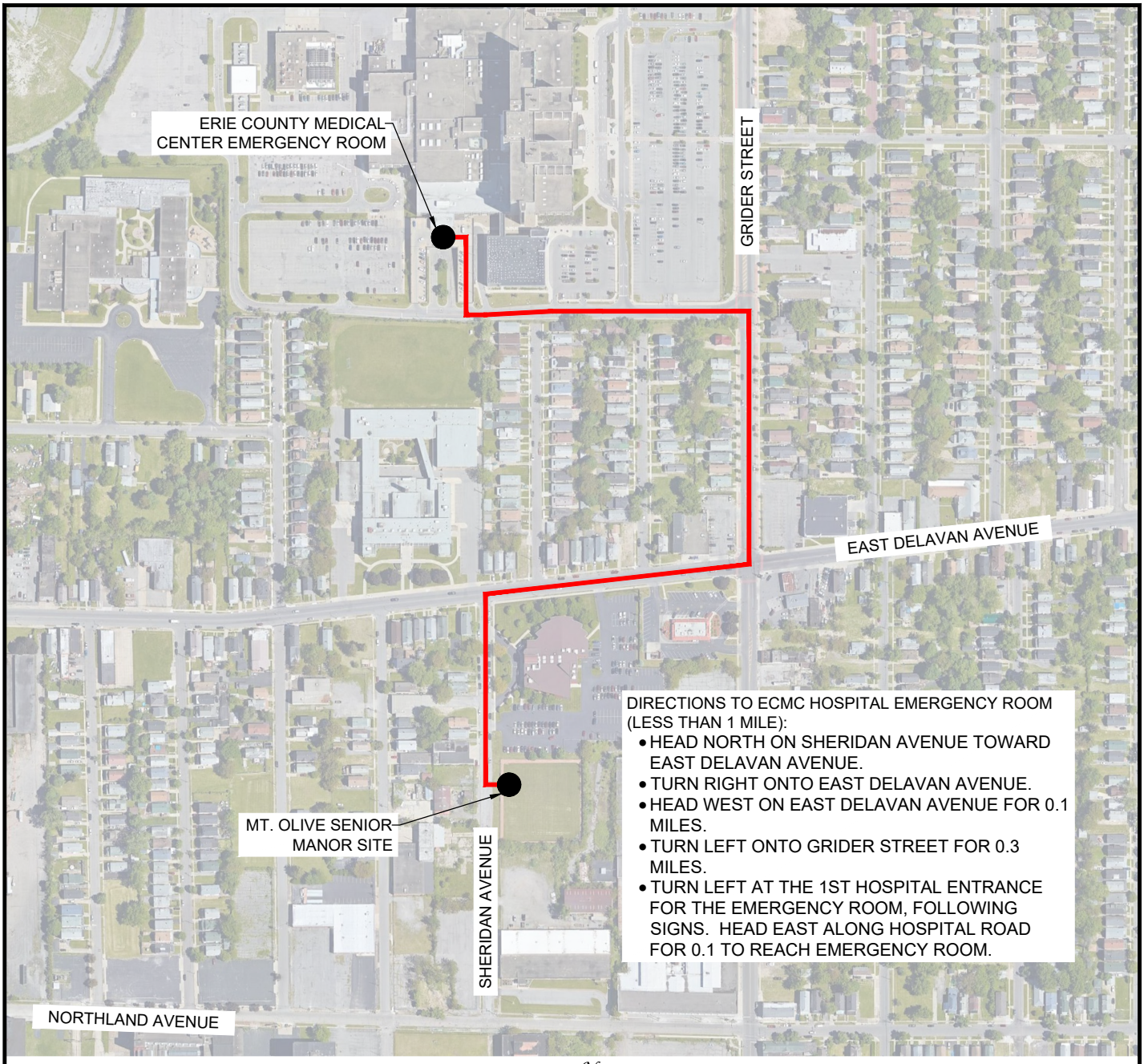
10.0 EMERGENCY RESPONSE TRAINING

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

FIGURES

F:\CAD\Benchmark\People Inc\703 East Delevan\RAWP\HASP\Figure 1; Hospital Route Map.dwg, 12/30/2022 2:32:50 PM, DWG To PDF.pc3

FIGURE 1



400' 0' 400' 800'

SCALE: 1 INCH = 400 FEET
SCALE IN FEET
(approximate)

N

BENCHMARK

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

PROJECT NO.: 0670-022-001

DATE: JANUARY 2023

DRAFTED BY: CNK

HOSPITAL ROUTE MAP

EMERGENCY RESPONSE PLAN

MT. OLIVE SENIOR MANOR SITE (C915377)
703 EAST DELAVAN AVENUE
BUFFALO, NEW YORK

PREPARED FOR

MT. OLIVE SENIOR MANOR LLC

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

ATTACHMENT B

HOT WORK PERMIT FORM

BENCHMARK

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

HOT WORK PERMIT

PART 1 - INFORMATION

Issue Date:	
Date Work to be Performed: Start:	Finish (permit terminated):
Performed By:	
Work Area:	
Object to be Worked On:	

PART 2 - APPROVAL

(for 1, 2 or 3: mark Yes, No or NA)*

Will working be on or in:	Finish (permit terminated):	
1. Metal partition, wall, ceiling covered by combustible material?	yes	no
2. Pipes, in contact with combustible material?	yes	no
3. Explosive area?	yes	no

* = If any of these conditions exist (marked "yes"), a permit will not be issued without being reviewed and approved by Thomas H. Forbes (Corporate Health and Safety Director). Required Signature below.

PART 3 - REQUIRED CONDITIONS**

(Check all conditions that must be met)

	PROTECTIVE ACTION		PROTECTIVE EQUIPMENT
	Specific Risk Assessment Required		Goggles/visor/welding screen
	Fire or spark barrier		Apron/fireproof clothing
	Cover hot surfaces		Welding gloves/gauntlets/other:
	Move movable fire hazards, specifically		Wellintons/Knee pads
	Erect screen on barrier		Ear protection: Ear muffs/Ear plugs
	Restrict Access		B.A.: SCBA/Long Breather
	Wet the ground		Respirator: Type:
	Ensure adequate ventilation		Cartridge:
	Provide adequate supports		Local Exhaust Ventilation
	Cover exposed drain/floor or wall cracks		Extinguisher/Fire blanket
	Fire watch (must remain on duty during duration of permit)		Personal flammable gas monitor
	Issue additional permit(s):		

Other precautions:

** Permit will not be issued until these conditions are met.

SIGNATURES

Orginating Employee:	Date:
Project Manager:	Date:
Part 2 Approval:	Date:

ATTACHMENT C

NYSDOH GENERIC COMMUNITY AIR MONITORING PLAN

BENCHMARK

Appendix 1A
New York State Department of Health
Generic Community Air Monitoring Plan

Overview

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate DEC/NYSDOH staff.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. “Periodic” monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or

overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (DEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

3. All readings must be recorded and be available for State (DEC and NYSDOH) and County Health personnel to review.

December 2009

Appendix 1B
Fugitive Dust and Particulate Monitoring

A program for suppressing fugitive dust and particulate matter monitoring at hazardous waste sites is a responsibility on the remedial party performing the work. These procedures must be incorporated into appropriate intrusive work plans. The following fugitive dust suppression and particulate monitoring program should be employed at sites during construction and other intrusive activities which warrant its use:

1. Reasonable fugitive dust suppression techniques must be employed during all site activities which may generate fugitive dust.

2. Particulate monitoring must be employed during the handling of waste or contaminated soil or when activities on site may generate fugitive dust from exposed waste or contaminated soil. Remedial activities may also include the excavation, grading, or placement of clean fill. These control measures should not be considered necessary for these activities.

3. Particulate monitoring must be performed using real-time particulate monitors and shall monitor particulate matter less than ten microns (PM10) with the following minimum performance standards:

(a) Objects to be measured: Dust, mists or aerosols;
(b) Measurement Ranges: 0.001 to 400 mg/m3 (1 to 400,000 :ug/m3);
(c) Precision (2-sigma) at constant temperature: +/- 10 :g/m3 for one second averaging; and +/- 1.5 g/m3 for sixty second averaging;
(d) Accuracy: +/- 5% of reading +/- precision (Referred to gravimetric calibration with SAE fine test dust (mmd= 2 to 3 :m, g= 2.5, as aerosolized);
(e) Resolution: 0.1% of reading or 1g/m3, whichever is larger;
(f) Particle Size Range of Maximum Response: 0.1-10;
(g) Total Number of Data Points in Memory: 10,000;
(h) Logged Data: Each data point with average concentration, time/date and data point number
(i) Run Summary: overall average, maximum concentrations, time/date of maximum, total number of logged points, start time/date, total elapsed time (run duration), STEL concentration and time/date occurrence, averaging (logging) period, calibration factor, and tag number;
(j) Alarm Averaging Time (user selectable): real-time (1-60 seconds) or STEL (15 minutes), alarms required;
(k) Operating Time: 48 hours (fully charged NiCd battery); continuously with charger;
(l) Operating Temperature: -10 to 50^{o} C (14 to 122^{o} F);
(m) Particulate levels will be monitored upwind and immediately downwind at the working site and integrated over a period not to exceed 15 minutes.

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

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

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

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

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

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

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

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

APPENDIX D

COMMUNITY AIR MONITORING PLAN

Appendix 1A
New York State Department of Health
Generic Community Air Monitoring Plan

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(g) Reducing the excavation size and/or number of excavations.

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

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

APPENDIX E

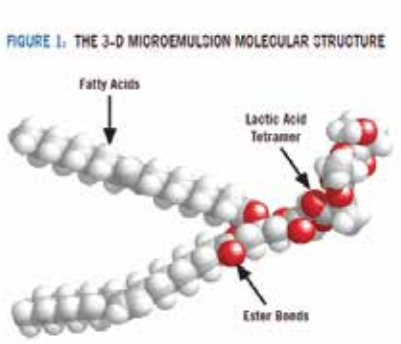
REGENESIS AMENDMENT INFORMATION

3-D Microemulsion® Factory Emulsified Technical Description

3-D Microemulsion (3DME®) is comprised of a patented molecular structure containing oleic acids (i.e., oil component) and lactates/polylactates, which are molecularly bound to one another (figure 1). The 3DME molecule contains both a soluble (hydrophilic) and in-soluble (lipophilic) region. These two regions of the molecule are designed to be balanced in size and relative strength. The balanced hydrophilic/lipophilic regions of 3DME result in an electron donor with physical properties allowing it to initially adsorb to the aquifer material in the area of application, then slowly redistribute via very small 3DME "bundles" called micelles. These 3DME micelles spontaneously form within sections of the aquifer where concentrations of 3DME reach several hundred parts per million. The micelles' small size and mobility allow it to move with groundwater flow through the aquifer matrix, passing easily through the pore throats in between soil grains resulting in the further redistribution of 3DME within the aquifer. This allows for advective distribution of the oleic acids which are otherwise insoluble and unable to distribute in this manner, allowing for increased persistence of the lactate/polylactates component due to their initial attachment to the oleic acids.



Example of 3-D Microemulsion



Due to its patented molecular structure, 3DME offers far greater transport when compared to blended emulsified vegetable oil (EVO) products, which fail to distribute beyond the limits of pumping. 3DME also provides greater persistence when compared to soluble substrates such as lactates or simple sugars. The 3DME molecular structures capitalize on the best features of the two electron-donor types while at the same time, minimize their limitations. 3DME is delivered to the site as a ready-to-apply emulsion that is simply diluted with water to generate a large volume of a 3DME colloidal suspension.

Suspension of 3DME generated by this mixing range from micelles on the order of .02 microns to .05 microns in diameter, to "swollen" micelles, (termed "microemulsions") which are on the order of .05 to 5 microns in diameter. Once injected into the subsurface in high volumes, the colloidal suspension mixes and dilutes in existing pore waters. The micelles/microemulsions on the injection front will then begin to sorb onto the surfaces of soils as a result of zeta potential attraction and organic matter within the soils themselves. As the sorption continues, the 3DME will "coat" pore surfaces developing a layer of molecules and in some cases a bilayer. This sorption process continues as the micelles/microemulsion moves outward and disassociates into their hydrophilic/hydrophobic components. The specialized chemistry of 3DME results in a staged release of electron donors: free lactate (immediate); polylactate esters (mid-range) and free fatty acids & fatty acid esters (long-term). Material longevity of three years or greater has been seen at most sites as determined from biogeochemical analyses.

For a list of treatable contaminants with the use of 3DME, view the Range of Treatable Contaminants Guide

Chemical Composition

- Hydrogen Release Compound Partitioning Electron Donor – CAS #823190-10-9
- Sodium Lactate – CAS# 72-17-3
- Water – CAS# – 7732-18-5

3-D Microemulsion® Factory Emulsified Technical Description

Properties

- Density – Approximately 1.0 grams per cubic centimeter (relative to water)
- pH – Neutral (approximately 6.5 to 7.5 standard units)
- Solubility – Soluble in Water
- Appearance – White emulsion
- Odor – Not detectable
- Vapor Pressure – None
- Non-hazardous

Storage and Handling Guidelines

Storage
Store in original tightly closed container
Store in a cool, dry, well-ventilated place
Store away from incompatible materials
Recommended storage containers: plastic lined steel, plastic, glass, aluminum, stainless steel, or reinforced fiberglass

Handling
Avoid contact with eyes, skin, and clothing
Provide adequate ventilation
Wear appropriate personal protective equipment
Observe good industrial hygiene practices

Applications

- 3DME is diluted with water prior to application. Resulting emulsion has viscosity similar to water.
- Easily injects into formation through direct push injection points, injection wells or other injection delivery systems.

Application instructions for this product are contained here 3DME FE Application Instructions.

Health and Safety

Material is food grade and relatively safe to handle. We recommend avoiding contact with eyes and prolonged contact with skin. OSHA Level D personal protection equipment including vinyl or rubber gloves, and eye protection are recommended when handling this product. Please review the Material Safety Data Sheet for additional storage, usage, and handling requirements here: SDS-3DME FE.

REGENESIS®

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3-D Microemulsion® Installation Instructions

Introduction

3-D Microemulsion® (3DME), a form of HRC Advanced®, should ONLY be applied as a high- volume, microemulsion. In this form it offers greater physical distribution of the 3DME material across a larger potential radius from a single injection point. The production of a 3DME emulsion involves the on-site, volumetric mixing of 10 parts water with 1 part delivered 3DME concentrate to form the injection-ready 3DME. This microemulsion suspension can then be injected directly or further diluted to a predetermined ratio of 3DME to water. The following instructions provide details in the production and installation of 3DME.

Material Overview Handling and Safety

3DME concentrate is shipped and delivered in 4.25-gallon buckets. Each bucket has a gross weight of approximately 32 pounds. Each bucket contains 30 pounds of 3DME concentrate (net weight) and a nominal volume of 3.7 gallons. At room temperature, 3DME concentrate is a liquid material with a viscosity of approximately 500 centipoise, roughly the equivalent of pancake syrup. The viscosity of 3DME is not temperature sensitive above 50 °F (10 °C). However, below 50 °F the viscosity may increase significantly. If the user plans to apply the product in cold weather, consideration should be given to heating the material to above 60 °F so that it can be easily handled. 3DME concentrate should be stored in a warm, dry place that is protected from direct sunlight. It is common for stored 3DME concentrate to settle somewhat in the bucket, a quick pre-mix stir by a hand held drill with a paint or "jiffy mixer" attachment will rapidly re-homogenize the material. 3DME concentrate is non-toxic, however field personnel should take precautions while handling and applying the material. Field personnel should use appropriate personal protection equipment (PPE) including eye protection. Gloves should be used as appropriate based on the exposure duration and field conditions. A Material Safety Data Sheet is provided with each shipment. Personnel who operate field equipment during the installation process should have appropriate training, supervision, and experience and should review the MSDS prior to site operations.

Micro-Emulsion Production 3DME to Water Ratio

3DME concentrate should be mixed with water on a volume to volume (v/v) basis to produce a micro-emulsion starting at 10 parts water: 1 part 3DME. Although microemulsions can be easily produced using greater water volumes than 10 parts, e.g. 20 to 50 parts water to 1 part 3DME, the initial microemulsion should never be produced below a ratio of less than 10 parts water: 1 part 3DME v/v.

WARNING: Do not attempt to produce a microemulsion at less than 10 parts water to 1 part 3DME ratio v/v. This will produce an undesirable and unstable solution. The field production of 3DME is a very simple procedure; however, it is critical that the user follow the mixing directions outlined below. Never attempt to add water to the 3DME as this will produce an undesirable and unstable large emulsion. Always add the 3DME to a large volume of water.

As indicated previously the 10:1 ratio of water to 3DME v/v is the minimum water ratio that can be used, a greater ratio (more dilute solution) can easily be achieved and is governed by: A) the volume of

3DME required to treat the estimated contaminant mass, B) the pore volume in which the material is applied, C) the time available for installation (gallons/pump rate), and C) the estimated volume of 3DME that the target zone will accept over the time period allocated for installation.

Conceptually, although a higher volume of water to volume of 3DME will produce a larger volume of the suspension, it will lower the concentration of 3DME per gallon of solution. Thus, the benefit of using a high water/3DME v/v ratio in order to affect a greater pore volume of the subsurface aquifer is offset by the dilution of the 3DME per unit volume of suspension as well as by the limitations of the subsurface hydraulic conductivity and effective porosity (capacity of the aquifer to accept the volume of 3DME microemulsion).

It is important that the user plan in advance the v/v 3DME/water ratio to be employed at a project site. The resulting volume of solution will dictate the site water requirements and the time required for injection, etc. If upon injection of greater than 10:1 3DME microemulsion, the subsurface does not readily accept the volume of solution as designed, the user can adjust downward the v/v water to 3DME ratio until a more concentrated suspension is produced (this solution should never drop below the required 10 parts water: 1 part 3DME v/v production ratio).

For more information on designing a 3DME/water ratios to meet specific site conditions, please contact REGENESIS Technical Services.

Direct Push Application Requirements

One of the best methods to deliver the 3DME microemulsion into the subsurface is to pressure inject the solution through direct-push rods using hydraulic equipment, or to pressure inject/gravity feed the microemulsion into the dedicated injection wells. The use of low cost push points or temporary injection points allows the applier to more cost effectively distribute the 3DME material across shallow sites by employing multiple points per site. In the case of treating deep aquifer sites, the use of the microemulsion applied via dedicated injection wells is likely to be the most cost effective remediation approach. Please note that this set of instructions is specific to direct-push equipment. Please contact REGENESIS Technical Services to assist you with dedicated injection well applications.

In general, REGENESIS strongly recommends application of the 3DME microemulsion using an injection pump with a minimum delivery rate of three gallons per minute (gpm) and a pressure rating of between 150 to 200 pounds per square inch (psi).

Note: The injection pump requirements are different than the requirements of the mixing pump (see Mixing to Generate 3DME Microemulsion). High pressure, positive displacement pumps and progressive cavity pumps are appropriate for injecting 3DME. For low permeability lithologies (clay, silt) higher pressure pumps (800-1600 psi) may be necessary, while for more permeable lithologies (gravel, sand) a lower pressure pump may be adequate.

Examples of appropriate pumps are: Rupe Models 6-2200, 9-1500 and 9-1600 (positive displacement), Geoprobe® GS- 2000 (positive displacement) and DP-800 (progressive cavity), Yamada (air diaphragm), Moyno (progressive cavity), and Wilden (air diaphragm). Delivery rate is a critical factor in managing installation time and costs. Generally, higher delivery rates (>6 gpm) are more cost effective for these types of applications but pump selection should be on a site specific basis and account for the volume of 3DME solution and specific aquifer conditions present at the site.

The installation of the 3DME microemulsion should span the entire vertical contaminated saturated thickness. If the vertical extent of the application is confined to a limited interval, then the microemulsion should be placed across a vertical zone extending a minimum of one-foot above and one-foot below the screened interval of monitoring wells that are being used to evaluate the performance of the project.

Producing the 3DME Microemulsion

The application of 3DME requires the creation of a microemulsion. Technically the optimal suspension is an 3DME-in-water suspension containing microemulsions. Before beginning the mixing procedure the user should have in mind the desired water to 3DME ratio v/v desired.

It is critical that the microemulsion be produced using a high-shear apparatus such as a high speed centrifugal pump. The shearing provided by the vanes in these types of pumps is sufficient to form and maintain a homogeneous milky emulsion. This pump will be a different pump than that used to inject the 3DME microemulsion into the subsurface. If the user is uncertain as to requirements for the pump or the applicability of a certain pump, please contact REGENESIS Technical Services. REGENESIS typically suggests using a water trailer/pump apparatus commonly found at equipment rental facilities. REGENESIS recommends using a Magnum Products LLC model MWT500 or equivalent water trailer (fitted with centrifugal recirculation pump). This “trash pump” or transfer pump is an ideal high shear pump and the water tank (400 gallons) serves as an excellent mixing tank.

To ensure that proper microemulsion suspension is generated REGENESIS suggests a two-step process that simply requires mixing at least 10 parts water to 1 part 3DME concentrate using water at a temperature ≥ 60 °F.

Step 1. REGENESIS recommends that the 3DME concentrate in each bucket be re- homogenized using a drill equipped with a paint or “jiffy” mixer attachment as minor settling may have occurred during shipment.

Step 2. To calculate the volume of water necessary to produce a 10:1 v/v microemulsion, each bucket of 3DME concentrate containing 3.7 gallons of material should be mixed with 37 gallons of water.

Example: 6 buckets x 3.7 gallons 3DME concentrate/bucket yields a total of 22.2 gallons of 3DME concentrate. Thus, a 10:1 v/v solution will require 222 gallons of water (22.2 gallons 3DME concentrate x 10 gallons water yields 222 gallons of water). A nominal total volume microemulsion would result from the summation of the 3DME concentrate volume (22.2 gallons) and the water volume (222 gallons). This yields a total fluids delivery volume of approximately 244 gallons.

The previously calculated water volume (222 gallons) should be transferred into an appropriately sized mixing tank. The water should be circulated by the high shear centrifugal pump and each of the six 3DME buckets slowly poured into the tank. Each bucket of 3DME concentrate should be poured at a slow rate (approx. 1 minute per bucket) and the contents of the tank continually recirculated using the high hear centrifugal pump. A period of 1-2 minutes should be allowed between addition of each subsequent bucket of 3DME concentrate to allow the centrifugal pump to continue to shear and mix the water/3DME concentrate. Upon addition of the entire volume of 3DME concentrate the pump

should remain on to allow the solution mixture to recirulate. The recirculation of the 3DME microemulsion should continue until the material is injected to maintain microemulsion consistency.

Application of microemulsion Using Direct-Push Methods

1. Prior to the installation of the microemulsion, any surface or overhead impediments should be identified as well as the location of all underground structures. Underground structures include but are not limited to: utility lines, tanks, distribution piping, sewers, drains, and landscape irrigation systems.
2. Planned installation locations should be adjusted to account for all impediments and obstacles.
3. Pre-mark the installation locations, noting any points that may have different vertical application requirements or total depth.
4. Set up the direct-push unit over each specific point and follow the manufacturer's standard operating procedures (SOP). Care should be taken to assure that probe holes remain vertical.
5. For most applications, REGENESIS suggests using drive rods with an O.D. of at least 1.25-inches and an I.D. of at least 0.625-inches I.D (Geoprobe or equivalent). However, the lithologic conditions at some sites may warrant the use of larger 2.125-inch O.D./1.5-inch I.D. drive rods.
6. The most typical type of sub-assembly currently being used is designed for 1.25-inch direct-push rods and is manufactured by Geoprobe. Other brands of drive rods can also be used but require the fabrication of a sub-assembly that allows for a connection between the pump and drive rod.
7. For mixing large volumes of the microemulsion, REGENESIS recommends using a Magnum Products LLC model MWT500 water trailer (fitted with centrifugal recirculation pump) or equivalent unit. However, single large volume poly tanks are adequate. We suggest filling the tank with an appropriate quantity (e.g. from the example above 222 gallons) of water before start of mixing operations. The tank should be configured so that both a hose and a fire hydrant or larger water tank can be connected to it simultaneously and filled with water quickly and easily. This will dramatically reduce the time needed to fill the tank with mixing water.
8. REGENESIS highly recommends preparing the microemulsion before pushing any drive rods into the subsurface. NOTE: best if the microemulsion is produced a single day application volumes.
9. After the microemulsion mixing/shearing step has been completed as described above, the microemulsion is ready to be applied. Check to see if a hose has already been attached to the inlet side of the centrifugal pump. If this has not been done, do so now.
10. If a non-water trailer tank is being used for mixing the microemulsion a stand alone centrifugal pump and hose system should be used for the shearing and mixing operations.
11. Advance drive rods through the ground surface, as necessary, following SOP.
12. Push the drive rod assembly with an expendable tip to the desired maximum depth. REGENESIS suggests pre-counting the number of drive rods needed to reach depth prior to starting injection activities to avoid any miscalculations.
13. After the drive rods have been pushed to the desired depth, the rod assembly should be withdrawn three to six inches. The expendable tip can be dropped from the drive rods, following SOP.
14. If an injection tool is used instead of a direct-push rod with an expendable tip, the application of material can take place without any preliminary withdrawal of the rods.
15. In some cases, introduction of a large column of air may be problematic. This is particularly the case in deep injections (>50 ft) with large diameter rods (>1.5-inch O.D.). To prevent the injection of air into the aquifer during the application, fill the drive rods with 3DME emulsion after they have been pushed to the desired depth and before the disposable tip has been dropped or before the injection tip is operational.

16. Transfer the appropriate quantity of the microemulsion from the water trailer to the working/ application pump hopper or associated holding tank.
17. A volume check should be performed prior to the injection of the microemulsion. Determining the volume discharged per unit time/stroke using a graduated bucket and stopwatch or stroke counter.
18. Start the pump and use the graduated bucket to determine how many gallons of micro- emulsion are delivered each minute or stroke per unit volume.
19. Connect the 1.25-inch O.D., 1-inch I.D. delivery hose to the pump outlet and the appropriate sub-assembly. Circulate the microemulsion through the hose and the sub-assembly to displace any air present in the system.
20. Connect the sub-assembly to drive rod. After confirming that all of the connections are secure, pump the microemulsion through the delivery system to displace water or other fluids in the rods.
21. The pump engine RPM and hydraulic settings should remain constant throughout the day to maintain a constant discharge rate.
22. The material is now ready to be installed in the subsurface. Use the pumps discharge rate as calculated in step 18 to determine the withdrawal rate of the drive rods needed for the application.
23. Slowly withdraw the drive rods using Geoprobe Rod Grip or Pull Plate Assembly (Part AT1222-For 1.25-inch drive rods). While slowly withdrawing single lengths of drive rod (3 or 4 feet), pump the pre-determined volume of microemulsion into the aquifer across the desired treatment interval.
24. Remove one or two sections of the drive rod at a time. The drive rod may contain some residual material, REGENESIS suggests placing it in a clean, empty bucket and allowing the material to drain. Eventually, the material recovered in the bucket should be returned to pump hopper for reuse.
25. Observe any indications of aquifer refusal such as “surfacing” around the injection rods or previously installed injection points. If aquifer acceptance appears to be low, allow enough time for the aquifer to equilibrate prior to removing the drive rod.
26. Repeat steps 19-25 until treatment of the entire contaminated vertical zone has been achieved.
27. Install an appropriate seal, such as bentonite, above the microemulsion injection zone. The seal should span across the entire vadose zone. Depending on soil conditions and local regulations, a bentonite seal using chips or pellets can be used. If the injection hole remains open more than three or four feet below the ground surface sand can be used to fill the hole and provide a base for the bentonite seal. The installation of an appropriate seal assures that the microemulsion remains properly placed and prevents contaminant migration from the surface. If the microemulsion continues to “surface” up the direct-push borehole, an oversized disposable drive tip or wood plug/stake can be used to temporarily plug the hole until the aquifer equilibrates and the material stops surfacing.
28. Remove and clean the drive rods as necessary.
29. Finish the borehole at the surface as appropriate (concrete or asphalt cap, if necessary).
30. Periodically compare the pre- and post-injection discharge rates of the microemulsion in the pump hopper or holding tank using any pre-marked volume levels. If volume level indicators are not on the pumps hopper or holding tank use a pre-marked dipstick or alternatively temporary mark the hopper or holding tank with known quantities/volumes of water using a carpenter’s grease pencil (Kiel crayon).
31. Move to the next probe point, repeating steps 11-29.

Helpful Hints

1. Application in Cold Weather Settings

As discussed in the Material Overview, Handling, and Safety section, cold weather tends to increase the viscosity of 3DME as well as decrease the ease of microemulsion formation.

To optimize an application in cold weather settings REGENESIS recommends maintaining the 3DME concentrate and the associated water at a temperature ≥60oF (16oC). The following procedures can be used to facilitate the production and installation of a 10:1 v/v 3DME microemulsion.

- Raise and maintain the temperature of the HRC-A to at least 60 °F (16 °C) prior to mixing with water. A hot water bath can be used to heat up the 3DME concentrate buckets. A Rubbermaid fiberglass Farm Trough Stock Tank (Model 4242-00-GRAY) has been used for this process. This trough can hold up to 16 buckets of 3DME concentrate.
- Hot water (approximately 130-170 °F or 54-77 °C) should be added to the tank after the buckets of 3DME have been placed inside. The hot water should be delivered from a heated pressure washer (Hotsy® Model No. 444 or equivalent) or steam cleaner unit.
- It is equally critical that a moderate water temperature (>60 °F or 16°C) be used in the production of the microemulsion. If on-site water supply is below 60 °F use a hot water or steam cleaner to generate a small volume (e.g. 5-10% of total water volume) of hot water (130–170 °F/54-77 °C). This small volume of hot water should be added to remaining cold water volume to raise the total volume temperature to >60 °F. When the 3DME concentrate and water each reach a minimum temperature of 60 °F or 16 °C the two materials are ready for mixing.
- Upon achieving a minimum temperature of 60 °F or 16 °C (approximately 10-20 minutes). When the 3DME and the associated water volumes have reached a minimum temperature of 60 °F or 16 °C (approximately 10-20 minutes) they are ready for mixing.
- In exceptionally harsh winter temperature settings use of a separate insulated pump containment structure and insulated delivery hoses may be necessary.
- Use a pump with a heater unit.
- Periodically check the temperature of the material in the hopper.
- Re-circulate the 3DME microemulsion through the pump and hose to maintain temperature adequate temperatures.
- Care should be taken to avoid the re-circulation of material volumes that exceed the volume of the pump hopper or holding tank.

Table 1: Equipment Volume and 3DME microemulsion Weight per Unit Length of Hose (Feet)

Equipment	Volume	Product Weight
1-inch OD; 0.625-inch ID hose (10 feet)	0.2 gallon	1.6 lbs.
1.25-inch OD; 0.625-inch ID drive rod (3 feet):	0.05 gallon	0.4 lbs.
1.25-inch OD; 0.625-inch ID drive rod (4 feet):	0.06 gallon	0.5 lbs.

2. Pump Cleaning

For best results, use a heated pressure washer to clean equipment and rods periodically throughout the day. Internal pump mechanisms and hoses can be easily cleaned by re-circulating a solution of hot water and a biodegradable cleaner such as Simple Green through the pump and delivery hose. Further cleaning and decontamination (if necessary due to subsurface conditions) should be performed according to the equipment supplier's standard procedures and local regulatory requirements.

Note: Before using the Rupe Pump, check the following:

- Fuel level prior to engaging in pumping activities (it would be best to start with a full tank)
- Remote control/pump stroke counter LCD display [if no display is present, the electronic counter will need to be replaced (Grainger Stock No. 2A540)]
- Monitor pump strokes by observing the proximity switches (these are located on the top of the piston).

3. Bedrock Applications

When contaminants are present in competent bedrock aquifers, the use of direct-push technology as a delivery method is not possible. REGENESIS is in the process of developing methods for applying 3DME via boreholes drilled using conventional rotary techniques. To develop the best installation strategy for a particular bedrock site, it is critical that our customers call the Technical Services department at REGENESIS early in the design process.

The microemulsion can be applied into a bedrock aquifer in cased and uncased boreholes. The microemulsion can be delivered by simply filling the borehole without pressure or by using a single or straddle packer system to inject the material under pressure. Selection of the appropriate delivery method is predicated on site-specific conditions. The following issues should be considered in developing a delivery strategy:

- Is the aquifer's hydraulic conductivity controlled by fractures?
- Backfilling may be the better delivery method in massive, unfractured bedrock. This is particularly true in an aquifer setting with high permeability and little fracturing (such as that found in massive sandstone).
- Down-hole packer systems may be more advantageous in fractured bedrock aquifers.
- In this case the fracture type, trends, and interconnections should be evaluated and identified.
- Are the injection wells and monitoring wells connected by the same fractures?
- Determine if it is likely that the injection zone is connected to the proposed monitoring points.
- If pressure injection via straddle packers is desired, consideration should be given to the well construction. Specific issues to be considered are:
- Diameter of the uncased borehole (will casing diameter allow a packer system to be used under high pressures?).
- Diameter of the casing (same as above).
- Strength of the casing (can it withstand the delivery pressures?).
- Length of screened interval (screened intervals greater than 10 feet will require a straddle packer system).

For further assistance or questions please contact REGENESIS Technical Services at 949.366.8000

REGENESIS
Technology-Based Solutions for the Environment

SAFETY DATA SHEET

1. Identification

Product identifier **3-D Microemulsion®**

Other means of identification None.

Recommended use Remediation of soils and groundwater.

Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Company Name Regenesis

Address 1011 Calle Sombra
San Clemente, CA 92673

Telephone 949-366-8000

E-mail CustomerService@regenesis.com

Emergency phone number CHEMTREC® at 1-800-424-9300 (International)

2. Hazard(s) identification

Physical hazards Not classified.

Health hazards

Skin corrosion/irritation	Category 2
Serious eye damage/eye irritation	Category 1

OSHA defined hazards Not classified.

Label elements



Signal word Danger

Hazard statement Causes skin irritation. Causes serious eye damage.

Precautionary statement

Prevention Wash thoroughly after handling. Wear protective gloves. Wear eye/face protection.

Response If on skin: Wash with plenty of water. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. If skin irritation occurs: Get medical advice/attention. Take off contaminated clothing and wash before reuse.

Storage Store away from incompatible materials.

Disposal Dispose of waste and residues in accordance with local authority requirements.

Hazard(s) not otherwise classified (HNOC) None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
HRC-PED	823190-10-9	48-53
Fatty Acids (neutralized)	61790-12-3 or 112-80-1	30-35
Glycerol Tripolylactate	201167-72-8	<10

Composition comments All concentrations are in percent by weight unless otherwise indicated.

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Remove contaminated clothing. Wash with plenty of soap and water. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.
Ingestion	Rinse mouth. Never give anything by mouth to a victim who is unconscious or is having convulsions. Do not induce vomiting without advice from poison control center. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Skin irritation. May cause redness and pain.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO2). Dry chemical powder. Foam.
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed. Combustion products may include: carbon oxides, phosphorus compounds and metal oxides.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk. Water spray should be used to cool containers.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.
General fire hazards	No unusual fire or explosion hazards noted.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Surfaces may become slippery after spillage. Wear appropriate protective equipment and clothing during clean-up. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Spilled product may create a slipping hazard. The product is immiscible with water and will spread on the water surface. Large Spills: Stop the flow of material, if this is without risk. Use water spray to reduce vapors or divert vapor cloud drift. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water. Flush area clean with lots of water. Be aware of potential for surfaces to become slippery. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Do not get this material in contact with eyes. Avoid contact with eyes, skin, and clothing. Provide adequate ventilation. Wear appropriate personal protective equipment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in original tightly closed container. Store in a cool, dry, well-ventilated place. Store away from incompatible materials (see Section 10 of the SDS). Recommended storage containers: plastic lined steel, plastic, glass, aluminum, stainless steel, or reinforced fiberglass.

8. Exposure controls/personal protection

Occupational exposure limits	No exposure limits noted for ingredient(s).
Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.
Individual protection measures, such as personal protective equipment	
Eye/face protection	Wear approved, tight fitting indirect vented or non-vented safety goggles where splashing is probable. Face shield is recommended.
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Rubber or vinyl-coated gloves are recommended.
Other	Wear appropriate chemical resistant clothing.
Respiratory protection	If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	
Physical state	Liquid.
Form	Semi-solid.
Color	Amber.
Odor	Odorless.
Odor threshold	Not available.
pH	Not available.
Melting point/freezing point	Not available.
Initial boiling point and boiling range	Not available.
Flash point	> 200.0 °F (> 93.3 °C) Closed Cup
Evaporation rate	Not available.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Relative density	0.9 - 1.1
Solubility(ies)	
Solubility (water)	Insoluble.
Solubility (other)	Slightly soluble in acetone.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Undergoes hydrolysis in water to form lactic acid, glycerol and fatty acids.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong oxidizing agents. Bases. Acids.
Hazardous decomposition products	Thermal decomposition or combustion may produce: carbon oxides, phosphorus compounds, metal oxides.

11. Toxicological information

Information on likely routes of exposure

Inhalation	May cause irritation to the respiratory system.
Skin contact	Causes skin irritation.
Eye contact	Causes serious eye damage.
Ingestion	Ingestion may cause irritation and malaise.
Symptoms related to the physical, chemical and toxicological characteristics	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Skin irritation. May cause redness and pain.

Information on toxicological effects

Acute toxicity	Not available.
Skin corrosion/irritation	Causes skin irritation.
Serious eye damage/eye irritation	Causes serious eye damage.

Respiratory or skin sensitization

Respiratory sensitization	Not a respiratory sensitizer.
Skin sensitization	This product is not expected to cause skin sensitization.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity	This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	Not an aspiration hazard.

12. Ecological information

Ecotoxicity	The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.
Persistence and degradability	Material is readily degradable and undergoes hydrolysis in several hours.
Bioaccumulative potential	No data available.
Mobility in soil	The product is immiscible in water.
Other adverse effects	None known.

13. Disposal considerations

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Hazardous waste code	The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not established.

15. Regulatory information

US federal regulations

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
One or more components are not listed on TSCA.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - Yes Delayed Hazard - No Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical	Yes

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA)	Not regulated.

US state regulations

US. Massachusetts RTK - Substance List

Not regulated.

US. New Jersey Worker and Community Right-to-Know Act

Not listed.

US. Pennsylvania Worker and Community Right-to-Know Law

Fatty Acids (neutralized) (CAS 61790-12-3 or 112-80-1)

US. Rhode Island RTK

Not regulated.

US. California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 22-April-2015

Revision date -

Version # 01

Further information HMIS® is a registered trade and service mark of the American Coatings Association (ACA).

HMIS® ratings Health: 3
Flammability: 1
Physical hazard: 0

NFPA ratings



Disclaimer Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

S-MicroZVI Specification Sheet

S-MicroZVI Technical Description



S-MicroZVI™ is an *In Situ* Chemical Reduction (ISCR) reagent that promotes the destruction of many organic pollutants and is most commonly used with chlorinated hydrocarbons. It is engineered to provide an optimal source of micro-scale zero valent iron (ZVI) that is both easy to use and delivers enhanced reactivity with the target contaminants via multiple pathways. S-MicroZVI can destroy many chlorinated contaminants through a direct chemical reaction (**see Figure 1**). S-MicroZVI will also stimulate anaerobic biological degradation by rapidly creating a reducing environment that is favorable for reductive dechlorination.

S-MicroZVI is Best in Class For

- ☑ Longevity
- ☑ Kinetics
- ☑ Transport

Sulfidated ZVI

S-MicroZVI is composed of colloidal, sulfidated zero-valent iron particles suspended in glycerol using proprietary environmentally acceptable dispersants. The passivation technique of sulfidation, completed using proprietary processing methods, provides unparalleled reactivity with chlorinated hydrocarbons like PCE and TCE and increases its stability and longevity by minimizing undesirable side reactions. In addition to superior reactivity, S-MicroZVI is designed for easy handling that is unmatched by any ZVI product on the market. Shipped as a liquid suspension, S-MicroZVI requires no powder feeders, no thickening with guar, and pneumatic or hydraulic fracturing is not mandatory. When diluted with water prior to application, the resulting suspension is easy to inject using either direct push or permanent injection wells.

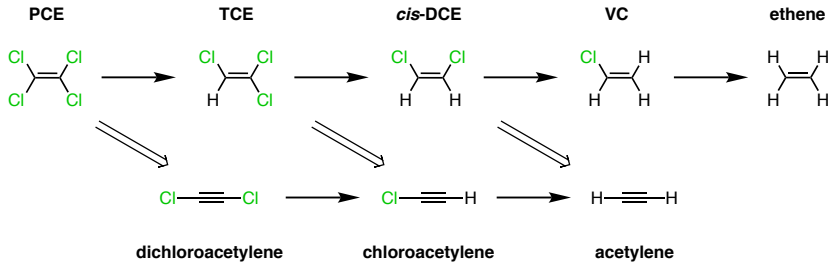


Figure 1: *Chlorinated ethene degradation pathways and products. The top pathway with single line arrows represent the reductive dechlorination (hydrogenolysis) pathway. The lower pathway with downward facing double line arrows represent the beta-elimination pathway.*

To see a list of treatable contaminants, view the S-MicroZVI treatable contaminants guide.

S-MicroZVI
Sulfidated Zero-Valent Iron

S-MicroZVI Specification Sheet

Chemical Composition

Iron, powders CAS 7439-89-6
Iron (II) sulfide CAS 1317-37-9
Glycerol CAS 56-81-8

Properties

Physical State: Liquid
Form: Viscous metallic suspension
Color: Dark gray
Odor: Slight
pH: Typically 7-9 as applied
Density: 15 lb/gal

Storage and Handling Guidelines

Storage:

- Use within four weeks of delivery
- Store in original containers
- Store at temperatures below 95F°
- Store away from incompatible materials

Handling:

- Never mix with oxidants or acids
- Wear appropriate personal protective equipment
- Do not taste or swallow
- Observe good industrial hygiene practices

Applications

S-MicroZVI is diluted with water on site and easily applied into the subsurface through low-pressure injections. S-MicroZVI can also be mixed with products like 3-D Microemulsion® or PlumeStop® prior to injection.

Health and Safety

The material is relatively safe to handle; however, avoid contact with eyes, skin and clothing. OSHA Level D personal protection equipment including: vinyl or rubber gloves and eye protection are recommended when handling this product. Please review the Safety Data Sheet for additional storage, and handling requirements here: S-MicroZVI SDS.

REGENESIS®

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Application Instructions

S-MicroZVI™ is a remediation amendment engineered for the *in situ* chemical reduction of chlorinated contaminants. The product features zero valent iron particles that are less than 5 microns in size and are suspended in a glycerol carrier. These materials are strong reductants and should never be combined with acids or oxidizers (see Health and Safety section).

S-MicroZVI Composition

40% sulfidated colloidal ZVI
45% food grade glycerol
15% water-based carrier

Physical Characteristics

Appearance: Dark gray viscous liquid
Viscosity: About 5000 cP (temperature dependent)
Density: 15 lb/gal

Helpful Chemical Property Measurements

The following solution characteristics measurements were obtained on a suspension mixture comprise of 4000 mg/L activated carbon from PlumeStop and 4000 mg/L zero valent iron from S-MicroZVI.

pH = 8.7
ORP = -492 mV
Conductivity = 2.36 mS/cm

Best Practices

Material Handling: S-MicroZVI is packaged in 50 lb buckets, 500 lb drums and 3000 lb totes. Use care/assistance if moving a tote with a pallet jack. A double diaphragm pump should be used to transfer S-MicroZVI from drums and totes into the mixing tank. Centrifugal drum pumps and dosing or metering pumps are not recommended due to the high viscosity of the material. Because of the low mass of S-MicroZVI typically required in the mixing tank, a bucket or similar container should be used to batch the ZVI material by weight or volume.

Mixing: S-MicroZVI should be homogenized in its packaging container before adding it into the mixing tank. Pails of S-MicroZVI are best mixed using a hand drill equipped with a paint mixer attachment. Totes and drums of S-MicroZVI should be mixed to a homogeneous consistency at the start of each application day using a 4 ft paint mixer attachment. As with all remedial reagents, it is a best practice to make sure the entire drum/tote is well mixed – including corners & bottom - before transferring into the mixing tank.

Mixing Order: Whenever S-MicroZVI is co-applied with other remedial reagents (PlumeStop®, 3D Microemulsion®, pH modifiers, etc.), the order of addition should be as follows:

1) Water
2) Other amendments (PlumeStop®, 3DME, etc.)
3) S-MicroZVI

Mix Tank: A conical tank less than 500 gal is recommended for batching. It should be equipped with a mixer than has enough power to gently agitate the mixture. The goal is to keep solids suspended without overly aerating the material.

Cleaning: Always thoroughly rinse all S-MicroZVI containers before disposal. Rinse water from this step should be placed into the mixing tank for application. Inspect tanks for any residue of reagents that were recently used in the tank. If there is any evidence rinse tank thoroughly. A thorough cleaning step should be performed at the end of each work day. This should be accomplished by flushing the entire injection system with municipal water.

Health & Safety

Risk Potential, Hydrogen Sulfide: S-MicroZVI will give off hydrogen sulfide (H2S) gas when exposed to acid. For this reason, it is imperative that low pH (acid) solutions NOT come into contact with solutions containing S-MicroZVI.

In the interest of safety, a hydrogen sulfide detector should be part of every S-MicroZVI application program.

S-MicroZVI™
Sulfidated Zero-Valent Iron

Hydrogen sulfide is toxic, corrosive, and flammable. The threshold of odor detection for hydrogen sulfide is approximately 0.0005 ppm; however, at higher concentrations hydrogen sulfide will suppress the olfactory senses. For this reason, one's sense of smell is not a reliable method of detection, and failure to rely on a hydrogen sulfide detector can lead to overexposure and potentially death. The OSHA Permissible Exposure Limit for an 8-hour timeweighted average is 10 ppm, and hydrogen sulfide is classified as Immediately Dangerous to Life and Health at 100 ppm. With proper handling, no detectable hydrogen sulfide will be produced by S-MicroZVI.

Do not mix S-MicroZVI with acid, this includes HRC or HRC Primer.

- Adding acid to S-MicroZVI can cause hydrogen sulfide to be produced for many hours. If hydrogen sulfide is being produced, work must stop.

Do not combine S-MicroZVI with any oxidizing agent (PersulfOx®, RegenOx®, etc.)

- S-MicroZVI is a strong reductant. Combining
- S-MicroZVI with oxidizers will cause a vigorous exothermic reaction and has the potential to produce hydrogen sulfide.

Preferred Storage Conditions: S-MicroZVI should be stored in cool, dry places if possible. Indoor storage is preferred – if this is not available, seek a covered or shaded spot outdoors.

Shelf Life:** S-MicroZVI should be used within 4 weeks of arrival onsite.

** Shelf life may decrease with extreme temperatures. For situations where prolonged temperature may exceed 90F we advise to use the product as soon as possible. Small amounts of hydrogen gas may evolve from the material during storage. For this reason, buckets, drums, and totes are vented.

Handling Practices: Standard PPE should be used when handling S-MicroZVI. This includes eye protection, gloves and face shield when mixing.

There are some specific characteristics to keep in mind for these materials:

Density: A half-full pail may be heavier than it appears, use care when lifting.
Cleanliness: This product will stain clothes.
Slip concerns: S-MicroZVI can be very slick if spilled. In the event of a spill, use caution as the floor may be very slippery.

Do's & Don'ts

Do	Don't
✓ Use a diaphragm pump to transfer S-MicroZVI from totes or drums.	✗ Use dose pumps, drum pumps, etc. to transfer S-MicroZVI.
✓ Use a bucket or graduated vessel to measure S-MicroZVI for the mixing tank from totes or drums.	✗ Store product below 30 degrees to avoid thickening.
✓ Rinse each mix tank at the end of the day to prevent excess buildup of ZVI solids.	✗ Use buckets that contained RegenOx®, PersulfOx®, HRC®, or HRC Primer.
✓ Use tap water for rinsing and cleaning.	✗ Leave suspensions containing S-MicroZVI in the mixing tank overnight or for an excess period (4-5 hours).
✓ Inject the equivalent of a 7-borehole volume of clear water into injection wells and any affected monitoring well upon completion of the injection program.	✗ Ever add acid or oxidizers to S-MicroZVI.
✓ BDI Plus™ and S-MicroZVI are compatible. Apply BDI Plus as typical.	✗ Use sodium bisulfite or other oxygen scavengers. These are unnecessary with S-MicroZVI.
✓ Use pails of S-MicroZVI within 2-3 days of opening.	✗ Use partial pails of S-MicroZVI that were opened for a previous site.
✓ Use standard PPE when using S-MicroZVI. This includes safety glasses, face shield, and gloves.	✗ When batching, add more than 50lb. of total suspension to pails

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REGENESIS
Technology-Based Solutions for the Environment

SAFETY DATA SHEET

1. Identification

Product identifier	**S-MicroZVI or S-MZVI**
Other means of identification	None.
Recommended use	Remediation of contaminants in soil and groundwater.
Recommended restrictions	None known.

Manufacturer/Importer/Supplier/Distributor information

Company Name	Regenesis
Address	1011 Calle Sombra San Clemente, CA 92673 USA
General information	949-366-8000
E-mail	CustomerService@regenesis.com

Emergency phone number	For Hazardous Materials Incidents ONLY (spill, leak, fire, exposure or accident), call CHEMTREC 24/7 at:
USA, Canada, Mexico	1-800-424-9300
International	1-703-527-3887

2. Hazard(s) identification

Physical hazards	Not classified.
Health hazards	Not classified.
OSHA defined hazards	Not classified.

Label elements

Hazard symbol	None.
Signal word	None.
Hazard statement	The mixture does not meet the criteria for classification.
Precautionary statement	
Prevention	Observe good industrial hygiene practices.
Response	Wash hands after handling.
Storage	Store away from incompatible materials.
Disposal	Dispose of waste and residues in accordance with local authority requirements.
Hazard(s) not otherwise classified (HNOC)	None known.
Supplemental information	Contact with acids liberates very toxic gas.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Glycerol	56-81-5	40 - 50
Zero valent iron	7439-89-6	30 - 50
Iron(II) sulfide	1317-37-9	1 - 4

Composition comments All concentrations are in percent by weight unless otherwise indicated.
Components not listed are either non-hazardous or are below reportable limits.

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Wash off with soap and water. Get medical attention if irritation develops and persists.

Eye contact	Rinse with water. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Direct contact with eyes may cause temporary irritation.
Indication of immediate medical attention and special treatment needed	Treat symptomatically.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	None known.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed. Combustion products may include: carbon oxides, iron oxides.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.
General fire hazards	This material will not burn until the water has evaporated. Residue can burn. When dry may form combustible dust concentrations in air.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Avoid prolonged exposure. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
Glycerol (CAS 56-81-5)	PEL	5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.

Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear safety glasses with side shields (or goggles).

Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Suitable gloves can be recommended by the glove supplier.
Skin protection	
Other	Wear suitable protective clothing.
Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	
Physical state	Liquid.
Form	Viscous metallic suspension.
Color	Dark gray
Odor	Slight.
Odor threshold	Not available.
pH	7 - 8 (When mixed with water) 10 (As shipped)
Melting point/freezing point	Not available.
Initial boiling point and boiling range	Not available.
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Relative density	Not available.
Solubility(ies)	
Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	3000 cP (77 °F (25 °C))
Other information	
Explosive properties	Not explosive.
Oxidizing properties	Not oxidizing.

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	Contact with acids will release highly flammable and highly toxic hydrogen sulfide gas. Can react with some acids with the evolution of hydrogen.
Conditions to avoid	Contact with incompatible materials. Avoid drying out product. May generate combustible dust if material dries.
Incompatible materials	Strong oxidizing agents. Acids.

Hazardous decomposition products No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation Spray mist may irritate the respiratory system. For dry material: Dust may irritate respiratory system.

Skin contact Prolonged or repeated exposure may cause minor irritation.

Eye contact Direct contact with eyes may cause temporary irritation.

Ingestion May cause discomfort if swallowed.

Symptoms related to the physical, chemical and toxicological characteristics Direct contact with eyes may cause temporary irritation.

Information on toxicological effects

Acute toxicity Not expected to be acutely toxic.

Components	Species	Test Results
Glycerol (CAS 56-81-5)		
Acute		
Dermal		
LD50	Rabbit	> 18700 mg/kg
Oral		
LD50	Rat	27200 mg/kg

Skin corrosion/irritation Prolonged skin contact may cause temporary irritation.

Serious eye damage/eye irritation Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity Not classifiable as to carcinogenicity to humans.

IARC Monographs. Overall Evaluation of Carcinogenicity

Not listed.

NTP Report on Carcinogens

Not listed.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not regulated.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

Further information Contains an ingredient known to produce adverse effects in a small percentage of hypersensitive individuals exhibited as respiratory distress and allergic skin reactions.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Components		Species	Test Results
Glycerol (CAS 56-81-5)			
Aquatic			
Acute			
Crustacea	EC50	Daphnia magna	> 10000 mg/l, 24 Hours

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential No data available.

Partition coefficient n-octanol / water (log Kow)

Glycerol (CAS 56-81-5)	-1.76

Mobility in soil No data available.

Other adverse effects None known.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not established.

15. Regulatory information

US federal regulations This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

SARA 304 Emergency release notification

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not regulated.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical No

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

FEMA Priority Substances Respiratory Health and Safety in the Flavor Manufacturing Workplace

Glycerol (CAS 56-81-5)	Other Flavoring Substances with OSHA PEL's

US state regulations

US. Massachusetts RTK - Substance List

Glycerol (CAS 56-81-5)

US. New Jersey Worker and Community Right-to-Know Act

Glycerol (CAS 56-81-5)

US. Pennsylvania Worker and Community Right-to-Know Law

Glycerol (CAS 56-81-5)

US. Rhode Island RTK

Glycerol (CAS 56-81-5)

California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 2016 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins. For more information go to www.P65Warnings.ca.gov.

US. California. Candidate Chemicals List. Safer Consumer Products Regulations (Cal. Code Regs, tit. 22, 69502.3, subd. (a))

Zero valent iron (CAS 7439-89-6)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 27-December-2018

Revision date -

Version # 01

HMIS® ratings Health: 1
Flammability: 1
Physical hazard: 0

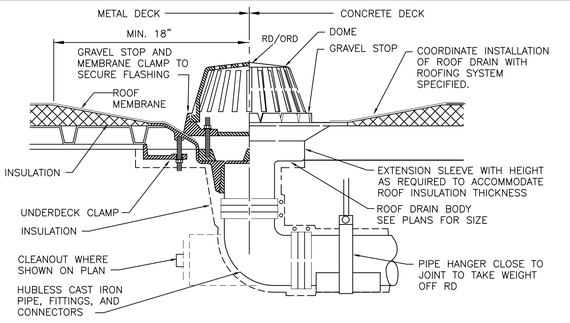
NFPA ratings



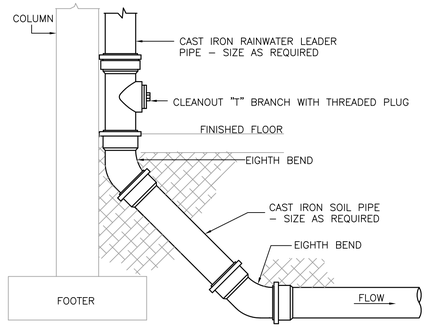
Disclaimer Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

APPENDIX F

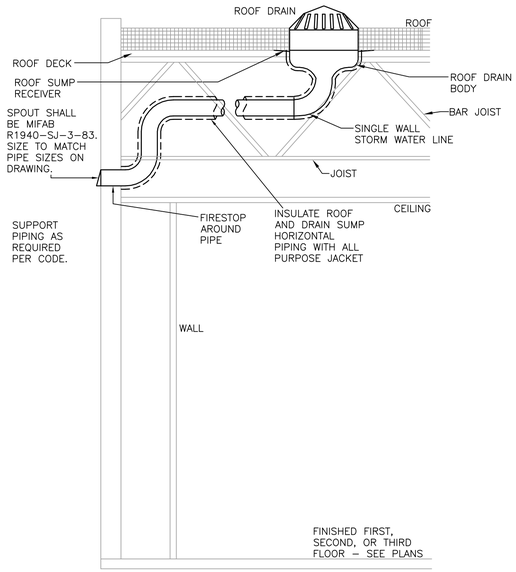
REDEVELOPMENT DRAWINGS



UNDERDECK CLAMP AND SUMP RECEIVER ARE NOT REQUIRED WHEN ROOF DRAIN BODY IS CAST INTO CONCRETE ROOF. INSTALL PER MANUFACTURER'S RECOMMENDATIONS. INSULATE ROOF DRAIN SUMP AND PIPE PER SPECIFICATIONS. LOCATE DRAINS WHERE SHOWN ON ARCHITECTURAL PLANS – VERIFY WITH STRUCTURAL PLANS FOR ROOF LOW POINTS. COORDINATE WITH ROOFING CONTRACTOR. REFER TO STRUCTURAL DRAWINGS AND COORDINATE THEREWITH IF REQUIRED FOR SUPPLEMENTARY STEEL AROUND ROOF OPENING. PLUMBING CONTRACTOR SHALL CUT HOLE IN ROOF AND SET ROOF DRAIN. ROOFING CONTRACTOR WILL SECURE FLASHING AND PATCH ROOFING AROUND ROOF DRAIN.



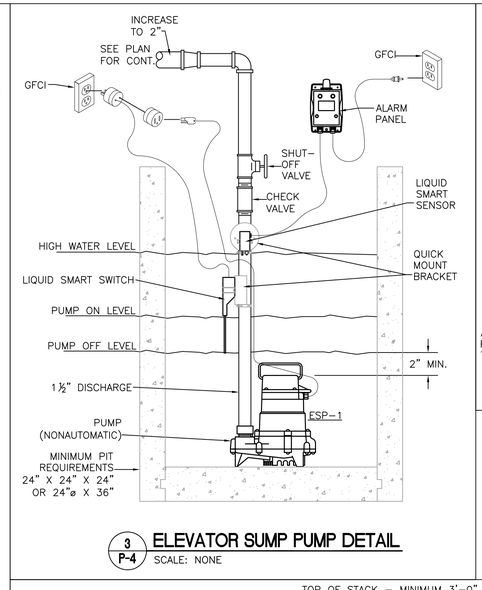
1 P-4 ROOF DRAIN + LEADER DETAIL
SCALE: NONE



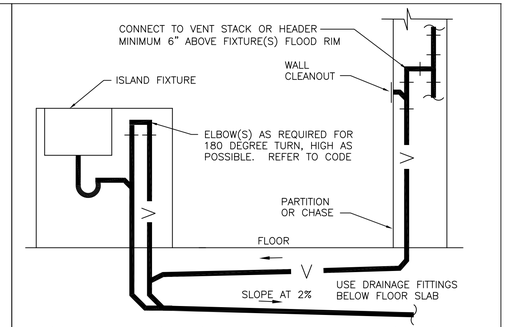
PIPING TO BE RUN IN WORK AREA TRUSS SPACE – COORDINATE WITH VARYING TRUSS SIZE (PER STRUCTURAL DRAWINGS), MECHANICAL WORK, ELECTRICAL WORK, FIRE PROTECTION WORK, AND OTHER PLUMBING WORK.

SHOULD THE PIPING NOT BE ABLE TO BE RUN IN TRUSS SPACE – COORDINATE FINAL SPOUT LOCATION WITH VARYING CEILING HEIGHTS (PER ARCHITECTURAL DRAWINGS), MECHANICAL WORK, ELECTRICAL WORK, FIRE PROTECTION WORK, AND OTHER PLUMBING WORK.

2 P-4 OVERFLOW ROOF DRAIN DETAIL
SCALE: NONE

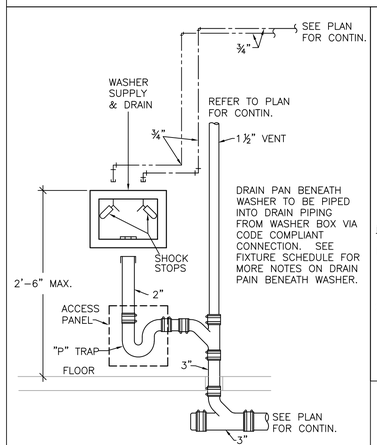


3 P-4 ELEVATOR SUMP PUMP DETAIL
SCALE: NONE

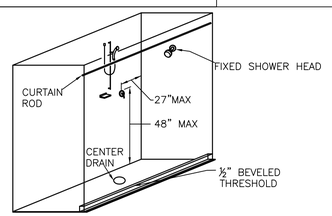


ARRANGEMENT SHOWN IS SCHEMATIC. ADJUST AS REQUIRED TO SUIT ACTUAL CONDITIONS. REFER TO FLOOR PLANS. PROVIDE SIMILAR SEPARATE SYSTEM FOR EACH FIXTURE. REFER TO LOCAL CODE FOR OTHER INFORMATION.

4 P-4 ISLAND FIXTURE DETAIL
SCALE: NONE



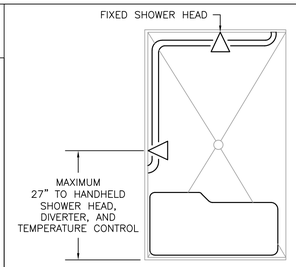
5 P-4 WASHER SUPPLY + DRAIN PIPING DIAGRAM
SCALE: NONE



NOTES:

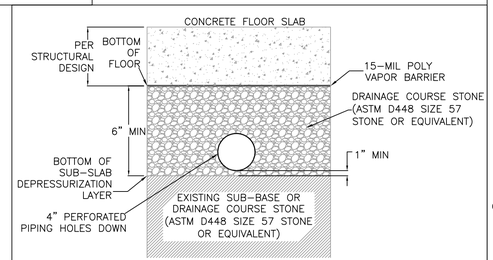
1. FOR SHWR-1 – PROVIDE SINGLE ADA HAND RAIL AS NOTED ON ARCHITECTURAL DRAWINGS WITH BLOCKING FOR FUTURE HAND RAILS AND SEAT. UNIT TO BE ORDERED WITH BUILT-IN SOAP DISH.
2. FOR SHWR-2 – PROVIDE ADA HAND RAILS WITH BLOCKING, SEAT, AND BUILT-IN SOAP DISH.

6 P-4 TYPICAL SHOWER DETAIL
SCALE: NONE



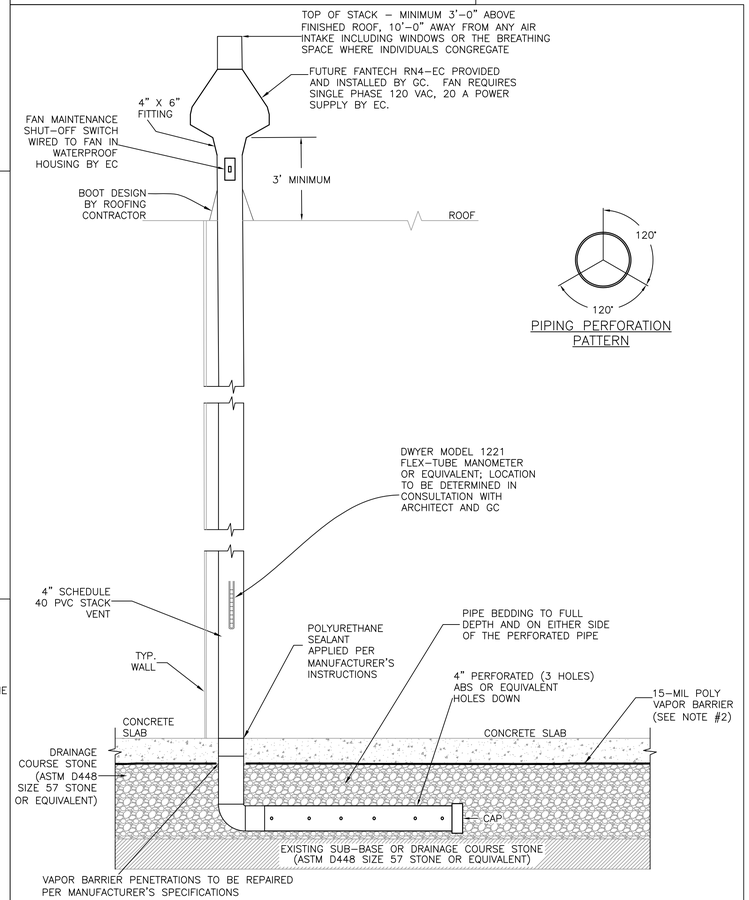
NOTE:
SHOWER CONTROLS MUST BE WITHIN 27" OF THE CORNER NEXT TO THE FOLDABLE SEAT AND MUST BE MOUNTED 42" ABOVE THE SHOWER FLOOR PER ANSI A117.1.

7 P-4 TYPICAL SHOWER CONTROLS DETAIL
SCALE: NONE



NOTE:
1. STRUCTURAL STABILITY OF AGGREGATE, PIPING, AND CONCRETE FLOOR SYSTEM DETERMINED BY OTHERS.

9 P-4 RADON SUB-SLAB TRENCH AND PIPING DETAIL
SCALE: NONE



NOTES:
1. STUB STACK VENT RISER 1 FOOT MINIMUM ABOVE CONCRETE FLOOR SLAB AND TEMPORARILY CAP UNTIL VERTICAL RISERS ARE INSTALLED.
2. USE MEASURES AS NECESSARY TO PROTECT VAPOR BARRIER DURING CONSTRUCTION. INSPECT FOR INTEGRITY OF VAPOR BARRIER PRIOR TO CONCRETE POUR AND REPAIR AS NECESSARY.

8 P-4 RADON PIPING SECTION VIEW DETAIL
SCALE: NONE

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ISSUE:
2022-12-01: HCR SUBMISSION

SA PROJECT TEAM: PRINCIPAL P.Silvestri
PROJ. ARCH. S.Hunt DRAFTER
JOB CAPT. INTERIORS A.Nagle

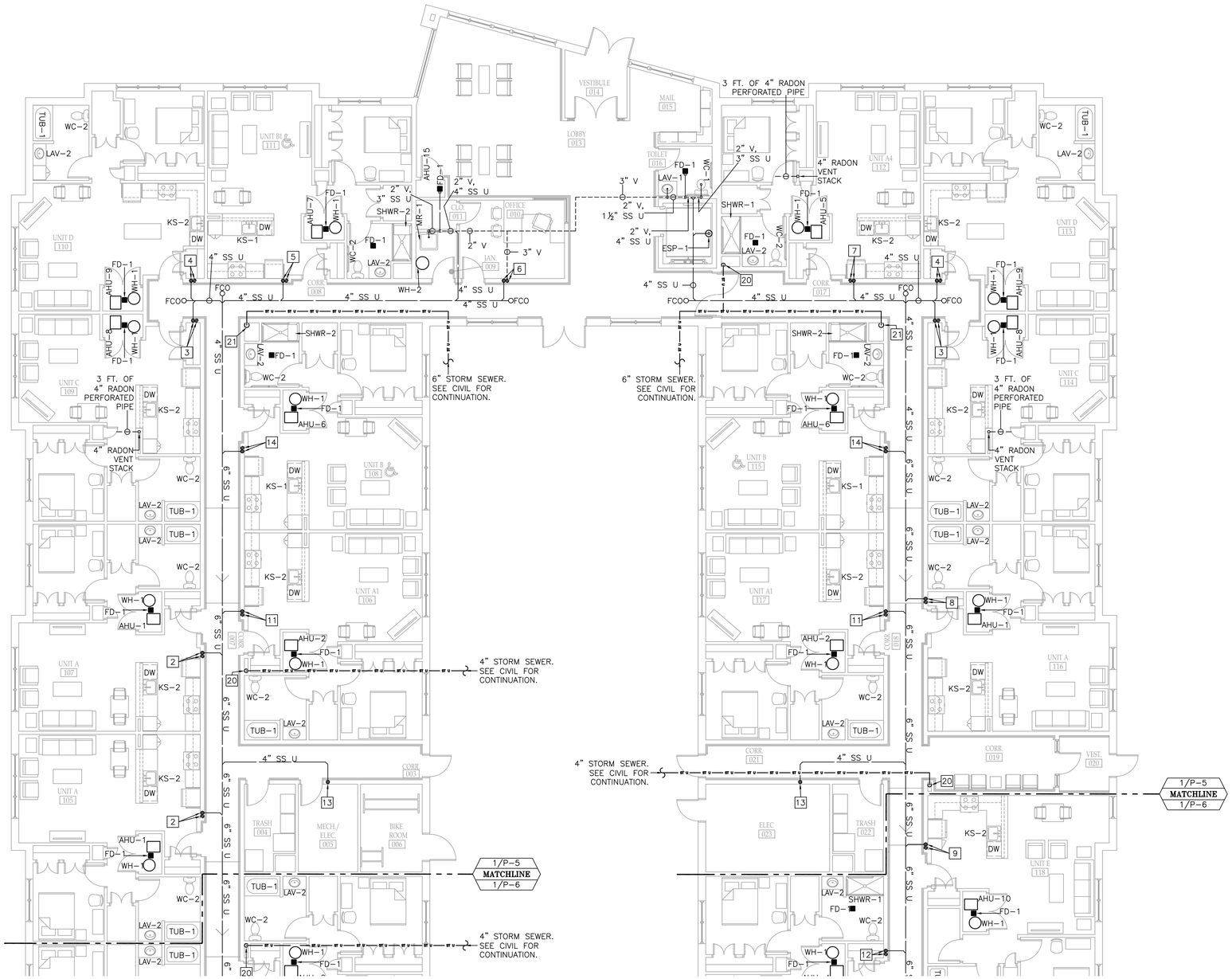
SEAL:

TITLE:
PLUMBING DETAILS CONTINUED

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SA JOB #: 20117-01
DATE: 12-1-2022

DRAWING #: P-4



SANITARY + STORM SEWER + RADON PARTIAL FIRST FLOOR PLAN

1/P-5 — SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. NOT ALL PIPE SIZES SHOWN. SEE FIXTURE SCHEDULE FOR MAIN CONNECTIONS SIZES.
2. NOT ALL SHUTOFF VALVES ARE SHOWN. SHUTOFF VALVES FOR ALL FIXTURES DOMESTIC WATER CONNECTIONS SHALL BE LOCATED WHERE THEY ARE ACCESSIBLE. PROVIDE ACCESS DOOR AS REQUIRED PER FIXTURE IF VALVES WILL NOT BE ACCESSIBLE. SEE FIXTURE SCHEDULE FOR PIPE SIZES.
3. ALL VENTED FIXTURES ARE TO HAVE THE VENT PIPING CONNECT TO THE SANITARY PIPING ABOVE THE FLOOD RIM. VENT PIPING COMING FROM BELOW THE FLOOR (I.E. TOILET VENTS, FLOOR DRAINS, AND FLOOR SINKS) SHALL COME OFF THE TOP OF THE SANITARY PIPE. FIXTURES THAT ARE VENTED BEFORE SANITARY HEADS BELOW THE FLOOR (I.E. LAVATORIES) SHALL HAVE THE VENT GO UP AND THE SANITARY GO DOWN AT LOCATION INDICATED (UNLESS OTHERWISE NOTED). AIR ADMITTANCE VALVES MAY BE SUBSTITUTED FOR VENTING IN NOTED AREAS.
4. BREAKS ARE SHOWN IN THE PIPING (BOTH UNDERSLAB AND ABOVE CEILING) FOR CLARITY ONLY. ALL SYSTEMS SHALL BE INSTALLED IN THEIR ENTIRETY FOR A FULL WORKING SYSTEM.
5. FINAL RISER LOCATIONS SHALL BE COORDINATED BETWEEN FLOORS AS NECESSARY TO ACCOMMODATE VARYING WALL LOCATIONS & STRUCTURE BETWEEN FLOORS. COORDINATE WITH MECHANICAL, ELECTRICAL, AND FIRE PROTECTION CONTRACTORS BEFORE BEGINNING WORK.
6. PROVIDE EXPANSION LOOPS OR EXPANSION FITTINGS ON COLD AND HOT WATER SUPPLY AND RETURN PIPING AS REQUIRED BASED ON PIPING TEMPERATURES, MATERIALS, AND CODE REQUIREMENTS.
7. PER STATE OF NEW YORK ENERGY CODE ALL SINKS INTENDED FOR PUBLIC USE MUST HAVE THE SOURCE OF DEVELOPED HOT WATER (RECIRC LINE) LOCATED WITHIN 2 FEET OF THE FAUCET IN QUESTION. ADDITIONALLY, A MIXING VALVE SHALL BE INSTALLED TO ACHIEVE TEMPERED WATER AT THESE SINKS (SEE DETAIL #5 ON DRAWING P–2). FOR ALL OTHER FIXTURES THE SOURCE OF HOT WATER CANNOT EXCEED 43 FEET IN DEVELOPED LENGTH.

SANITARY SEWER/STORM SEWER DRAWING NOTES [#]:
(THIS IS A MASTER LIST. NOT EVERY NOTE IS USED ON EVERY SANITARY SEWER/STORM SEWER DRAWING.)

1. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST FLR. SPRINK./WATER RM. 001 & UNIT A VENTS, 2ND FLR. UNIT G1, & 3RD FLR. UNIT G. UNIT G1 IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. UNIT G IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–12 FOR RISER DIAGRAM.
2. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT A'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–12 FOR RISER DIAGRAM.
3. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT C'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–12 FOR RISER DIAGRAM.
4. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT D'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–12 FOR RISER DIAGRAM.
5. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST FLR. UNIT B1 & 3RD FLR. UNIT A2. UNIT B1 & UNIT A2 ARE TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & EACH CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–13 FOR RISER DIAGRAM.
6. AT 1ST FLR. – 4" SS & 3" V RISERS. AT 2ND & 3RD FLRS. – 4" SS & V RISERS. RISERS SERVE 1ST FLR. FD–1, JAN. 009, TOILET 016 VENTS, & 2ND FLR. MECH 031, KITCHEN 035, WOMEN 036, MEN 037, JAN. 040, & MECH 041, & 3RD FLR. TOILET 056, JAN. 057, & MECH 061. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–13 FOR RISER DIAGRAM.
7. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT A4'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–13 FOR RISER DIAGRAM.
8. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST FLR. UNIT A, & 2ND & 3RD FLR. UNIT H'S. UNIT A IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. UNIT H IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–13 FOR RISER DIAGRAM.
9. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT E'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–14 FOR RISER DIAGRAM.
10. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT F'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–14 FOR RISER DIAGRAM.
11. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT A1'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–14 FOR RISER DIAGRAM.
12. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT A3'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–14 FOR RISER DIAGRAM.
13. AT 1ST FLR. – 4" SS RISER. AT 2ND & 3RD FLRS. – 4" SS & 3" V RISERS. BUILDING RIGHT SIDE RISERS SERVE 2ND FLR. LAUNDRY 047, & 3RD FLR. MECH/ELEC 067 & LAUNDRY 068. BUILDING LEFT SIDE RISERS SERVE 2ND FLR. LAUNDRY 030, & 3RD FLR. MECH/ELEC 052 & LAUNDRY 053. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–14 FOR RISER DIAGRAM.
14. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT B'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P–14 FOR RISER DIAGRAM.
15. CONDENSATE FROM FAN COIL TO BE CONNECTED TO NEARBY SANITARY RISERS OR FLOOR DRAIN VIA INDIRECT CONNECTION. SEE DETAIL #7 ON DRWG. P–3. COORDINATE INSTALLATION WITH HVAC CONTRACTOR.
16. 3" STORM DOWN FROM RD/ORD ABOVE.
17. 4" STORM DOWN FROM RD/ORD ABOVE.
18. 3" OVERFLOW STORM DOWN FROM RD/ORD ABOVE.
19. 4" OVERFLOW STORM DOWN FROM RD/ORD ABOVE.
20. 4" STORM DOWN FROM ABOVE.
21. 6" STORM DOWN FROM ABOVE.

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SHARS ID: 20220048

ISSUE:
2022-12-01: HCR SUBMISSION

SA PROJECT TEAM: PRINCIPAL P.Silvestri
PROJ. ARCH. S.Hunt DRAFTER
JOB CAPT. INTERIORS A.Nagle

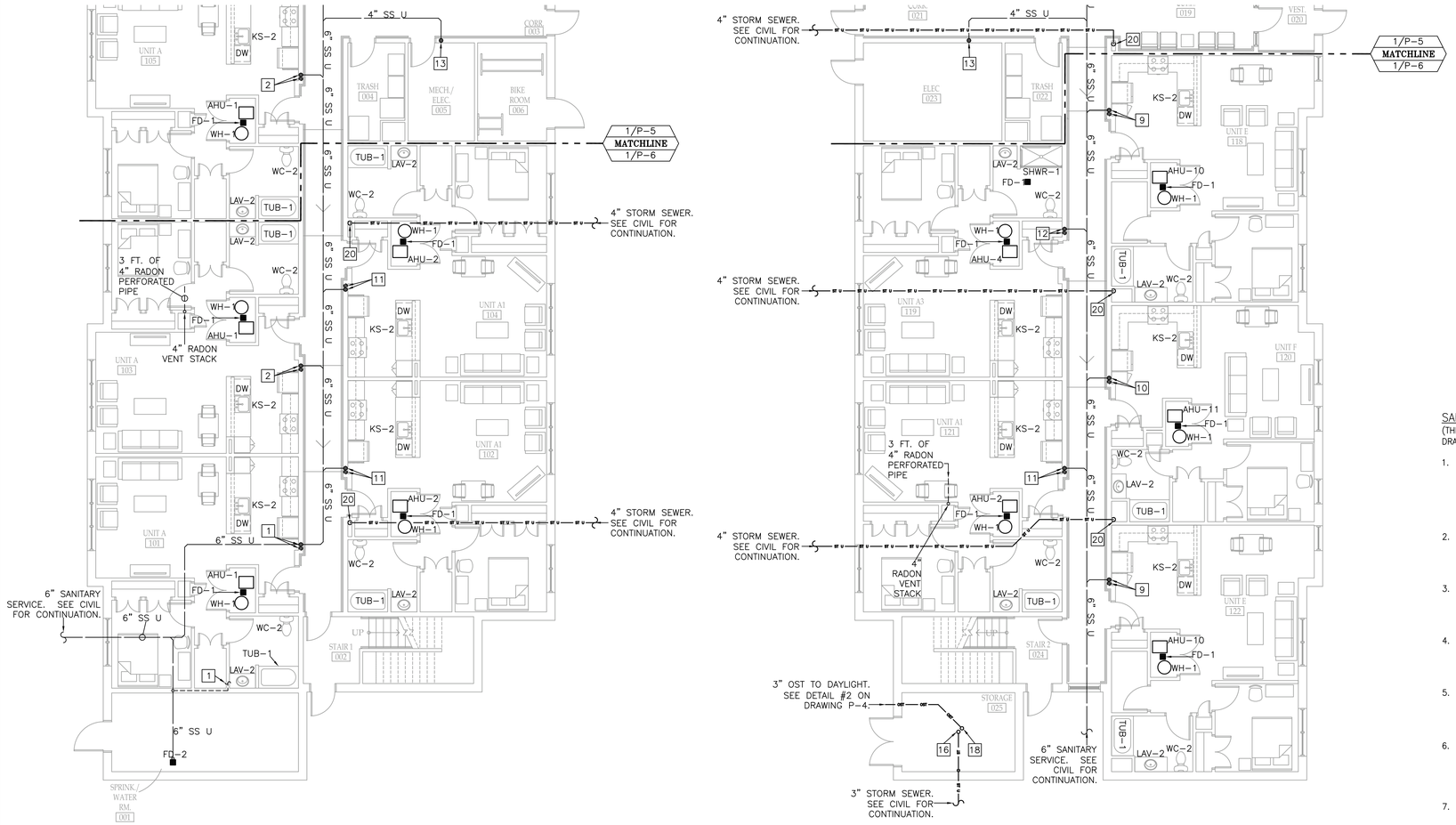
SEAL:

TITLE:
PLUMBING SANITARY & STORM SEWER & RADON PARTIAL 1ST FL. PLAN

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SA JOB #: 20117-01
DATE: 12-1-2022

DRAWING #: P-5



1 P-6 SANITARY + STORM SEWER + RADON PARTIAL FIRST FLOOR PLAN

SCALE: 1/8" = 1'-0"

GENERAL NOTES:

1. NOT ALL PIPE SIZES SHOWN. SEE FIXTURE SCHEDULE FOR MAIN CONNECTIONS SIZES.
2. NOT ALL SHUTOFF VALVES ARE SHOWN. SHUTOFF VALVES FOR ALL FIXTURES DOMESTIC WATER CONNECTIONS SHALL BE LOCATED WHERE THEY ARE ACCESSIBLE. PROVIDE ACCESS DOOR AS REQUIRED PER FIXTURE IF VALVES WILL NOT BE ACCESSIBLE. SEE FIXTURE SCHEDULE FOR PIPE SIZES.
3. ALL VENTED FIXTURES ARE TO HAVE THE VENT PIPING CONNECT TO THE SANITARY PIPING ABOVE THE FLOOD RIM. VENT PIPING COMING FROM BELOW THE FLOOR (I.E. TOILET VENTS, FLOOR DRAINS, AND FLOOR SINKS) SHALL COME OFF THE TOP OF THE SANITARY PIPE. FIXTURES THAT ARE VENTED BEFORE SANITARY HEADS BELOW THE FLOOR (I.E. LAVATORIES) SHALL HAVE THE VENT GO UP AND THE SANITARY GO DOWN AT LOCATION INDICATED (UNLESS OTHERWISE NOTED). AIR ADMITTANCE VALVES MAY BE SUBSTITUTED FOR VENTING IN NOTED AREAS.
4. BREAKS ARE SHOWN IN THE PIPING (BOTH UNDERSLAB AND ABOVE CEILING) FOR CLARITY ONLY. ALL SYSTEMS SHALL BE INSTALLED IN THEIR ENTIRETY FOR A FULL WORKING SYSTEM.
5. FINAL RISER LOCATIONS SHALL BE COORDINATED BETWEEN FLOORS AS NECESSARY TO ACCOMMODATE VARYING WALL LOCATIONS & STRUCTURE BETWEEN FLOORS. COORDINATE WITH MECHANICAL, ELECTRICAL, AND FIRE PROTECTION CONTRACTORS BEFORE BEGINNING WORK.
6. PROVIDE EXPANSION LOOPS OR EXPANSION FITTINGS ON COLD AND HOT WATER SUPPLY AND RETURN PIPING AS REQUIRED BASED ON PIPING TEMPERATURES, MATERIALS, AND CODE REQUIREMENTS.
7. PER STATE OF NEW YORK ENERGY CODE ALL SINKS INTENDED FOR PUBLIC USE MUST HAVE THE SOURCE OF DEVELOPED HOT WATER (RECIRC LINE) LOCATED WITHIN 2 FEET OF THE FAUCET IN QUESTION. ADDITIONALLY, A MIXING VALVE SHALL BE INSTALLED TO ACHIEVE TEMPERED WATER AT THESE SINKS (SEE DETAIL #5 ON DRAWING P-2). FOR ALL OTHER FIXTURES THE SOURCE OF HOT WATER CANNOT EXCEED 43 FEET IN DEVELOPED LENGTH.

SANITARY SEWER/STORM SEWER DRAWING NOTES [#]:

(THIS IS A MASTER LIST. NOT EVERY NOTE IS USED ON EVERY SANITARY SEWER/STORM SEWER DRAWING.)

1. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST FLR. SPRINK./WATER RM. 001 & UNIT A VENTS, 2ND FLR. UNIT G1, & 3RD FLR. UNIT G. UNIT G1 IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. UNIT G IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-12 FOR RISER DIAGRAM.
2. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT A'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-12 FOR RISER DIAGRAM.
3. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT C'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-12 FOR RISER DIAGRAM.
4. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT D'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-12 FOR RISER DIAGRAM.
5. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST FLR. UNIT B1 & 3RD FLR. UNIT A2. UNIT B1 & UNIT A2 ARE TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & EACH CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-13 FOR RISER DIAGRAM.
6. AT 1ST FLR. – 4" SS & 3" V RISERS. AT 2ND & 3RD FLRS. – 4" SS & V RISERS. RISERS SERVE 1ST FLR. FD-1, JAN. 009, TOILET 016 VENTS, & 2ND FLR. MECH 031, KITCHEN 035, WOMEN 036, MEN 037, JAN. 040, & MECH 041, & 3RD FLR. TOILET 056, JAN. 057, & MECH 061. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-13 FOR RISER DIAGRAM.
7. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT A4'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-13 FOR RISER DIAGRAM.
8. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST FLR. UNIT A, & 2ND & 3RD FLR. UNIT H'S. UNIT A IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. UNIT H IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-13 FOR RISER DIAGRAM.
9. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT E'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-14 FOR RISER DIAGRAM.
10. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT F'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-14 FOR RISER DIAGRAM.
11. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT A1'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A TUB, WC, LAV, KS, DW, & FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-14 FOR RISER DIAGRAM.
12. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT A3'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-14 FOR RISER DIAGRAM.
13. AT 1ST FLR. – 4" SS RISER. AT 2ND & 3RD FLRS. – 4" SS & 3" V RISERS. BUILDING RIGHT SIDE RISERS SERVE 2ND FLR. LAUNDRY 047, & 3RD FLR. MECH/ELEC 067 & LAUNDRY 068. BUILDING LEFT SIDE RISERS SERVE 2ND FLR. LAUNDRY 030, & 3RD FLR. MECH/ELEC 052 & LAUNDRY 053. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-14 FOR RISER DIAGRAM.
14. AT 1ST & 2ND FLRS. – 4" SS & 3" V RISERS. AT 3RD FLR. – 4" SS & V RISERS. RISERS SERVE 1ST, 2ND, & 3RD FLR. UNIT B'S. EACH UNIT IS TO BE SERVED BY 4" SS & 3" V BRANCH PIPING & CONTAIN A SHWR, WC, LAV, KS, DW, & (2) FD. SEE FIXTURE SCHEDULE FOR FIXTURE CONNECTION SIZES & DRWG. P-14 FOR RISER DIAGRAM.
15. CONDENSATE FROM FAN COIL TO BE CONNECTED TO NEARBY SANITARY RISERS OR FLOOR DRAIN VIA INDIRECT CONNECTION. SEE DETAIL #7 ON DRWG. P-3. COORDINATE INSTALLATION WITH HVAC CONTRACTOR.
16. 3" STORM DOWN FROM RD/ORD ABOVE.
17. 4" STORM DOWN FROM RD/ORD ABOVE.
18. 3" OVERFLOW STORM DOWN FROM RD/ORD ABOVE.
19. 4" OVERFLOW STORM DOWN FROM RD/ORD ABOVE.
20. 4" STORM DOWN FROM ABOVE.
21. 6" STORM DOWN FROM ABOVE.

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