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18 May 2023

Mr. Michael Belveg
Division of Environmental Remediation
New York State Department of Environmental Conservation
615 Erie Boulevard West
Syracuse, New York 13204

RE: Pre-Design Investigation Letter Work Plan - DRAFT
Monitoring Wells
Contract/Work Assignment No: D009806-32
Zip Zip Mini Market, Syracuse, New York
Site No. B00075

Dear Mr. Belveg:

This Letter Work Plan provides detail for the field activities for the Pre-Design Investigation (PDI) at the Zip Zip Mini Market Site (Number [No.] B00075) (Site) in the city of Syracuse, Onondaga County, New York (Figure 1). EA Engineering, P.C. and its affiliate EA Science and Technology (EA) will complete additional site characterization to refine the nature and extent of impacts to soil, groundwater, and soil vapor through installation and sampling of new and replacement monitoring wells and soil vapor points (SVPs). The existing monitoring well network is shown on Figure 2.

Under this Work Plan, EA will mobilize to the Site three times. The first mobilization will include a ground-penetrating radar (GPR) survey and utility clearance activities. The second mobilization will include advancement of up to 10 soil borings, collection of subsurface soil samples, installation and development of a maximum of eight permanent 2-inch internal diameter groundwater monitoring wells, potential redevelopment of existing groundwater monitoring well TW-2 (dependent on condition of the existing well), and installation of two SVPs. Well and SVP locations are presented on Figure 3. The final mobilization will include groundwater sampling at newly installed and replacement monitoring wells, soil vapor sampling at newly installed SVPs, and hydraulic conductivity testing (slug testing) at newly installed monitoring wells.

Field activities will be completed in accordance with this Letter Work Plan including Appendix A EA's Generic Field Activities Plan (FAP); Appendix B Site-Specific Health and Safety Plan; Appendix C Generic Quality Assurance Project Plan. Additional specific tasks and any deviations are described in the following sections.

SITE DESCRIPTION AND BACKGROUND

The Site is 1.14 acres, identified as tax parcel 031.-08-02.0, and is owned by the city of Syracuse (Figure 1). The property is located at 1410 Erie Boulevard East along the eastern side of the city of Syracuse in a dense commercial corridor. The property is irregularly shaped and less than 100 feet (ft) in depth. The Site is zoned for commercial use and currently used as a parking area. A plumbing supply shop located on the adjacent parcel to the east and owned by the adjoining property owner slightly encroaches onto the western portion of the Site.

Immediately surrounding the Site is Erie Boulevard to the north, Cherry Street to the east, East Washington Street to the south, and South Beech Street to the west. Proximate businesses include food establishments, a bank, municipal buildings, truck rental, and other miscellaneous businesses. An expansive residential area is located to the south.

Topography at the Site is relatively flat, with an approximate elevation of 440 ft above mean sea level. The ground surface is mostly made up of hard compact soil and gravel. Site soil consists of Urban Land. Non-native overburden consists of fill and gravel material. Native overburden material consists of a thin layer of silt and clay overlying dense red-brown glacial till. Depth to till during previous investigations was variable, ranging from 4 to 16 ft below ground surface (bgs). Bedrock underlying the Site is the Upper Silurian Syracuse Formation, which consists of dolostone, shale, gypsum, and salts. Previous reports stated that perched groundwater was encountered within non-native fill, and shallow groundwater was encountered at a depth of 14 to 18 ft bgs. Groundwater flow direction at the Site was documented to the east/southeast in the 2000 Site Investigation Report.[1] However, the Remedial Investigation Report stated that groundwater at the Site generally flows to the north.[2] No documentation of static groundwater conditions later than the site investigation was available to confirm groundwater flow direction conclusion.

Until 1997, the Site was used as a retail gasoline business prior to a fire that destroyed the service building. Contamination at the Site is believed to be the result of four underground storage tanks being left at the property without being closed properly.

PREVIOUS INVESTIGATIONS

A site investigation completed in 2000 included 21 test pits, 6 soil borings, and installation of 4 monitoring wells. Soil, groundwater, and floor drain sediments were collected and analyzed. Evidence of up to six underground storage tanks (USTs) were observed. Petroleum impacts were noted in soil and groundwater, and more than 2 feet of free product was observed in one monitoring well.

The first Interim Remedial Measure was completed in 2005 to remove the USTs and residual contaminated soil around the USTs. A second Interim Remedial Measure was completed in 2008 to excavate two other hot spot areas of contaminated soil. Work included the removal of over 10,000 gallons of petroleum contaminated liquid and more than 1,700 tons of petroleum impacted soil.

A remedial investigation (RI) completed in 2019 included collection and analysis of 8 surface/near-surface soil samples, advancement of 6 soil borings (SB-1 to SB-6), collection and

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[1] C&S Engineers, Inc. 2000. *Brownfields Site Investigation Report*. July.
[2] C&S Engineers, Inc. 2019. *Remedial Investigation Report for Former Zip Zip Mini Mart; 1410 Erie Boulevard East; Environmental Restoration Program; NYSDEC Site No. B00075.* April

analysis of 15 subsurface soil samples, installation of 3 temporary monitoring wells (TW-1 to TW-3), and collection and analysis of groundwater samples from each temporary monitoring well and two previously existing wells reportedly installed in 2018 (MW-2 and MW-4). Evidence of petroleum impacts including detectable PID readings [up to 60 parts per million], staining, and/or petroleum odors were noted in subsurface soil from borings SB-1, SB-3, SB-4, and SB-5 advanced along the perimeter of previous IRM excavations. In addition, a petroleum sheen and odor were observed on groundwater at TW-1, MW-2, and TW-3.

RI soil samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), herbicides/pesticides, and/or metals. Analytical results were compared to New York State Department of Environmental Conservation (NYSDEC) Part 375 soil cleanup objectives (SCOs). Concentrations of one VOC (acetone), six SVOCs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, and indeno[1,2,3-cd]pyrene), one pesticide (DDT), and two metals (lead and zinc) in surface soil samples exceeded Unrestricted Use SCOs. Herbicides and PCBs were not detected in surface soil. Concentrations of 5 VOCs (acetone, benzene, ethylbenzene, methylene chloride, and xylenes) and 2 metals (mercury and nickel) exceeded Unrestricted Use SCOs in subsurface soil. No SVOCs in subsurface soil exceeded SCOs, and pesticides and herbicides were not detected in subsurface soil. An overview of RI sample results is presented in Figure 3 of the Remedial Investigation Report.[2]

RI groundwater samples were analyzed for VOCs, SVOCs, and total and dissolved metals. Concentrations of 6 VOCs (benzene, toluene, ethylbenzene, and xylene, isopropylbenzene, and methyl tertiary butyl ether) and 3 SVOCs (2,4-dimethylphenol, naphthalene, and phenol) in groundwater exceeded NYSDEC Ambient Water Quality Class GA Standards (Figure 2). Metals concentrations in groundwater were below NYSDEC Ambient Water Quality Class GA Standards.

GROUND PENETRATING RADAR SURVEY AND UTILITY CLEARANCE

GPR survey and utility clearance activities will be completed by Ground Penetrating Radar Systems, LLC (GPRS) prior to the start of drilling activities. GPRS will complete a geophysical survey of the entire Site to identify utility and subsurface anomalies using electromagnetic and magnetic geophysical methods. The survey and methods employed will be capable of detecting utilities and buried metal/anomalies to approximately 5 ft bgs. Any utilities or structures will be marked out in the field either with spray paint or pin flags so they may be surveyed at a later date by a New York State licensed land surveyor. GPRS will provide a brief letter report with drawings showing locations of detected anomalies.

Prior to the start of drilling activities, the drilling subcontractor, Parratt-Wolff, Inc. (PWI) will contact Dig Safe New York to locate and mark any underground public utilities. PWI will be provided copies of the GPRS reports to assist in the subsurface utility clearance. PWI will provide copies of all Dig Safe New York notifications and responses to EA prior to the start of drilling activities.

See SOP- 003 “Subsurface Utility Clearance” in Appendix A of the FAP for further information.

INSTRUMENT CALIBRATION

Field equipment including photoionization detectors and water quality meters will be calibrated each day prior to the start of field activities in accordance with manufacturer recommendations and SOP 011 "PID" and SOP 043 "Multi-Probe Water Quality Monitoring Instruments" presented in Appendix A of the FAP.

SOIL BORING INSTALLATION AND SOIL SAMPLING

Up to 10 soil borings will be advanced at the Site by the drilling subcontractor, PWI, under the full-time supervision of an EA geologist. Up to eight borings will be advanced to refusal at anticipated depths of 20 ft bgs and converted to monitoring wells. The remaining two borings will be advanced to approximately 5 to 6 ft bgs and converted to SVPs (SVP-1 and SVP-2).

Access agreements will be obtained by the NYSDEC project manager prior to the start of drilling activities for drilling locations across Erie Boulevard East and north of the subject property. Once all access agreements are secure, PWI will hand clear each soil boring location to 5 ft bgs (10 total) to confirm no utility interferences exist at each location. If any obstructions are encountered during hand clearing activities, the borehole will be properly abandoned (filled in with original excavated material and resurfaced with the same material as the surrounding surface), and a new location will be hand cleared a few feet from the abandoned borehole location. After all boreholes have been hand cleared, the soil borings will be advanced using a truck mounted drilling rig utilizing hollow stem augers and continuous split-spoon sampling techniques following American Society for Testing and Materials (ASTM) International D1586-11 protocols for soil sampling.

The EA field geologist will complete soil logging and classification following ASTM D 2488 and in accordance with EA-SOP-064 "Sediment Boring Logs" in Appendix A of the FAP. At a minimum, the following information will be recorded on boring logs:

- Date/times drilling occurred
- Drill rig behavior and blow counts
- Subsurface interval and recovery
- Headspace photoionization detector (PID) readings in accordance with SOP 011 "PID" in Appendix A of the FAP
- Lithology description in accordance with the Unified Soil Classification System (USCS) ASTM Method D2487 (including USCS code, soil type, color, grain size and shape, texture, moisture content, density, consistency, etc.)
- Any unusual characteristics (e.g., odor, sheens, staining, etc.)
- Depth to water
- Borehole depth information.

Soil samples for chemical analysis will be collected in accordance with SOP 025 "Soil Sampling" in Appendix A of the FAP per the following protocols:

- One subsurface soil sample will be collected from the soil/water interface at each of the two borings located across Erie Boulevard East. These samples will be used to determine if soil is impacted within the capillary fringe zone (water fluctuation zone) and if impacts are potentially related to a groundwater plume located upgradient of the subject property. Additional soil samples will be collected from the vadose zone above the water table interface if there is evidence of gross contamination. However, it is anticipated that vadose zone contamination is not related to the subject property.

- One subsurface soil sample will be collected from the water table interface at each of three boring locations advanced on the subject property, including one location adjacent to the billboard, one location that will serve as the replacement well for MW-4R, and one location that will be converted to well TW-1). These borings are outside the former excavation area situated in soil native to the subject property. The samples will be used to provide the same information as the borings advanced across Erie Boulevard East.

- Subsurface soil samples will not be collected from the remaining three boring locations advanced on the subject property that will be converted to wells TW-2R, TW-3R, and MW-2R. These three borings will be advanced in former excavation areas that were backfilled with clean fill material.

Subsurface soil samples will be collected in laboratory provided sample containers for analysis of VOCs (Environmental Protection Agency [EPA] Method Terracore SW846, 5035), SVOCs (EPA Method 8270), Target Analyte List (TAL) metals (EPA Method 6010B), mercury (EPA Method 7471), herbicides (EPA Method 8151A), pesticides (EPA Method 8081B), polychlorinated biphenyls (PCBs) (EPA Method 8082A), per- and polyfluoroalkyl substances (EPA Method 1633), 1,4-dioxane (EPA Method 8270 selected ion monitoring [SIM]), total organic carbon (EPA Method 9060), and grain size (ASTM-D422). Subsurface soil samples will also be collected from the MW-4R and TW-1 boring locations to be utilized in Treatability Testing during the Pilot Study. Table 1 presents the sampling scheme and analytical methodology for the analyses. Sample collection information (sample identification, collection date/time, sample depth interval, sample analyses) will be recorded on the purge form. Soil samples will be analyzed by NYSDEC Call-out Laboratory, Con-Test.

MONITORING WELL INSTALLATION

Up to eight soil boring locations will be converted to permanent, 2-inch diameter monitoring wells (Figure 3). In addition, if the existing well TW-2 cannot be re-developed, then this well will be abandoned and a new replacement well will be installed.

Monitoring wells will be constructed of 2-inch internal diameter polyvinyl chloride (PVC) casing with a 10-ft long, #10-slot PVC screen. The annulus around the outside of the screen will be backfilled with sand (#0 US Silica or equivalent) to 2 ft above the screen. A minimum 2-ft bentonite seal will be installed above the sand pack with the remaining borehole annulus being tremie grouted with a bentonite/cement grout mixture to grade. Each well will be completed with a 2 ft by 2 ft concrete pad and curb box with a minimum diameter of 6-inches. The concrete pad will be constructed so that water drains away from the well. See SOP- 019 “Monitoring Well Installation” for further information. Field forms and documents including a well construction diagram will be completed in accordance with SOP-016 “Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists” in Appendix A of the FAP.

MONITORING WELL DEVELOPMENT AND REDEVELOPMENT

Monitoring well development will be conducted for each newly installed monitoring well and one existing monitoring well identified as needing to be re-developed (TW-2). Well development will be conducted in accordance with SOP 019 “Monitoring Well Installation” in Appendix A of the FAP using surge and pump techniques to remove fines from the filter pack and assure effective communication between the well and the surrounding aquifer. Newly installed monitoring wells will be developed no sooner than 48 hours but no longer than 7 calendar days following installation.

Water levels and well depths will be measured prior to initiation of well development with an electronic water level indicator with an accuracy of 0.01 ft in accordance with SOP-010 “Water Level and Well Depth Measurements” in Appendix A of the FAP. Wells will be purged with a submersible pump (Grundfos or similar). Water depths, flow rates and water quality parameters (pH, specific conductance, temperature, ORP, DO, TDS, and turbidity) will be monitored at 5-minute intervals throughout the development process using an electronic water level indicator with an accuracy of 0.01 ft; a flow measurement device (containers graduated in milliliters) and stop watch; and a calibrated multi-parameter water quality monitor with flow-through cell (Horiba U-22 water quality monitoring system or similar). A PID will be used to monitor vapor concentrations during purging and sampling in accordance with SOP-011 “PID” in Appendix A of the FAP.

Liquid levels and water quality parameters will be recorded on well development logs. Any unusual conditions (colors, odors, surface sheens, etc.) noticed during well development, purging, or sampling will be recorded and reported.

Monitoring well development will be considered complete when water quality parameters have stabilized, a turbidity of less than 50 nephelometric turbidity units has been achieved, and a minimum of three to five times the standing water volume in the well (to include the well screen, casing, plus saturated annulus, assuming 30 percent annular porosity) has been removed. Stabilization parameters are as follows:

- pH: ±0.1 standard units.
- Specific conductance: ±3 percent
- Temperature: ±10 percent
- Oxidation-reduction potential (ORP): ±10 millivolts
- Dissolved oxygen (DO): ±0.3 milligrams per liter
- Turbidity: <50 nephelometric turbidity units

Development water will be containerized, handled, and disposed of as described below in the investigation-derived waste (IDW) section and as detailed in Section 3.4 of the site-specific Health and Safety Plan Addendum (Appendix B).

GROUNDWATER SAMPLING

Following the installation and development of the permanent monitoring wells, an EA field geologist will be responsible for collecting groundwater samples from each newly installed well, redeveloped well, and each replacement well (8 wells total) using low-flow sampling techniques in accordance with SOP-048 “Low-Flow Sampling” in Appendix A of the FAP. Static water levels and well depths will be gauged prior to purging with an electronic water level indicator with an accuracy of 0.01 ft in accordance with EA-SOP-010 “Water Level and Well Depth Measurements” in Appendix A of the FAP, and well headspace will be screened with a PID in accordance with EA-SOP-011 “PID” in Appendix A of the FAP prior to the start of purging. The date, time, well number, headspace readings, and gauging data will be recorded in the field log in accordance with the SOP-016 “Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists” in Appendix A of the FAP.

A peristaltic pump and dedicated high density polyethylene and silicon tubing will be used to purge and collect groundwater for analysis by Con-Test. Water depths will be recorded throughout purging to the nearest 0.01 ft using an electric water-level tape. Water quality parameters (including pH, temperature, conductivity, DO, turbidity, and ORP) will be recorded throughout purging using a calibrated water quality meter and flow-through cell (Horiba U-22 water quality monitoring system or similar). Readings will be taken every 3 minutes until water quality parameters stabilize. Stabilization is considered to be achieved when 3 consecutive readings are within the limits as follows:

- Drawdown less than 0.3 ft; or stable drawdown if the minimal drawdown exceeds 0.3 ft
- pH readings within ± 0.1 pH units
- Water temperatures within ± 3%
- ORP within ± 10 millivolts
- DO within ± 10% for values greater than 0.5 milligrams per liter (mg/L); if three DO values are less than 0.5 mg/L, the values are considered stabilized.
- Specific conductance within ± 3%
- Turbidity within ± 10 % for values greater than 5 nephelometric turbidity units (NTU); if three turbidity values are less than 5 NTU, the values are considered stabilized.

Water quality parameters and pertinent sampling information will be recorded on groundwater purge and sample collection logs in accordance with the SOP-016 “Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists” in Appendix A of the FAP. Unusual conditions (colors, odors, surface sheens, etc.) noticed during well purging or sampling will also be recorded and reported.

Groundwater samples will be collected following stabilization of water quality parameters. Samples will be collected in laboratory provided sample containers for analysis of VOCs (EPA

Method 8260C), SVOCs (EPA Method 8270C), TAL metals (EPA Method 6020B-total and dissolved), mercury (EPA Method 7470A-total and dissolved), herbicides (EPA Method 8151A), pesticides (EPA Method 8081B), PCBs (EPA Method 8082A), per- and polyfluoroalkyl substances (EPA Method 1633), and 1,4-dioxane (EPA Method 8270 SIM). A subset of monitoring wells will be sampled for geochemical parameters including total organic carbon (EPA Method 5310 B), chemical oxygen demand (EPA Method 410.1), sulfate/sulfite (EPA Method 9056 A/300.0), nitrate/nitrite (EPA Method 9056 A/300.0), methane (EPA Method RSK 175), ethane (EPA Method RSK 175), and ethene (EPA Method RSK 175), and alkalinity (EPA Method SM 2320). Select monitoring wells (MW-XX, MW-2R, and TW-1) will also be sampled for per- and polyfluoroalkyl substances (Method 1633) and 1,4-dioxane (Method 8270 SIM). Table 1 presents the sampling scheme and analytical methodology for on-site and off-site monitoring wells. Sample collection information (sample identification, collection date/time, sample analyses) will be recorded on the purge form. Groundwater samples will be analyzed by NYSDEC Call-out Laboratory, Con-Test.

SOIL VAPOR POINT INSTALLATION AND SAMPLING

Two of the soil boring locations will be converted to SVPs (SVP-1 and SVP-2) in accordance with SOP-020 “Active Soil Gas Sampling” presented in Appendix A of the FAP. SVPs will be installed to an approximate depth of 5 to 6 ft bgs with an effort to install the point above the saturation zone. A 2-inch diameter soil boring will be installed at each location, and the vapor probe will be set in the open borehole. The gas vapor probes will be constructed with a 6-inch length stainless steel screen attached to a dedicated section of ¼-inch Teflon-lined or polyethylene tubing . Glass beads or a coarse filter sand (Morie #0N) comparable to the screen slot size will be used for the filter pack, extending 6 inches above the top of screen. Granular bentonite will be used to seal from top of filter pack to within 6 inches of ground surface. Bentonite will be hydrated concurrently with placement. The remaining 6-inches will be grouted and then completed with a 2-ft by 2-ft concrete pad and 6-inch diameter curb box for protection of the SVP. The concrete pad will be constructed so that water drains away from the SVP.

SVPs will be allowed to cure for a minimum of 24-hours prior to sampling. Sample tubing will be purged with two to three implant volumes prior to sample collection to ensure representative samples are collected. SVPs will be sampled with 6-liter Summa® canisters for VOCs via EPA Method TO-15. Canisters will be certified and regulated for a 2-hour collection period by Con-Test. Samples will be collected in accordance with EA SOP-020 “Active Soil Gas Sampling” in Appendix A of the FAP. A shut-in test will be performed prior to sample collection to check the sample train for leaks. Field forms and documentation will be completed in accordance with SOP-016 “Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists” presented in Appendix A of the FAP.

SINGLE-WELL HYDRAULIC CONDUCTIVITY (SLUG) TESTS

EA will perform in situ hydraulic conductivity tests (i.e., slug tests) at each newly installed monitoring well. These tests will provide data on characteristics of the water bearing zones. Hydraulic conductivity tests (i.e., slug tests) will be conducted in accordance with SOP-033

"Aquifer (Hydraulic) Testing" (Appendix A of the FAP) and ASTM D4044/D4044M-15. Static water levels will be measured at each well location prior to testing in accordance with SOP 010 "Water Level and Well Depth Measurements" in Appendix A of the FAP.

A pressure transducer/data logger (15 or 30 pounds per square inch) will be placed into each well and a mechanical slug will then be lowered into the well to displace a known and fixed volume of water. The slug will be constructed of stainless steel or PVC pipe (filled with sand, capped, and sealed) and will be of an appropriate size to cause sufficient water displacement depending on water column in the well and well diameter. The transducer will continuously record the water level in the monitoring well as the hydraulic head is decreased during the falling head test. Data logging will continue as the hydraulic head increases during the rising head test in response to removal of the slug until the water level within the monitoring well has again reached equilibrium. The slug test data will be analyzed using the Bower-Rice (1976) method and the results will be presented in both tabular and graphical form. Field forms and documents will be completed in accordance with SOP-016 "Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists" in Appendix A of the FAP.

DECONTAMINATION PROCEDURES AND INVESTIGATION-DERIVED WASTE

Non-dedicated drilling equipment and tools will be decontaminated prior to, between each drilling location, and prior to departure from site using steam cleaning methods. A temporary decontamination pad will be constructed on-site (e.g. plastic sheeting and hale bales).

IDW including personal protective equipment, solids and liquids generated during the well drilling, well development, decontamination, and well sampling activities, will be stored, handled, and disposed of in accordance with the FAP in Appendix A. PWI will also be required to contain and manage any liquids used for drilling to the extent practicable to prevent off-site runoff of IDW. PWI will stage drums at the Site at a location to be determined by EA and EA will ensure drums are labeled and secured.

A composite sample from the soil drums will be submitted for the analysis of Toxicity Characteristic Leaching Procedure (TCLP) VOCs, TCLP SVOCs, TCLP Resource Conservation and Recovery Act metals, TCLP Herbicides, TCLP Pesticides, TCLP PCBs, reactive sulfide, reactive cyanide, total organic halides, corrosivity, reactivity, paint filter test, and flash point. A composite sample of purge water will be submitted for the analysis of TCL VOCs, TCL SVOCs, Resource Conservation and Recovery Act metals, PCBs, reactive cyanide, reactive sulfide, total organic halides, corrosivity, reactivity, and flash point. The IDW contractor will complete the waste profile for disposal at the appropriate destination facility. It is anticipated that solid and liquid IDW will be non-hazardous. Refer to SOP- 005 "Field Documentation" and SOP- 042 "Disposal of Investigation-Derived Material" in Appendix A of the FAP for further information regarding field decontamination and disposal of IDW, respectively.

SURVEY

After all field activities are complete, a topographic and site survey of all investigation locations and previously existing and newly installed monitoring well locations, including the natural ground surface (not the top of the grout collar) of monitoring well and the highest point on the riser casing rim of the uncapped well casing and the protective casing, will be completed by a licensed surveyor under the oversight of EA.

PROPOSED SCHEDULE

The work outlined above is anticipated to begin in late June 2023 and be completed within one to two months pending subcontractor availability.

Please feel free to contact me if you have any questions or concerns at 315-565-6553.

Sincerely yours,
EA SCIENCE AND TECHNOLOGY

Final to be signed.

Emily Cummings
Project Manager

EA ENGINEERING, P.C.

Final to be signed.

Donald F. Conan, P.E., P.G.
Program Manager

Tables

Table 1. PDI Sample Summary

Method/Analyte	Sampling Points											QA/QC Samples				
	New MW-X	**New MW-X**	**New MW-X (near billboard)**	**New MW-X (MW-2R)**	**New MW-X (MW-4R)**	**New TW-1**	**TW-2**	**New TW-3**	**SVP-1**	**SVP-2**	**Total parent samples**	**Duplicates (5%)**	**MS/MSD (pair)**	**Trip (VOCs only) (aq.)**	**EB/FB (aq.)**	**Total samples**
Soil																
VOCs via Terracore SW846, 5035	1	1	1	--	1	1	--	--	--	--	5	1	2	1	1	**10**
SVOCs via 8270	1	1	1	--	1	1	--	--	--	--	5	1	2	0	1	**9**
TAL Metals 6010B, Hg 7471	1	1	1	--	1	1	--	--	--	--	5	1	2	0	1	**9**
Herbicides- 8151A, Pesticides-8081B, and PCBs-8082A	1	1	1	--	1	1	--	--	--	--	5	1	2	0	1	**9**
PFAS via 1633	1	--	1	--	1	1	--	--	--	--	4	1	2	0	2	**9**
1,4-Dioxane via 8270 SIM	1	--	1	--	1	1	--	--	--	--	4	1	2	0	1	**8**
TOC via 9060	1	--	--	1	--	1	1	1	--	--	5	0	0	0	0	**5**
Grain size -ASTMD422	--	--	--	3	3	3	3	3	--	--	15	0	0	0	0	**15**
Benchscale	--	--	--	1	--	1	--	--	--	--	2	0	0	0	0	**2**
Groundwater																
VOCs via 8260C	1	1	1	1	1	1	1	1	--	--	8	1	2	1	0	**12**
SVOCs via 8270C	1	1	1	1	1	1	1	1	--	--	8	1	2	0	0	**11**
TAL Metals 6020B and Hg 7470A-Total & Dissolved	1	1	--	1	--	1	1	1	--	--	6	1	2	0	0	**9**
Herbicides 8151A, Pesticides 8081B, and PCBs 8082A	1	1	--	--	--	--	--	--	--	--	2	1	2	0	0	**5**
PFAS via 1633	1	--	1	--	--	1	--	--	--	--	3	1	2	0	2	**8**
1,4-Dioxane via 8270 SIM	1	--	1	--	--	1	--	--	--	--	3	1	2	0	0	**6**
TOC via 5310 B	--	--	--	1	--	1	1	1	--	--	4	0	0	0	0	**4**
COD via 410.1	--	--	--	1	--	1	1	1	--	--	4	0	0	0	0	**4**
MNA - Anions (Sulfate/Sulfite, Nitrate/Nitrite) via 9056 A/300.0	--	--	--	1	--	1	1	1	--	--	4	0	0	0	0	**4**
MNA - MEE via RSK 175	--	--	--	1	--	1	1	1	--	--	4	0	0	0	0	**4**
Alkalinity via SM 2320	--	--	--	1	--	1	1	1	--	--	4	0	0	0	0	**4**
Benchscale	--	--	--	1	--	1	--	--	--	--	2	0	0	0	0	**2**
Soil Vapor Points																
VOCs via TO-15	--	--	--	--	--	--	--	--	1	1	2	1	0	0	0	**3**

Notes:

-- = No sample
= Percent
aq. = Aqueous
COD = Chemical oxygen demand
EB = Equipment blank
FB = Field blank
MEE = Methane, ethane, ethylene
MNA = Monitored natural attenuation
MS/MSD = Matrix spike/matrix spike duplicate
PCB = Polychlorinated biphenyl
PFAS = Per- and polyfluoroalkyl substances
QA = Quality assurance
QC = Quality control
SVOC = Semivolatile organic compound
SM = Standard method
TO = Toxic organic
TOC = Total organic carbon
VOC = Volatile organic compound

If redevelopment of TW-2 is successful, no soil samples will be collected

Anions to include nitrate/nitrite and sulfate/sulfite

Benchscale testing to be conducted by subcontractor to EA.

Using dedicated tubing / equipment so no RB needed for GW samples; except for PFAS

Grain size number of samples TBD based on field observation of changes in geological units.

Assumes subset of soil boring samples collected for PFAS and 1,4-Dioxane on-site, one location off-site for background comparison; assumes limited collection of additional parameters in key in situ chemical oxidation application areas

Figures

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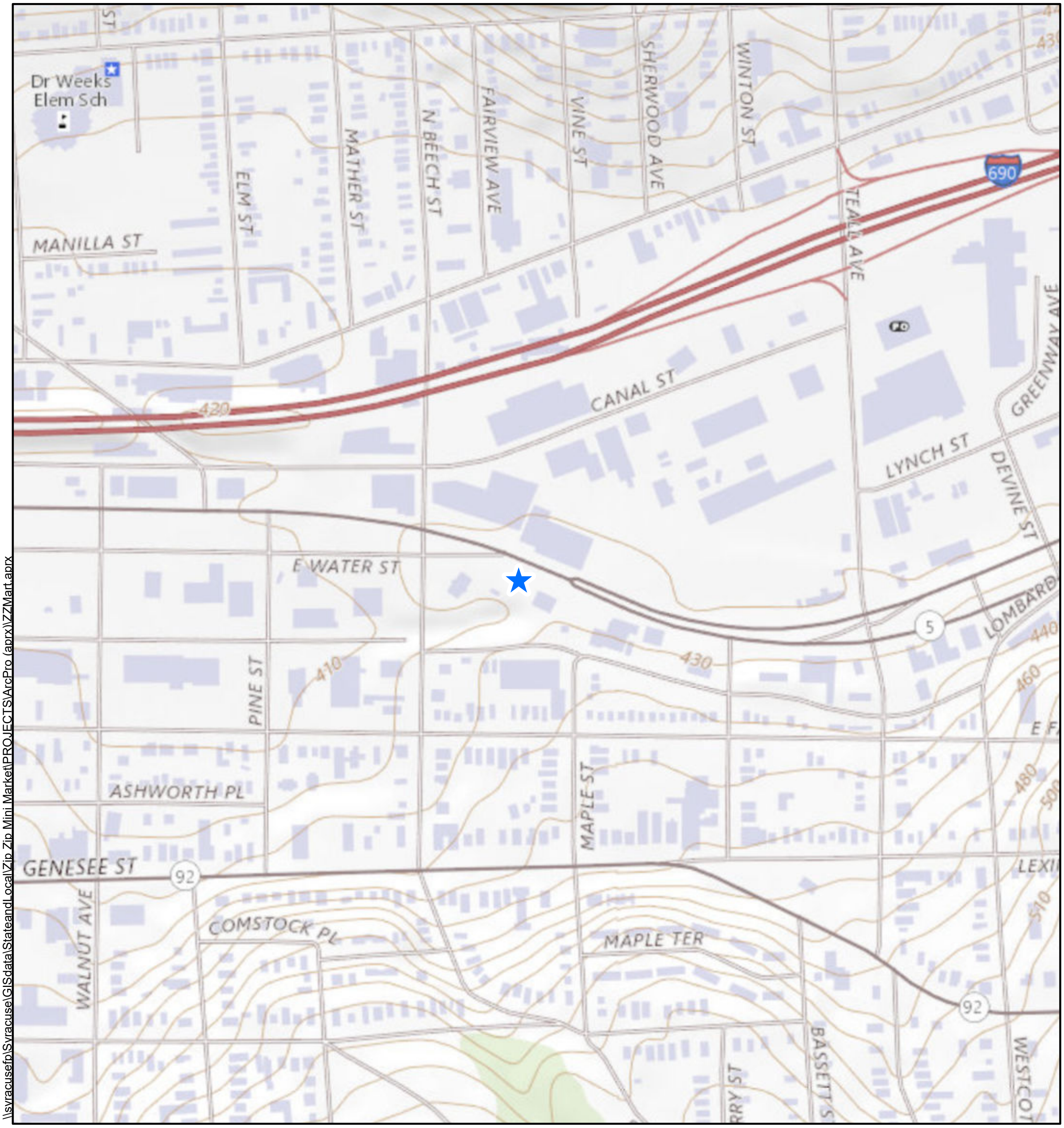
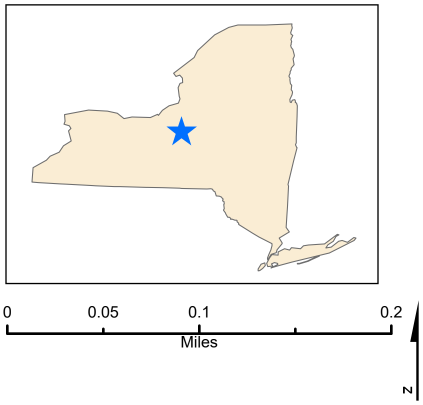




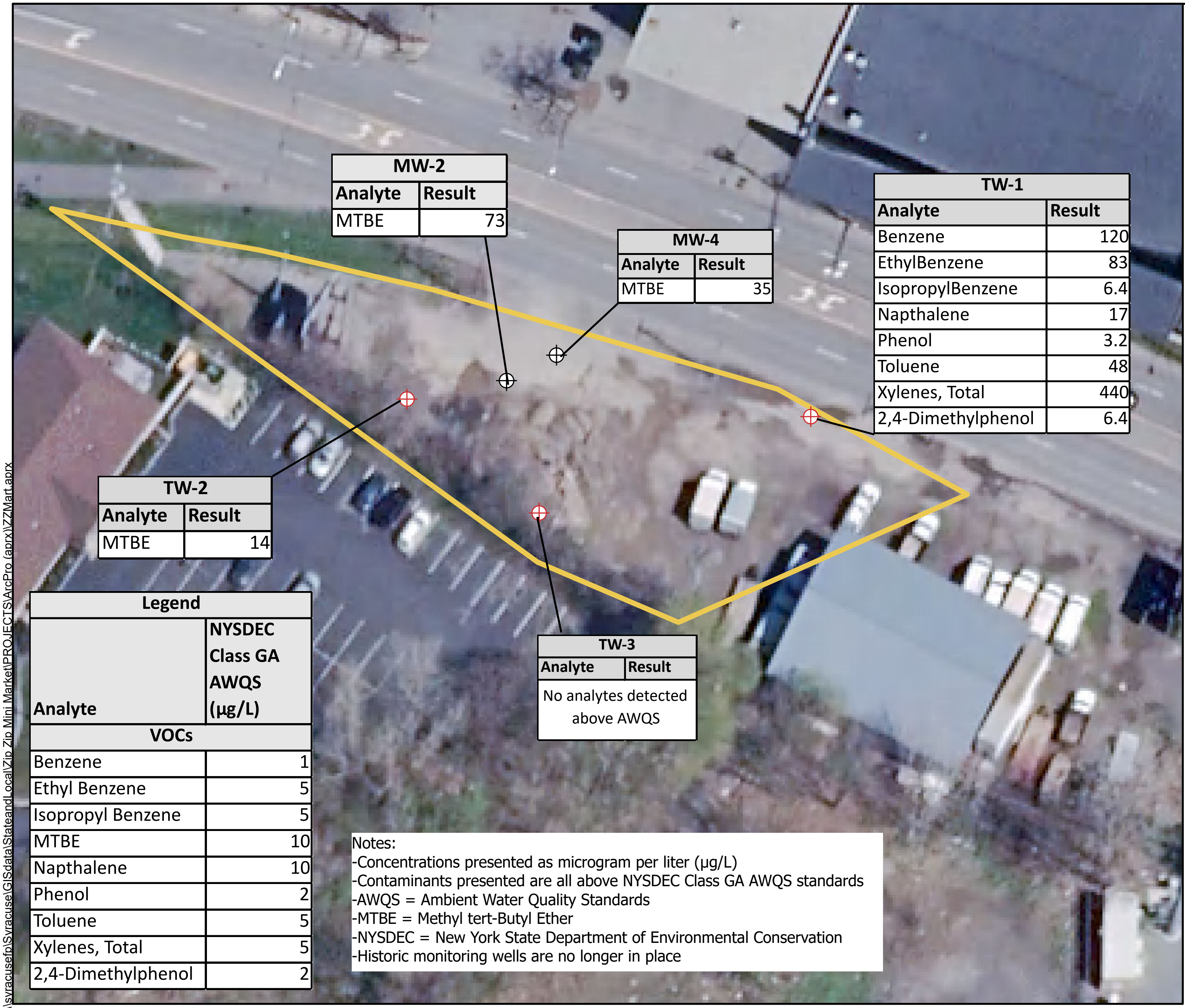
Legend

★ Site Location

Figure 1
Site Location
Zip Zip Mini Market
Syracuse, New York
NYSDEC Site No. B00075

Map Date: 4/27/2023
Projection: NAD 1983 State Plane New York Central FIPS

NEW YORK STATE Department of Environmental Conservation



MW-2	
Analyte	**Result**
MTBE	73

MW-4	
Analyte	**Result**
MTBE	35

TW-1	
Analyte	**Result**
Benzene	120
EthylBenzene	83
IsopropylBenzene	6.4
Napthalene	17
Phenol	3.2
Toluene	48
Xylenes, Total	440
2,4-Dimethylphenol	6.4

TW-2	
Analyte	**Result**
MTBE	14

TW-3	
Analyte	**Result**
No analytes detected above AWQS	

Legend	
Analyte	**NYSDEC Class GA AWQS (µg/L)**
VOCs	
Benzene	1
Ethyl Benzene	5
Isopropyl Benzene	5
MTBE	10
Napthalene	10
Phenol	2
Toluene	5
Xylenes, Total	5
2,4-Dimethylphenol	2

Notes:
-Concentrations presented as microgram per liter (µg/L)
-Contaminants presented are all above NYSDEC Class GA AWQS standards
-AWQS = Ambient Water Quality Standards
-MTBE = Methyl tert-Butyl Ether
-NYSDEC = New York State Department of Environmental Conservation
-Historic monitoring wells are no longer in place

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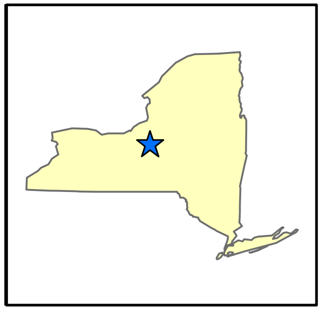
VICINITY MAP



Legend

⌖ Historic Monitoring Well
⌖ Historic Temporary Well
▭ Site Outline

N

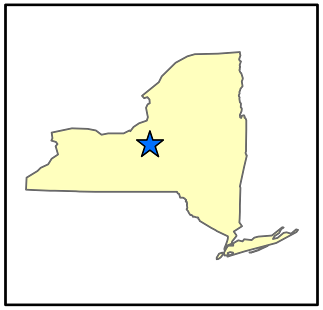
0 37.5 75
Feet

Map Date: 5/1/2023
Projection: NAD 1983 2011 StatePlane
New York Central FIPS 3102 Ft US
Source: NYS Clearinghouse

Figure 2
Existing Well Network and
Groundwater Sampling Data
Zip Zip Mini Market
Syracuse, New York
NYSDEC Site No. B00075

Note:
(1) The proposed reinstalled temporary well point will be installed if existing TW-2 is unable to be redeveloped.

VICINITY MAP



Legend

- Proposed Replacement Monitoring Well Location
- Proposed New Monitoring Well Location
- ● Proposed Soil Vapor Point Location
- ▭ Site Outline

N

0 45 90
Feet

Map Date: 4/27/2023
Projection: NAD 1983 2011 StatePlane
New York Central FIPS 3102 Ft US
Source: NYS Clearinghouse

NEW YORK STATE | Department of Environmental Conservation

Figure 3

Proposed Monitoring Well
and Soil Vapor Point Locations
Zip Zip Mini Market
Syracuse, NY
NYSDEC Site No. B00075

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Appendix A

Field Activities Plan

Generic Field Activities Plan for Work Assignments

NYSDEC Standby Contract No. D009806

Prepared for

New York State Department of Environmental Conservation
Division of Environmental Remediation

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
269 W. Jefferson Street
Syracuse, New York 13202

March 2023

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Generic Field Activities Plan for Work Assignments

NYSDEC Standby Contract No. D009806

Prepared for

New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
269 West Jefferson Street
Syracuse, New York 13202

Revision No.	Description of changes	Date Revisions Completed	Author(s)
00	Original submittal	Not applicable	AE
01	Added reference to NYSDEC guidance on PFAS analysis and sampling	4/3/2020	AE
02	Added/updated new/revised EA SOPs.	3/3/2023	MEM

March 2023
Version: Revision 02

Generic Field Activities Plan for Work Assignments

NYSDEC Standby Contract No. D009806

Prepared for

New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233

NEW YORK STATE | Department of Environmental Conservation

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
269 West Jefferson Street
Syracuse, New York 13202

Donald Co

3 March 2023

Donald Conan, P.E., P.G., Program Manager
EA Engineering, P.C.

Date

Frank DeSantis Jr.

3 March 2023

Frank DeSantis Jr., Deputy Program Manager
EA Science and Technology

Date

March 2023
Version: Revision 02

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LIST OF ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	Microgram(s) per cubic meter
CAMP	Community Air Monitoring Plan
COC	Contaminants of concern
DER	Division of Environmental Regulation
EA	EA Engineering, P.C. and its affiliate EA Science and Technology
ELAP	Environmental Laboratory Approval Program
EPA	U.S. Environmental Protection Agency
FAP	Field Activities Plan
ft	Foot (feet)
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
P.E.	Professional Engineer
P.G.	Professional Geologist
PID	Photoionization detector
ppm	Part(s) per million
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedure
SVI	Soil vapor intrusion
VI	Vapor intrusion
VOC	Volatile organic compound

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1. PURPOSE AND OBJECTIVES

1.1 PURPOSE

This Generic Field Activities Plan (FAP) has been prepared as a generic document of potential field activities that EA Engineering, P.C. and its affiliate EA Science and Technology (EA) may perform or oversee work assignments issued by the New York State Department of Environmental Conservation (NYSDEC) under Division of Environmental Remediation (DER) Standby Engineering Services Contract No. D009806. The principal purpose of this document is to define, detail, and provide rationale for potential field activities that may be performed with each work assignment.

1.2 FIELD ACTIVITY PLAN OBJECTIVES

The elements of this Generic FAP have been prepared in accordance with the current version and applicable guidelines and requirements of the NYSDEC and the New York State Department of Health (NYSDOH), including *DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDEC). In addition, technical guidance from the U.S. Environmental Protection Agency (EPA) has been incorporated into the planning for potential field activities.

Working with standardized approaches to field activities assures all participants (field personnel, clients, and other stakeholders) that effective, consistent processes are followed, and quality is maintained for the project. EA has developed Environmental Standard Operating Procedures (SOPs) to represent EA standards for work performance. These SOPs represent an important part of EA's overall Quality Program and are regularly reviewed and updated, as necessary.

An initial step in every work assignment is the development of a site-specific Work Plan, which will describe the specific work activities to be performed. Site-specific work plans will include this FAP, will be developed separately under each individual work assignment, or as requested by the NYSDEC.

Where applicable, and to promote consistency across the program, EA's SOPs have been referenced in the following sections of this FAP, and referenced SOPs are included in **Appendix A**. If site-specific conditions or requests from NYSDEC result in a change to a standardized approach in the SOPs, changes will be made in consultation with NYSDEC and EA's technical staff, and those changes will be documented in the site-specific Work Plan. Current versions of SOPs will be used during development of Site-Specific Work Plans, and the best available information will be incorporated. EA SOPs may not have been developed for all proposed work. In those cases, details of the proposed work will be described in Site-Specific Work Plans.

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2. BRIEF DESCRIPTION AND RATIONALE OF FIELD ACTIVITIES

The primary focus of a work assignment is to evaluate existing onsite conditions, groundwater flow direction, the nature and extent of potential contamination, and possible human exposure to contaminants through a systematic site investigation/characterization or a full-scale remedial investigation.

The following tasks are anticipated to be completed by EA under Standby Contract No. D009806 as part of a site investigation/characterization and/or remedial investigation:

- ***Section 3 Direct-Push/Macro-Core® Drilling and Sampling***—Identify possible source areas, characterize the overall volume and distribution of contaminants in an area of concern and delineate the limit and extent of contaminants of concern (COCs).

- ***Section 4 Monitoring Well Installation, Construction, and Decommissioning***—Identify hydrogeologic characteristics, groundwater constituents, contaminant plume transport, and the hydraulic relationship between the site and localized groundwater flow.

- ***Section 5 Monitoring Well Development***—Develop new or existing wells using surging and/or pumping techniques. Monitor temperature, conductivity, pH, and turbidity for stabilization and appropriate values.

- ***Section 6 Groundwater Monitoring and Sampling***—Conduct periodic monitoring and/or sampling events to delineate the extent of COCs within a groundwater monitoring well network. Monitor groundwater elevations to determine the local groundwater flow gradient and direction.

- ***Section 7 Exploratory Test Pits/Trenches***—Provide field identification and verification of potential contaminant source areas, subsurface impact areas, and visual classification of geology.

- ***Section 8 Surface Water Sampling***—Collect water samples from surface water bodies (i.e., storm sewers, ditches, streams, etc.) on or adjacent to the site that may receive or convey site COCs.

- ***Section 9 Sediment Sampling***—Collect sediment samples on or adjacent to the site, typically completed in conjunction with surface water sampling.

- ***Section 10 Soil Vapor Point Installation and Sampling***—Install soil vapor points using direct-push technologies for the purpose of collecting representative soil vapor samples for laboratory analysis, at relevant locations as determined by the NYSDEC and in consultation with the NYSDOH.

- ***Section 11 Vapor Intrusion Evaluation*****—**Evaluate the migration of vapors into onsite and offsite residential, commercial, and/or industrial structures through the collection of sub-slab vapor, indoor air, and outdoor ambient air samples.

- ***Section 12 Community Air Monitoring Plans*****—**Monitor volatile organic compounds (VOCs) and particulate levels at the perimeter of the work area in real-time. May consist of a combination of continuous and periodic monitoring, which will be contingent upon site-specific field and construction activities. Continuous monitoring is required for all ground intrusive activities. Periodic monitoring is required during non-intrusive activities

- ***Section 13 Storage and Disposal of Waste*****—**EA will provide proper storage, handling, and disposal of investigative-derived waste.

- ***Section 14 Site Survey and Base Map Preparation*****—**Involves the surveying of all investigation/characterization locations, performing a topographic survey, and preparation of a site base map by a licensed professional land surveyor. EA will locate all field sampling locations using a high-precision global positioning system unit as directed by the NYSDEC.

- ***Section 15 References.***

Details of each anticipated field activity are provided in the following sections.

3. DIRECT-PUSH/MACRO-CORE® DRILLING AND SAMPLING

The purpose of direct-push/Macro-Core® drilling and sampling is to evaluate the shallow overburden at a site and to assess the nature and extent of contamination. During a direct-push/Macro-Core® drilling program, subsurface soil samples are collected continuously from each soil boring until a target depth is reached, or boring refusal. Soil borings are commonly used to classify shallow overburden soils, collect soil samples, delineate the limits and extent of COCs, install temporary monitoring wells/piezometers, and install soil vapor points. Subsurface soil is extracted, screened, and classified to identify soil types, visualize potential contaminants, assess VOC vapors within the soil, and collect representative soil samples from selected depth intervals. Locations of proposed soil samples and rationale for selection for laboratory analysis will be made on a site-specific basis in consultation with NYSDEC. A Community Air Monitoring Plan (CAMP) that includes continuous monitoring is required during ground intrusive activities (Section 12).

An example soil boring log is provided in **Appendix B**. Some or all the following EA SOPs may apply to direct-push drilling and sampling activities:

- SOP-001: Labels
- SOP-002: Chain of Custody Forms
- SOP-003: Subsurface Utility Clearance
- SOP-004: Sample Packing and Shipping
- SOP-005: Field Decontamination
- SOP-011: Photoionization Detector
- SOP-016: Field Logbooks and Surface Water, Groundwater, and Soil-Sediment Field Checklists
- SOP-017: Ground Penetrating Radar Survey
- SOP-025: Soil Sampling
- SOP-028: Well and Boring Abandonment
- SOP-039: Sample Preservation and Container Requirements
- SOP-042: Disposal of Investigation-Derived Material
- SOP-047: Direct-Push Technology Sampling

- SOP-056: XRF Analysis of Soil

- SOP-073: Sampling Per- and Polyfluorinated Alkyl Substances

4. MONITORING WELL INSTALLATION, CONSTRUCTION, AND DECOMMISSIONING

Monitoring wells are installed and constructed to identify hydrogeologic characteristics, groundwater constituents, contaminant plume transport, and the hydraulic relationship between the site and localized groundwater flow direction. Monitoring wells may be installed in overburden or bedrock and within confined and/or unconfined aquifers in order to delineate the nature and extent of a contaminant plume on a horizontal and vertical basis. The exact locations of monitoring wells are based upon the information collected during the field investigation activities, knowledge of the existing distribution of contaminants, historical data and/or preliminary site assessment results. Monitoring well locations will be determined on a site-specific basis. The typical construction of a monitoring well is depicted on **Figure 1**. Monitoring well decommissioning will be conducted in a manner consistent with *CP-43: Groundwater Monitoring Well Decommissioning* Policy (NYSDEC). A Community Air Monitoring Plan (CAMP) that includes continuous monitoring is required during ground intrusive activities (Section 12).

Some or all the following EA SOPs apply to monitoring well installation, construction, and decommissioning activities:

- SOP-003: Subsurface Utility Clearance
- SOP-011: Photoionization Detector
- SOP-016: Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists
- SOP-017: Ground Penetrating Radar Survey
- SOP-019: Monitoring Well Installation
- SOP-028: Well and Boring Abandonment
- SOP-032: Piezometer Installation

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5. MONITORING WELL DEVELOPMENT

Groundwater monitoring wells installed at a site will be developed prior to sampling, in order to purge any drilling fluids or sediment that may have entered the well through the filter pack and well screen during installation. In some cases, existing monitoring wells may also require development. Well development helps to establish good hydraulic connection between the well and the surrounding formation and to remove fine-grained material that may have infiltrated the sand pack and/or well during installation. Well development procedures are described in EA SOP-019, Monitoring Well Installation. An example monitoring well development log is provided in **Appendix B**.

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6. GROUNDWATER MONITORING AND SAMPLING

Groundwater samples may be collected from temporary and permanent monitoring wells. A monitoring well sampling log is provided in **Appendix B**. Some or all the following EA SOPs apply to groundwater monitoring and sampling activities. If sampling activities include analysis for per- and polyfluorinated substances (PFAS), refer to EA SOP-073, and *Guidelines for Sampling and Analysis of PFAS* (NYSDEC 2020).

- SOP-001: Labels
- SOP-002: Chain-of-Custody Form
- SOP-003: Subsurface Utility Clearance
- SOP-004: Sample Packing and Shipping
- SOP-005: Field Decontamination
- SOP-010: Water Level and Well Depth Measurement
- SOP-011: Photoionization Detector
- SOP-013: Collection of Monitoring Well Samples
- SOP-016: Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists
- SOP-033: Aquifer Hydraulic Testing
- SOP-039: Sample Preservation and Container Requirements
- SOP-043: Multi-probe Water Quality Monitoring Instruments
- SOP-044: Assessment of Existing Wells Using Downhole Geophysics
- SOP-046: Aqueous Diffusion Samplers
- SOP-048: Low-flow Sampling
- SOP-051: Low-flow Purge and Sampling with Dedicated Pumps
- SOP-055: Continuous Multi-Channel Tubing Groundwater Sample Collection
- SOP-056: XRF Analysis of Soil

- SOP-073: Sampling for Per- and Polyfluorinated Alkyl Substances

7. EXPLORATORY TEST PITS/TRENCHS

When detailed observation of subsurface soil and/or fill material is necessary, exploratory test pits/trenches can be utilized for visual inspection and collection of subsurface soil samples. Test pits/trenches will utilize either a backhoe, an excavator, or similar equipment, to remove significant amounts of subsurface soil/fill material for visual inspection and soil classification. Procedures for test pit and trench sampling are described below. A Community Air Monitoring Plan (CAMP) that includes continuous monitoring is required during ground intrusive activities (**Section 12**). Some or all the following EA SOPs may apply to test pit and trenching activities:

- SOP-001: Labels
- SOP-002: Chain-of-Custody Form
- SOP-003: Subsurface Utility Clearance
- SOP-004: Sample Packing and Shipping
- SOP-005: Field Decontamination
- SOP-011: Photoionization Detector
- SOP-016: Field Logbooks and Surface Water, Groundwater, and Soil-Sediment Field Checklists
- SOP-017: Ground Penetrating Radar Surveys
- SOP-025: Soil Sampling
- SOP-039: Sample Preservation and Container Requirements
- SOP-040: Confined Space Entry
- SOP-073: Sampling for Per- and Polyfluorinated Alkyl Substances

7.1 PROCEDURES FOR TEST PIT/TRENCHING SAMPLING

The appropriate equipment will be chosen based on site-specific conditions and the goals of the sampling program. The following procedures will be utilized during test pit/trench installation and sampling.

- Remove a 3 feet (ft) wide section of soil to a depth of approximately 1 ft below ground surface. Place excavated soils on plastic sheeting or per the requirements of the site-specific work plan.

- Screen and classify the excavated material to identify soil types, perform visual inspection for signs of contamination, and collect representative soil samples from selected depth intervals. Assess VOC vapors within the soil using photoionization detectors (PID), flame ionization detectors, and/or visual and olfactory observations.

- Continue excavation by removing shallow layers of soil for classification until the desired depth of the test pit/trench is reached.

- The selection of subsurface soils for laboratory analysis will be made in consultation with NYSDEC based the following parameters:

  - Subsurface soil materials that exhibit visual or olfactory signs of contamination

  - Subsurface soil materials that cause a sustained response above the measured background response on a calibrated PID or flame ionization detectors flame ionization detectors screening instrument.

- Following sample collection, backfill the excavation with the excavated soil/fill material and flag the corners of the test pit for future surveying.

Soil samples will be collected from the most contaminated interval at each test pit location utilizing visual observations and measurements from instruments such as a PID or FID to determine which samples will be sent for laboratory analysis. If no contamination is detected or observed, a subsurface soil sample is collected from the base of the test pit/trench.

Test pits/trenches will be classified and logged according to EA SOP-016. A field record of each pit or trench classification, sampling interval, PID reading, and other field observations will be recorded on a test pit/trench log form (**Appendix B)**.

Soil samples collected will be labeled, handled, and packaged following the procedures described EA SOP-025, the Generic Quality Assurance Project Plan (QAPP), and site-specific QAPP Addendum. If sampling activities include analysis for PFAS, refer to EA SOP-073, and *Guidelines for Sampling and Analysis of PFAS* (NYSDEC 2020). Quality assurance/quality control samples will be collected at the frequency detailed in the Generic QAPP, and site-specific QAPP Addendum.

8. SURFACE WATER SAMPLING

Surface water sampling may be required in marine and estuarine systems, streams, river, ditches, lakes, ponds, and lagoons. A surface water sampling log is provided in **Appendix B**. If sampling activities include analysis for PFAS, refer to EA SOP-073, and *Guidelines for Sampling and Analysis of PFAS* (NYSDEC 2020). Some or all the following EA SOPs may apply to surface water sampling activities:

- SOP-001: Labels
- SOP-002: Chain-of-Custody Forms
- SOP-003: Subsurface Utility Clearance
- SOP-004: Sample Packing and Shipping
- SOP-005: Field Decontamination
- SOP-007: Surface Water Sampling
- SOP-016: Field Logbooks and Surface Water, Groundwater and Soil-Sediment Field Checklists
- SOP-035: Small Boat Operations
- SOP-039: Sample Preservation and Container Requirements
- SOP-043: Multiprobe Water Quality Monitoring Instruments
- SOP-073: Sampling for Per- and Polyfluorinated Alkyl Substances

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9. SEDIMENT SAMPLING

Sediment sampling may be required to characterize contamination from sediment in streams, rivers, ditches, lakes, ponds, lagoons, and marine and estuarine systems. The collection of benthic organisms and fish is often conducted in conjunction with sediment sampling. Example sampling logs for sediment and fish are provided in **Appendix B**. If sampling activities include analysis for PFAS, refer to EA SOP-073, and *Guidelines for Sampling and Analysis of PFAS* (NYSDEC 2020). Some or all the following EA SOPs may apply to sediment sampling activities:

- SOP-001: Labels
- SOP-002: Chain-of-Custody Forms
- SOP-003: Subsurface Utility Clearance
- SOP-004: Sample Packing and Shipping
- SOP-005: Field Decontamination
- SOP-016: Field Logbooks and Surface Water, Groundwater and Soil-Sediment Field Checklists
- SOP-021: Sediment Sampling
- SOP-022: Sediment and Benthic Macroinvertebrate Sampling with Eckman Grab
- SOP-035: Small Boat Operations
- SOP-038: Redox Potential Measurements
- SOP-039: Sample Preservation and Container Requirements
- SOP-041: Sludge-Lagoon Sampling
- SOP-042: Disposal of Investigation-Derived Material
- SOP-054: Collection of Fish Tissue for Chemical Analysis
- SOP-064: Sediment Boring Logs
- SOP-073: Sampling for Per- and Polyfluorinated Alkyl Substances

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10. SOIL VAPOR POINT INSTALLATION AND SAMPLING

The primary purpose of a soil vapor investigation is to characterize and quantify the lateral and longitudinal extents of soil vapor contamination within the vadose zone. The soil vapor data may be used to evaluate the potential for vapor intrusion (VI) in structures located onsite, downgradient of the site, or adjacent to the sampling locations.

Vadose zone monitoring can be used to develop subsequent site characterization activities such as installation of groundwater monitoring points. The vadose zone monitoring will be completed using an acceptable soil gas methodology and will include the collection of quality assurance and quality control samples.

The typical construction of a soil vapor point is depicted on **Figure 2**, and **Figure 3** shows the typical construction of a sub-slab soil vapor point. The following EA SOPs apply to soil vapor point installation and sampling activities:

- SOP-001: Labels
- SOP-002: Chain-of-Custody Forms
- SOP-003: Subsurface Utility Clearance
- SOP-004: Sample Packing and Shipping
- SOP-005: Field Decontamination
- SOP-006: Summa Canister Sampling
- SOP-011: Photoionization Detector
- SOP-016: Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists
- SOP-020: Active Soil Gas Sampling
- SOP-026: Active Soil Gas Analysis
- SOP-027: Passive Soil Gas Surveys
- SOP-047: Direct-Push Technology Sampling

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11. VAPOR INTRUSION EVALUATION

The planning and implementation of any VI evaluation will be completed in accordance with the current versions of *Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (NYSDOH) and *DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDEC).

Indoor air sampling and analysis is performed at structure locations identified by the NYSDEC and NYSDOH. The overall goal of a VI evaluation is to determine and evaluate the potential for VI into these structures.

Notices of solicitation to participate in the indoor air monitoring program should include an access agreement granting permission to perform the work. Negotiation of access agreements with affected property owners will be conducted by NYSDEC. If property owners refuse to provide access to the site, NYSDEC may seek access though Environmental Conservation Law (ECL) Article 27 § 1309, (3)-(4) and § 1313(3), which authorizes NYSDEC or its authorized agents to enter upon any site, areas near such site, or area on which it has reason to believe that contaminants were disposed or discharged for purposes of inspection, sampling and testing, implementing a remedial program, long-tern operation and maintenance, and temporary occupancy.

Prior to initiating the air sampling, property owners will be contacted by NYSDEC or NYSDOH to discuss the sampling program and schedule the sampling. The NYSDEC Project Manager will provide EA with a copy of the correspondence and indoor air sampling schedule.

Procedures for elements of a VI evaluation are described below. Soil vapor sampling logs are provided in **Appendix B**. Also, some or all the following EA SOPs may apply to VI evaluation activities:

- SOP-001: Labels
- SOP-002: Chain-of-Custody Forms
- SOP-003: Subsurface Utility Clearance
- SOP-004: Sample Packing and Shipping
- SOP-005: Field Decontamination
- SOP-006: Summa Canister Sampling
- SOP-011: Photoionization Detector
- SOP-016: Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists
- SOP-020: Active Soil Gas Sampling

- SOP-026: Active Soil Gas Analysis

- SOP-027: Passive Soil Gas Surveys

- SOP-047: Direct-Push Technology Sampling

11.1 INDOOR AIR SAMPLE COLLECTION

An inspection of general site conditions will be performed at each property location as part of the VI evaluation. Field activities should not be scheduled without the following:

- Either a voluntary access agreement or other authorization by NYSDEC to enter the property, and

- Verbal communication with property owner confirming the sampling activity schedule.

The inspection will include the following activities:

- Completion of the NYSDOH Indoor Air Quality Questionnaire and Building Inventory included in Indoor Air Sampling and Analysis Guidance. A sample of the questionnaire is included in **Appendix B**.

- Documentation of weather conditions outside and temperature inside.

- Ambient air (indoor and outdoor) screening using field equipment (i.e., parts per billion PID).

- Selection of air sampling locations.

Indoor air samples will be collected at structures during the soil vapor intrusion (SVI) evaluation in accordance with the NYSDOH SVI Guidance and applicable EA SOPs.

Prior to initiating the sampling, the serial number of the canisters and associated regulators will be recorded on the field sampling forms. Field sampling forms will include the collection of canister/regulator serial numbers, sample identifications, sample start date/times, vacuum gauge pressures, and required analysis. Indoor air sampling field forms are provided in **Appendix B**.

11.2 OUTDOOR AIR SAMPLE COLLECTION

Outdoor ambient air samples will be collected to determine outdoor air quality during the sampling event. Outdoor ambient air samples will be collected at the same time as any sub-slab vapor or indoor air sampling activities. Outdoor air samples will be collected in accordance with the NYSDOH SVI Guidance, and any applicable EA SOPs.

Prior to initiating the sampling, the serial number of the canisters and associated regulators will be recorded on the field sampling forms. Field sampling forms include the collection of canister/regulator serial numbers, sample identifications, sample start date/times, vacuum gauge pressures, and required analysis (EPA Method TO-15).

11.3 LABORATORY ANALYSIS OF AIR SAMPLES

Air samples will be analyzed by an ELAP-certified laboratory. Detection limits for the analyzed compound list will be defined by the NYSDEC and NYSDOH prior to sample submittal and outlined in the site-specific work plan. For specific parameters identified by NYSDOH where the selected parameters may have a higher detection limit (e.g., acetone), the higher detection limits will be designated by NYSDOH.

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12. COMMUNITY AIR MONITORING PLANS

In accordance with DER-10, A Community Air Monitoring Plan (CAMP) will be developed at sites in which the public using the site, surrounding community, or site workers may be exposed to contamination at the site. A site-specific CAMP will be prepared for sites in which intrusive activities at the site may impact site workers or the surrounding community. The following sections provide generic information regarding CAMPs, which may be implemented at a site, based upon the intrusive work completed at the site, and in accordance with the NYSDEC and NYSDOH. The NYSDOH Generic CAMP, provided in Appendix 1A of DER-10, shall be the basis for development of site-specific CAMPs for intrusive site work. Additional guidance for fugitive dust and particulate monitoring is provided in Appendix 1B of DER-10. EA SOP-011 (Photoionization Detector) applies to community air monitoring activities. Community air monitoring shall be based on contaminants of concern, proposed work activities, and site-specific features.

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13. STORAGE AND DISPOSAL OF WASTE

EA is responsible for the proper storage, handling, and disposal of investigative-derived waste (IDW); including personal protective equipment, solids and liquids generated during the well drilling, well development, and well sampling activities. Management of IDW will be conducted in accordance with *DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDEC) and EA's SOP-042: Disposal of Investigation-Derived Material.

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14. SITE SURVEY AND BASE MAP PREPARATION

A site survey will involve the surveying of all soil boring locations, monitoring well locations, test pit locations, soil vapor point locations, and surface water/sediment sampling locations, performing a topographic survey, and preparation of a site map (typically based upon a previous base map or site control markers). To ensure the collection of consistent elevation data, each of the existing monitoring wells or other pertinent locations will be included in the site survey.

A detailed topographic base map of the site and immediate vicinity will be developed. All relevant features of the site and adjacent areas will be plotted. Elevations will be referenced to the North American Vertical Datum of 1988 (NAVD 88), and all horizontal locations will be referenced to the North American Datum of 1983 (NAD 83). The base map will be used to accurately plot all sampling locations including soil borings, monitoring wells, and all other sample/monitoring locations. Elevations of all monitoring well casings will be established to within 0.01 ft. A permanent reference point will be marked on the interior of all well casings to provide a point to collect future groundwater elevation measurements.

The site map will also include site-specific features associated with the characterization/ investigation (i.e., surface water drainage, above and underground storage tanks, buildings, drywells, cesspools). Additionally, engineering controls implemented or to be implemented at the site must be clearly labeled. Contours will be plotted at 1-ft intervals. The location and elevation of each survey point will be surveyed by a New York State licensed surveyor. The estimated survey area will include the entire site boundary. The site tax map number will also be identified. The tax maps will be reviewed, and the property lines of the parcels will be plotted on the base map.

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15. REFERENCES

EA Engineering, P.C. and Its Affiliate EA Science and Technology (EA). 2020. *Generic Quality Assurance Project Plan for Work Assignments.* March.

———. 2020. *Generic Health and Safety Plan for Work Assignments.* February.

New York State Department of Environmental Conservation (NYSDEC). *DER-10 Technical Guidance for Site Investigation and Remediation.* May.

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

———. 2020. *Guidelines for Sampling and Analysis of PFAS Under NYSDEC's Part 375 Remedial Programs*. January.

New York State Department of Health (NYSDOH). *Guidance for Evaluating Soil Vapor Intrusion in the State of New York. New York State Department of Health, Division of Environmental Health Assessment, Center for Environmental Health.* October.

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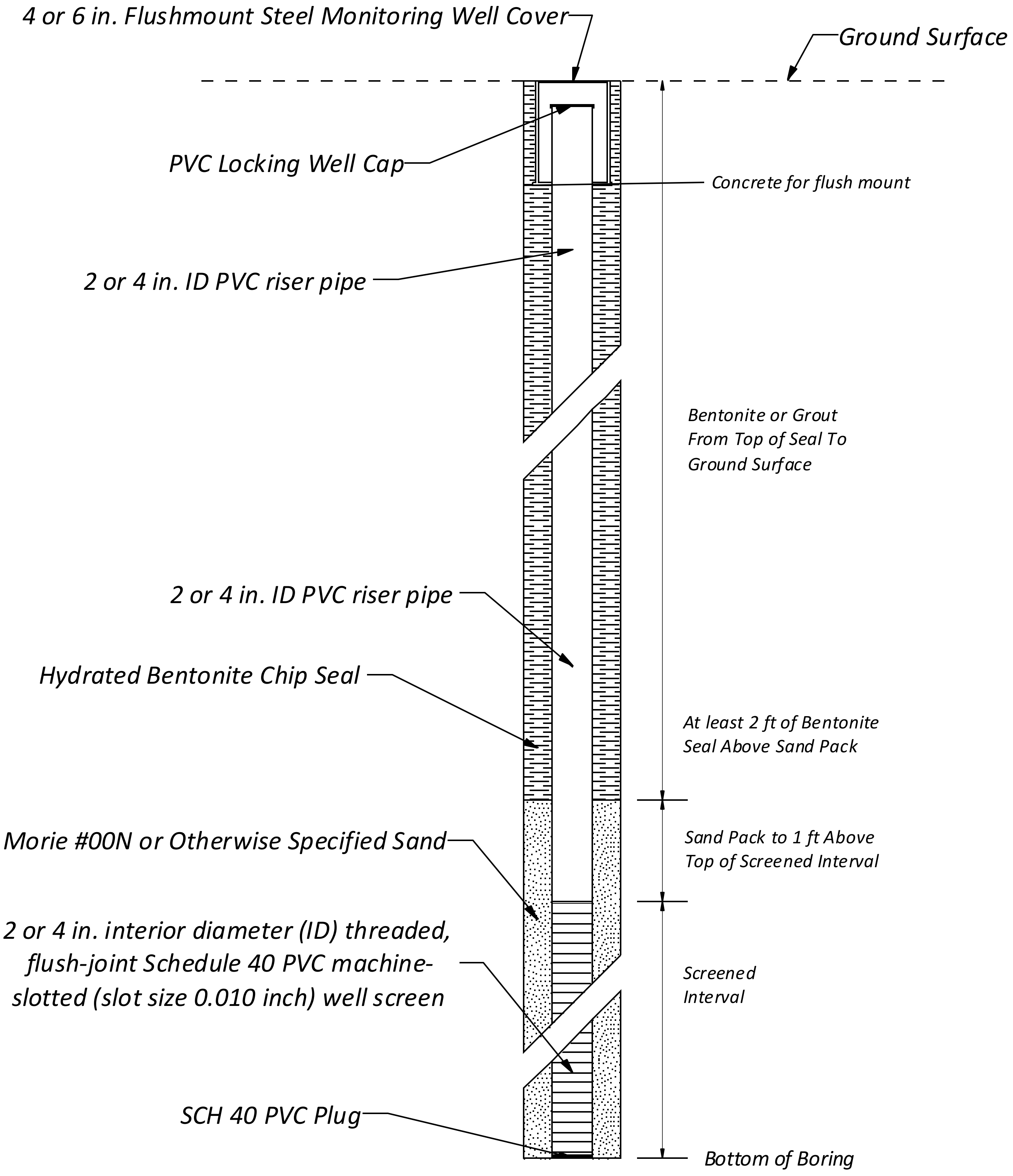
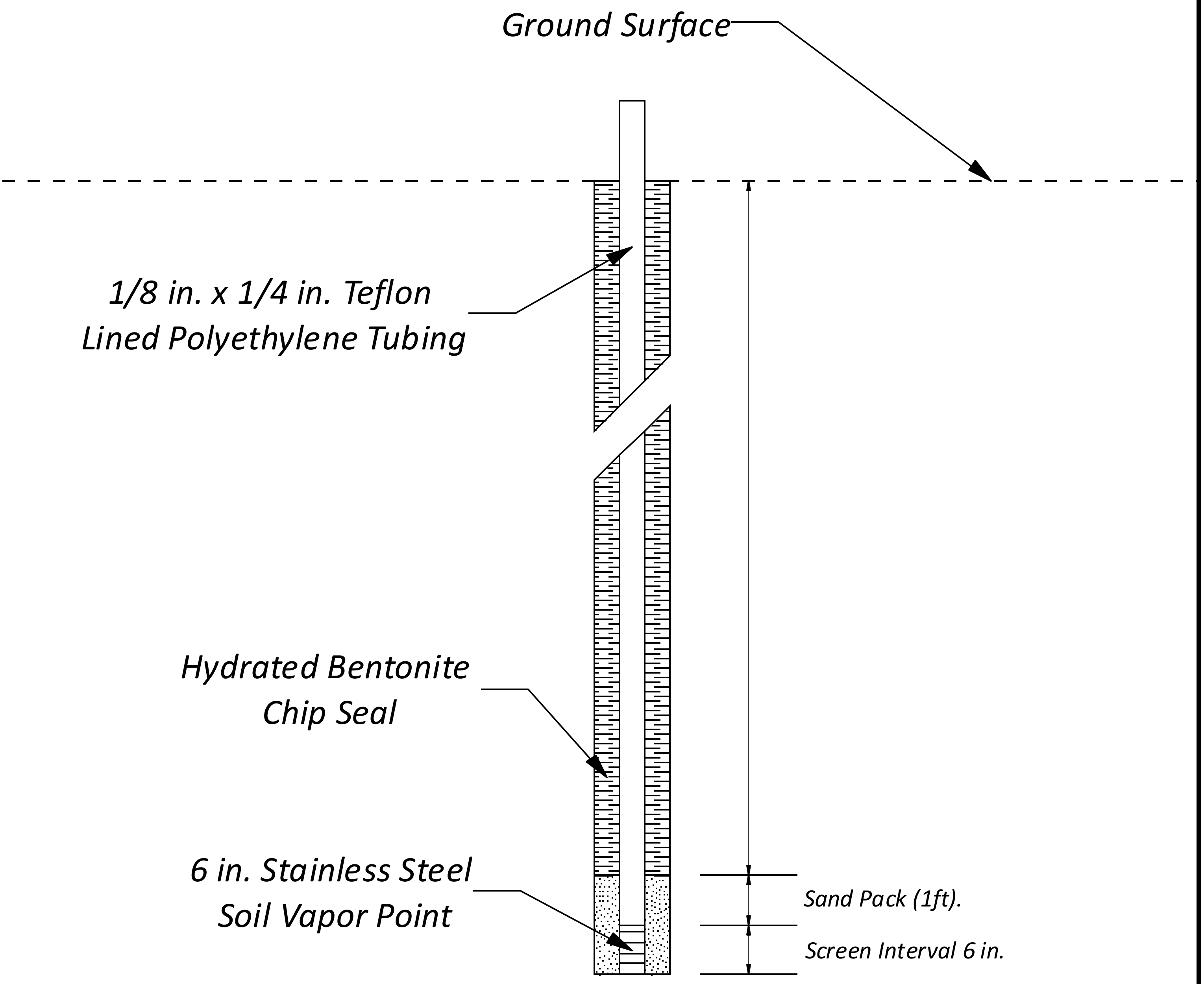
Figures



NYSDEC
CONTRACT NO. D009806
GENERIC FIELD ACTIVITIES PLAN

Figure 1
Typical Monitoring Well
Construction Diagram

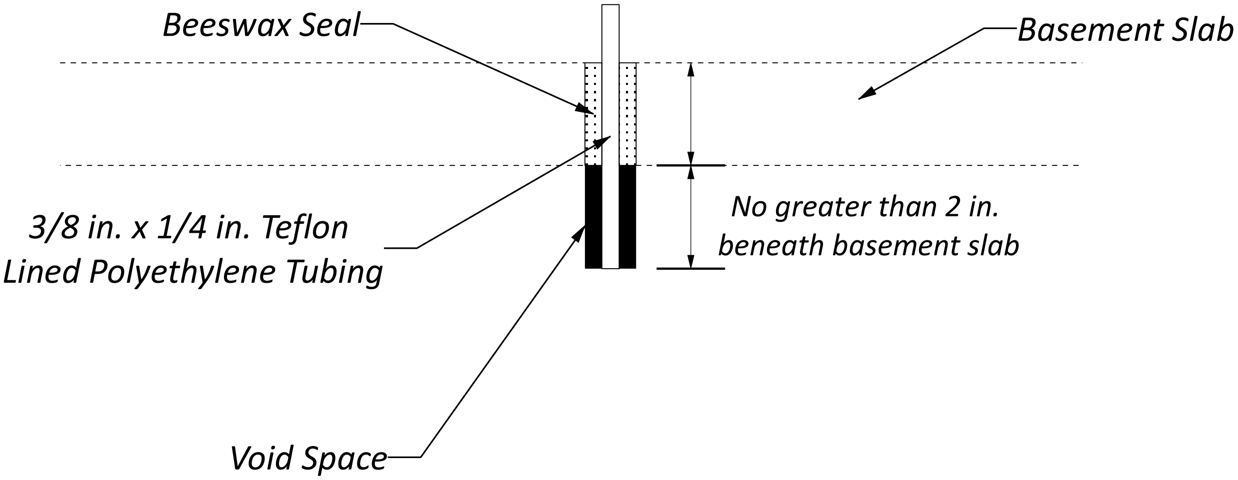


Soil vapor sampler set at 8 ft bgs or 1 ft above water table

NYSDEC
CONTRACT NO. D009806
GENERIC FIELD ACTIVITIES PLAN

Figure 2
Typical Temporary Soil Vapor
Point Construction Diagram

NEW YORK STATE Department of Environmental Conservation



NYSDEC
CONTRACT NO. D009806
GENERIC FIELD ACTIVITIES PLAN

Figure 3
Typical Sub-Slab Vapor Sample
Point Construction Diagram

NEW YORK STATE | Department of Environmental Conservation

Appendix A

EA Standard Operating Procedures

SOP No.	Title
001	Labels
002	Chain-of-Custody Form
003	Subsurface Utility Clearance
004	Sample Packing and Shipping
005	Field Decontamination
006	Summa Canister Sampling
007	Surface Water Sampling
008	Trimble Geo 7X Global Positioning System Units
009	Fieldwork during Times of High Risk for Wildfire
010	Water Level and Well Depth Measurements
011	Photoionization Detector
012	Drone Operations
013	Collection of Monitoring Well Samples
014	Collection of Production Well Samples
016	Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists
017	Ground Penetrating Radar Survey
019	Monitoring Well Installation
020	Active Soil Gas Sampling
021	Sediment Sampling
022	Sediment and Benthic Macroinvertebrate Sampling with Eckman Grab
025	Soil Sampling
026	Active Soil Gas Analysis
027	Passive Soil Gas Surveys
028	Well and Boring Abandonment
029	Extraction Wells
032	Piezometer Installation
033	Aquifer (Hydraulic) Testing
034	Drum Sampling
035	Small Boat Operations
039	Sample Preservation and Container Requirements
040	Confined Space Entry
041	Sludge/Lagoon Sampling
042	Disposal of Investigation-Derived Material
043	Multi-Probe Water Quality Monitoring Instruments
044	Assessment of Existing Wells Using Downhole Geophysics
046	Aqueous Diffusion Samplers
047	Direct-Push Technology Sampling
048	Low-Flow Sampling
051	Low Flow Purge and Sampling with Dedicated Pumps
053	Concrete Coring

SOP No.	Title
054	Collection of Fish Tissue for Chemical Analysis
055	Continuous Multi-Channel Tubing Groundwater Sample Collection
056	XRF Analysis of Soil
057	Incremental Sampling Methodology
064	Sediment Boring Logs
071	In Situ Respiration Testing of a Bioventing System
072	Non-Aqueous Phase Liquid Baildown Testing
073	Sampling for Per- and Polyfluorinated Alkyl Substances

Standard Operating Procedure No. 001
for
Sample Labels

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 1
November 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 001	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	29 November 2018	Systematic review and update	Dan Hinckley Sheena Styger Sanita Corum	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the use of sample labels. Every sample will have a sample label uniquely identifying the sampling point and analysis parameters. An example label is provided below. Other formats with similar levels of detail are acceptable. Some project software including Scribe (U.S. Environmental Protection Agency (EPA)-associated projects) and FUDSchem (U.S. Army Corps of Engineers-associated projects) can generate pre-prepared labels thus minimizing efforts in the field.

NOTE: It is important to review with the Project/Program Manager to determine if client or project-specific modifications to this SOP are required. For example, if using EPA laboratories, case numbers may be assigned in lieu of having site or project names on the label.

PROJECT NAME ______________ PROJECT NUM. ____________
SAMPLE LOCATION/SITE ID _____________________________
DATE: ____/____/____ TIME: _____:_____
ANALYTES: METALS VOC EXPLOSIVES ORGANICS OTHER
FILTERED: [NO] [YES]
PRESERVATIVE: [NONE] [HNO_3] [OTHER ______]
SAMPLER: _____________________

2. MATERIALS

The following materials may be required:

- Sample label
- Indelible marker.

3. PROCEDURE

The following sections describe how to use the sample labeling system.

3.1 LABEL INFORMATION

As each sample is collected/selected, fill out a sample label. Enter the following information on each label:

- Project name (do not include if there is a project or client-specific requirement to exclude)
- Project Number (or Case Number, as applicable)
- Location/site identification—enter the media type (i.e., well number, surface water, soil, etc.) sampling number, and other pertinent information concerning where the sample was taken
- Date of sample collection
- Time of sample collection
- Analyses to be performed (NOTE: Due to number of analytes, details of analysis should be arranged with laboratory *prior to start of work)*
- Whether filtered or unfiltered (water samples only)
- Preservatives (water samples only)
- Number of containers for the sample (e.g., 1 of 2, 2 of 2).

3.2 ROUTINE CHECK

Double-check the label information to make sure it is correct. Detach the label, remove the backing, and apply the label to the sample container. Cover the label with clear tape, ensuring that the tape completely encircles the container.

3.3 RECORD INFORMATION

Record the sample number and designated sampling point in the field logbook, along with the following sample information:

- Time of sample collection (each logbook page should be dated)
- Location of the sample
- Organic vapor meter or photoionization meter readings for the sample (when appropriate)
- Any unusual or pertinent observations (oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, etc.)
- Number of containers required for each sample

- Whether the sample is a quality assurance sample (split, duplicate, matrix spike/matrix spike duplicate, or blank).

3.3.1 Logbook Entry

A typical logbook entry might look like this:

- 7:35 a.m. Sample No. MW-3. Photoionization Detector = 35 parts per million.
- Petroleum odor present. Sample designated MW-3-001.

NOTE: Duplicate samples may be given a unique sample designation rather than the actual sample number with an added prefix or suffix. This will prevent any indication to the laboratory that this is a duplicate sample thus making it “blind” to the laboratory. This fictitious sample number must be listed in the logbook along with the actual location of the sample.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

If “blind” field duplicate samples have been called for, then no indication of which samples are duplicates is to be provided to the laboratory.

6. REFERENCES

Not applicable.

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Standard Operating Procedure No. 002
for
Chain-of-Custody Form

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
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Hunt Valley, Maryland 21031

Revision 1
November 2018

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 002	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	29 November 2018	Systematic review and update	Dan Hinckley, Sheena Styger, Sanita Corum	Matthew Bowman

1. SCOPE AND APPLICATION

A chain-of-custody record (attached) is used as physical evidence of sample custody and as a permanent record for each sample collected. A chain-of-custody record documents the exchange and transportation of samples from the field to the laboratory. The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for use of the chain-of-custody form. Three example forms are provided as Figures SOP002-1 (EA's standard electronic chain-of-custody form), SOP002-2 (EA's Toxicology Laboratory chain-of-custody form), and SOP002-3 (U.S. Environmental Protection Agency [EPA] Scribe chain-of-custody form). Other formats with similar levels of detail are acceptable.

Most EPA projects utilize sampling and chain-of-custody instructions as documented in EPA's Samplers Guide (2014), which includes the use of Scribe, an in-house software program used to establish computer records of all environmental data and includes generation of chain-of-custodies. Using Scribe requires training, and the software and guidance can be found at the following link: https://response.epa.gov/site/site_profile.aspx?site_id=ScribeGIS. Training on Scribe is necessary and can be obtained through the Scribe weblink.

All new U.S. Army Corps of Engineers projects require the use of Formerly Used Defense Sites chemistry database (FUDSchem), which can be found at the following link: http://fudschem.com/public/framework/bannerhtml.aspx?dsn=systm&idhtml=10642&themesuffix=default&banner=banner_fudschem.jpg. This software will generate chain-of-custody forms specific to the sampling session. As with Scribe, FUDSchem training is necessary.

It is essential that chain-of-custody forms be completed properly, and that sample relinquishment be signed and dated appropriately. Laboratories use chain-of-custodies as their statement of work and, if it is not correct, the samples will not be analyzed appropriately. Sample custody documentation assures that the particular samples have been in secure locations, and that none of them have been tampered with, thus assuring appropriate results.

2. MATERIALS

The following materials may be required: chain-of-custody form and indelible ink pen.

3. PROCEDURE

- Give the site name and project name/number.
- Enter the sample identification code.
- Indicate the sampling dates for all samples.
- List the sampling times (military format) for all samples.

- Enter the total number of containers per cooler.

- List the analyses/container volume.

- Obtain the signature of sample team leader.

- State the carrier service and airbill number, analytical laboratory, and custody seal numbers (if applicable).

- Sign, date, and time the "relinquished by" section. Be sure the carrier signs and enters dates and time of acceptance of the samples.

- Upon completion of the form, retain a copy or portable document format, and affix the laboratory copy to the inside of the sample cooler in a zip-seal bag to protect from moisture, to be sent to the designated laboratory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency (EPA). 2014. Sampler's Guide, Contract Laboratory Program Guidance for Field Samplers. EPA/540/R014/013, Directive 92400.2-147. October.

Figures

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Figure SOP002-1 EA Chain-of-Custody Form

Company Name:

Project Manager or Contact:

Phone:

Project No.

Project Name:

Dept.: Task:

Sample Storage Location:

P.O. No.:

Page of

Report No.:

Parameters/Method Numbers for Analysis

Chain-of-Custody Record

EA Laboratories
231 Schilling Circle
Hunt Valley, MD 21031
Telephone: (410) 584-7000

Report Deliverables:
1 2 3 4 D E

EDD: Yes/No

DUE TO CLIENT: __________

Date	Time	Water	Soil	Sample Identification 19 Characters	**No. of Containers**														**EA Labs Accession Number**	Remarks
				XXXXXXXXXXXXXXXXXXX																**LPM**:
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
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Company Name:	Project Manager or Contact: Phone:	Parameters/Method Numbers for Analysis	Chain-of-Custody Record EA Laboratories 231 Schilling Circle Hunt Valley, MD 21031 Telephone: (410) 584-7000
Project No. Dept.: Task:	Project Name:		
Sample Storage Location:	P.O. No.:		**Report Deliverables:** **1 2 3 4 D E**
Page of	**Report No.:**		**EDD: Yes/No** **DUE TO CLIENT: _________**

Date	Time	Water	Soil	Sample Identification 19 Characters	**No. of Containers**														**EA Labs Accession Number**	Remarks
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																

Samples by: (Signature)	Date/Time |	Relinquished by: (Signature)	Date/Time |	Received by: (Signature)	Date/Time |
Relinquished by: (Signature)	Date/Time |	Received by Laboratory: (Signature)	Date/Time |	Airbill Number:	Sample Shipped by: (Circle) Fed Ex. Puro. UPS Hand Carried Other:

Cooler Temp. _______C pH: ___ Yes ___ No Comments: Custody Seals Intact ___ Yes ___ No

NOTE: Please indicate method number for analyses requested. This will help clarify any questions with laboratory techniques.

Figure SOP002-2 EA Toxicology Laboratory Chain-of-Custody Form

Client:

Project Manager:

Phone:

Project Contact:

Phone:

Project Name:

Project#:

Page 1 of 1

Sample Collected		Matrix		SAMPLE IDENTIFICATION	No. of Containers																							
Date	Time	Sediment	Water																									

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time

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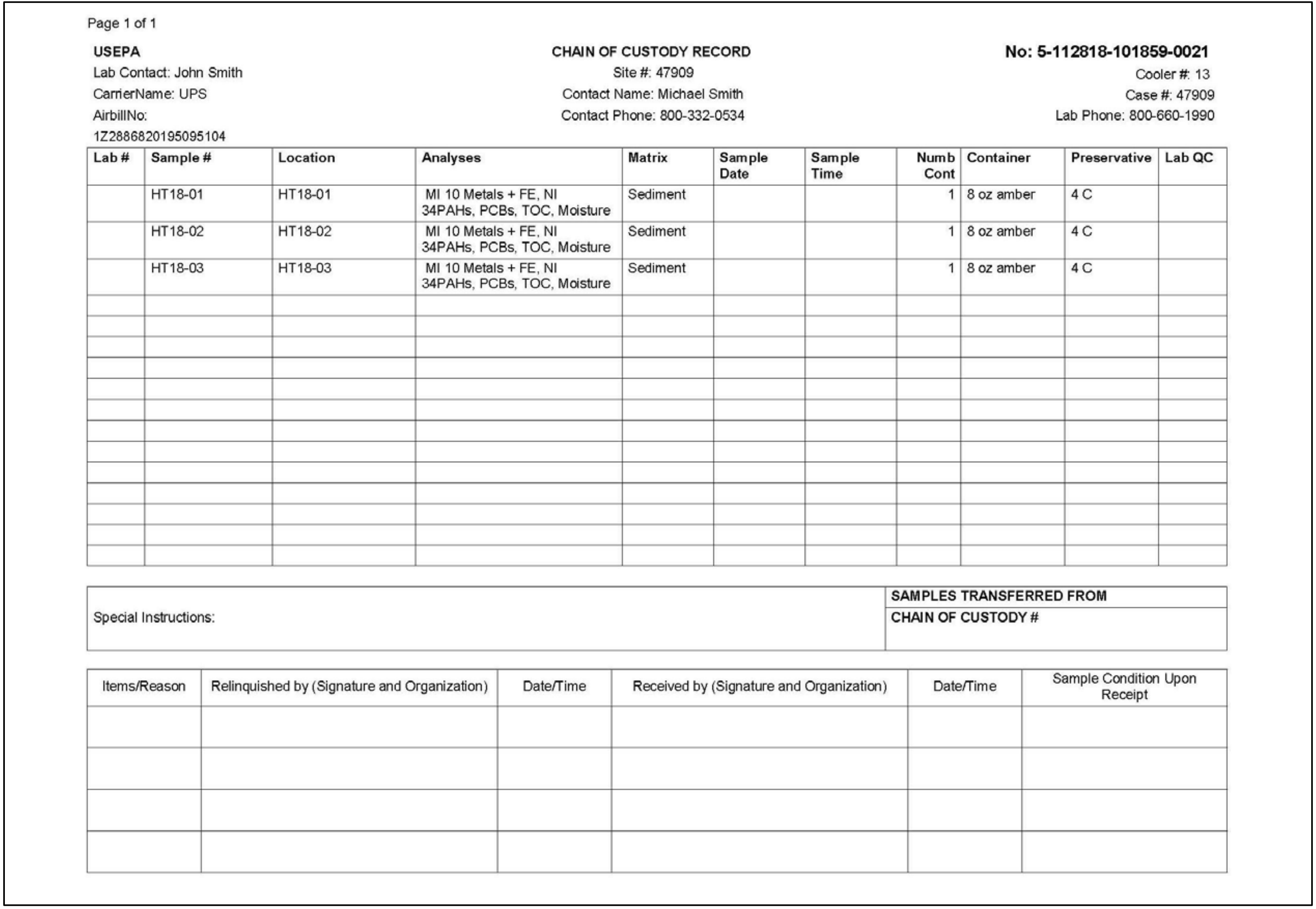
Figure SOP002-3 EPA Scribe Chain-of-Custody Form



Page 1 of 1

USEPA
Lab Contact: John Smith
CarrierName: UPS
AirbillNo:
1Z2886820195095104

CHAIN OF CUSTODY RECORD
Site #: 47909
Contact Name: Michael Smith
Contact Phone: 800-332-0534

No: 5-112818-101859-0021
Cooler #: 13
Case #: 47909
Lab Phone: 800-660-1990

Lab #	Sample #	Location	Analyses	Matrix	Sample Date	Sample Time	Numb Cont	Container	Preservative	Lab QC
	HT18-01	HT18-01	MI 10 Metals + FE, NI 34PAHs, PCBs, TOC, Moisture	Sediment			1	8 oz amber	4 C	
	HT18-02	HT18-02	MI 10 Metals + FE, NI 34PAHs, PCBs, TOC, Moisture	Sediment			1	8 oz amber	4 C	
	HT18-03	HT18-03	MI 10 Metals + FE, NI 34PAHs, PCBs, TOC, Moisture	Sediment			1	8 oz amber	4 C	

Special Instructions:	**SAMPLES TRANSFERRED FROM** **CHAIN OF CUSTODY #**

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt

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Standard Operating Procedure No. 003
for
Subsurface Utility Clearance

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 1
July 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 003	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

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Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	6/28/2018	Systematic review and update	Matt Bowman	Pete Garger

1. SCOPE AND APPLICATION

1.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to prevent injury to workers and damage to subsurface structures (including tanks, pipe lines, water lines, gas lines, electrical service, etc.) during ground disturbance activities (including drilling, augering, sampling, use of direct-push technologies, excavation, trenching, concrete coring or removal, fence post installation, grading, or other similar subsurface operations).

1.2 LIMITATIONS

The procedures set forth in this document are general guidance, but may not be entirely applicable to particular sites based on the site-specific considerations. The Project Manager is responsible for making a site-specific evaluation of each site to determine how subsurface utility clearance procedures should be utilized or modified. If safety or other site-specific considerations require a modified or different procedure, the Project Manager should review the modified procedure with the Business Unit Director, Profit Center Manager, or Senior Technical Reviewer. Evaluation support of modified procedures may be provided by the Corporate Health and Safety Director or the Lead Construction Quality Engineer.

Special considerations may be required for utility location activities at complex or challenging project sites (underwater utilities, hazardous waste sites, etc.). Additional subsurface utility clearance procedures should be added as appropriate for difficult sites. When health and safety risks to workers or potential utility damage cannot be effectively managed through utility location, clearance, and protection measures, the Project Manager must consider the modification of ground disturbance activities (e.g., establishing a safe offset from high risk utilities). In these cases, detailed coordination with the client and/or regulatory staff is likely required.

1.3 SCOPE

This SOP provides minimum guidance for subsurface utility clearance activities, which must be followed prior to and during ground disturbance activities at EA project sites. Even after completing the subsurface utility clearance activities required in this SOP, all ground disturbance activities should proceed with due caution.

Deviations from this SOP may be provided on an exception basis for specific situations, such as underground storage tank systems removals, verified aboveground/overhead services/lines, undeveloped land/idle facilities, shallow groundwater conditions, soil stability, or well construction quality assurance/quality control concerns, etc.

EA or its subcontractors are responsible for, and shall ensure that, all ground disturbance activities are completed safely, without incident, and in accordance with applicable federal, state, and local regulations.

This SOP shall not override any site-specific or consultant/contractor procedures that are more stringent or provide a greater degree of safety or protection of health or the environment.

2. PROCEDURES

The EA Project Manager or his/her designee must complete the Subsurface Utility Clearance Checklist (Attachment A) in conjunction with the following procedures. The checklist must be completed before initiating any ground disturbance activities. The completed checklist must be submitted to the appropriate team individuals, subcontractors, and/or the client and included in the project files.

2.1 SAFETY

A Health and Safety Plan must be available onsite and followed by all contractors and subcontractors.

Work areas should be defined and secured with safety cones, safety tape, construction fence, other barriers, or signs as appropriate.

Site work permits must be obtained as required by site procedures. Based on site conditions or classification, the use of intrinsically-safe equipment may be required.

To ensure the safety of all onsite personnel and subsurface structure integrity, consideration should be given to de-energizing and locking out selected site utilities or temporarily shutting down a portion of or the entire facility.

2.2 SUBSURFACE UTILITY LOCATION ACTIVITIES

To gather all relevant information about potential subsurface structures prior to ground disturbance activities, the project team should pursue multiple lines of evidence on the type, location, depth, size, material of construction, and status (active/abandoned) of all utilities within and near the area planned for ground disturbance activities. A minimum of three lines of evidence should be obtained and documented; however, additional lines of evidences should be secured when possible. Lines of evidence may include the following:

- Historical Site Information
- Public Utility Mark-Out (One Call – 811)
- Private Utility Mark-Out
- Site Inspection
- Client/Facility Interviews and Coordination.

2.2.1 Historical Site Information

The most recent as-built drawings and/or site plans (including underground storage tank, product, and vent lines) should be obtained, as available.

NOTE: As-built drawings may not accurately depict the locations and depths of improvements and subsurface structures and should, therefore, not be **solely** relied upon.

EA should obtain any other site information such as easements, right-of-ways, historical plot plans, fire insurance plans, tank (dip) charts, previous site investigations, soil surveys, boring logs, and aerial photographs, etc. as relevant to the planned ground disturbance activities. Where applicable, EA should also contact contract personnel who may have historical site knowledge.

2.2.2 Public and Private Utility Mark-Outs

EA must ensure that a thorough mark-out at the site is completed to locate electrical, gas, telephone, water, sewer, low voltage electric lines, product delivery pipelines, fiber optic, and all other subsurface utilities/services.

- Where available, public utility companies must be contacted to identify subsurface utilities. (This can be accomplished through the One-Call system in most instances.) Attachment B provides a brochure for the 811 Utility Locate Call Center.

- In addition, where available and warranted by site conditions, a private utility/pipeline mark-out company should be contracted to perform an electronic subsurface survey to identify the presence of suspected hazardous or critical subsurface utilities and structures. In some cases, this is necessary to confirm public utility mark-outs in the vicinity of planned ground disturbance activities.

EA will review all available site plan subsurface information with the private mark-out company to assist in locating utilities and other subsurface structures.

NOTE: Mark-outs may not accurately depict the exact locations of improvements and subsurface structures and should, therefore, not be **solely** relied upon.

Where possible, EA personnel are encouraged to be onsite at the time of subsurface mark-outs. This is to ensure accuracy and understanding of subsurface utility structures identified and provides an opportunity to exchange information with mark-out company personnel regarding planned work activities.

Subsurface utility structures should be marked throughout the entire work area(s) with adequate materials (e.g., site conditions may require paint and tape/flags). Ground disturbance activities must be started within 30 days of mark-out, unless local ordinances specify a shorter time period.

If activities are not started within required time period or markings have faded, mark-outs must be redone.

EA personnel will record time and date of mark-out request and list all companies contacted by the service and confirmation number. This information should be available for review onsite and checked off after visual confirmation of markings.

2.2.3 Site Inspection

To compare the site plan to actual conditions based on information gathered in other lines of evidence, a site inspection should be performed to identify potential signs of subsurface utilities. These signs may include:

- Signage identifying subsurface utilities
- Asphalt patching or paving scars
- Pull boxes, junction boxes, valve box covers, or manhole covers
- Sewer drains and clean-out traps
- Meters and light poles
- Piping or conduit on the walls or roofs of buildings
- Linear ground depressions
- Markings from previous utility mark-out efforts
- Other utilities including fire hydrants, on/below grade electrical transformers, splice cages, sprinkler systems, steam lines (including insulated tanks that may indicate steam lines), and cathodic protection on lines/tanks.

EA will document all findings and update the site plan with this information. In some regions, it may be more effective and efficient to conduct the site inspection at the same time the contractor performing the ground disturbance activity is mobilized to the site. The site inspection may include others as determined by the consultant/contractor and the Project Manager.

2.2.4 Client/Facility Interviews and Coordination

Knowledgeable client and facility staff familiar with site utilities should be interviewed to obtain information and documentation on potential subsurface utility locations, depth, etc. Results of these interviews should be documented and included with the Subsurface Utility Clearance Checklist. On third party sites, close coordination with the site owner's representatives for mark-outs, review of as-builts, and other information reviews should be conducted prior to any ground disturbance work. Project Managers are encouraged to provide updated as-built information to the client.

EA will review the selected ground disturbance locations with the client. EA will not proceed with the subsurface activities until the plan has been discussed with the client. During execution of the project, if subsurface activities are required outside of the area previously approved by the client, EA will submit these changes to the client for approval prior to execution.

2.2.5 Ground Disturbance Activity Sequence

When practical, EA will plan ground disturbance activities starting at the point farthest from the location of suspected underground improvements. This is done to determine the natural subsurface conditions and to allow EA site personnel to recognize fill conditions.

Experience has shown that the following warning signs may indicate the presence of a subsurface structure:

- Warning tape (typically indicative of underground services).
- Pea gravel/sand/non-indigenous material (typically indicative of tanks or lines).
- Red concrete (typically indicative of electrical duct banks).
- The abrupt absence of soil recovery in a hand auger. This could indicate pea gravel or sand that has spilled out of the auger. This may not be indicative in areas where native soil conditions typically result in poor hand auger recoveries.
- Any unexpected departure from the native soil or backfill conditions as established by prior onsite digging.

If any of these conditions is encountered by EA site personnel, digging should stop and the client should be contacted.

3. UTILITY PROTECTION MEASURES DURING GROUND DISTURBANCE ACTIVITIES

After mobilization, but prior to the primary ground disturbance activities, the physical location of subsurface utilities should be cleared and verified whenever possible and practical. The clearance method used to clear and verify the subsurface utilities should be compatible with the inherent associated risk given the type of facility/property, subsurface utility material of construction, utility depth, soil stratigraphy, and the location of the ground disturbance activity, such that required delineation is obtained. It should be noted that in areas where there is paving, sufficient paving should be removed to allow clear visibility of the subsurface conditions during clearance activities. The following is a list of potential clearance methods that may be used on a job site:

- Vacuum digging
- Probing
- Hand digging
- Hand augering
- Post-hole digging.

EA personnel will evaluate the potential for electrical shock or fire/explosion for each subsurface disturbance project and will evaluate as necessary the use of non-conductive or non-sparking tools (i.e., fiberglass hand shovels, and thick electrically insulating rubber grips on hand augers or probes). The potential need for the use of non-conductive materials, electrical safety insulated gloves, and footwear will also be evaluated on a case-by-case basis.

For drilling, direct-push technology, fence post installation, or other borehole installation, the area to be delineated will exceed the diameter of the largest tool to be advanced and sufficiently allow for visual inspection of any obstructions encountered.

3.1 SUBSURFACE CLEARANCE PROCEDURES FOR TRENCHING/ EXCAVATION ACTIVITIES

For trenching and excavation activities, appropriate subsurface clearance methods should be conducted along the length and width of the excavation at a frequency sufficient to ensure adequate precautions have been applied to the entire work area. The frequency and density of investigations will be based on site knowledge, potential hazards, and risks of the work area to surrounding locations.

Whenever subsurface structures are exposed, EA will cease work and mark the area (e.g., flags, stakes, cross bracing) to ensure the integrity of these exposed structures is maintained during subsequent trenching/excavation/backfilling.

During ground disturbance activities, EA and its subcontractors should consider the use of spotters to monitor the excavation for signs of subsurface utilities (pipes, conduits, cables, bedding material, warning tape, tracing wire, soil material changes, etc.) to provide early warning in the event unknown subsurface utilities are encountered. The decision to use spotters should be based on the risk of encountering unknown subsurface utilities, utility hazards associated potential unknown utilities that could be encountered (electrical, natural gas, etc.), and the physical and environmental hazards to have a spotter in proximity to the excavation. Spotters, if used, should be briefed on the potential physical and utility hazards that may be present at the site and the signs of subsurface utilities that they should be monitoring for during ground disturbance activities.

Uniform color codes for marking of underground facilities are provided in Attachment C.

Attachment A

Subsurface Utility Clearance Checklist

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SUBSURFACE UTILITY CLEARANCE CHECKLIST

Site Identification: ______________________________

Project Consultant/Contractor: ______________________________

Section 1: Safety, Preparation Tasks, and Mark-Outs

Activity	Yes	No	N/A	Comments including Justification if Response Is No or Not Applicable
Health and Safety Plan is available and all contractors and subcontractors are familiar with it.				
All applicable local, state, and federal permits have been obtained.				
Site access/permission has been secured.				
Most recent as-built drawings and/or site plans (including underground storage tank, product, and vent lines) obtained.				
Reviewed site information to identify subsurface structures relevant to planned site activities (easements, rights-of-way, historical plot plans, fire insurance plans, tank dip charts, previous site investigations, soil surveys, boring logs, aerial photographs, etc.).				
Utility mark-outs have been performed by public utility company(s). Mark-outs clear/visible.				
Subsurface structure mark-outs performed by private mark-out company. Mark-outs clear/visible.				
Additional Activities: Were dig locations reviewed with site representative?				

Section 2: Initial Site Visit and Selecting Ground Disturbance Locations

Activity	Yes	No	N/A	Comments, including Justification if Response Is No or Not Applicable
Location of all aboveground indicators of subsurface utilities/services that may be leading to or from buildings within the planned work area has been identified.				
Location of utility mark-outs by all utility companies previously contacted has been identified within required time period.				
Location of all subsurface structure mark-outs by private mark-out company has been identified within required time period.				
Location of area lights/signs and associated subsurface lines identified.				
Location of all phones and associated subsurface lines identified.				
Location of all drains and associated interconnecting lines identified.				
Location of all electrical junction boxes and associated interconnecting lines identified				
Location of all natural gas meters or connections and all interconnecting lines identified				

Completed by: ______________________________
Name

Signature: ______________________________ ____________
Company Date

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Attachment B

811 Utility Locate Brochure

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ALWAYS CALL BEFORE YOU DIG

One free, easy call gets your utility lines marked AND helps protect you from injury and expense.

Know what's below. Always call 811 before you dig. Visit call811.com for more information.

811

Know what's below.
Call before you dig.

INSERT
CALL CENTER
LOGO HERE

U.S. Department of Transportation

Building Your Quality of Life

JOHN DEERE

TRAVELERS

Common Ground Alliance

811

Know what's below.
Call before you dig.

Q: WHAT IS 811?

A: 811 is a new federally-mandated N-11 number designated by the FCC to consolidate all local "Call Before You Dig" numbers and help save lives by minimizing damages to underground utilities. One easy phone call to 811 quickly and easily begins the process of getting underground utility lines marked. Local One Call Center personnel will then notify affected utility companies, who will continue to mark underground lines for free.

Q: WHY SHOULD I CALL 811 BEFORE EVERY DIG?

A: Calling 811 will help save lives and protect infrastructure. Knowing where underground utility lines are buried before each digging project begins helps protect you from injury, expense and penalties. The depth of utility lines varies and there may be multiple utility lines in the same area. Even simple digging projects can damage utility lines and can disrupt vital services to an entire neighborhood, harm diggers, and potentially result in expensive fines and repair costs. Marked lines show diggers the approximate location of underground lines and help prevent undesired consequences.

Q: I'M JUST A HOMEOWNER, NOT A CONTRACTOR—IS 811 FOR ME?

A: Calling 811 is for professional excavators and do-it-yourself homeowners. A recent national survey revealed that roughly half of Americans are "active diggers" who have done (or are planning to do) some type of digging project at home. Whether you are a professional excavator or an avid do-it-yourselfer, you need to call 811 before every dig every time.

Q: WHO IS PROMOTING AWARENESS OF 811?

A: The national 811 campaign is a project of The Common Ground Alliance (CGA), working with its 1,400 individual members, member organizations, sponsors and 811 campaign national launch partners. CGA is a member-driven association dedicated to ensuring public safety, environmental protection, and the integrity of services by promoting effective damage prevention practices. In recent years, the association has established itself as the leading organization in an effort to reduce damages to all underground facilities in North America through shared responsibility among all stakeholders.

Attachment C

Uniform Color Codes for Marking of Underground Facilities

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APWA UNIFORM COLOR CODE

⬜ **WHITE** - Proposed Excavation

PINK - Temporary Survey Markings

🟥 **RED** - Electric Power Lines, Cables, Conduit and Lighting Cables

🟨 **YELLOW** - Gas, Oil, Steam, Petroleum or Gaseous Materials

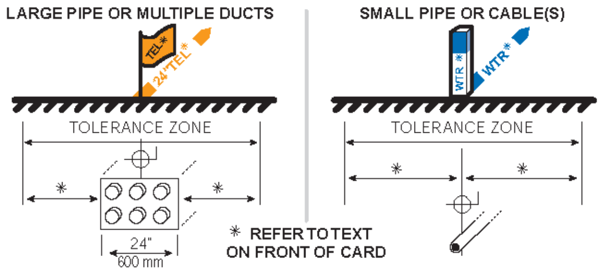
🟧 **ORANGE** - Communication, Alarm or Signal Lines, Cables or Conduit

🟦 **BLUE** - Potable Water

🟪 **PURPLE** - Reclaimed Water, Irrigation and Slurry Lines

🟩 **GREEN** - Sewers and Drain Lines

TYPICAL MARKING



Customize with your center's phone and address information

GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS

The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION

Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING

Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE

Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE

The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/99

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Standard Operating Procedure No. 004
for
Sample Packing and Shipping

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 1
September 2018

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 004	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	25 September 2018	Systematic update and review	Cristina Radu, Amanda Kohn	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the packing and shipping of environmental samples to the laboratory for analysis. Additional requirements are applicable when shipping samples under the U.S. Environmental Protection Agency's Superfund Contract Laboratory Program.

NOTE: Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated could require shipment as dangerous goods; procedures for shipping of such samples are not covered in this SOP.

2. MATERIALS

The following materials may be required:

- Clear tape
- Custody seals
- Ice
- Packing material
- Plastic garbage bags
- Sample documentation
- Waterproof coolers (hard plastic)
- Zip-seal plastic bags.

3. PROCEDURE

Refer to SOP Numbers (Nos.) 001, 002, 016, and 039 as applicable.

Samples will be placed in clean, bubble-wrap lined sample coolers with double-bagged ice immediately after collection to ensure proper preservation. Most sample analyses require that the sample material is maintained at 2-6 degrees Celsius (°C). It is also important to ensure that sample containers are maintained at all times at the temperature required by the analytical method used to analyze the sample media; as such, samples should be retained in a chilled cooler during the inventory, quality control, and packaging process.

Check cap tightness and wipe down outside of each sample container. Verify that information on sample labels is correct and matches chain-of-custody forms. Ensure that both waterproof labels and indelible ink are used to label sample containers. Clear tape should be placed completely over the label. Wrap breakable sample containers in bubble wrap. Enclose each sample in a clear zip-seal plastic bag.

Prepare cooler for shipping. Empty any water that has accumulated in coolers from melting ice. Securely seal all valves and/or drain holes in the shipping container, both inside and out, with duct tape to prevent leakage in the event of sample container breakage or melting ice. Place several layers of bubble wrap on top of absorbent material and line the cooler sidewalls with bubble wrap. Line cooler with open garbage bag.

Prepare sample containers for shipping as follows:

- ***Glass Containers***—Wrap each glass sample container in bubble wrap or closed cell foam sheets. It is acceptable to package up to three 40-milliliter vials in one bubble wrap bag that is usually provided by the analytical laboratory. Enclose sample containers in a clear zip-seal plastic bag.

- ***Polyethylene Containers***—Place sample containers in clear zip-seal bags.

- ***Zip-Seal Bags***—Double-bag the samples to ensure that moisture will not reach the label.

Place all the sample containers upright inside garbage bag. Do not stack glass containers or lay them on their sides. Add additional bubble wrap between and around sample containers as needed to ensure containers do not shift during transport. If a second garbage bag was used, tie the (inner) garbage bag to isolate samples.

Double bag and seal loose, fresh ice to prevent melting ice from soaking the packing material. Fill gallon-size or larger zip-seal bags with fresh ice about two-thirds full and squeeze excess air out of the bags before sealing. Turn bag upside down and place in a second zip-seal bag, also removing excess air. Prepare sufficient bags to cover sample containers and ensure that the proper temperature (2-6° C) is maintained during transport.

Place ice on top of sample containers. Ensure that packing material does not insulate samples from ice. Do not use loose ice in sample coolers. Do not use bagged ice as packing material between or around sample bottles. Tie the garbage bag ensuring that the cooler lid will close securely.

Place a temperature blank into the cooler. The temperature blank consists of a plastic bottle containing either potable or deionized water. Temperature blanks are typically provided by the analytical laboratory. If temperature blanks are not provided, field staff must add a clean container filled with deionized water; ensure the cap is tight and container is labeled before placing in cooler.

If aqueous volatile organic analyte samples are being submitted, ensure a trip blank sample set is placed in each cooler containing volatile organic analyte samples. Trip blanks are used to check for contamination of volatile organic compound samples during handling, storage, and shipment from field to laboratory. The trip blanks consist of volatile organic analyte vials filled with deionized water and are typically provided by the analytical laboratory. Ensure that the trip blank samples and analyses are included on the chain-of-custody record.

Make copies of sample documentation (chain-of-custody forms or other field records) and retain in field files for record. Enclose the original field documentation forms in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is being used, each cooler will have its own documentation.

Seal coolers with signed and dated custody seals such that if the coolers were opened, the custody seals would be broken. Place clear tape over the custody seals to prevent damage to the seals.

Tape the cooler shut with packing tape over the hinges and custody seals. Tape should be wrapped around the cooler a minimum of five times. Ship all samples via overnight delivery on the same day they are collected if possible. Project-specific shipping requirements (e.g., Saturday delivery, communication with the receiving laboratory, etc.) should be discussed with the sample manager or project manager during project planning.

After samples are packaged within shipping containers, place shipping labels clearly on the outside of the container; clearly mark the number of containers in the shipment on the shipping label. Mark each cooler as “1 of 2,” “2 of 2,” etc.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

The project manager and field team leader are responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample meets or is suspected to meet the definition of “dangerous goods” per the Dangerous Goods Regulation of the International Air Transport Association, then that sample must be handled according to the instructions given for that material. Dangerous goods must be prepared for shipping only by personnel trained and certified by International Air Transport Association in dangerous goods shipment.

6. REFERENCES

Not applicable.

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Standard Operating Procedure No. 005
for
Field Decontamination

Prepared by

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Revision 2
September 2018

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-*specific* variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 005	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

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Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	25 September 2018	Systematic update and review	Cristina Radu, Amanda Kohn	Matthew Bowman

1. SCOPE AND APPLICATION

All personnel or equipment involved in intrusive sampling, or that enter a hazardous waste site, must be thoroughly decontaminated prior to leaving the site to minimize the spread of contamination and prevent adverse health effects. This Standard Operating Procedure (SOP) describes the normal decontamination of sampling equipment and site personnel. Specific projects and programs may have additional decontamination requirements. Refer to the planning document(s) for additional site-specific requirements.

As a good practice, sampling at a site should be conducted moving from least to most impacted locations to minimize the potential for cross-contamination. It is advisable to use disposable tools and personal protective equipment to the extent possible such that decontamination is not necessary. If disposable equipment cannot be used, all attempts will be made to minimize the need for decontamination by using dedicated equipment when practical.

1.1 MATERIALS

The following materials may be required:

0.01 normal (N) hydrochloric acid	Non-phosphate laboratory detergent (Liquinox)
0.10 N nitric acid	Plastic garbage bags
Aluminum foil or clean plastic sheeting	Plastic sheeting, buckets, etc. to collect washwater and rinsates
Approved water (deionized, potable, etc.)	Pressure sprayer, spray bottles, brushes, laboratory wipes, disposable cloth (shop towel or similar)
High performance liquid chromatography (HPLC)-grade water[a]	Reagent grade alcohol[b]

a. For the purpose of this SOP, HPLC-grade water is considered equivalent to “deionized ultra-filtered water,” “reagent-grade distilled water,” and “deionized organic-free water.” The end product is water that is pure with no spurious ions or organics to contaminate the sample. The method of generation is left to the individual contractor.

b. For the purpose of this SOP, the term “reagent grade alcohol” refers to either pesticide grade isopropanol or reagent grade methanol.

1.2 PROCEDURE

All reusable (non-dedicated) equipment that contacts or could potentially contact environmental samples shall be decontaminated prior to use at a site, between sampling locations, and at the completion of sampling events before leaving the site. Decontamination procedures are conducted in the Contaminant Reduction Zone, which may or may not be contiguous to the Exclusion Zone. The Contaminant Reduction Zone should be located on a level, preferably paved surface, either in an area upwind of the investigation/sampling area or in an area believed to be free of surface contamination. Care must be employed when moving contaminated tools and equipment to the Contaminant Reduction Zone to prevent the spread of contamination.

Specially designated and properly built decontamination pads may be built at a centralized location to accommodate larger pieces of equipment. The pads are built such that any water produced during the decontamination process can be contained and pumped into investigative-derived waste holding containers (i.e., frac tank, 55-gallon drum, etc.) for waste profiling and disposal.

For other field equipment, the Contaminant Reduction Zone may be a mobile decontamination station set up in the vicinity of the Exclusion Zone or sampling location. Plastic sheeting will be used to create a clean surface for the sampling and decontamination equipment to be placed upon.

1.2.1 Sample Bottles

At the completion of each sampling activity, the exterior surfaces of the sample bottles must be decontaminated as follows:

- Ensure the bottle lids are on tight.
- Wipe the outside of the bottle with a paper towel to remove gross contamination.

1.2.2 Personnel Decontamination

Review the Health and Safety Plan for the appropriate decontamination of site personnel and reusable personal protective equipment, such as protective suits used at highly contaminated sites, respirators, safety boots, safety glasses, etc. Decontamination will be conducted in a designated Contaminant Reduction Zone as per the Health and Safety Plan and the general decontamination procedures outlined further in this SOP.

1.2.3 Non-Dedicated Equipment

Reasonable attempts will be made to minimize the need for decontamination by using dedicated equipment when practical.

All reusable (non-dedicated) equipment that contacts or could potentially contact environmental samples shall be decontaminated prior to use at a site, between sampling locations, and at the completion of sampling events before leaving the site. Decontamination shall be conducted at a central decontamination station (i.e., decontamination pad) or at the sampling location.

Decontamination stations should be located on a level, preferably paved surface, either in an area upwind of the investigation area or in an area believed to be free of surface contamination. Plastic sheeting will be used to create a clean surface for the sampling and decontamination equipment to be placed upon.

Used decontamination solutions will be disposed of properly according to the site-specific Health and Safety Plan or applicable planning documents.

1.2.3.1 Field Monitoring and Testing Equipment

Water quality meters and temperature, pH, conductivity, redox, and dissolved oxygen probes will be cleaned per the manufacturer's instructions. If no such specifications exist, remove gross contamination and triple rinse probe with HPLC-grade water. If downhole probes are used, wipe the wetted portion of the cable with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination and rinse with approved water.

Electronic water level indicators, weighted tapes, measuring tapes transducers, level loggers, etc. will be decontaminated after each use as follows:

- Wipe the wetted or contaminated portion of the tape or cable and the probe with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination. Rinse cloth in the solution and continue wiping until tape or cable is clean.

- Wipe with a second wipe or cloth or rinse with HPLC-grade water to remove soap residue.

- Dry tape with a third cloth (or laboratory wipe) and rewind into case or on spool, or re-coil tape.

Other field monitoring or measuring equipment such as beakers and graduated cylinders used to measure flow rates; flow-through cells used for monitoring water quality parameters; piezometers used to determine water levels; packers, mechanical slug device, and downhole equipment used during aquifer (hydraulic) testing; etc. will be decontaminated by washing with a non-phosphate laboratory detergent solution, followed by approved water and HPLC-grade water rinse.

1.2.3.2 Bladder Pumps

Non-dedicated bladder pumps with disposable bladders will be decontaminated as follows:

- Disconnect tubing from pump.

- Completely disassemble the pump, being careful to note the initial position of and retain any springs and loose ball checks.

- Discard the pump bladder.

- Clean all parts in the same manner as provided in Section 1.2.3.1.

- Install a new Teflon® bladder and reassemble pump.

- Store pump in a clean, dedicated polyvinyl chloride, polytetrafluorethylene (PTFE), or low density polyethylene (for perfluorooctanesulfonic acid/per- and polyfluoroalkyl substances sampling) storage container.

1.2.3.3 Grundfos Redi-Flow® or Similar Submersible Pumps

Non-dedicated Grundfos Redi-Flow® and similar pumps will be disassembled and decontaminated per the manufacturer's instructions on an as-needed basis (i.e., where high concentrations and an elevated risk of cross-contamination exist). Due to the challenges associated with pump decontamination, if possible, consider designating one pump for sampling in highly contaminated areas and a second pump for sampling non-impacted areas or areas with lower contaminant concentrations. In most cases, the pumps will be decontaminated following the procedures below.

The pump and support cable/electrical wires that come in contact with water will be decontaminated via pumping as detailed below. To avoid electrical shock, always disconnect power from the pump when handling the pump body during decontamination procedures.

- Disconnect sample tubing from pump.

- Decontaminate the wetted portion of the cable/electrical wires by washing with non-phosphate laboratory detergent solution, followed by approved water and HPLC-grade water rinse. Coil cable/electrical wires on spools or clean plastic sheeting.

- Scrub the exterior of the pump to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate detergent (steam cleaning may be substituted for detergent scrub).

- Transfer pump to rinse bucket filled with approved water. Rinse by pumping no less than nine volumes or a minimum of 5 minutes of approved water.

- Rinse pump exterior with reagent grade alcohol.

- Rinse pump exterior with HPLC-grade water.

- Rinse pump exterior with 0.10 N nitric acid solution

- Rinse pump exterior with HPLC-grade water.

- Allow pump to air dry.

- Wrap pump in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.

- Prior to reusing pump, rinse exterior again with HPLC-grade water.

1.2.3.4 Other Liquid Sampling Equipment

Other sampling equipment used to collect surface water, groundwater, non-aqueous phase liquid (NAPL), or other liquid samples includes but is not limited to PTFE double-check valve bailers, dip samplers (whether bucket, long-handled, or short-handled), discrete interval stainless-steel samplers, ball check valves and foot valves, and labware (i.e., beakers, graduated cylinders, vials, and other containers that are used to hold samples for field measurements/screening and water chemistry). This equipment will be decontaminated after each use as follows:

- Discard all ropes, tubing, etc. used in sampling in a properly marked sealable container, or as directed by the Health and Safety Plan. NOTE: No tubing is to be used in conjunction with a bailer in collecting samples.
- Wash sampling equipment with non-phosphate laboratory detergent and approved water solution using appropriate brush(es), laboratory wipes, or disposable cloth (shop towel or similar) to remove gross (visible) contamination.
- Rinse with approved water.
- Rinse with reagent grade alcohol.
- Rinse with HPLC-grade water.
- Rinse with 0.10 N nitric acid solution using a spray bottle. This rinse may be eliminated if inorganic compounds such as metals are not being sampled/are not a contaminant of concern.
- Rinse with HPLC-grade water.
- Allow equipment to air dry. If sampling equipment has just been used for purging and is being decontaminated prior to sampling, do not air dry. Double rinse with HPLC-grade water and proceed to collect samples.
- Wrap equipment in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.
- Rinse equipment with HPLC-grade water immediately prior to re-use.

1.2.3.5 Solid Materials Samplers

Solid materials samplers include soil and sediment sampling probes, augers, trowels, shovels, sludge samplers, and other sampling equipment (e.g., core tubes, grab samples, core catchers, core liners, scoops, spoons, etc.), which will be decontaminated as follows:

- Scrub the sampler to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate laboratory detergent (steam cleaning may be substituted for detergent scrub).

- Rinse off detergent with approved water.

- Rinse sampler with reagent grade alcohol.

- Rinse sampler with HPLC-grade water.

- For non-metallic samplers only, rinse sampler with 0.10 N nitric acid solution.

- For non-metallic samplers only, rinse sampler with HPLC-grade water.

- Allow sampler to air dry.

- Wrap sampler in aluminum foil or clean plastic sheeting, or store in a new zip-seal bag (size permitting) or clean, dedicated polyvinyl chloride or PTFE storage container.

- Rinse sampler with HPLC-grade water immediately prior to re-use.

For larger sediment sampling equipment, if sediment can be collected from the interior of a sampling device and away from potentially contaminated surfaces of the sampler, a site water rinse may be sufficient between stations. A site water rinse may also be sufficient for vessel surfaces between sample locations. However, all tools and equipment coming into contact with the sample should be decontaminated in accordance with the procedures above. Washwater from decontamination activities should be collected and disposed of properly.

1.2.3.6 Other Sampling and Measurement Probes

Soil (or sediment) gas sampling probes will be decontaminated as solids sampling devices.

1.2.3.7 Drilling Rigs, Sediment Sampling Vessels, and Other Heavy Equipment

All drilling rigs, sediment sampling vessels, and associated equipment such as augers, drill casing, rods, samplers, tools, recirculation tank, and water tank (inside and out) will be decontaminated prior to site entry after over-the-road mobilization and immediately upon departure from a site after drilling a hole. Supplementary cleaning will be performed prior to site entry when there is a likelihood that contamination has accumulated on tires and as spatter or dust on the way from one site to the next.

- Place contaminated equipment in an enclosure (i.e., existing wash pad, decontamination pad, etc.) designed to contain all decontamination residues (water, sludge, etc.).

- Steam clean equipment until all dirt, mud, grease, asphaltic, bituminous, or other encrusting coating materials (with the exception of manufacturer-applied paint) have been removed.

- Water used will be taken from an approved source.

- Containerize decontamination fluids in 55-gallon drums; sample; characterize; and, based on sample results, dispose of all decontamination residues properly.

Other heavy equipment includes use of backhoes, excavators, skid steers, etc. If heavy equipment is utilized during field activities (i.e., a backhoe for test pitting), the bucket should not come in contact with soil to be sampled. If the bucket contacts the soil to be sampled, then it should be decontaminated between sample locations, following the same procedures as listed above for a drill rig.

1.2.3.8 Ice Chests and Reusable Shipping Containers

Scrub exterior/interior with approved brush and Liquinox detergent. Rinse off detergent with approved water. Let air dry and properly store until re-use.

NOTE: If container/ice chest is severely contaminated, clean as thoroughly as possible, render unusable, and properly dispose of.

2. PRECAUTIONS

Segregate all waste streams as specified in the sampling documents and store investigation-derived waste properly. Dispose of all washwater, rinse water, rinsates, and other sampling wastes (tubing, plastic sheeting, etc.) in properly marked, sealable containers, or as directed by the Health and Safety Plan or applicable planning documents.

Once a piece of equipment has been decontaminated, be careful to keep it in such condition until needed.

3. REFERENCES

Site-specific Health and Safety Plan and/or applicable planning documents.

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Standard Operating Procedure No. 007
for
Surface Water Sampling

Prepared by

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Revision: 1
December 2014

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for sampling surface water. This procedure can be applied to the collection of surface water samples from marine and estuarine systems, streams, rivers, ditches, lakes, ponds, and lagoons. Surface water samples provide an indication of the amount of contaminant in the surface water. It is, therefore, important to collect a representative sample.

2. MATERIALS

The following materials may be required:

0.45-µ disposable filters	Sample bottles
Cooler with ice	Short-handled dip sampler (PTFE or stainless steel)
Long-handled dip sampler (polytetrafluoroethelyne [PTFE] or stainless steel)	Stainless steel or PTFE-lined bucket
Peristaltic pump with 0.45-µM filters and disposable Tygon tubing	Niskin bottle (or similar sampling device)

3. PROCEDURE

For all surface water samples, use a Global Positioning System to record sampling coordinates and mark the sampling locations on a site map. Photograph (if cameras are allowed onsite) and describe each location, place a numbered stake above the visible high water mark on the bank closest to the sampling location, and/or mark adjacent trees with surveyor's flagging. The photographs and descriptions must be adequate to allow the sampling station to be relocated at some future date by someone other than the original sampling crew. Use a long-handled dip sampler where access is poor or non-contact with water is suggested in the Health and Safety Plan.

Sampling should be performed deliberately and methodically to minimize disturbance of bottom sediments, yet as quickly as possible to ensure a representative sample. If wading in a stream, sample downstream of the sampling location to prevent disturbance of the bottom. To prevent contamination of the exterior of the sample container, and/or potential contamination of the surface water sample by laboratory contaminants on the exterior of the bottle, the sample container should never be dipped into the water, rather a decontaminated sampling device should be used to collect unfiltered samples.

Sampling with the PTFE or stainless steel sampler (long-handled or measuring cup-type):

- Remove the cap from the sample bottle.
- Dip a sample of surface water using the sampler.

- Tilt sample bottle and gently pour sample from sampler into the bottle. Allow the sample to trickle down the side of the bottle. Avoid aerating the sample.

- Add preservative as required by SOP No. 039. Replace cap, and place in cooler immediately.

Sampling with stainless steel or PTFE-lined bucket:

- Remove cap from sample bottle.

- Gently dip collection bucket in the water. Fill bucket and carefully lift from water body.

- Tilt sample bottle and gently pour sample from sampler into the bottle. Allow the sample to trickle down the side of the bottle. Avoid aerating the sample.

- Add preservative as specified by the project-specific Sampling and Analysis Plan. Replace cap, and place in cooler immediately.

– OR –

- Use smaller sampling cup to transfer sample from bucket to sample bottle as described above.

Sampling with a Niskin bottle (or similar device):

- Prepare the bottle for deployment by placing the ends of the bottle in the open position and lock the ends into the trigger mechanism.

- Lower the bottle to desired depth of sampling (on either a wire cable or rope).

- Place a messenger (triggering device) on the cable/rope and deploy by allowing free-fall down the cable/rope.

- Bring the bottle back to the surface and pour sample into a sample container.

Sampling with a peristaltic pump and Tygon tubing:

- Cut a length of Tygon tubing to the depth of sampling specified by the client or project-specific Sampling and Analysis Plan.

- Insert one end of the tubing into the intake hose on the peristaltic pump.

- Place a weight on the tubing and lower to the specified depth;

- Cut a length of tubing and insert into the output (out-flow) hose on the peristaltic pump.

- After applying power to the peristaltic pump, proceed to pump site water through the tubing apparatus. Approximately five times the hose volume should be pumped through the tubing before sampling.

- Fill the required sample containers.

- If filtering is required, obtain filtered sample by placing a 0.45-µM in-line filter on the end of the output tube and fill the required sample containers.

Both filtered and unfiltered samples may be required for metals analyses. Bulk samples for filtration will be collected using the stainless steel or PTFE-lined bucket method described above. Sample filtration must be performed immediately upon retrieval of the bulk sample as follows.

Filtration will be performed immediately after collecting sample. Set up filtration equipment prior to collecting sample. Filtration may be accomplished by gravity or, if necessary due to slow filtering, a peristaltic pump will be used to pressure filter the sample. Vacuum filtration will not be used due to the possibility of analyte volatilization.

Gravity filtration will be accomplished as follows:

- Using decontaminated forceps, place a 0.45-µM membrane in a decontaminated filter funnel.

- Slowly pour sample into the funnel and collect filtrate directly into appropriate sample container(s).

- Add preservative(s) as required by project-specific Sampling and Analysis Plan. Immediately cap container and place in cooler.

- Dispose of filter membrane.

Pressure filtration will be accomplished as follows:

- Using previously assembled disposable tubing, 45-µ in-line filter, and peristaltic pump, filter sample from collection bucket into appropriate container.

- Adjust pump rate to avoid aeration of sample.

- Fill container, preserve as indicated in SOP No. 039, immediately cap container, and place in cooler.

- Dispose of filter and tubing.

Refer to SOP Nos. 001, 002, 004, 005, 016, and 039.

4. MAINTENANCE

Refer to manufacturer's specifications for maintenance procedures on generators and pumps.

5. PRECAUTIONS

Avoid disturbing bottom sediments.

Consult the Health and Safety Plan prior to collecting any samples for personal protective equipment such as dermal and respiratory protection and personal flotation devices when sampling in or near deep water or from boats.

Always decontaminate the sampling and filtration equipment, and change gloves between sampling locations to minimize the risk of cross-contamination.

Always set up generators downwind of working area. Never service generators onsite.

6. REFERENCES

None.

Standard Operating Procedure No. 008
for
pH Measurement

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
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Revision 0
December 2014

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring the pH of all types of aqueous solutions, including drinking water, saline water, and industrial and domestic wastes. As a measure of the hydrogen ion content of a solution, pH gives a general indication of the acidity or alkalinity of a water sample.

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

Φ ® 12 pH Meter
Automatic temperature compensator (ATC) probe
Beakers
Combination (pH) electrode
Commercial buffer solutions (standards) of pH 4.00, 7.00, and 10.00
HPLC-grade water
Laboratory wipes for blotting electrodes
Wash bottle

3. PROCEDURE

3.1 CALIBRATION CHECK

Calibration of the pH meter will be checked on a daily basis. A two-point calibration should be used as follows:

1. Prepare beakers of buffer solutions of pH 4.00, 7.00, and 10.00.

2. Calibration should closely bracket the expected pH range of the samples to be taken.

3. Turn on instrument, clear instrument.

4. Rinse the electrode with distilled water and blot excess.

5. Immerse probes in beaker of pH 4.00 or 7.00 standard, swirl gently.

6. Press pH key, then STD key.

7. Keep the probes in the sample until the reading stabilizes. The reading should be the pH of the standard.

8. Rinse the electrode with distilled water and blot excess.

9. Repeat the procedure with pH 7.00 and 10.00 standards.

10. Record the initial readings.

11. If the measured values vary from the expected value by greater than 0.2 pH units, recalibrate the instrument with fresh aliquots of buffer solution. If the discrepancy persists, alert the Field Operations Leader, who has the option of trying to fix the meter or obtaining a second pH meter.

12. Record all measurements in the field logbook.

13. Verify calibration by reading the pH of the third buffer solution.

14. Refer to SOP No. 016.

3.2 pH MEASUREMENTS

Measurements of pH will be taken using the two-point standardization method as follows:

1. Connect the ATC and pH electrodes to the appropriate inputs.

2. Turn on instrument, clear instrument.

3. Prepare two small beakers of standard buffer solutions. Ideally, the pH values of these standards will "bracket" the expected pH value of the sample and be as close as possible to the pH of the sample.

4. Rinse a small beaker with distilled water, then sample water. Fill the beaker with sample water.

5. Rinse the probes with distilled water. Blot excess.

6. Immerse electrode and ATC in first standard. Swirl gently. Press pH key and STD key. Wait for display to stop flashing.

7. Rinse the probes with distilled water. Blot excess.

8. Immerse electrode and ATC in second standard. Swirl gently. Press STD key. Wait for display to stop flashing.

9. Rinse the probes with distilled water. Blot excess.

10. Immerse the probes in the sample and swirl gently, keeping the probes in the sample until the display stops flashing.

11. Record the sample pH and temperature after stabilization. Note any problems such as meter drift.

12. Rinse the probes with distilled water. Blot excess.

13. Repeat Steps 9 through 12 for additional samples.

Decontaminate probe according to manufacturer's specifications.

Decontaminate beakers according to SOP No. 005, Section 3.3.1.4 (Labware).

4. MAINTENANCE

The following steps will be taken to maintain the pH meter:

1. Check the batteries each time the meter is used.

2. Keep the probe stored in a 0.1 M KCl solution adjusted to pH 4 when the meter is not in use. Alternatively, the electrode may be rinsed with deionized water and the protective cap put on, trapping any residual water inside it (do not blot the electrode dry prior to putting the cap on).

5. PRECAUTIONS

Remove coatings of oil material or particulate matter that can impair electrode response by gentle wiping or detergent washing, followed by distilled water rinsing.

As noted in Section 1, these procedures may not apply to alternate manufacturer's equipment.

Calibration is always performed using the pH 7.00 and one end point (pH4.00 or 11.00) standard. **Never** calibrate the instrument using two end points only.

6. REFERENCES

Beckman Instruments, Inc. Users Manual for Φ® 10 pH Meter, Φ® 11 pH meter, and Φ® 12 pH/ISE Meter.

Franston, M.H. et al. (eds). 1981. Standard Methods for the Examination of Water and Wastewater, 15th Edition. American Public Health Association, American Water Works Association and Water Pollution Control Federation.

U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. March.

Standard Operating Procedure No. 009
for
Temperature Measurement

Prepared by

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Revision 0
December 2014

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring the temperature of a solid or liquid sample, in particular, for measuring water temperature. Groundwater temperature does not vary dramatically over the course of a year. Therefore, groundwater temperature can be used to help identify an aquifer, identify stream reaches where groundwater inflow is occurring, identify thermal gradients in lakes or ponds, and also indicate when sufficient water has been removed from a well during purging.

2. MATERIALS

The following materials may be required: digital reading thermocouple thermometer in combination meter or in a stick. Accuracy = ±0.5°C.

3. PROCEDURE

Rinse the probe with distilled water. Insert the probe into the sample, and leave it in the sample until the temperature stabilizes. Record the temperature reading, being sure to indicate °C or °F. Decontaminate the probe according to Section 3.3 of SOP No. 005 (Field Decontamination).

Refer to SOP Nos. 005 and 016.

NOTE: $°C = (°F - 32)(5/9)$
$°F = ([9/5]°C) + 32.$

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. March.

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Standard Operating Procedure No. 010
for
Water Level and Well Depth Measurements

Prepared by

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Revision 1
September 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 010	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	25 September 2018	Systematic update and review	Cristina Radu, Amanda Kohn	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to present the protocols for measuring depth to groundwater, presence and thickness of non-aqueous phase liquid (NAPL), and well depth in groundwater wells. This procedure is applicable to the sampling of monitoring wells and must be performed prior to any activities that may disturb the water level (i.e., purging or aquifer testing).

2. MATERIALS

The following materials may be required:

- Electronic sounding device with calibrated cable or tape measured at 0.01-foot increments (i.e., water level meter or oil/water interface probe) OR transducer and datalogger
- Plastic sheeting
- Photoionization detector or intrinsically safe flame ionization detector
- Materials required for decontamination per SOP Number (No.) 005
- Well construction diagrams, well records, and/or survey information
- Field forms (i.e., well gauging forms, well assessment forms, purge logs) and/or field logbook.

3. PROCEDURE

3.1 PRELIMINARY STEPS

Compile well construction data/forms, survey information, and historical data, if available, prior to field mobilization. The type and length of electronic sounding device to be used will be based on the monitoring well diameter, well installation depth, and the presence/absence of NAPL. Oil/water interface probes will be used in all wells for the first round of sampling, regardless of site history.

When planning on measuring depth to water at a site where product may be present in wells, the wells should be segregated between potentially contaminated and not contaminated categories. The sequence of well gauging should be established to minimize the potential of cross contamination by generally gauging clean wells first.

Ensure that the electronic sounding device is working prior to mobilization by submerging the probe in a container of potable or deionized water. Keep the indicator probe in its protective case when not in use. Locate the well and verify its position on the site map. Record on the applicable field form(s) or in the field logbook whether positive identification was obtained, including the well number/identification and any identifying marks, codes, or tags contained on the well casing or protective casing.

3.2 WELL HEADSPACE SCREENING

Refer to the Health and Safety Plan or applicable planning documents to determine if well headspace screening is required. At a site where historical information is available, well headspace screening may be omitted.

Headspace screening will be conducted using an organic vapor meter (photoionization detector or flame ionization detector). All headspace screening should be performed at arm's length and from the upwind side of the well if possible. Refer to SOP Nos. 011, 023, or 024 as appropriate.

Screen the ambient air in the breathing area around the wellhead and record the reading on the applicable field form(s) and/or in the field logbook. Once the breathing area is deemed safe, unlock/open the well protective casing to get access to the wellhead. Re-screen the ambient air again to determine if organic vapors may have accumulated.

Screen the air in the wellhead (headspace) for gross organic vapors. This will indicate the presence of gross volatile contaminants as well as potential sampler exposure. Most well casings are covered with a cap, some are outfitted with pump assemblies, while some may not have a cap at all. If a cap is present, sample the air in the wellhead for gross organic vapors by lifting the well cap only high enough for the organic vapor meter probe to be entered into the well casing. If a pump assembly is present on top of the casing, locate the gauging port, remove the cap, and insert the probe to make the measurement. If a cap is not present, insert the probe in the well casing. Record the reading on the applicable field form(s) and/or in the field logbook.

If volatiles are detected, allow the well to vent for 60-90 seconds and re-screen and record the headspace readings. If the second reading is lower than the first, use the second reading to determine whether respiratory protection will be required during subsequent activities.

3.3 WELL ASSESSMENT

Once the breathing zone at the wellhead is deemed safe or applicable respiratory protection is donned if needed, conduct the well assessment. Record the well assessment information on applicable field forms (well assessment form) or in the field logbook.

Assess and record the condition of the well casing, well pad and bollards, well cover, and any equipment (pump assembly). Record any observations and remarks regarding the completion characteristics and well condition (i.e., evidence of cracked casing or surface seals, security of the well [locked cap], or evidence of tampering). Note if there are discrepancies between current well condition/completion and well construction diagrams/records or well survey data (i.e., damage or modifications to the well including but not limited to frost heaving, broken or otherwise damaged casing, conversion to/from flush mount or stick-up, installation or removal of polyvinyl chloride collar or other material on inner casing, installation or removal of a pump assembly, etc.).

Next, locate the measurement reference point from where water, NAPL, and well depth measurements will be performed. This reference point should be scribed, notched, or otherwise noted and the elevation will be recorded in the well survey data. It is critical that the actual survey point is known and used consistently throughout monitoring events.

If no reference marks are present or if changes have been made to the well casing since the survey, measure depths based on highest point of the well casing. If there is no high point, measure depths to the northern side of either the well polyvinyl chloride casing or the pump assembly cover. Permanently mark the measurement location for future survey and/or measurement purposes. Determine the new reference point elevation by measuring the distance from a known surveyed point (surveyed elevation of the protective casing or ground surface). Record this difference on the applicable field form(s) or in the field logbook for use in groundwater elevation calculations.

3.4 LIQUID LEVEL AND WELL DEPTH MEASUREMENTS

Typically, a complete round of static liquid levels and monitoring well depths is conducted as one of the first steps during groundwater monitoring. However, if monitoring wells are to be sampled for polyfluorinated alkyl substances, gauging should be completed after groundwater sampling to mitigate the possibility of cross-contamination.

Equipment should be decontaminated prior to first use in the field and after each use. Refer to SOP No. 005 for decontamination procedures. Keep all equipment and supplies protected from gross contamination; use clean plastic sheeting and keep the electronic sounding device probe in its protective case when not in use.

Measure NAPL and water levels and well depths as detailed in the subsections below. When measuring depths, grasp the cable with the thumb and forefingers at the top of the casing and record the depth based on the measurement reference point detailed in Section 3.3.

Gauging information including dates/times, water depths, NAPL depths and thicknesses, and well depths will be recorded on applicable field forms (i.e., well gauging form, well assessment form, purge form, etc.) and/or in the field logbook.

3.4.1 Non-Aqueous Phase Liquid Level Measurements

Always perform NAPL checks for the following conditions:

- The first time a well is sampled
- In wells installed in or near areas with suspected or confirmed NAPL contamination
- If headspace test reveals presence of volatiles.

Use an oil/water interface probe to determine the presence and thickness of NAPL. An oil/water interface probe will have a different alarm tone (continuous or intermittent) for NAPL versus water. The air/liquid interface depth measurements will be more accurate if the probe is lowered into liquid. The NAPL/water depths will be more accurate if the probe is moved from water into NAPL. Always lower and raise the interface probe slowly to prevent undue mixing of media. Complete all measurements as follows:

- Upon removing the well cap as a part of headspace screening described in Section 3.2, ensure that enough time (a couple of minutes) has passed for the air pressure in the well to have equalized with atmospheric pressure.

- Turn the interface probe on and test the alarm and liquid indication light.

- Remove the indicator probe from the protective case. Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the alarm sounds and the liquid indication light comes on.

- If LNAPL is detected on top of the water column, record the depth of the initial level/first alarm (top of the product layer). Continue to slowly lower the probe until it passes into the water phase. Slowly retract the probe until the NAPL alarm sounds and record the product/water interface depth (base of the product layer). Calculate and record the LNAPL thickness.

- Continue to slowly lower the interface probe through the water column to check for the presence of dense non-aqueous phase liquid (DNAPL). If DNAPL is encountered, measure and record the product interface depths (top and base of the DNAPL layer[s]) and calculate and record the DNAPL thickness(es).

- Continue lowering the probe until the base of the well is encountered. Measure the depth of the well as detailed in Section 3.4.3.

- Slowly raise the interface probe, recording the depth to each interface as the probe is withdrawn. While raising the probe, wipe the wetted portion of the tape with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination. If there is a discrepancy in depths, clean the probe sensors and re-measure the depths.

- Decontaminate the measuring tape and probe between well locations as detailed in SOP No. 005 to minimize the potential of cross contamination.

3.4.2 Water Level Measurements

If a well has been sampled previously and no NAPLs were present, or if none of the preceding NAPL check conditions are met, the NAPL check may be omitted and an electronic water level detector can be used to measure water levels.

- Upon removing the well cap, ensure that enough time (a couple of minutes) has passed for the air pressure in the well to have equalized with atmospheric pressure.

- Turn the water level meter and test the alarm and liquid indication light. Adjust the sensitivity scale as needed.

- Remove the water level indicator probe from the case, and slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the alarm sounds and the liquid indication light comes on. Very slowly, raise and lower the probe until the point is reached where the alarm just sounds. Record the depth to water.

- Slowly raise the probe and wipe the wetted portion of the tape (if any) with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination.

- Decontaminate the measuring tape and probe between well locations as detailed in SOP No. 005 to minimize the potential of cross contamination.

3.4.3 Well Depth Measurements

The depth of a well is a stable value established during well construction; changes in well depth are usually indicative of a potential problem with the well. Fluctuations in well depth may be caused by either settlement of fine-grained material (i.e., silt) at the bottom of the well or damage to the well casing or screen.

Do not attempt to measure the depth of a well when a dedicated pump is installed in the casing. The weighted tape or the electric water level indicator will likely get snagged onto the tubing and damage the pump assembly. The depth of the well should also not be measured in wells in which passive diffusion samplers have been deployed; tag the bottom of the well after the samplers have been removed and before their re-deployment for the next sampling round.

A weighted tape is the preferred tool for measuring well depths. For shallow wells, an electronic water level indicator probe may be employed. In deeper wells, a weight may be attached to the probe to aid in measuring the well depth. Well depths will be measured as follows:

- Lower the probe until it is resting on the bottom of the well. Slowly pull upward on the tape until a tug can be felt while lifting the probe off the well bottom.

- Record the depth of the well. If the tape distance markings on the electronic sounding device are not marked to the end of the probe (i.e., markings are referenced to an electrode in the middle of the probe), add the length of the probe beneath the electrode to the measured depth to obtain the true depth of the well.

- Compare the recorded depth to the installation depth in the well construction diagram/record and note any discrepancies. If discrepancies exist, re-measure the well depth. Note the presence of sediment at the base of the well (i.e., hard bottom versus soft bottom).

- Withdraw the probe and tape. While raising the probe, wipe the wetted portion of the tape with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination.

- Decontaminate the measuring tape and probe between well locations as detailed in SOP No. 005 to minimize the potential of cross contamination.

3.5 TRANSDUCERS AND DATALOGGERS

Transducers and dataloggers may be used for depth to water measurements in wells where water level fluctuations over time are to be measured, such as tidal fluctuation studies (SOP No. 045) and aquifer (hydraulic) tests (SOP No. 033). Note that transducers are inappropriate for measuring well depth.

No calibration is necessary before use. Depending upon the device used, correction factors may be required for some measurements. Check instrument batteries prior to each use. Exercise care not to break the seals at the top of the electric water level indicator probe.

3.5.1 Transducers Deployment

Attach the transducer umbilical leads to the datalogger. Turn datalogger on. Program the transducer following instructions provided in the instrument user manual. Refer to the planning document(s) for site-specific parameters and recording frequency.

Measure and record the depth to water and well depth using an electronic sounding device as detailed in Sections 3.4.2 and 3.4.3. Slowly lower the transducer into the well until it is below the lowest possible piezometric level (typically 2-3 feet below the water table). Attach the cable grip to the well protective casing and/or tape the cable to the casing to prevent the transducer from falling further.

Record the following information and computations in the field logbook during transducer deployment:

- Date and time of deployment
- Weather
- Casing elevation
- NAPL surface elevation = casing elevation – depth to NAPL
- NAPL thickness = depth to bottom of NAPL – depth to top of NAPL
- Water level elevation = casing elevation – depth to water
- Well bottom elevation = casing elevation – depth to bottom (or read directly from tape).
- Method of measurement.

With the transducer deployed and the umbilical secured to the protective casing, ensure that the transducer unit is programmed to start logging at a desired date and time, or manually start logging. Record the logging start time. View real-time readings using the data logger and download a series of data using the data logger to verify proper operation. If the transducer is logging as desired, allow the transducer to continue logging. If the data are not logging as required in the planning documents, stop data collection, re-program the transducer, and restart logging.

3.5.2 Transducer Data Recording and Manipulation

Periodically check and download data per the manufacturer's instructions at the frequency detailed in the planning document(s) using a datalogger or computer and instrument software to download the transducer. If data are downloaded onto a datalogger, upload the data to a computer upon returning to the office.

Use the transducer manufacturer's software and transducer deployment information to make the following updates to the transducer data as needed:

- Correct the raw water pressure data files from the submersible transducer(s) for barometric effects

- Convert the transducer-reported values to equivalent feet of water over the sensor

- Normalize the transducer water levels as depths to groundwater in feet below the water level measuring point.

3.5.3 Transducer Retrieval

Upon completion of data collection, withdraw the transducer and cable from the well. Decontaminate the transducer and cable as detailed in SOP No. 005.

4. SPECIAL CONSIDERATIONS

Measurement of depth to water in new wells should only be performed after the water elevation in the well has stabilized. This may take as long as 72 hours; however, if the formation in which the well was installed is tight, the well may take even longer to achieve steady state. Ensure that steady-state conditions have been reached before making measurements as determined by the project geologist.

Electronic sounding devices may sometimes give erroneous readings due to water droplets along the side of polyvinyl chloride casing or on sample/pump tubing within a well. To check for erroneous readings, raise the probe above the point where the first sound was noted; a continued buzzer alarm indicates that the water table has not been reached. Shake the tape to remove water adhered to the tape and continue lowering to the water table.

5. CALIBRATION

No calibration is required. However, the marked tapes of the instruments described in this SOP may stretch, especially when depth of the wells is great. If more than one instrument is used at a site during the same gauging event, consider comparing the markings of the tapes on all instruments by stretching them on clean plastic sheeting to the anticipated length to be used. If the delta is known between the tapes, corrections of the measurements can be done at the time data are processed.

6. PRECAUTIONS

Depending upon the device used, correction factors may be required for some measurements. Check instrument batteries prior to each use. Exercise care not to break the seals at the top of the electric water level indicator probe.

7. REFERENCES

Not applicable.

Standard Operating Procedure No. 011
for
Photoionization Detector

Prepared by

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Revision 0
December 2014

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for field operations with the photoionization detector (MiniRae). The photoionization detector uses an ultraviolet emitting lamp designed to detect, measure, and display the total concentration of airborne ionizable gases and vapors. This information is used to determine control measures such as protection and action levels.

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

Battery pack	Tedlar bag
Calibration gas (100 ppm isobutylene)	Tygon tubing
Microtip/MiniRae	Regulator

3. STARTUP/CALIBRATION PROCEDURE

Turn the instrument on by pressing the back of the power switch located on the handle of the instrument.

The message “Warming up now, please wait” will be displayed for up to 3 minutes. After normal display appears, the instrument is ready for calibration.

Fill a Tedlar bag with the desired calibration gas (usually 100 ppm Isobutylene).

Press SETUP button and select the desired Cal Memory using the arrow keys (normally set to 200 ppm). Press EXIT button to leave setup function.

Press CAL button and expose instrument to Zero Gas. (Usually clean outdoor air will be suitable. If any doubt exists as to the cleanliness of the background air a commercial source of zero gas should be used.)

The instrument then asks for the Span Gas concentration. Enter the known span gas concentration and then connect the Tedlar bag containing the Span Gas.

NOTE: The span gas concentration is dependent upon both the concentration of the span gas used and the rating of the UV lamp in the instrument at time of calibration. If using 100 ppm isobutylene and the standard 10.6 eV lamp, the span gas concentration will be 56 ppm.

Press enter and the instrument sets its sensitivity. Once the display reverts to normal, the instrument is calibrated and ready for use. Remove the Span Gas from the inlet probe. The instrument should be calibrated at least once a day.

4. BATTERY CHARGING

Ensure instrument is off. Set the voltage selector switch on the bottom of the battery charger to the appropriate AC line voltage. Press the release button on the bottom of the instrument and remove the battery pack by sliding it backwards. Plug charger into the battery pack and then into an AC outlet and allow the battery to charge for at least 8 hours. After charging, remove the charger, first from the outlet then from the battery pack, and slide the battery pack back onto the instrument.

5. PRECAUTIONS

Instrument does not carry an Intrinsic Safety Rating and must not be used in a hazardous location where flammable concentrations of gases or vapors are constantly present.

All calibration, maintenance, and servicing of this device, including battery charging, must be performed in a safe area away from hazardous locations.

Do not open or mutilate battery cells. Do not defeat proper polarity orientation between the battery pack and battery charger. Substitution of components may affect safety rating.

6. REFERENCES

Instrument User's Manual.

Standard Operating Procedure No. 012
for
Specific Conductance Measurements

Prepared by

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Revision 0
December 2014

CONTENTS

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring the specific conductance of any aqueous solution, including drinking water, saline water, and industrial and domestic wastes. Conductivity is the ability of an aqueous solution to pass an electrical current. The current is primarily carried by dissolved inorganic ions such as chlorides, nitrates, sulfates, along with cations such as sodium, calcium, magnesium and others. Organic compounds do not carry current and, therefore, have almost no conductivity.

2. MATERIALS

The following materials may be required:

Conductivity meter with integral temperature compensation; accuracy = ±2 percent at 25°C (77°F)
Conductivity cell
Appropriate conductivity reference solution
High performance liquid chromatography (HPLC)-grade water (see SOP No. 005, Footnote 2)
Thermometer (optional, Section 5)

3. PROCEDURE

3.1 CALIBRATION

The specific conductivity meter should be calibrated at the beginning of each day[1] as follows:

1. Thoroughly rinse the probe with appropriate conductivity reference solution.

2. Zero meter if appropriate.

3. Measure the specific conductance of fresh appropriate conductivity reference solution record it in the field notebook, and adjust the calibration knob until the meter reads properly.

4. Rinse probe with HPLC-grade water.

5. Measure the specific conductance of HPLC-grade water and record in the field logbook. If specific conductivity of HPLC-grade water is not 0 (±2 percent) recalibrate instrument.

---

[1] The meter should be recalibrated any time the readings are suspect (e.g., out of expected range).

3.2 OPERATION

The specific conductivity meter will be operated as follows:

1. Thoroughly rinse the probe and sample beaker with sample water.

2. Measure the temperature of the sample water. Convert Fahrenheit temperature readings to Celsius using C = 5/9(F - 32) if Celsius temperature is not obtained directly.

3. Place the probe in the sample beaker with sufficient sample to completely submerge the probe. Swirl the probe to remove any air bubbles trapped in the probe.

4. Select the highest multiplier scale on the meter and turn the instrument on. Progressively use lower multiplier scales until a mid-scale deflection is obtained.

5. If appropriate, check probe accuracy by pressing cell test button. If value change is >10 percent check probe.

6. Record the temperature and conductivity values.

7. Specific conductivity values are corrected for temperature using:

   K^25^oC = {*K measured*} over {1+ 0.0191 (t-25)}

   where

   K = Conductivity in μmhos
   t = Temperature, °C

8. Decontaminate the probe (see SOP No. 005, Section 3.3.3).

Refer to SOP Nos. 005 and 016.

4. MAINTENANCE

The following steps will be taken to properly maintain the conductivity meter:

1. Check the batteries each time the instrument is used.

2. Inspect the probe on a daily basis for damage or loss of platinum black plating from the electrode. If the platinum is damaged, alert the Field Team Leader and arrange to get a new cell.

3. Follow manufacturer's specifications regarding storage of probe between uses.

5. PRECAUTIONS

Be certain there is no air in the cell before taking a reading. If conductivity meter does not have integral temperature compensation, use a thermometer to determine temperature of the sample.

6. REFERENCES

Manufacturer's Manual.

U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. March.

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Standard Operating Procedure No. 013
for
Collection of Monitoring Well Samples

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Revision: 1
January 2019

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 013	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	1/23/2019	Systematic update and review	Jason Stroup, Scott Dobson	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the collection of groundwater samples from monitoring wells.

2. MATERIALS

The following materials may be required:

0.45-µM filters	Polyvinyl chloride bailer (for purging only)
Bladder pump (dedicated to one well only)	Sample bottles and labels
Conductivity meter	Stainless steel bailer (for purging and sampling)
Dissolved oxygen meter	Submersible pump and hose (for purging only)
Generator	Thermometer (optional)[1]
Logbook or book of field parameter forms	Transparent bailer with a double check valve
Peristaltic pump with tubing for filtering samples	Turbidity meter
pH meter with oxidation-reduction potential probe	Poly or Teflon® and/or Teflon® lined tubing **(PTFE or Teflon® should not be used when sampling for PFCs/PFAS)**
Photoionization detector organic vapor analyzer.	Variable speed, low flow submersible pump (e.g., Grundfos MP1 groundwater sampling pump) (for purging and sampling)
Variable speed peristaltic pump	Peristaltic head tubing
Plastic sheeting	Water level indicator
Polypropylene rope	Interface probe

NOTES:
µM = Micrometer(s).
L = Liter.
mL = Millimeter.
PFAS = Per- and polyfluoroalkyl substances.
PFC = Perfluorinated compound.
PTFE = Polytetrafluoroethelyne.
VOC = Volatile organic compound.
PTFE bailer with PTFE-coated stainless steel cable, double check valve top, and controlled flow bottom discharge attachment[2] for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles) (for purging and sampling)

3. PROCEDURE

3.1 GENERAL

Groundwater sampling will follow these general steps:

---

[1] Temperature compensation and measurement capabilities are generally available as integral functions of pH meters and conductivity meters. If this is the case, a separate thermometer is not required.

[2] Although use of a controlled flow bottom discharge valve is historically preferred, use of such a device can cause aeration of the sample.

- Arrive onsite
- Set up apparatus (generators, pumps, etc.)
- Glove
- Organic vapor check, water level, and well depth measurements
- Sample non-aqueous phase liquids (NAPLs) (as required)
- Begin purge procedure
    - If using bailer to purge and sample, see Section 3.6
    - If using pump to purge and bailer to sample, see Section 3.7
    - If using bladder or low-flow pump to purge and sample, see Section 3.8
- Decontaminate/re-glove
- Take samples
    - If with bailer, see Section 3.6
    - If with bladder or low flow pumps, see Section 3.8
- Decontaminate/dispose of wastes, move equipment to next site.

NOTE: Sampling monitoring wells that contain PFAS have specific requirements that must be followed. Review SOP No. 073 prior to planning or conducting any sampling for PFAS.

3.2 GENERAL RULES FOR GROUNDWATER FIELD PARAMETER LOGBOOK

Use only one site or installation per logbook, and only one sampling location per page or form (if using pre-printed forms). The same logbook may be used for more than one sampling event. The first five pages will be reserved for index, general notes, etc. Sign and date each entry. The last five pages will be reserved for recording calibration data for the pH, temperature, turbidity, oxidation-reduction potential, dissolved oxygen, and conductivity meters. Use the page number or a separately recorded "Cal Reference Number" to refer to each calibration.

As appropriate, insert the cardboard flap under the form being filled out so that writing does not go through to the pages below. As appropriate, fill in the forms from front to back of the logbook, tearing out the white copy for each sample when the sample has been collected. This copy goes in the cooler with the sample, directly to the laboratory. The original copy must be torn out before you write on the back of the duplicate form. As appropriate, duplicate copies, index pages, and calibration sheets remain intact.

Reference SOP No. 016 for additional procedures and requirements for the use and maintenance of field logbooks for sampling.

3.3 GROUNDWATER SAMPLING GENERAL RULES

Groundwater samples will be collected from the least contaminated wells first, progressing to the most contaminated[3]. Upon arrival at the well site, immediately set up and organize the purging, sampling, and filtration equipment. If needed, due to muddy or contaminated ground, remoteness from sampling vehicle, and/or for placement of hose(s) and/or power cord if a pump is used, place clean plastic sheeting at, or around the well, to serve as a clean staging area for purging and sampling equipment, as conditions warrant. Care must be exercised not to step on plastic sheeting. If the well is remote from the sampling vehicle, set up the filtration equipment and place rope, wrapped bailer, and pre-labeled sample containers on the plastic sheet from the well. When a pump is to be used, situate the portable generator on level ground approximately 15 feet (ft) away from and downwind from the well. All generator maintenance (oil and fueling) is to be performed offsite. If the hose(s) and/or power cord of the pump are not on a reel, place the pump with its hose and power cord on the plastic sheeting downhill from the well.

Check well headspace for organic vapor, which may pose a health and safety hazard and indicate the presence of NAPL. Measure depth(s) to and thickness(es) of NAPL(s) as appropriate. Measure the depth to water and depth of well. From the water depth, well diameter, sand pack length, etc., calculate the equivalent volume (1 EV) of water in the well.

$$1 \text{ EV} = \text{volume in casing} + \text{volume in saturated sand pack}$$

Therefore, if the water table lies below the top of the sandpack, use the following equation:

$$1 \text{ EV} = (\pi R_w^2 h_w) + (0.30\pi(R_s^2 - R_w^2)h_w) * (0.0043)$$

If the water table lies above the top of the sandpack use this equation:

$$1 \text{ EV} = [(\pi R_w^2 h_w) + (0.30\pi(R_s^2 - R_w^2)h_s)] * (0.0043)$$

where

R_s = Radius of sandpack in inches
R_w = Radius of well casing in inches
h_s = Height of sandpack in inches
h_w = Water depth in inches
0.0043 gallons (gal)/inch (in.)^3
Assumed filter pack porosity = 30 percent.

---

[3] First round samples are to be collected from upgradient wells first, moving to downgradient wells under the assumption that upgradient wells will be less contaminated than downgradient wells. Results of first round analysis may mandate a change in sampling sequence.

Samples will always be collected in order of decreasing volatility (i.e., the samples to be analyzed for the volatile constituents should be collected first). Deliver the VOC sample to the vial by allowing the water to trickle down the inside wall of the vial at a rate no greater than approximately 100 mL/minute. Other samples may be delivered at a faster rate. Sampling rates will at no time exceed 1 L/minute. Procedures for each class of samples are contained in the site-specific Quality Assurance Project Plan.

When collecting samples for volatile analysis, care should be taken to prevent analyte loss by volatilization. The following procedures should be adhered to when collecting these samples:

- Avoid excessive aeration and agitation of sample.

- Fill vial so that a reverse meniscus is present by adjusting the flow rate from the sampling device.

- Place septum on vial so that the PTFE side is in contact with the sample. After the cap is on the bottle, check for air bubbles in the sample. If air bubbles are present, properly dispose of that sample and recollect the sample in the same vial or a new vial if prepreserved.

- Make sure vial is labeled and immediately transfer the vial to the cooler with ice.

Filtered and unfiltered samples will be taken for inorganics (metals) analyses, as appropriate. The samples will be filtered through an in-line 0.45-µM filter (preferred method), or by gravity through a 0.45-µM membrane placed in a filter funnel. Use forceps to place the membrane into the funnel and pour sample through funnel until appropriate volumes have been filtered.

If necessary, due to slow filtering, a peristaltic pump may be used to filter the sample through an in-line filter. Connect the pump to the generator, and attach tygon tubing to the bottom discharge valve on the bailer. Start pump and collect sample from the end of the in-line filter directly into the proper container, preserved, and placed in the cooler. Filtered samples will be preserved in the field with acid to a pH of less than 2. Make sure sample bottle is labeled and the cap is on tightly. Then place in cooler with ice immediately.

— OR —

If a low flow pump is used collect the samples, filtered samples will be taken by installing a 0.45-µM filter in-line and pumping the water through the filter. Collect sample from the end of the in-line filter directly into the proper container, preserved, and placed in the cooler. If a flow-through cell is used to measure water quality parameters, collect samples before flow-through cell. Filtered samples will be preserved in the field with acid to a pH of less than 2. Make sure sample bottle is labeled and the cap is on tightly. Then place in cooler with ice immediately.

Unfiltered samples will be collected by slowly pouring the sample water into the appropriate sample container, being careful not to agitate or cause bubbles to form. Do not overfill bottles. Make sure sample bottle is labeled and the cap is on tightly, then place the sample in cooler with ice immediately.

All samples will be delivered to the laboratory as soon as possible. If possible, samples will be shipped on the same day as they are collected. If samples must be retained due to weekend sampling (Friday through Sunday), the laboratory will be notified as to the time sensitive nature of the samples.

3.4 SAMPLING OF NON-AQUEOUS PHASE LIQUIDS

If NAPLs are detected in the well, a sample from all layers must be collected prior to any purging activities. NAPLs may be indicated by the presence of volatiles in the well headspace, and confirmed by the oil/water interface probe.

Collecting light non-aqueous phase liquid (LNAPL) will be accomplished using a transparent bailer with a double check valve. This bailer will be slowly lowered until the bottom of the bailer is 1-2 in. below the LNAPL-water interface, then slowly withdrawn. Verify that the interface was sampled by visual inspection of the bailer contents through the side of the bailer. Measure the thickness of the LNAPL in the bailer and note in the Field Logbook. Sample for laboratory analysis. An additional field verification may be performed by decanting the remainder of the contents of the bailer into a glass jar, adding a hydrophobic dye such as Sudan IV, or Redoil, shaking the sample and looking for coloration of NAPL. Alternate field tests are: examine the sample under ultraviolet light (many fluoresce), or allow the sample to stand overnight, and examine for interface and/or volatiles in the headspace the following day. Refer to the following sections on purging and sample collection for setup and general operation.

Collecting dense non-aqueous phase liquids (DNAPLs) will be accomplished using a transparent bailer with a double check valve. The bailer must be lowered very slowly to the bottom of the well and raised slowly out of the well in a controlled fashion. Sample for analysis as above. The same field check described above may be employed for DNAPL. Refer to the following sections on purging and sample collection for set up and general operation.

If NAPLs are present in the well, **and** a low-flow pump is to be used for purging and sampling, the well will be allowed to re-equilibrate prior to purging and sampling. This will be accomplished by allowing the well to stand undisturbed for at least 8 hours prior to purging and sample collection.

3.5 WELL PURGING GENERAL RULES

Water within the casing of a well will stagnate, de-gas, lose volatiles, possibly precipitate metals due to changes in redox potential, and may react with the screen and/or casing material. It is, therefore, necessary to purge a sufficient volume of this stagnant water from the well and/or casing to ensure that a representative sample of formation water can be obtained. Traditionally, the volume of water to be purged was arbitrarily set at 3-5 equivalent volumes. Recent advances in sampling technologies have caused a re-thinking of such arbitrary purge volumes. It is, for this reason, that monitoring of select chemical and physical properties of the sample medium will be used instead of strict volumes to determine when a representative sample may be taken from a well.

Acceptable purge/sampling devices include: bailers, high-discharge submersible pumps (purge only), and variable speed, low-flow pumps that include both submersible pumps (purge and sample) and dedicated bladder pumps (purge and sampling). It is recommended to purge and sample at similar rates with one type device per well. An acceptable exception to this general rule is to use a high-discharge submersible pump to purge a deep, fast-recharging well, and a bailer to sample the same well.

Peristaltic, gas-lift, and centrifugal pumps can cause volatilization, produce high pressure differentials, and result in variability in the analysis of some analytes of interest. For this reason, these pumps should be used with caution and flow rate slowed to minimize volatilization.

To prevent groundwater from cascading down the sides of the screen into an open hole, thereby aerating the sample, purge rates will closely match recharge rates. If the static water level is within the casing, the initial purge rates may be set high enough to lower the water level to the top of the screen, then reduced to maintain that level and identify the well’s recharge rate.

Purging will be accomplished with either a submersible pump, a low-flow (submersible or bladder) pump, or bailer. The choice of bailer or pump will be based on depth to water table, volume to be purged, and permeability of the aquifer. If the well recharges rapidly and/or has greater than 20 gal (estimated EV) to be purged, water may be removed with a submersible pump or a low-flow pump. If the well recharges slowly and/or has less than 20 gal to be purged, water will be removed with a bailer or a low-flow pump.

Purging will be accomplished with as minimal disturbance to the surrounding formation as possible.

Purge water will be containerized onsite until analysis of samples is completed. Based on sample results, accumulated purge water will be properly disposed of.

If the water level is within the screened interval and the well recharge rate is less than 0.1 L/minute, purge the well using a low-flow pump as follows:

1. Draw the water down to within 1 ft of the top of the pump.
2. Allow the well to recover.
3. Check and record field parameters.

4. Repeat Steps 1 through 3 then collect samples for metals analysis only[4].

5. Note the event in the Field Logbook, and report the problem to the Project Manager. If this extremely low recharge problem consistently occurs in a given well, the well may be considered for re-development and/or replacement.

6. If adjacent wells have elevated VOC levels, additional soil gas surveys will be considered in the vicinity of the low recharge well to help determine the need for replacement.

3.6 PURGING AND SAMPLING WITH BAILERS

Bailers may be used for both purging and sampling wells if: (1) the well recharge rate is less than 4 L/minute, (2) depth to the water table is less than 50 ft, and (4) less than 20 gal are to be purged (5 EV < 20 gal)[5].

When purging with a bailer, either a polyvinyl chloride, PTFE, or stainless steel bailer may be used. The bailer will be attached to either a spool of PTFE-coated stainless steel cable or polypropylene rope. If using cable, attach it to the bailer using stainless steel cable clamps. Thoroughly decontaminate the cable after each use, prior to rewinding cable onto spool. Cable clamps and raw cable ends may serve to trap contamination. Exercise particular caution in decontaminating these areas. If using rope, attach the rope to the bailer using a bowline knot, dispense the needed length (a few feet more than the well depth), and cut the remainder away; then, at the end opposite the bailer, make a slip knot and place it around the well casing or protective posts to prevent losing the bailer and rope down the well. The polypropylene rope will be not reused; it will be properly disposed of. Either type of bailer will be repeatedly lowered gently into the well until it fills with water, is removed, and the water discharged into an appropriate container until purging is complete. Care must be taken not to unduly agitate the water, as this tends to aerate the sample, increase turbidity, makes stabilization of required parameters difficult to achieve, and generally prolongs purging.

After purging 2 EV, obtain a sample of groundwater and measure the following stabilization parameters: temperature, conductivity, pH, turbidity, redox potential (Eh), and dissolved oxygen level at each successive half-well volume. When three of these stabilization parameters are in agreement within approximately 10 percent in three consecutive half-well volume samples, sufficient water has been purged from the well. The results of these tests should be recorded in the sampling logbook. Should these parameters not reach agreement, no more than five well volumes will be purged.

---

[4] Analyte losses due to volatilization in a drained well are too high for valid VOC sampling (McAlary and Barker 1987).

[5] These numbers are based on the following assumptions: (1) In purging, it is preferable to remove water at approximately the recharge rate; (2) 4 L/minute is estimated as the approximate maximum rate at which water can be removed with a bailer from depths of 20-50 ft; and (3) 20 gal is estimated to be at the limit of the sampler's endurance, at which point fatigue and sloppiness of technique begin.

Immediately upon completion of purging, collect samples for laboratory analysis using a PTFE bailer on a PTFE-coated stainless steel cable. The bailer will be equipped with double check valve top and controlled flow bottom discharge attachments for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles).

Slowly, so as not to agitate the water, lower the bailer into the well, using a spool of PTFE-coated cable. Allow bailer to fill, withdraw smoothly. Refill bailer as needed.

If the controlled flow bottom discharge attachment is used for VOC sampling, attach it to the bottom of the bailer. Using the stopcock valve on the bailer to control the flow, and fill sample vials as described above in Section 3.3.

Remove check valve top and pour unfiltered sample into inorganics sample bottles.

Collect filtered samples as described in Section 3.3. Decontaminate bailer and cable.

3.7 PURGING WITH PUMP, SAMPLING WITH BAILER

If the recharge rate of the well is greater than 30 L/minute, or the water level is deeper than 50 ft, or more than 20 gal of purge water will be generated (5 EV > 20 gal), then purging and sampling may be accomplished using a submersible pump/bailer combination.

When purging with a pump, gradually lower the intake until it is submerged within the screened interval. Lower an electronic water level probe to the top of the screen (as determined from completion records) to the monitor water level, start pump, and slowly lower the pump as the water level continues to fall. Care should be exercised to lower the water column to the top of the screened interval (water level probe will stop beeping) but not below the top of the screen if possible. This will ensure that the stagnant layer has been removed, but should minimize the detrimental effects of over pumping the well. Secure hose(s) and/or power cord to casing and place discharge hose into the proper container, downhill and as far away from the well as possible. Determine and record the discharge rate.

Discharge rate = volume of container/time to fill container

The discharge rate will be established at approximately equal to or just greater than the well's recharge rate (determined from well development). If well development records are incomplete, recharge rate can be determined by monitoring the rise/fall of the water level within the casing as one purges the well. If the water level is static at a given pumping rate, but fluctuates up or down as pumping rate is decreased or increased, the pumping rate at which the water level is static is the recharge rate.

After purging 2 EV, obtain a sample of groundwater and measure the following stabilization parameters: temperature, conductivity, pH, turbidity, redox potential (Eh), and dissolved oxygen level at each successive half-well volume. When three of these stabilization parameters are in agreement within approximately 10 percent in three consecutive half-well volume samples, sufficient water has been purged from the well. The results of these tests should be recorded in the sampling logbook. Should these parameters not reach agreement, no more than five well volumes will be purged.

Immediately upon completion of purging, collect samples for laboratory analysis using a PTFE bailer on a PTFE-coated stainless steel cable. The bailer will be equipped with a double check valve top and controlled flow bottom discharge attachments for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles). Filtration of metals samples will be accomplished using either an in-line filter attached to the bottom of the bailer, or a funnel and appropriate filter (Section 3.3).

Slowly, so as not to agitate the water, lower the bailer into the well, using a spool of PTFE-coated cable. Allow bailer to fill, withdraw smoothly, and fill sample containers as described in Section 3.6. Decontaminate bailer and cable in and decontaminate pump.

3.8 PURGING AND SAMPLING WITH LOW-FLOW PUMP

To obtain representative samples, subsurface disturbances should be kept to a minimum, thereby preventing sample alteration due to sampling actions. The reasoning behind the use of low-flow pumps to purge and sample monitoring wells is that these pumps minimize physical disturbance (turbulence) at the sampling point and chemical changes (aeration) in the medium. For these reasons, the low-flow pump is the preferred method for both purging and sampling in most cases. For the purposes of this SOP, “low-flow pumps” are defined as either dedicated bladder pumps or variable speed submersible pumps. Practical operational flow rates for these sampling devices range from 0.1 to 30 L/minute.

Low-flow pumps may be used for purging and sampling any well having recharge greater than 0.1 L/minute, which is the practical lower limit of pump performance. Below that pumping rate, pump inefficiencies and/or overheating may alter the physical and chemical properties of the sample. If the pump is continuously operated at sampling rates higher than the well recharge rate, the water level will be lowered in the well, possibly allowing aeration of the sample that is unacceptable sampling procedure. Low-flow pumps are suitable for sampling wells with recharge rates lower than 0.1 L/minute if precautions are taken to avoid aeration of the sample.

Low flow submersible pumps will be used as follows:

- Lower the pump into the well, slowly so as not to agitate the water, until the pump is at the mid-point of the screened interval or the mid-point of the water column if the static water table lies below the top of the screen.[6]

- Attach the pump's umbilical cord (which will consist of power cord and sampling tubing) to the protective casing, or lock the cord spool so that the pump cannot move vertically in the well during sampling.

- Lower the water level probe into the well behind the pump until it just touches water. This will allow the sampler to monitor the water level while purging and sampling, and prevent the inadvertent drying of the well.

- Begin purging at the pump's lowest setting, then gradually increase rate[7] until the pumping rate matches the aquifer recharge rate. **If the water level is above the top of the screen**, the pumping rate may be allowed to slightly exceed recharge rate, lowering the water level to no less than 1 ft above the screen, then reduced until it matches recharge rate and purging continued. **If the water level is below the top of the screen**, always keep the purge rate lower than well's recharge rate.

- Monitor stabilization parameters listed in Section 3.6 beginning immediately, using an in-line monitoring system. Record parameters regularly, at a rate of one set of parameters per each 1-3 liters of water removed from the well. When these parameters stabilize to within 10 percent over three consecutive readings, reduce[8] flow rate to 0.1 L/minute (if needed) and begin collecting VOC samples directly from the discharge line.

- If the well recharges at a rate less than 0.1 L/minute, purge until the water level is even with the top of the screen, allow the well to recover, and sample immediately.

- Remove and decontaminate water level probe and pump.

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[6] This assumes a 10-ft screened interval. If the screened interval is greater than 10 ft, multiple samples should be taken as follows:
  - If the screen is 10-12 ft, sample the canter of the water column, as outlined above.
  - If the screen is longer than 12 ft, and the water column is 10 ft or less, sample the center of the water column.
  - If the screen is longer than 12 ft, and the water column fills the screen, or extends above the screen, sample at 1/3 and 2/3 the height of the water column, or about every 6 ft.

[7] Some sources indicate that the pumping rate should not exceed 1 L/minute, with 0.5 L/minute being preferable. The optimal purge rate is highly aquifer dependent, and may range from less than 0.5 L/minute to greater than 10 L/minute. The purge rate for a given well will, therefore, be a field decision, based on well development, purge, and sampling records rather than SOP mandate.

[8] Sampling should occur at the same rate as purging as long as aeration of sample does not occur.

4. MAINTENANCE

Refer to manufacturer's requirements for maintenance of pumps and generators.

5. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for appropriate personal protective equipment.

6. REFERENCES

McAlary, T.A. and J.F. Barker. 1987. Volatilization Losses of Organics During Groundwater Sampling From Low Permeability Materials, in Groundwater Monitoring Review. Fall.

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Standard Operating Procedure No. 016
for
Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists

Prepared by

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Revision 1
July 2019

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 016	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	27 June 2019	Combine SOP 059 with 016. Reviewed and updated content as appropriate.	Dan Hinckley and Jesse Drummond	Matthew Bowman

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for completion of field logbooks and completion of field forms used to record surface water, groundwater, soil/sediment sampling information, instrument calibration data, and data from hydrologic testing. Acceptable field logbooks are bound, unprinted books such as a surveyor's field logbook, or a Federal Supply Service Number (No.) 7530-00-222-3525 record book (or equivalent); or they may be company-proprietary, pre-printed forms bound into a field logbook. Example forms are provided herein. Alternate, equivalent forms are acceptable.

2. MATERIALS

The following material may be required: field logbook, indelible ink pen, and field checklists documented in Sections 3.1 through 3.7.

3. PROCEDURE

All information pertinent to a field survey or sampling effort will be recorded in a bound logbook. Each page/form will be consecutively numbered, dated, and signed. All entries will be made in indelible ink, and all corrections will consist of line-out deletions that are initialed and dated. The person making the correction will provide a brief explanation for the change. Entries are factual only. No personal opinions should be entered.

There should be no blank lines on a page. A single blank line or a partial blank line (i.e., at the end of a paragraph) should be lined to the end of the page. If only part of a page is used, the remainder of the page should have an "X" drawn across it. The bottom of each page must be signed and dated by the field personnel entering the information.

At a minimum, entries in the field logbook will include but not be limited to the following:

- Date.
- Project number and project name.
- Name and address of field contact.
- Identification of sample crew members.
- Documentation should include model numbers of equipment used (e.g., data loggers, drilling rigs) and calibration (if applicable). Each day's entry should begin with time onsite, who is onsite (including observers other than the sampling crew), brief description of what work will be performed that day and how, and the weather.

- If samples are being taken in or near tidal waters, the time of high and low tide for the site should be determined from local gauges or tables and recorded.

- References such as maps of the sampling site.

- Times of key daily milestones should be entered (e.g., time borings began, times personnel arrived and left site, times subcontractors arrived and left site, etc.). Time should be recorded in the left-hand margin on the page in military time.

- Sample-specific information:

  — Unique, sequential field sample number

  — Purpose of sampling

  — Location, description, and log of photographs of each sampling point

  — Details of the sample site (e.g., elevation of the casing, casing diameter and depth, integrity of the casing, etc.)

  — Documentation of procedures for preparation of reagents or supplies that become an integral part of the sample (e.g., filters and absorbing reagents)

  — Type of media of sample (e.g., groundwater, surface water, soil, sediment, and product)

  — Suspected waste composition

  — Number and volume of sample taken

  — Sampling methodology, including distinction between grab and composite sample

  — Sample preservation

  — Date and time of collection

  — Collector's sample identification number(s)

  — Sample shipment (e.g., name of the laboratory and cartage agent: Federal Express, United Parcel Service, etc.)

  — Field observations (e.g., oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, moisture content, layering, Unified Soil Classification System classification, etc.)

- — Any field measurements made (e.g., pH, conductivity, explosivity, water depth, organic vapor analyzer readings, etc.)
- — Signature and date by the personnel responsible for observations
- — Decontamination procedures.

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a field logbook. However, records should contain sufficient information so that someone can reconstruct the sampling activity without relying on the sampler's memory. Further, the project work plan or field sampling plan should be reviewed to identify additional specific information or requirements that should be included in the field logbook.

The Project Manager will keep a master list of all field logbooks assigned to the Sampling Team Leaders. One field logbook kept by the Project Manager will be a master site log of daily activities and will contain the list of field logbooks assigned to Sampling Team Leaders.

Project name and number should be clearly marked on the outside cover using indelible ink. If more than one field logbook exists for the project, then the number of the field logbook should also be clearly marked on the outside cover.

Field checklists associated with the collection of soil, sediment, surface water, and groundwater are shown in Figures SOP016-1 through SOP016-9 and described in Sections 3.1 through 3.7. The details described above for completion of the field logbook should be completed even though these field checklists have been completed, and the field checklists noted in the field logbook. While the importance of the use of field logbooks is emphasized in this SOP, it is acknowledged that alternate documentation approaches may be necessary (e.g., higher reliance on documentation forms, use of electronic tablets) for a variety of client and project-specific reasons. It is essential the team establish clear expectations for the use of field logbooks during project planning and document any differences from this SOP in the project-specific variance form.

3.1 SOIL/SEDIMENT FIELD CHECKLISTS (REQUIRES FIGURES SOP016-1 AND SOP016-3)

3.1.1 Field Parameter Form (Items on Figures SOP016-1 and SOP016-2)

1. HIGH CONCENTRATION EXPECTED?: Answer "Yes" or "No."

2. HIGH HAZARD?: Answer "Yes" or "No."

3. SITE: Record the complete name of the site.

4. AREA: Record the area designation of the sample site.

5. INST CODE: Record the 2-letter installation code appropriate for the installation or site. Correct abbreviations can be found on Pages 3-6 of the Installation Restoration Data Management System (IRDMS) User's Guide for chemical data entry.

6. FILE NAME: Record "CSO" for a soil sample or "CSE" for a sediment sample.

7. SITE TYPE: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User's Guide for chemical data entry. This entry must match the Site Type on the map file form.

8. SITE ID: Record a code up to 10 characters or numbers that is unique to the site.

9. FIELD SAMPLE NUMBER: Record a code specific for the sample.

10. DATE: Enter the date the sample was taken.

11. TIME: Enter the time (12-hour or 24-hour clock acceptable as long as internally consistent) the sample was taken.

12. AM PM: Circle "AM" or "PM" to designate morning or afternoon (12-hour clock).

13. SAMPLE PROG: Record "GQA" (Groundwater Quality Assessment) or other appropriate sample program.

14. DEPTH (TOP): Record the total depth sampled.

15. DEPTH INTERVAL: Record the intervals at which the plug will be sampled.

16. UNITS: Record the units of depth (feet, meters)

17. SAMPLE MEASUREMENTS: Check the appropriate sampling method.

18. CHK: Check off each container released to a laboratory.

19. ANALYSIS: Record the type of analysis to be performed on each sample container.

20. SAMPLE CONTAINER: Record the sample container type and size.

21. NO.: Record the number of containers.

22. REMARKS: Record any remarks about the sample

23. TOTAL NUMBER OF CONTAINERS FOR SAMPLE: Record the total number of containers.

24. SITE DESCRIPTION: Describe the location where the sample was collected.

25. SAMPLE FORM: Record the form of the sample (i.e., clay, loam, etc.) using The Unified Soil Classification System.

26. COLOR: Record the color of the sample as determined from standard Munsell Color Charts.

27. ODOR: Record the odor of the sample or "none." See SOP No. 001 Section 5.

28. PID (HNu): Record the measured photoionization detector (PID) (HNu) values.

29. UNUSUAL FEATURES: Record anything unusual about the site or sample.

30. WEATHER/TEMPERATURE: Record the weather and temperature.

31. SAMPLER: Record your name.

3.1.2 Map File Form (Figure SOP016-3)

1. The map file logbook form will be located on the reverse of the field parameter logbook form, or on an adjoining page of the field logbook (if level book is used).

2. SITE ID: Record the Site ID from the field parameter form.

3. POINTER: Record the field sample number for the sample being pointed to.

4. DESCRIPTION/MEASUREMENTS: Describe the location where the sample was taken, along with distances to landmarks.

5. SKETCH/DIMENSIONS: Diagram the surroundings and record the distances to landmarks.

6. MAP REFERENCE: Record which U.S. Geological Survey Quad Map references the site.

7. COORDINATE DEFINITION: Write the compass directions the X- and Y-Coordinates of the map run.

8. COORDINATE SYSTEM: Write "UTM" (Universal Transverse Mercator).

9. SOURCE: Record the 1-digit code representing the Map Reference.

10. ACCURACY: Give units (e.g., write "1-M" for 1 meter).

11. X-COORDINATE: Record the X-Coordinate of the sample site location.

12. Y-COORDINATE: Record the Y-Coordinate of the sample site location.

13. UNITS: Record the unit's map sections are measured in.
14. ELEVATION REFERENCE: Record whether topography was determined from a map or a topographical survey.
15. ELEVATION SOURCE: Record the 1-digit code representing the elevation reference.
16. ACCURACY: Record the accuracy of the map or survey providing the topographical information.
17. ELEVATION: Record the elevation of the sampling site.
18. UNITS: Write the units in which the elevation is recorded.
19. SAMPLER: Write your name.

3.2 SURFACE WATER FIELD CHECKLISTS (REQUIRES FIGURES SOP016-2 AND SOP016-3)

3.2.1 Field Parameter Form (Items Unique to Figure SOP016-3)

1. CAL REF: Record the calibration reference for the pH meter.
2. pH: Record the pH of the sample.
3. TEMP: Record the temperature of the sample in degrees Celsius.
4. COND: Record the conductivity of the water.
5. For all other sections, see Section 3.2.1.

3.3 GROUNDWATER SAMPLING FIELD CHECKLISTS (REQUIRES FIGURES SOP016-2, SOP016-3, AND SOP016-4)

3.3.1 Field Parameter Form (Items on Figure SOP016-4)

1. WELL NO. OR ID: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User's Guide for chemical data entry.
2. SAMPLE NO.: Record the reference number of the sample.
3. WELL/SITE DESCRIPTION: Describe the location where the sample was taken, along with distances to landmarks.

4. X-COORD and Y-COORD: Record the survey coordinates for the sampling site.

5. ELEV: Record the elevation where the sample was taken.

6. UNITS: Record the units the elevation was recorded in.

7. DATE: Record the date in the form MM/DD/YY.

8. TIME: Record the time, including a designation of AM or PM.

9. AIR TEMP.: Record the air temperature, including a designation of C or F (Celsius or Fahrenheit).

10. WELL DEPTH: Record the depth of the well in feet and inches.

11. CASING HT.: Record the height of the casing in feet and inches.

12. WATER DEPTH: Record the depth (underground) of the water in feet and inches.

13. WELL DIAMETER: Record the diameter of the well in inches.

14. WATER COLUMN HEIGHT: Record the height of the water column in feet and inches.

15. SANDPACK DIAM.: Record the diameter of the sandpack. Generally, this will be the same as the bore diameter.

16. EQUIVALENT VOLUME OF STANDING WATER: Use one of the following equations, to determine one equivalent volume (EV):

    1 EV = Volume in casing + volume in saturated sand pack. Or to restate:

    $$1\ \text{EV} = (BR_w^2h_w + 0.30B(R_s^2 - R_w^2)h_s) * (0.0043)$$

    where

    R_s = Radius of sandpack in inches
    R_w = Radius of well casing in inches
    h_s = Height of sandpack in inches
    h_w = Water depth in inches

    0.0043 = gal/in.^{3}
    and filter pack porosity is assumed as 30 percent

— OR —

Volume in casing = $(0.0043 \text{ gal/in.}^3)(B)(12 \text{ in./ft})(R_c^2)(W_h)$

where

R_c = Radius of casing in inches
W_h = Water column height in feet

Vol. in sandpack = $(0.0043 \text{ gal/in.}^3)(B)(12 \text{ in./ft})(R_b^2 - R_c^2)(W_h)(0.30)$

(if W_h is less than the length of the sandpack),

— PLUS —

Vol. in sandpack = $(0.0043 \text{ gal/in.}^3)(B)(12 \text{ in./ft})(R_b^2 - R_c^2)(S_h)(0.30)$

(if W_h is greater than the length of the sandpack).

where

R_b = Radius of the borehole
S_h = Length of the sandpack.

Show this calculation in the comments section.

17. VOLUME OF BAILER OR PUMP RATE: Record bailer volume or pump rate.

18. TOTAL NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers required to remove 3 equivalent volumes (EV) of water from the well or the total purge time and volume as applicable.

19. WELL WENT DRY? Write “YES” OR “NO.”

20. NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers or pump time which made the well go dry.

21. VOLUME REMOVED: Record the volume of water (gal) removed before the well went dry.

22. RECOVERY TIME: Record the time required for the well to refill.

23. PURGE AGAIN?: Answer “YES” or “NO.”

24. TOTAL VOL. REMOVED: Record the total volume of water (in gal) removed from the well.

25. CAL REF.: Record the calibration reference for the pH meter.

26. TIME: Record time started (INITIAL T[0]), 2 times DURING the sampling and the time sampling ended (FINAL).

27. pH: Record the pH at start of sampling (INITIAL), twice DURING the sampling and at the end of sampling (FINAL).

28. TEMP: Record the water temperature (Celsius) at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

29. COND: Record the conductivity of the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

30. D.O.: Record the dissolved oxygen level in the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

31. TURBIDITY: Record the readings from the turbidity meter (nephelometer) and units at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

32. ORD: Record the oxidation/reduction (RedOx) potential of the water sample at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

33. HEAD SPACE: Record any positive readings from organic vapor meter reading taken in well headspace prior to sampling.

34. NAPL: Record the presence and thickness of any non-aqueous phase liquids (light or dense)

35. COMMENTS: Record any pertinent information not already covered in the form.

36. SIGNATURE: Sign the form.

3.4 FIELD CALIBRATION FORMS (MAINTAINED AS A SEPARATE LOGBOOK, OR INCORPORATED INTO SAMPLING LOGBOOKS)

3.4.1 Items on Figure SOP016-5

1. Record time and date of calibration. Note whether 12- or 24-hour clock was used.

2. Record calibration standard reference number.

3. Record meter I.D. number

4. Record initial instrument reading, recalibration reading (if necessary), and final calibration reading on appropriate line.

5. Record value of reference standard (as required).

6. COMMENTS: Record any pertinent information not already covered on form.

7. SIGNATURE: Sign form.

3.5 GROUNDWATER HYDROLOGY TESTS CHECKLISTS (MUST INCLUDE FIGURES SOP016-6 AND SOP016-7 AND/OR SOP016-8 OR SOP016-9)

3.5.1 Field Permeability Test Data Sheet (Items on Figures SOP016-6)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

4. PROJECT NO.: Record the contractor assigned project number or the contract number.

5. LOCATION: Specific location

6. CLIENT: Agency or company with the contract under which the work is being performed.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

9. TEST TYPE: Short description of the type of test to be performed.

10. RISING/FALLING HEAD WITH SLUG: Check if the test involved the insertion/removal of and inert object.

11. RISING/FALLING HEAD WITHOUT SLUG: Check if the test involved the addition/removal of a quantity of water.

12. START DATE: Date on which the test was begun.

13. CLOCK TIME: Time each datum (depth to groundwater level) is collected. Note whether 12- or 24-hour clock was used.

14. ELAPSED TIME: Time since the last datum was collected.

15. DEPTH TO GWL (ft): Depth to the top of the groundwater table (Groundwater Level) as measured by manual methods.

16. REC. (ft): Water level as reported by transducer/datalogger (this is the depth of water above the transducer.

17. TIME: Time the discharge rate check was begun (addition or removal of water method). Note whether 12- or 24-hour clock was used.

18. FLOW METER (Addition or removal of water method): The amount of water added or removed as registered by the flowmeter, in gal of liters.

19. DISCHARGE RATE: Flowmeter reading divided by time interval (gal/min or liters/min).

20. SIGNATURE: The person completing this form must sign the form at the end of the test.

21. DATE: Date the form was signed.

3.5.2 Groundwater Levels – Single Well (Items on Figure SOP016-7)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

Well Data

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's fieldwork.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: Remedial investigation wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATE: Date of each water level reading

16. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.

17. ELAPSED TIME: Time since test was begun.

18. DEPTH TO WATER: Measured depth to the groundwater table.

19. WATER ELEVATION: Elevation of the top of the groundwater table (use datum listed above).

20. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).

21. TAPE NO.: The unique identification number of the traceable standard tape used to calibrate the measuring device.

22. WELL STATUS: Condition of the well at the time of measuring (see abbreviation key at the bottom of the data sheet).

23. REMARKS: Any additional pertinent comments not specifically required above.

24. INITIALS: Initials of person completing this data entry.

25. ABBREVIATION KEYS: Self-explanatory.

26. SIGNATURE: The person completing this form must sign the form at the end of the test.

27. DATE: Date the form was signed.

3.5.3 Groundwater Levels – Single Well (Items on Figure SOP016-8)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

Well Data

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's fieldwork.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATALOGGER: This section is record of pertinent datalogger information.

16. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

17. MODEL: Enter the model number of the datalogger.

18. S/N: Enter the serial number of this datalogger.

19. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger's program to indicate that this unit was used to record a given data set?

20. TRANSDUCER: This section is a listing of pertinent information about the transducer used.

21. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

22. MODEL: Enter the model number of the transducer.

23. S/N: Enter the serial number of this transducer.

24. INPUT/UNITS: What are the units this transducer uses?

25. RANGE: Record the pressure or depth range over which this transducer is certified.

Calibration

26. PRESSURE RATING: This is taken from the manufacturer's specifications for a given transducer. (Usually in psi, or kpa).

27. "SUBMERGENCE = ___ (V) / (MV)": Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

28. VOLUME WATER ADDED/REMOVED: (Applicable if inert object insertion/removal method was not employed.) Record the volume of water added to or removed from the well.

29. DISCHARGE RATE: If z (above) is filled, enter the rate at which this water was added or removed.

30. INITIAL WATER LEVEL (ft): Enter the water level in the well at the beginning of the test.

31. PRESSURE TRANSDUCER SUBMERGENCE: Record the depth to which the transducer is submerged at the beginning of the test and the depth to the transducer at the end if the test. All depths will be recorded to the nearest 0.01 ft.

32. TIME: Record the time the test is begun and ended. Note whether 12- or 24-hour clock was used.

33. OBSERVED CHANGES IN ADJACENT WELLS: Note any changes in water levels in nearby wells.

34. RESULTS RECORDED ON DISKETTE #: Tracking number of the diskette on which these data are archived.

35. DISKETTE FILE NAME: Name of the file(s).

36. SIGNATURE: The person completing this form must sign the form at the end of the test

37. DATE: Date the form was signed.

3.6 GROUNDWATER LEVELS – MULTIPLE WELLS (ITEMS ON FIGURE SOP016-9)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. PROJECT NAME: Record the name assigned by the contractor’s organization to the project.

5. LOCATION: Specific location.

6. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

7. CLIENT: Agency with the contract under which the work is being performed.

8. REMARKS: Any pertinent observations not specifically required above.

9. WELL: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

10. DATE: Date this measurement was made.

11. TIME: Time this measurement was made. Note whether 12- or 24-hour clock was used.

12. DEPTH TO WATER: Depth from MP to top of groundwater table.

13. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

14. MP ELEV.: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's fieldwork.

15. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).

16. REMARKS/MP: Describe the location and nature of the measuring point.

17. INITIALS: Initials of the person completing this form.

18. ABBREVIATION KEYS: Self-explanatory.

19. SIGNATURE: The person completing this form must sign the form at the end of the test.

20. DATE: Date the form was signed.

3.7 GROUNDWATER LEVELS – DATALOGGERS

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

Well Data

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's fieldwork.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019, Section 3.4).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

Datalogger (This section is a record of pertinent datalogger information)

15. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

16. MODEL: Enter the model number of the datalogger.

17. S/N: Enter the serial number of this datalogger.

18. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger's program to indicate that this unit was used to record a given data set?

Transducer (This section is a listing of pertinent information about the transducer used)

19. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

20. MODEL: Enter the model number of the transducer.

21. S/N: Enter the serial number of this transducer.

22. INPUT/UNITS: What are the units this transducer uses?

23. RANGE: Record the pressure or depth range over which this transducer is certified.

Calibration

24. PRESSURE RATING: This is taken from the manufacturer's specifications for a given transducer (usually in psi, or kpa).

25. "SUBMERGENCE = ___ (V) / (MV)": Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

26. DATE: Date of each water level reading

27. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.

28. LOGGING TIME INTERVAL: Time since test was begun.

29. WL FEET BELOW MP: Measured depth to the groundwater table from measuring point.

30. SUBMERGENCE: Depth of water above the transducer.

31. MEAS.METHOD: What device/method was used to measure the water level.

32. TAPE NO.: Record the tape identification number.

33. TRANSDUCER MOVED?: Was the transducer moved since the last water level reading?

34. REMARKS: Any pertinent remarks not otherwise specified.

35. INITIALS:

Data Transfer to Diskette

36. DATE: Date data were archived onto diskette.

37. TIME: Time stamp the computer assigns the data file.

38. FILE NAME: Name assigned the data file.

39. SOFTWARE USED FOR TRANSFER: Any special software, or computer operating system used to write the files to diskette. NOTE: If a “shareware” archiver which compresses files was used, and the archived file is not self-extracting, a copy of the unarchive program should be copied onto the diskette also.

40. OUTPUT FORMAT: What is the format of the output file? (DOS, UNIX, Binary, Compressed?)

41. INITIALS: Initials of the person who copied the data to diskette.

42. ABBREVIATION KEY: Self-explanatory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

None.

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Figures

FIGURE SOP016-1
FIELD PARAMETER LOGBOOK
SOIL AND SEDIMENT SAMPLES

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

INSTALLATION/SITE ________________________________ AREA ___________________

INST CODE FILE NAME ____

SITE TYPE SITE ID
FIELD SAMPLE NUMBER

DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.

DEPTH (TOP) DEPTH INTERVAL UNIT _____________

SAMPLING METHOD:

SPLIT SPOON AUGER SHELBY TUBE SCOOP OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS
SITE DESCRIPTION:____
SAMPLE FORM ______________________ COLOR _____________ ODOR _____________
PID (HNu) _______________________ UNUSUAL FEATURES _______________________

WEATHER/TEMPERATURE
SAMPLER

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

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FIGURE SOP016-2
FIELD PARAMETER LOGBOOK
GROUNDWATER AND SURFACE WATER SAMPLES

INSTALLATION/SITE AREA
INST CODE FILE NAME SITE TYPE
SITE ID FIELD SAMPLE NUMBER
DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.
DEPTH (TOP) DEPTH INTERVAL UNITS

SAMPLING MEASUREMENTS

CAL REF. pH TEMPERATURE C CONDUCTIVITY OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION
SAMPLING METHOD
SAMPLE FORM COLOR ODOR
PID (HNu)
UNUSUAL FEATURES
WEATHER/TEMPERATURE ___________________________ SAMPLER ___________________

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FIGURE SOP016-3
MAP FILE LOGBOOK

SITE ID POINTER ____________________
DESCRIPTION/MEASUREMENTS
SKETCH/DIMENSIONS:

MAP REFERENCE
COORDINATE DEFINITION (X is Y is)
COORDINATE SYSTEM SOURCE ACCURACY
X-COORDINATE Y-COORDINATE UNITS
ELEVATION REFERENCE
ELEVATION SOURCE ACCURACY ELEVATION
UNITS

SAMPLER

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FIGURE SOP016-4
MAP FILE AND PURGING LOGBOOK
GROUNDWATER SAMPLES

WELL COORD. OR ID SAMPLE NO.______________
WELL/SITE
DESCRIPTION____
____
X-COORD. Y-COORD. _______________ ELEV. UNITS
DATE ____/____/____ TIME AIR TEMP.

WELL DEPTH _________ ft _________ in. CASING HT. _________ ft _______ in.
WATER DEPTH __________ ft _________ in. WELL DIAMETER __________ in.
WATER COLUMN HEIGHT _________ ft _________ in. SANDPACK DIAM. ________ in.
EQUIVALENT VOLUME OF STANDING WATER ____________ (gal) (L)
VOLUME OF BAILER ___________ (gal) (L) <u>or</u> PUMP RATE ___________ (gpm) (lpm)
TOTAL NO. OF BAILERS (5 EV)___________ or PUMP TIME ___________ MIN.
WELL WENT DRY? [Yes] [No] NUM. OF BAILERS ________ or PUMP TIME_______MIN
VOL. REMOVED __________ (gal) (L) RECOVERY TIME __________ MIN
PURGE AGAIN? [Yes] [No] TOTAL VOL. REMOVED __________ (gal) (L)

Date and Time	Quantity Removed	Time Required	pH	Cond	Temp	ORD	Turb	DO	Character of water (color/ clarity/odor/partic.)
(before)									
(during)									
(during)									
(during									
(after)									

COMMENTS:____
____
____
____

____
SIGNATURE

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FIGURE SOP016-5
FIELD CALIBRATION: pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY, OXIDATION-REDUCTION POTENTIAL, AND DISSOLVED OXYGEN METERS

INITIAL CALIBRATION	FINAL CALIBRATION
DATE:	DATE:
TIME:	TIME:

pH METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ______________________________

pH STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
7.0			
10.0			
4.0			

CONDUCTIVITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID _________________

COND. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

TEMPERATURE METER CALIBRATION

METER ID ________________

TEMP. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
ICE WATER			
BOILING WATER			
OTHER			

FIGURE SOP016-5 *(continued)*

TURBIDITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

ORD METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

DISSOLVED OXYGEN METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ____________________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

COMMENTS:____

____

____

____

____
SIGNATURE

FIGURE SOP016-6
FIELD PERMEABILITY TEST DATA SHEET

Contractor:

Seq. # /

Project Name:	Project #:
Location:	Client:
Party Chief:	Contractor:
Observation Well:	
Test Type: Rising/Falling Head w/Slug	Rising/Falling Head w/out Slug

Start Date:								Discharge Rate		
Clock Time	**Elapsed Time (min)**	**Depth to GWL (ft)**	**Rec (ft)**	**Clock Time**	**Elapsed Time**	**Depth to GWL (ft)**	**Rec (ft)**	**Time**	**Flow Meter**	**Discharge Rate**

Signature: ____ **Date:** ______________________

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FIGURE SOP016-7
GROUNDWATER LEVELS – SINGLE WELL

Contractor: **Seq. #** _/_

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:

Well No.: Site: Area:

up (+)/down (-) from: Datum = MSL or:

Measuring Point Description:

Datalogger:
Manufacturer: Model: S/N:
Tag No. Programmed in Logger:

Transducer: Manufacturer: Model: S/N:
Input/Units: Range:

Calibration:
Pressure Rating:
0 ft submergence = (v) / (mv) ft submergence = (v) / (mv)

Volume Water Added/Removed:
Discharge Rate:
Initial Water Level (ft):

Pressure Transducer Submergence
Initial (ft): Final(ft): Time:Start: End:
Observed Changes in Adjacent Wells:

Results Recorded on Diskette #:
Diskette File Name:

Signature: ____ **Date:** ______________________

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FIGURE SOP016-8
GROUNDWATER LEVELS – MULTIPLE WELLS

Contractor: **Seq. #** /

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:
Measuring Point Description:
Remarks:
Well No.:
Site: Area: up (+)/down (-) from:
Datum = MSL or:

Date	Time	Elapsed Time	Depth to Water	Water Elevation	Meas. Meth.	Tape No.	Well Status	Remarks	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

Signature: ________________________________ **Date:** ____________________

FIGURE SOP016-8 *(continued)*

Contractor: **Seq. #** /

Project No.:
Project Name: Location:
Field Party Chief: Client:

Well	Date	Time	Depth to Water	Stickup	MP Elev.	Meas. Meth.	Tape No.	Remarks/MP	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

FIGURE SOP016-9
GROUNDWATER LEVELS DATALOGGERS

Contractor
Project No.: **Well No.:**
Project Name: **Site:**
Field Party Chief: **Area:**

WELL DATA: Stickup: **(ft)** **up (+)/down (-) from:**
MP Elevation: **Datum = MSL or:**

Measuring Point Description:
Remarks:

Datalogger:
Manufacturer: Model: S/N:
Tag No. Programmed in Logger:
Transducer: Manufacturer: Model: S/N:
Input/Units: Range:
Calibration: Pressure Rating:
0 ft submergence = (v) / (mv) ft submergence = (v)

Logging	Date	Time	Logging Time Interval	WL, ft Below MP	Submergence (logger reading)	Meas. Method	Tape No.	Well Status	Transducer Moved	Remarks	Initials
Start											
Stop											
Start											
Stop											

Data Transfer to Disk

Date	Time	File Name	Software Used for Transfer	Output Format	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently
NP = Nearby well pumping
NRP = Nearby well recently pumped
X = Obstructed

Signature **Date**

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Standard Operating Procedure No. 017
for
Ground Penetrating Radar Survey

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Revision 0
December 2014

CONTENTS

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a guideline and description of principles for the operation, instrumentation, applicability, and implementation of ground penetrating radar (GPR) geophysical surveys. GPR surveys can be used to: map subsurface stratigraphy; rapidly locate buried metallic objects, i.e., pipes, drums, ordnance, and tanks; locate buried waste disposal structures; locate voids within the subsurface; and, in some cases, directly detect contaminants.

2. DEFINITIONS

Dielectric Constant—The measure of the ability of a material to store a charge when an electromagnetic field is applied. This is the measure of the property which determines the reflection, adsorption, and transmission characteristics of the radar signal in the subsurface. Dielectric constants for common materials are listed in Table SOP017-1.

Ground Penetrating Radar Survey—A geophysical survey technique where an electromagnetic radar pulse is transmitted into the subsurface and the reflected pulse is measured and recorded.

Penetration or Exploration Depth—The maximum depth at which an object of interest can be detected using a given GPR configuration. The penetration depth is a function of the electrical properties of the subsurface materials and of the GPR signal strength and antenna design.

Radar Trace—The display of reflected signal strength on a graph of lateral distance along the ground versus travel time.

Transceiver—Antenna design consisting of a transmitter mounted on or within the antenna - also known as a monostatic configuration. A bistatic antenna configuration consists of the transmitter in a separate housing from the antenna.

Travel Time—The time required for a radar signal to travel from the antenna to a target, reflect, and return to the antenna. Travel time is a function of the depth of the target and the electromagnetic characteristics of the subsurface.

3. INSTRUMENTATION

The standard array of GPR instrumentation consists of the following:

- Transmitter/antenna unit(s)
- A DC power supply
- Control unit and the signal processing circuitry connected to the antenna by a cable

- An oscillograph or video display unit
- A plotter or an analog or digital recording device.

The field equipment may be vehicle mounted but is small enough that it may be hand carried into areas not having vehicle access. Examples of GPR units are Geophysical Survey Systems, Incorporated's (GSSI) SIR System 8 and System 10 GPR systems. Both GSSI systems utilize impulse radar technology to sense and record continuous, high resolution profiles of subsurface materials.

The primary variable in GPR instruments is the antenna configuration. Antennas are currently available in both monostatic (one-piece) and bistatic (two-piece) configurations and are generally designed to detect radar signals ranging from approximately 80 to 1000 MHz.

4. FIELD PROCEDURES

4.1 PLANNING

The planning phase of a GPR survey requires the development of information pertaining to the geophysical characteristics of the site and how they might vary across the area to be surveyed. The type and structure of soils, geologic formations, and the approximate elevation of the water table are critical factors that should be established. In addition to developing information about the characteristics of earth materials that are present at the site, the geophysicist needs to develop information about the targets of interest and factors that may interfere with execution of the survey or cause excessive noise in the acquired data. If possible, it is useful to know the depth, size and shape, and type of potential targets to be detected. The depth and size of the objects are very important such that the appropriate antenna configuration and spacing between survey lines may be selected. Surveys over known objects onsite are useful to cross-check the survey detection limit and depth calculations; however, they are not absolutely necessary. Other specifications include accuracy of locational resolution desired, probable weather conditions during site activities, and the type and sophistication of data processing required for data interpretation and presentation.

The time and effort required to perform GPR field surveys depends on several factors including the sophistication of the equipment used, type of target, and logistical considerations. Additional time and effort are required to process and interpret data. Sophisticated data processing, detailed interpretations, and high quality displays require considerable computer usage and may require more time to complete than the actual field survey.

4.2 SITE LAYOUT

GPR surveys are performed by establishing a grid of parallel survey lines across the site and moving the radar antenna along each of these lines. The spacing between the lines is dependent upon the size and depth of the targets of interest and the objectives of the survey (i.e., reconnaissance or detailed survey). GSSI systems employ an electronic marking device that records a mark on direct field graphic records or within digital radar files. Generally, double marks or clicks are made at the beginning and end of the survey lines and single clicks are recorded as the antenna passes over predetermined distance intervals. Following acquisition of data in the field, the data are downloaded from digital tape to computer storage for subsequent processing and analysis in the office.

4.3 DEPTH DETERMINATION

To determine the depth of anomalies noted on radar profiles, it is necessary to convert the data from recorded travel times to depths. This is done by determining the transmission velocity(ies) associated with the earth materials. The velocity of electromagnetic waves within the subsurface at the site may be determined through excavation of observed targets to determine their depth of burial. Several excavations may be made and an average or range of transmission velocities for materials at a given site may be determined. Once velocity values are determined, interpretations or determinations concerning the depths of other signatures or anomalies may be made. Two other simpler methods, discussed in the following section, provide a simple means of determining the radar-wave velocities through subsurface materials and, therefore, a means for converting travel times to depths. These are two graphical approaches, one involving examination of hyperbolic signatures and the other involving the examination of changes in the travel time within a given subsurface section as the transmitter and receiver antenna (bistatic configuration) are moved away from each other. The latter is referred to as wide angle radar reflection (WARR) measurements.

4.4 GROUND PENETRATING RADAR SURVEY MEASUREMENTS

Once an optimal GPR survey configuration has been decided upon, the survey itself is straightforward, barring changes in the subsurface electrical characteristics. The unit is activated and the antenna is towed along one of the prearranged grid lines. An electronic mark is placed on the data at the beginning and end of each survey line, and every 10 or 20 ft along the line, so that the position of the data and anomalies on each radar line is readily apparent. The locations of surface metal, utilities, walkways, etc. should be noted on the field logs during the survey.

5. DATA ACQUISITION

Although much of the data obtained in GPR surveys are automatically recorded by the instrumentation, additional information to unambiguously identify and interpret each trace should be recorded in the field logbook. At a minimum, the field logbook should contain the following information:

- Project name, number, and location
- Company or organization
- Date and time of day

- Operator's name
- Line and trace designation (also recorded directly on the signal recording medium)
- Equipment serial numbers
- Antenna frequency
- Direction and speed of antenna movement
- Weather and temperature
- Site map coordinates at the beginning and end of the trace
    - Other pertinent notes, remarks or comments
    - Electromagnetic velocity in the subsurface medium at the nearest calibration point.
- Map of grid and survey lines referenced to permanent features (wells, buildings, etc.)
- Data acquisition parameters (gain, range, filters used).

6. DATA PROCESSING AND INTERPRETATION

6.1 GENERAL

Reflected radar signals are electronically processed and displayed as an intensity-modulated time spectrum, where the time corresponds to target depth as described above. The series of signals corresponding to the reflected pulses as the antenna moves along a path forms a three-dimensional data set containing distance of traverse, depth, and intensity information.

Typically, the data are recorded on magnetic tape and/or displayed on a graphic recorder with distance displayed along the X-axis, time (i.e., depth) displayed along the Y-axis, and the intensity given by the degree of darkness of the trace. In a typical survey, a series of parallel traverses are made with the GPR, and the series of graphical traces provide X-Y-Z locational, as well as intensity of reflection information for targets of interest. Interpretation of anomalies in GPR traces requires considerable subjective evaluation by a trained geophysicist. Extensive experience is essential to distinguishing target reflections from inherent system noise and interferences. In many cases, the anomalies due to targets of interest are small compared to varying reflections from the antenna system, the ground surface, geologic perturbations, and other interferences. Similarly, an acceptable interpretation of target depth from travel time data requires knowledge of the varying geophysical characteristics across the site area surveyed.

A radar antenna transmits a “cone” rather than a thin beam of electromagnetic energy. The result is that reflections are obtained from objects not directly below the antenna. As the antenna moves across the plane of an object, reflections are obtained for a considerable distance along the antenna path. The radar reflections will generate a hyperbolic signature pattern. The size and shape of this hyperbolic signature varies as a function of the wave velocity within the subsurface materials, the size and the orientation of the object relative to the radar wave pulse, and the rate (t) at which the antenna configuration is moved along the surveyed line. The signal travel times will vary corresponding to the distance between the antenna and the object.

6.2 HYPERBOLIC REFLECTORS

A discrete spherical target, therefore, will generate a hyperbolic reflection pattern with the apex of the hyperbola corresponding to the location and depth of the object. Multiple or odd-shaped targets or targets of considerable size in comparison to the radar wavelength will generate complex reflection patterns consisting of overlapping hyperbolas. Thus, a true “picture” of subsurface objects is not obtained, and experience is necessary to translate the complex tracings into information concerning target depths, size, or shape.

6.3 DEPTH DETERMINATION

The calculation of the depth of exploration for a particular GPR configuration may be accomplished by knowing the dielectric constant of the earth materials or the depth to a particular reflector that is clearly visible on the radar record. In addition, the depth may be calculated through identification and graphical measurement of hyperbolic signatures or through the development WARR data. The values for resistivity (inverse of conductivity), dielectric constant, and wave velocity in Table SOP017-1 are typical values; however, the real values for subsurface materials may change significantly over short lateral distances. The use of the published values exclusively may not yield depth calculations of sufficient precision.

6.3.1 Wide Angle Radar Reflection Method

The WARR measurement requires the use of actual data from the surveys conducted at each of the areas, which are used to determine the velocities of the pulse, depth to significant reflectors, and total depth of penetration. WARR measurements are performed with a bistatic (separate transmitter and receiver) antenna configuration. The two antennae are moved away from each other at a constant rate as a record is developed. By knowing the distance between the transmitter and receiver at a given time during the development of the record, the geophysicist may calculate the electromagnetic wave velocity(ies) using a t^2-x^2 plot. The recorded reflections are graphically plotted with the square of the distance between transmitter and receiver on the x-axis and the square of the time period on the y-axis. The inverse of the slope of the line of the reflection is the velocity of propagation. A simple calculation relating distance versus time will yield a velocity of the propagated pulse. Once the transmission velocity is known, depths to reflectors may be determined. The WARR measurements require the presence of good horizontal reflectors.

6.3.2 Hyperbola Geometry Method

The second method, the identification and measurement of hyperbolas, also provides good estimates of GPR penetration depth. The shape and position of the hyperbolic signatures, caused by cylindrical objects (e.g., pipes or drums), is a function of the wave velocity within the subsurface, the size of the object, and the rate at which the antenna is moved. This type of calculation is possible because the GPR pulse has a broad cone-shaped radiation pattern and cylindrical objects have numerous surfaces that are normal to the pulse as the antenna is moved along a survey line: first approaching, directly over, and then away from the buried object.

The cone-shaped radiation pattern has an included angle of approximately 90 degrees. For flat or horizontal reflectors, only the vertical component of the pulse is reflected back to the receiver and the other sub-vertical components of the pulse are reflected or refracted away from the antenna not producing a record. Therefore, the two-way reflection sensitivity, or field of view, for flat surfaces is small. For cylindrical objects in the subsurface, the sub-vertical components of the pulse may also be reflected back to the receiver as the antenna approaches the object. Because the round trip travel time for the reflected pulse decreases as the antenna approaches the object, reaches a minimum directly over the object, and then increases again as the antenna moves away from the object, the record that is produced has a hyperbolic (inverted horseshoe) signature or pattern. The hyperbolic pattern generated on a radar record, distance (x) versus time (y), is a representation of the maximum round trip travel for the pulse when it first intersects the pipe, decreasing as the antenna approaches the axis of the pipe, and then increasing to a maximum again as it moves away from the pipe. Therefore, the position and shape of the hyperbola in the radar record are directly related to the wave transmission characteristics of the subsurface materials. Utilizing this simple geometric relationship, the geophysicist may calculate transmission velocities for the various areas and depths of penetration for the pulse and the depth to significant anomalies. Essentially, this results in a conversion of time on the y-axis of the GPR records to depth.

(Tz) represents the time of travel (or distance once velocity is known) for the “first” or “last” reflection that is produced when the center axis of the antenna is 45 degrees from the curved object (e.g., pipe). This reflection is recorded in the GPR record as the ends of the limbs of the hyperbola. This value is also referred to as the slant range or distance between the target and the antenna. The distance represented by (Tz) is greater than the actual depth of the target. As the antenna approaches the object, the radar signature (top of the hyperbola) approaches the actual depth of the object. (Ty) represents the time of travel (or distance once the velocity is known) when the antenna is directly over the reflector.

If it is assumed that the subsurface materials over path distance (Z) have on average the same electrical properties as those for path distance (Y) and the dimensions of the pipe are considered insignificant relative to the other dimensions, then the following geometric relations are true:

$$X2 + Y2 = Z2$$

and

$$T_y = \underline{Y}$$
$$T_z = Z.$$

Combining these equations and solving for Y (the actual depth of the pipe), the following equation may be derived:

$$Y = X * (1/[T_z/T_y{}^2 - 1]0.5)$$

where

X = Distance along the ground in any convenient unit
Y = Depth of pipe in distance units
T_z = Travel time or “slant range” to pipe in any units
T_y = Travel time when the antenna is directly over the pipe.

The distance along the surface and lengths of the Tz and Ty scaled directly from the record are all that are needed to calculate the depth to the object causing the hyperbola. While these graphical measurements and calculations are relatively simple, they may become tedious when performed on all of the hyperbolae. This process has been automated with RADAN software available from GSSI.

7. SURVEY DESIGN

7.1 PREREQUISITES

Appropriate planning of GPR surveys requires a basic understanding of the site subsurface and hydrogeologic features, including the probable lateral variability. A statement of work should be generated that describes, in as much detail as possible, the known site conditions that may affect the subsurface electrical properties and the objectives of the proposed survey efforts, and allows for changing the survey parameters if the subsurface conditions change or are not found to be as described. The type and degree of data interpretation and the desired format for data presentation should also be specified if possible.

7.2 INSTRUMENT SELECTION

The important instrument selection decision for the survey lies in the determination of the optimal antenna. Generally, the higher the antenna frequency, the smaller the object that it can resolve, and the smaller its depth of penetration. The optimal antenna is the one with the highest resolution that will have sufficient depth of exploration. However, the depth of penetration for a given antenna will vary widely between sites, primarily due to soil moisture content and the amount of clay/sand ratio of the soils. Overnight rainfall can often elevate the soil moisture content such that an antennas depth of penetration can be degraded by 30 percent in a few hours. No one antenna configuration is suitable for all cases, even at the same site. Ideally, the survey crew should carry multiple antennas to the site for the survey so that an optimal configuration will always be available.

7.3 GRID DESIGN

The survey grid should be designed such that the GPR measurements are spaced to adequately define the distribution and extent of the exploration targets. For convenience, an orthogonal survey grid, located relative to a known location, is usually established over the survey area and the GPR measurements and anomalies are located by their grid coordinates (x,y). This is a convenient method for recording the data in an organized manner, for graphically displaying the data, and for ease of locating the anomalies detected. For determination of geologic features or to detect large targets, reconnaissance-type, low-resolution surveys are typically performed with a track spacing of 5-20 ft. Surveys to detect small discrete targets or to resolve target details require a track spacing of 1-5 ft.

8. QUALITY CONTROL

The application of quality control principles to GPR surveys involves the following.

8.1 GENERAL

- Requiring that trained geophysicists be utilized in all aspects of the survey including the preparation of the project work plans and survey designs, conduct of the survey, interpretation of the data, and presentation of the results. Work plans need to be written such that some degree of latitude is given to the survey team so that they may adjust to site conditions.

- Clearly defining the objectives of the survey in terms of the: (a) degree of detail needed and size of the area to be surveyed; (b) type, depth, size, and composition of targets of interest (if known); (c) resolution required; (d) schedule limitations; (e) degree of sophistication required for data presentation and interpretation; and (f) specific deliverables required.

- Defining specific field quality control procedures.

- Justifying rejection of any data from a data set. Field data sheets should contain all observed data and the conditions that could impact data validation.

- Recording all field data in permanent ink in a bound logbook and tape logs with each page signed and dated by the survey team leader.

- Properly calibrating the GPR unit. In general, the objectives of most geophysical surveys may be achieved by obtaining relative measurements across the area surveyed. Absolute calibration is, therefore, of lesser importance. However, a properly calibrated instrument provides an added measure of data validity.

- Evaluating all sources of noise, interference, and obstructions at a site and noting their potential effects on certain measurements made along a surveyed line. These real-time field observations later allow for correcting the data results for noise, validating suspected external sources, and in detecting problems that may jeopardize the objectives of the survey.

8.2 CALIBRATION

Calibration of the radar traces for depth determinations is performed as follows:

- For reconnaissance surveys or surveys where lateral resolution is more important than depth, the traces may be roughly calibrated by estimating the velocity of electromagnetic waves in the media at the site from published values for similar materials. The crudeness of the calibration is evidenced by considering that the velocity may vary by more than an order of magnitude, depending on the soil/rock properties and moisture content.

- For surveys requiring reasonable resolution of target depth, the travel time to targets of known depths must be determined at each site. As the radar trace is made over the known targets, the reflection patterns provide direct depth-calibration points on the trace. Sites with uniform lithology may require only a few depth calibrations, however, generally, it is necessary to perform these calibrations at several locations and at several depths throughout the area of interest. Each radar trace should be referenced to the calibration most representative of the trace coordinates at the site. The preferred method is to use buried objects of known depth as calibration targets, or to excavate to detected objects and measure their depth below ground surface. A less desirable (but often necessary) procedure is to bury standard targets at various depths within the area of interest.

- In addition, WARR measurements may be conducted at several locations over the entire area of the site to determine how the transmission velocities change. If necessary, specific transmission velocities may be determined for each subarea within the surveyed area.

8.3 DAILY QUALITY CONTROL

Radar traces and interpreted data sets should be accompanied by quality control data that indicate the level of quality of the data. Periodic replicate measurements should be made so that measurement precision may be established. Time and/or depth calibrations should be performed on a daily basis.

A calibration that yields significant changes in instrument parameters or travel time may indicate the need for repetition of data or increased density of travel time calibrations in the area of interest. Graphical data should be reviewed during the field activities to determine that data quality is adequate, and whether the survey results appear to be consistent with conceptual models.

9. POTENTIAL PROBLEMS

GPR surveys are subject to a wide variety of potential problems that may impact conduct of the survey and/or proper interpretation of the survey results. The most significant problems include:

- ***Noise and Interferences***—GPR measurements may be affected severely both by natural and by man-made sources of electromagnetic interference. Sources of system noise that degrade the quality of radar traces include improper spacing of antennas above ground, improper cable placement, location of antennas too close to other system components, and facility instrument operation. Because reflections are obtained from any object with a dielectric constant differing from the surroundings, large masses or a high density of buried or surface rocks, metal, debris, wet soil, or structures can mask targets of interest. Some antennas are not shielded on their top surface and, as a result, are subject to interfering reflections obtained from overhead objects such as trees, power lines, and buildings. Topographic and geologic features can also interfere with acquisition of high quality target detection data. Small depressions in the ground surface, presence of boulders, clay lenses, and moist soil zones affect both the capability to detect the target and determine its depth. Sources of electromagnetic energy in the vicinity, i.e., radio or television transmitters, or navigational radar antennas may result in spurious signals in the radar traces. In some cases, these problems may be minimized by judicious selection of radar and/or data communications frequency, and by scheduling the surveys during period of transmission inactivity.

- ***Rebar***—The presence of steel reinforcing mesh or concrete rods in concrete(rebar) is a common problem for GPR surveys. The rebar generates regularly spaced hyperbolas in the data. If the rebar is thick and closely spaced, the reflections from the rebar can completely obscure the underlying material.

- ***Weather Conditions***—Because water absorbs radar signals, wet weather has a very serious effect on the ability to perform GPR surveys. Physical difficulties in executing a survey over wet terrain may also be expected. Therefore, survey activities should be planned, if at all possible, during periods when dry weather can be expected. The survey schedule should also account for moist soil conditions and changes in these conditions.

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TABLE SOP017-1 DIELECTRIC CONSTANTS FOR COMMON MATERIALS

	Resistivity (ohm/meter)	Relative Dielectric Constant	Electromagnetic Wave Velocity (cm/ns)
Air	---	1	30
Asphalt	Approximately 10	2.5-3.5	16-19
Concrete	Approximately 10	3-9	10-17
Conglomeratic soil	100-1,000	9-14	8-10
Sandy soil	50-400	11-18	7-9
Silty soil	20-200	14-36	5-8
Clayey soil	1-30	25-56	4-6
Sandstone	200-1,000	9-14	8-10
Limestone	2,000-10,000	6-11	9-12
Ice	---	3.2	17
Water	---	81	3.3
Sea water	5×10^{-2}	81	3.3

SOURCE: OYO Corporation. 1987. Operation Manual, Model 2441 GeoRadar-I.

Standard Operating Procedure No. 019
for
Monitoring Well Installation

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Revision 1
October 2019

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 019	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	14 October /2019	Updated various items associated with current practice and deeper (>100 feet) monitoring wells	Kevin Sharpe, Ryan Guth	Matthew Bowman

1. SCOPE AND APPLICATION

The installation approach and details for monitoring wells are driven by the existing conditions at the project site and state and local regulatory requirements. The project team should carefully address these considerations as they may require some deviations for procedures described in this Standard Operating Procedure (SOP). State and local regulatory requirements supersede the guidance prescribed herein. The purpose of this SOP is to delineate the quality control measures required to ensure the accurate installation of monitoring wells. The applicable site-specific Work Plan should be consulted for specific installation instructions. The term “monitoring wells,” as used herein, is defined to denote any environmental sampling well. An example Well Construction Log Form is provided in Attachment A. Alternate, equivalent forms are acceptable.

2. MATERIALS

2.1 DRILLING EQUIPMENT

The following drilling equipment may be required:

- Appropriately sized drill adequately equipped with augers, bits, drill stem, etc.
- Source of approved water
- Water level indicator
- Weighted steel tape measure
- Photoionization detector: RAE® Systems MiniRAE 3000 (or equivalent)
- Lower explosive limit – oxygen monitor
- Steel drums for intrusion-derived wastes (drill cuttings, contaminated personal protective equipment, decontamination solutions, etc.)
- Heavy plastic sheeting
- High temperature, high pressure sprayer and water obtained from approved source for decontaminating drilling equipment
- Sorbent pads and/or log.

2.2 WELL INSTALLATION MATERIALS[1]

The following well installation materials may be required:

- Well screen:[2]
  - Polyvinyl chloride (PVC): Johnson (or equivalent); PVC 0.010 slot; Schedule 40; flush-threaded (leak-proof) joints; PVC complies with ASTM International (ASTM) D2665, D1784, and F480; free of ink markings; and cleaned and prepackaged by manufacturer.
  - Stainless steel: Johnson (or equivalent); stainless steel 0.010 slot; 304 stainless steel[3]; ASTM F480 flush threads; cleaned, wrapped, and heat sealed by manufacturer.
- Riser pipe:
  - PVC: Johnson (or equivalent); STD; PVC; Schedule 40; flush-threaded (leak-proof) joints; PVC complies with ASTM, D1784, and F480; free of ink markings; and cleaned and prepackaged by manufacturer.
  - Stainless steel: Johnson (or equivalent); Schedule 5; 304 stainless steel; ASTM Type A312 material; 4-inch (in.) diameter; cleaned, wrapped, and heat sealed by manufacturer.
- Plugs/caps: Johnson (or equivalent); standard PVC or stainless steel.
- Filter pack: Morie, 100 well gravel (or equivalent). NOTE: Final gradation may vary as a function of the gradation of the formation.[2]
- Fine Silica or Ottawa sand (or equivalent).
- Bentonite seal: BAROID, bentonite pellets (3/8-in. diameter).
- Cement: Type II Portland cement (table below).

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1. Technical information on all installed materials (screens, riser pipe, filter pack, bentonite, cement, etc.) and representative samples of the proposed filter pack, bentonite powder, and bentonite pellets will be supplied to the Project Manager.
2. Well screen slot size and filter pack gradation will be determined from sieve analysis of aquifer materials. Screen and casing material type will be determined based on field tests of groundwater chemistry and contaminants.
3. Unless the sum of Cl-, F-, and Br- is >1,000 parts per million (ppm), in which case Type 316 should be used.

Cement Type	Special Characteristics	Recommended Usage
I	No special properties	General use as grout mix or cement plug (if sulfates <250 ppm), surface pad.
IA	Air-entraining Type I (Note that air entrainment properties can be achieved by chemical admixtures)	Air entrainment gives cement greater freeze-thaw resistance. Recommended for surface pads.
II	Moderate sulfate resistance, low heat of hydration	General use as grout mix or cement plug where groundwater sulfate >250 ppm and <1,500 ppm, surface pad.
IIA	Air-entraining Type II	See Type IA.
III	High early strength, high heat of hydration	Elevated temperature can damage well casing and fracture grout/cement plugs. NOT RECOMMENDED.
IIIA	Air-entraining Type III	NOT RECOMMENDED.
IV	Low heat of hydration	General use as grout mix or cement plug preferred type for well abandonment to ensure intact grout/cement plug.
V	High sulfate resistance	Use when groundwater sulfate levels >1,500 ppm.
NOTE: ppm = Part per million.		

- Bentonite powder: Baroid, Aquagel Gold Seal.
- Steel protective casing: Brainard-Kilman (or equivalent) zinc-plated steel, lockable, painted.[4]
- Geotextile: Milrafi (or equivalent); GTF 130; non-woven; 4 ounces.
- Coarse (blanket) gravel: Crushed stone aggregate.
- Containers for purged water, as required.
- Submersible pump or bailer of appropriate capacity, and surge block sized to fit well.
- Hach DREL 2000 portable laboratory (or equivalent).
- Conductivity, pH, oxidation-reduction potential (ORP), turbidity, dissolved oxygen, and temperature meters.
- Water level meter or interface probe
- Protective steel covers.

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4. All painted components (protector casing, steel bollards/pickets) will be painted high-visibility orange and allowed to dry completely prior to being brought onsite.

- Portland Type IA cement (see previous table) alone, or as part of concrete mix for surface pad.

- Steel posts (bollards/pickets), painted (see footnote).

2.3 DOCUMENTATION

The following documents may be required by field staff supervising the installation of monitoring wells:

- Copy of appropriate Work Plan
- Copy of approved Health and Safety Plan
- Copies of well and excavation permits
- Boring log forms
- Well completion diagram form
- Well development form.

2.4 GEOLOGIST’S PERSONAL EQUIPMENT

The following equipment may be required for the geologist:

- 10 times magnifying hand lens
- Unified Soil Classification System chart
- Munsell soil color chart
- Sieve set (Keck model SS-81 or equivalent)
- Personal protective equipment as required by the Health and Safety Plan.

3. PROCEDURE

3.1 MATERIALS APPROVAL

Water sources for drilling, grouting, sealing, filter placement, well installation, and equipment decontamination must be approved by the Project Manager prior to arrival of the drilling equipment. Information required for the water source includes: water source, manufacturer/ owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analyses over the past 2 years, and name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives (bentonite) will be the only drilling fluid additive allowed, and its use must be approved by the Project Manager prior to the arrival of the drilling equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer’s address and telephone number, product description, and intended use for the product.

Granular filter pack material must be approved by the Project Manager prior to drilling. A 1-pint representative sample must be supplied to the Project Manager. Information required includes: lithology, grain size distribution, brand name, source, processing method, and slot size of intended screen.

Screen and casing materials must be approved by the Project Manager prior to drilling. Materials for deep wells must have adequate strength to prevent collapse or damage. A collapsed well is an expensive and time-consuming mistake.

Portland Type II cement will be used for grout (see previous table).

3.2 DRILLING

The objective of the selected drilling technique is to ensure that the drilling method provides representative data while minimizing: (1) subsurface contamination, (2) cross-contamination of aquifers, and (3) drilling costs. The preferred drilling method for shallow (<100 feet [ft]) well installation is hollow-stem auger, although direct-push and sonic methods can also be considered, and other methods can be approved as conditions warrant. The method used at a specific site will be proposed in the work plan and evaluated by the Project Manager.

If the design depth of the well is >100 ft, other rotary drilling methods (mud rotary, air rotary, air rotary with downhole hammer, dual-tube reverse rotary, etc.) may be used to install wells. The following drilling fluids and methods are approved in the order listed: (1) rotary drilling with water from an approved source as drilling fluid (clays from the formations will tend to thicken the fluid and coat the walls of the borehole and this is acceptable); (2) rotary drilling with water as a fluid, advancing a temporary casing with the bit to maintain an open hole; and (3) mud rotary using water with additives as drill fluid. Due to the potential for aquifer contamination and plugging, mud rotary drilling is not recommended for monitoring wells. If, however, “running sands” are encountered and the aquifer is expected to have a relatively high flow rate, then mud rotary is considered an approved method. Pure sodium bentonite is the only approved additive. Mud rotary drilling must be halted at the last aquitard above the target aquifer. Casing must be set, all bentonite-bearing fluids flushed from the hole and drill rig, and drilling may be resumed using water only as the drill fluid until the target depth is reached. Rotary drilling with air is useful and efficient in bedrock drilling and is typically done with no additions to the air stream; however, additives (e.g., foam) can be considered if conditions warrant.

A site geologist will be present during all well drilling and installation activities and will fully characterize all tasks performed in support of these activities into the monitoring well logbook. The site geologist will be responsible at only one operating rig for: (1) logging of samples, (2) monitoring of drilling operations, (3) recording of water losses/gains and groundwater data, (4) preparing the boring logs and well diagrams, and (5) recording the well installation procedures of the rig. The site geologist will have onsite sufficient equipment in operable condition to perform efficiently his/her duties as outlined in the contractual documents. Items in the possession of each site geologist will include: (1) the approved Health and Safety Plan; (2) this SOP; (3) a hand lens (10 times); (4) a standard color chart; (5) grain-size chart;

(6) a weighted (with steel or iron) steel tape long enough to measure the deepest well, heavy enough to reach that depth, and small enough to fit readily within the annulus between the well and drill casing; and (7) a water level measuring device, preferably electrical.

Only anti-seizing compounds that are environmentally safe (i.e., commercial products for environmental drilling projects or solid vegetable shortening [e.g., Crisco®]) may be used on downhole drilling equipment. Compounds containing either lead or copper will not be allowed. In addition, polychlorinated biphenyls will not be permitted in hydraulic fluids or other fluids used in the drilling rig, pumps, and field equipment/vehicles.

Surface runoff or other fluids will not be allowed to enter any boring or well during or after drilling/construction. Steps in the form of grading or sandbagging can be taken to ensure that runoff is directed away from the borehole.

Antifreeze used to keep equipment from freezing will not contain rust inhibitors and sealants. Antifreeze is prohibited in areas in contact with drilling fluid. The ground surface at the well site will be protected from possible coolant, fuel, and hydraulic fluid spills and/or leakage by placement of plastic sheeting with raised edges; and draining into a lined catch basin large enough to contain spills and/or leakage from motors, radiators, or vehicle tanks. Sorbent pillows will be placed to catch obvious leaks from the drill rig. Sorbent logs may be used instead of, or in conjunction with, a lined catch basin to contain spills.

An accurate measurement of the water level will be made upon encountering water in the borehole and later upon stabilization (levels will have less usefulness during mud rotary drilling). Levels will be periodically checked throughout the course of drilling. Any unusual change in the water level in the hole (i.e., a sudden rise of a few inches may indicate artesian pressure in a confined aquifer) will be the basis for cessation of drilling. The geologist will immediately contact the Project Manager[5]. Particular attention for such water level changes will be given after penetrating any clay or silt bed, regardless of thickness, which has the potential to act as a confining layer.

Anticipated depths of wells are given in well-specific work plans. In case the previously defined criteria have not been met before the depth range for a given hole is reached, the geologist will stop the drilling and confer with the Project Manager. The current boring conditions (depth, nature of the stratigraphic unit, and water table depth) will be compared to those of other wells nearby to decide to continue drilling or terminate and complete the well.

If the well is to be installed in the surficial aquifer, drilling will be terminated before penetrating the basal aquitard. The basal aquitard is defined as the first 2 ft-thick clay below the water table, or below 5 ft in the case of a shallow aquifer.

If the well is to be installed in a lower, confined aquifer:

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[5] The contract technical oversight will also be contacted for guidance.

- Penetrations of aquifers located lower than the water table aquifer will be limited to avoid cross-contamination.

- Placement of new upper confined aquifer wells will be initially limited to those areas where contamination has been confirmed.

- The location of upper confined aquifer wells will be based upon the findings of the water table aquifer investigation. Areas of known contamination will be targeted for installing upper confined aquifer wells for the purposes of delineating vertical contamination.

- Where possible, upper-confined aquifer wells will be located such that they afford triangulation with other wells within the same aquifer to allow for a determination of groundwater flow direction.

- Some upper-confined aquifer wells will be installed approximately 10-15 ft from water table wells to enable the accurate assessment of vertical hydraulic gradients. If the direction of groundwater flow is known, wells within a group will be located sidegradient of each other.

- The boring will be advanced until the base of the surficial aquifer is reached (Section 3.2).

- An outer surface casing will be set 2-5 ft into the confining layer to minimize the potential for cross-contamination from the unconfined aquifer during drilling activities.

- The surface casing will be driven into the confining bed and grouted into place. Grout will be tremied into the annulus around the outside of the casing to within 5 ft of the ground surface. A grout plug at least 2 ft thick will be tremied into the bottom of the surface casing. The grout will be permitted to cure for 24 hours. All drilling fluids within the surface casing will then be removed, and the casing will be flushed with clean potable water.

- The drilling equipment will be decontaminated, a smaller bit or auger selected, and the hole will be continued through the grout plug into the confined aquifer.

- If deeper aquifers are to be screened, repeat preceding steps until total depth is reached.

If dense non-aqueous phase liquid (DNAPL) contamination is detected during drilling, the well will be terminated and completed at the base of the aquifer as described in Section 3.4. Drilling will not continue through the confining unit.

3.3 LOGGING

All borings for monitoring wells will be logged by a geologist. Logs will be recorded in a field logbook and/or a boring log. If the information is recorded in a logbook, it will be transferred to boring log forms on a daily basis. Field notes are to include, at a minimum:

- Boring number
- Material description (as discussed below)
- Weather conditions
- Evidence of contamination
- Water conditions (including measured water levels)
- Daily drilling footage and quantities (for billing purposes)
- Notations on man-placed materials
- Drilling method and borehole diameter
- Any deviations from established field plans
- Blow counts for standard penetration tests
- Core and split-spoon recoveries.

Material description for soil samples must include:

- Classification
- Unified Soil Classification System symbol
- Secondary components and estimated percentages
- Color
- Plasticity
- Consistency
- Density
- Moisture content
- Texture/fabric/bedding and orientation
- Grain angularity
- Depositional environment and formation
- Incidental odors
- Photoionization detector reading(s)
- Staining.

A typical boring log entry will include: (1) Munsell color, (2) moisture content, (3) primary components, (4) secondary components, (5) Unified Soil Classification System symbol, and (6) other attributes (density, consistency, and others from the list above). The relative proportions of secondary components will be described with descriptive terms: trace (less than 5 percent), few (6-15 percent), little (16-30 percent), some (31-49 percent), and (36-50 percent).

Material description for rock samples must include:

- Classification
- Lithologic characteristics

- Bedding/banding characteristics
- Color
- Hardness
- Degree of cementation
- Texture
- Structure and orientation
- Degree of weathering
- Solution or void conditions
- Primary and secondary permeability
- Sample recovery
- Incidental odors
- Photoionization detector reading(s)
- Staining.

3.4 WELL CONSTRUCTION AND INSTALLATION

3.4.1 General

After the borehole is drilled and logged, the hole will be backfilled as required for proper screen placement. The integrity of the aquitard will be restored by placing a bentonite plug of an appropriate thickness, either to the top of the aquitard (normal well installation) or to within 0.3 ft of the top of the aquitard (DNAPL well). Aquifer fill will be clean filter pack.

The installation of monitoring wells in uncased or partially cased holes will begin within 12 hours of completion of drilling or, if the hole is to be logged, within 12 hours of well logging, and within 48 hours for holes fully cased with temporary drill casings. Once installation has begun, work will continue until the well has been grouted and the drill casing has been removed.

The construction of each well will be depicted as built in a well construction diagram. The diagram will be attached to the boring log and will graphically denote:

- Borehole depth
- Screen location and length
- Joint location
- Granular filter pack
- Seal
- Grout
- Cave-in
- Centralizers
- Height of riser
- Protective casing detail.
- Water level on the construction date

3.4.2 Well Casing and Screen Installation

Assemble appropriate decontaminated lengths of pipe and screen. Make sure these are clean and free of grease, soil, and residue. Lower each section of pipe and screen into the borehole, one at a time, screwing each section securely into the section below it. No grease, lubricant, polytetrafluoroethelyne tape, or glue may be used in joining the pipe and screen sections. If a well extends below 50 ft, centralizers will be installed at 50 ft and every 50 ft thereafter except within screened interval and bentonite seal. Centralizer material will be PVC, polytetrafluoroethelyne, or stainless steel. Determination of centralizer material will be based on the same criteria as screen and casing selection.

Normal screen placement for the water table (surficial) aquifer will extend from 2 ft above the static water level to no more than 6 in. from the bottom of the hole or backfill material, whichever is applicable. The bottom of the screen will rest no more than 6 in. from the bottom of the hole or backfill material, whichever is applicable.

NOTE: The end cap in DNAPL wells will rest on the bottom of the hole, or bentonite backfill if applicable (Section 3.2).

Screen placement for a confined aquifer well will normally be at the top of the confined aquifer.

Screen lengths will not normally exceed 10 ft. If it appears advantageous in a given situation (e.g., to screen an entire aquifer that is thicker than 10 ft), approval must be sought on a case-by-case basis from the appropriate regulatory agency. Otherwise, wells will be screened as follows:

Thickness of Aquifer	Action
<10 ft	Screen entire aquifer
>10 ft <30 ft	Screen top 10 ft; consider vertically nested well cluster
>30 ft	Install vertically nested well cluster

Plastic well screens, casings, and fittings will conform to National Sanitation Foundation Standard 14 or ASTM equivalent for potable water usage. These materials will bear the appropriate rating logo. If the logos are not present, a written statement from the manufacturer/supplier stating that the materials contain the appropriate rating must be obtained. Material used will be new and essentially chemically inert to the site environment.

Well screen and casing should be inert with respect to the groundwater; therefore, the selection of screen and casing material will be based on select field tests of aquifer chemistry and potential contaminants. The screen will be capped without sediment trap or DNAPL sampling cup, and lowered into the hole. The well casing will be pre-cut to extend 2-2.5 ft above ground surface. Prior to placement of the last piece of well casing, a notch or other permanent reference point will be cut, filed, or scribed into the top edge of the casing.

Screen slot size will be appropriately sized to retain 90-100 percent of the filter pack material, the size of which will be determined by sieve analysis of formational material.

Stainless steel screens will be used in DNAPL wells. The formation grain size will be multiplied by the higher factor (6) to determine filter pack grain size. This will ensure that the filter pack is sufficiently coarse to permit DNAPL to pass freely from the formation into the coarser filter pack, then into the open well (Cohen and Mercer 1993).

DNAPL sampling cups are prohibited. The well screen will be capped and set 0.3 ft (0.5 ft maximum) into the top of the confining bed and rest on the bottom of the hole or bentonite backfill (if used). No sand will be placed below the screen.

3.4.3 Filter Sand Installation

Place the appropriate filter pack. Monitor the rise within the annulus with a weighted tape to assure that bridging is not occurring. After the filter pack is in place, wait 3-5 minutes for the material to settle, tamp and level with a capped PVC pipe, and check its depth with a weighted steel tape.

Filter pack material will be placed, lightly tamped, and leveled. Filter pack will extend from the bottom of the hole to a height of 1-2 ft above the top of the screen. The filter pack will be capped with a minimum of 1 ft of fine (e.g., Ottawa-type) sand to prevent the bentonite seal (placed as pellets) from infiltrating the filter pack. If the bentonite seal is placed as a slurry, a minimum of 2 ft of fine sand will be required.

If the hole is less than 20 ft deep, the filter pack may be poured into the annulus directly. If the hole is deeper than 20 ft, the filter pack must be tremied into place.

Granular filter packs will be chemically and texturally clean, inert, and siliceous.

Filter pack grain size will be based on formation grain size analysis. The D30 (70 percent retained) sieve size multiplied by a factor of not less than 3 nor greater than 6 will be used to determine the appropriate grain size.

Calculations regarding filter pack volumes will be entered into the field logbook along with any discrepancies between calculated and actual volumes used. If a discrepancy of greater than 10 percent exists between calculated and actual volumes exists, an explanation for the discrepancy will also be entered in the field logbook.

3.4.4 Bentonite Installation

Install the bentonite seal (2- to 5-ft thick) by placing bentonite pellets into the hole gradually. If the well is deeper than 20 ft, a tremie pipe will be used to place either bentonite pellets or slurry. Tamp and level pellets. If the well is within 20 ft deep, tamp with a capped PVC pipe; if >20 ft, tamping may be accomplished with the weighted end of the tape. In either case, check the depth to the top of the seal with a weighted tape as above.

If the bentonite pellets are of poor quality, they may have a tendency to hydrate and swell inside the tremie pipe and bridge. This situation may be solved by the following procedure:

1. Use a different brand of pellets. Different brands may have longer hydration times.

2. Freeze the pellets[6]. Note that this will require a longer wait time to allow proper hydration after the pellets thaw.

3. Place the bentonite seal as a slurry using a side-discharge tremie pipe as though installing grout. Note (Section 3.4) this will require that a minimum of 2 ft of fine sand be placed as a cap on top of the filter pack material.

Wait for the pellets to hydrate and swell. Hydration times will be determined by field test or by manufacturer's instructions. Normally this will be 30-60 minutes. Document the hydration time in the field notebook. If the pellets are above the water level in the hole, add several buckets of clean water to the boring. Document the amount of water added to the hole.

The final depth to the top of the bentonite seal will be measured and recorded.

3.4.5 Grout Installation

Mix an appropriate cement-bentonite grout (described below). Be sure the mixture is thoroughly mixed and as thick as is practicable.

Lower a side discharge tremie pipe into the annulus to the level of the pellet seal.

Pump the grout slurry into the annulus while withdrawing the tremie pipe and temporary casing. Stop the grout fill at 5 ft below the ground surface. Allow to cure for not less than 12 hours. If grout settles more than 6 in., add grout to bring level back up to within 5 ft of ground surface. Place approximately 2 ft of bentonite pellets (minimum 0.5 ft) in annulus. Seat the protective casing in the bentonite seal, allowing no more than 0.2 ft between the top of the well casing and the bottom of the protective casing cap. Fill inner annulus (between well casing and protective casing) with bentonite pellets to the level of the ground surface. Cover bentonite pellets with 1 ft of clean granular material (coarse sand or pea gravel filter pack). Fill the outer annulus (between the protective casing and the borehole) with neat cement. Allow the cement to mound above ground level and finish to slope away from the casing. Lock the cap.

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6. Bentonite pellets may be "flash-frozen" by brief immersion in liquid nitrogen (LN2). This can be accomplished by pouring LN2 over a small quantity (0.25-0.5 bucket) of pellets, allowing the LN2 to boil off, then pouring the pellets into the tremie pipe. NOTE: Use of LN2 is an additional jobsite hazard and must be addressed in the contractor's Health and Safety Plan. This contingency must be covered before drilling starts in order to avoid delays in well installation.

– OR –

Continue the grout fill to the ground surface. Seat the protective casing in the grout, allowing no more than 0.2 ft between the top of the well casing and the bottom of the protective casing cap. Lock the cap.

– AND –

Allow the grout slurry to set overnight.

Fill the outer annulus (between the casing and the borehole) with neat cement. Allow the cement to mound above ground level and finish to slope away from the casing.

Grout used in construction will be composed by weight of:

- 20 parts cement (Portland cement, Type II) (see previous table)
- 0.4-1 part (maximum) (2-5 percent) bentonite
- 8 gallons (maximum) of approved water per 94-pound bag of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

All grout material will be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump prior to placement. Grout placement will be performed using a commercially available grout pump and a rigid, side discharge tremie pipe.

The following will be noted in the field logbook: (1) calculations of predicted grout volumes; (2) exact amounts of cement, bentonite, and water used in mixing grout; (3) actual volume of grout placed in the hole; and (4) any discrepancies between calculated and actual volumes used. If a discrepancy of greater than 10 percent exists between calculated and actual volumes exists, an explanation for the discrepancy will also be entered in the field logbook.

Well protective casings will be installed around all monitoring wells on the following day as the initial grout placement around the well. Any annulus formed between the outside of the protective casing and the borehole will be filled to ground surface with cement.

3.4.6 Surface Completion

Cut the riser with a pipe cutter approximately 2-2.5 ft above grade. All pipe cuts MUST be square to ensure that the elevation between the highest and lowest point of the well casing is less than or equal to 0.02 ft. Notch, file, or otherwise permanently scribe a permanent reference point on the top of the casing.

Torches and saws may not be used to cut the riser. Care must be taken that all filings or trimmings cut from the reference point fall outside the riser rather than into the well. **Under no circumstances will a permanent marker or paint pencil be used to mark the reference point**.

The tops of all well casings will be capped with covers composed of materials compatible with the products used in the well installation. Caps may either be vented, or a telescopic fit, constructed to preclude binding to the well casing caused by tightness of fit, unclean surfaces, or weather conditions. In either case, it should be secure enough to preclude the introduction of foreign material into the well yet allow pressure equalization between the well and the atmosphere (e.g., avoid the use of unvented well plugs).

In some locations, safety requirements may mandate that a well be flush-mounted with no stickup. If a flush-mounted well is required at a given location, an internal pressure cap must be used instead of a vented cap to ensure that rainwater cannot pool around the wellhead and enter the well through the cap.

Slope the ground surface away from the casing for a distance of 2 ft, at a rate of no less than 1 in. in 2 ft. Surface this sloping pad with a geotextile mat covered by 6 in. of coarse gravel.

– OR –

Frame and pour a 4-ft square × 6-in. thick (4 ft × 4 ft × 6 in.) concrete pad centered around the protective casing.

– AND –

Set pre-painted protective steel pickets (3 or 4) evenly around and 4 ft out from the well. These pickets will be set into 2 ft deep holes, the holes will then be filled with concrete; and, if the pickets are not capped, they will also be filled with concrete.

3.5 WELL DEVELOPMENT

Well development is the process by which drilling fluids, solids, and other mobile particulates within the vicinity of the newly installed monitoring well have been removed while restoring the aquifer hydraulic conductivity. Development corrects any damage to or clogging of the aquifer caused by drilling, increases the permeability of the aquifer in the vicinity of the well, and stabilizes the formation and filter pack sands around the well screen.

Well development will be initiated after 48 consecutive hours but no longer than 7 calendar days following grouting and/or placement of surface protection.

Two well development techniques, over pumping and surging, will be employed in tandem. Over pumping is simply pumping the well at a rate higher than recharge. Surging is the operation of a plunger-like device (e.g. surge block) up and down within the well casing similar to a piston in a cylinder.

3.5.1 Materials Required

The following materials will be required for well development:

- Well Development Form
- Boring Log and Well Completion Diagram for the well
- Submersible pump or bailer of appropriate capacity, and surge block
- Conductivity, pH, ORP, turbidity, dissolved oxygen, and temperature meters
- Water-level meter or interface probe, as appropriate
- Containers for purged water, if required.

3.5.2 Summary of Procedures and Data Requirements

Pump or bail the well to ensure that water flows into it, and to remove some of the fine materials from the well. Removal of a minimum of one equivalent volume is recommended at this point. The rate of removal should be high enough to stress the well by lowering the water level to approximately half its original level. If well recharge exceeds 15 gallons per minute, the requirement to lower the head will be waived.

Slowly lower a close-fitting surge block into the well until it rests below the static water level, but above the screened interval. (NOTE: This latter is not required in the case of a light non-aqueous phase liquid well.)

Begin a gentle surging motion that will allow any material blocking the screen to break up, go into suspension, and move into the well. Continue surging for 5-10 minutes, remove surge block, and pump or bail the well, rapidly removing at least one equivalent volume.

Repeat previous step at successively lower levels within the well screen until the bottom of the well is reached. Note that development should always begin above, or at the top of, the screen and move progressively downward to prevent the surge block from becoming sand locked in the well casing. As development progresses, successive surging can be more vigorous and of longer duration as long as the amount of sediment in the screen is kept to a minimum.

Development is expected to take at least 2 hours in a small well installed in a clean sand, and may last several days in large wells, or in wells set in silts with low permeabilities.

Development will continue until little or no sediment can be pulled into the well, and target values for parameters listed below are met.

At a minimum, development will remove 3-5 well volumes of water. One development volume is defined as (1) equivalent volume, plus (2) the amount of fluid lost during drilling, plus (3) the volume of water used in filter pack placement.

1. Monitor water quality parameters (turbidity, pH, conductivity, ORP, dissolved oxygen, and temperature) before beginning development procedures, and after removing 2, 2.5, and 3 well volumes of water.

2. If these parameters have stabilized over the three readings, the well will be considered developed.

3. If the parameters have not stabilized after these three readings, continue pumping the well to develop, but stop surging. Monitor the stabilization parameters every half development volume.

4. When the parameters have stabilized over three consecutive readings at half development volume intervals, the well will be considered developed.

All water removed must be disposed of as directed by the Work Plan.

Record all data as required on a Field Record of Well Development Form (Attachment B), which is made a part of the complete well record. These data include:

- Depths and dimensions of the well, casing, and screen obtained from the well diagram.

- Water losses and uses during drilling, obtained from the boring log for the well.

- Depth-to-water measurements.

- Measurements of the following indicator parameters: turbidity, pH, conductivity, ORP, dissolved oxygen, and temperature.

- Target values for the indicator parameters listed above are as follows: pH – stabilize, conductivity – stabilize, ORP – stabilize, dissolved oxygen –- stabilize, temperature – stabilize, and turbidity – 5 nephelometric turbidity units or stabilize. A value is considered to have stabilized when three consecutive readings taken at half development volume intervals are within 10 percent of each other.

- Notes on characteristics of the development water.

- Data on the equipment and technique used for development.

- Estimated recharge rate and rate/quantity of water removal during development.

3.6 TEMPORARY WELLS

Temporary wells typically differ from permanent installations in the following ways: (1) the wells are typically shallow and have small diameters; (2) installation methods tend to be driving, direct-push, but could be any of the rotary methods or sonic; and (3) the wells tend to have limited surface completions with no protective casing, concrete pad, or bollard posts. Keep in mind that temporary wells may still require well permits and perhaps reporting on abandonment. The installation should follow steps to allow for expedited abandonment after a limited timeframe, meaning: (1) the casing should be amenable to pulling or ripping, (2) the borehole should be limited in diameter to expedite filling, and (3) surface disturbance should be minimized to allow for quick site restoration and possible reseeding.

3.7 WELL SURVEY

Newly installed monitoring wells will typically be surveyed by a state-registered surveyor to determine the geographical coordinates and elevations. Typical standards for the survey are surveying the well to vertical accuracy of 0.010 U.S. survey ft using the 1988 North American Vertical Datum and a horizontal accuracy to within 0.10 ft tied to site datum (World Geodetic System 1984 Universal Transverse Mercator Zone 11 North). The elevations for the natural ground surface (not the top of the grout collar) and the highest point on the riser casing rim of the uncapped well casing, and the protective casing for each well will be surveyed. A survey mark will be indicated by a small groove or other permanent marking in the well riser casing.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for discussion of physical and chemical hazards and preventive measures to be used during well installation and development activities.

6. REFERENCES

Cohen, R.M. and J.W. Mercer. 1993. DNAPL Site Evaluation, CRC Press, Inc.

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Attachment A

Well Construction Log Form

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WELL CONSTRUCTION LOG

EA Engineering, Science, and Technology, Inc., PBC

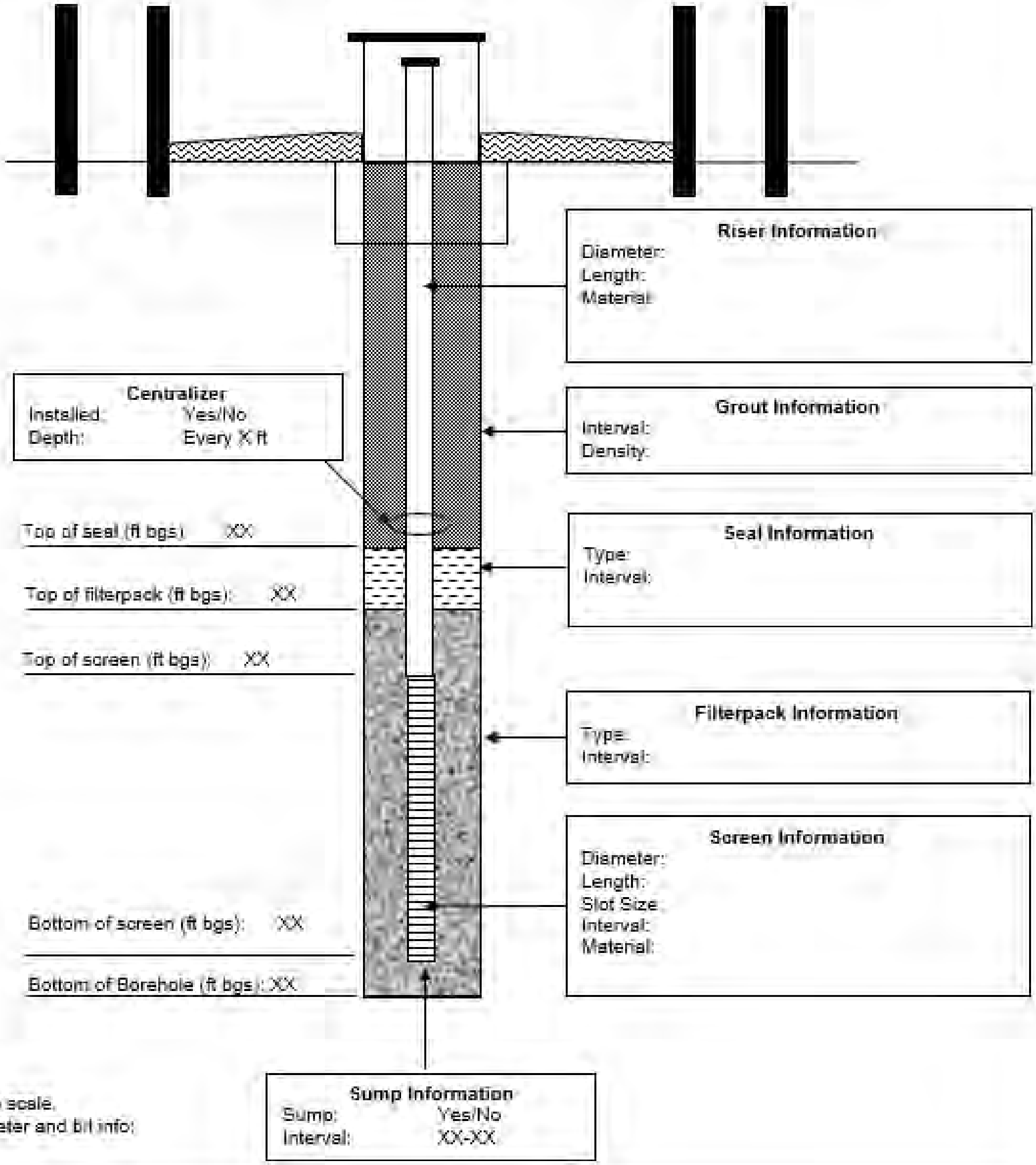
Project Name/ Project No.:

Location:

Monitoring Well ID No.:

[Coordinates]
Not Yet Surveyed
[Aquifer Type]

All footages indicated are below ground surface (bgs).



Riser Information
Diameter:
Length:
Material:

Centralizer
Installed: Yes/No
Depth: Every X ft

Grout Information
Interval:
Density:

Top of seal (ft bgs): XX

Seal Information
Type:
Interval:

Top of filterpack (ft bgs): XX

Top of screen (ft bgs): XX

Filterpack Information
Type:
Interval:

Screen Information
Diameter:
Length:
Slot Size:
Interval:
Material:

Bottom of screen (ft bgs): XX

Bottom of Borehole (ft bgs): XX

Sump Information
Sump: Yes/No
Interval: XX-XX

Notes:
Features not to scale.
Borehole diameter and bit info:

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Attachment B

Field Record of Well Development Form

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FIELD RECORD OF WELL DEVELOPMENT

Project Name:	Project No:	Date:
EA Personnel:	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No.:	Well Condition:
Well Diameter:	Measurement Reference:
Well Volume Calculations	
A. Depth To Water (ft):	D. Well Volume/ft:
B. Total Well Depth (ft):	E. Total Well Volume (gal)[C*D]:
C. Water Column Height (ft):	F. Five Well Volumes (gal):

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						
Parameter	**6 Volumes**	**7 Volumes**	**8 Volumes**	**9 Volumes**	**10 Volumes**	**End**
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS: ____________________

FIELD RECORD OF WELL DEVELOPMENT

Project Name:	Project No:	Date:
EA Personnel:	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No.:	Well Condition:
Well Diameter:	Measurement Reference:

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

Standard Operating Procedure No. 020
for
Active Soil Gas Sampling

Prepared by

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Hunt Valley, Maryland 21031

Revision 1
February 2019

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 020	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	18 February 2019	Systematic update and review	Jason Stroup, Geoffrey Little Robert Owens	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide guidelines for soil gas sampling. A soil gas survey is an effective screening tool in locating areas contaminated with volatile organic compounds.

2. MATERIALS

The following materials may be required:

1-L Tedlar bags	Probe set, including probe jack
3/16-inch (in.) outer diameter polyethylene tubing	Rotary hammer with 1 × 36-in. drill bit
Clean sand	Sample labels
Disposable shield points	Tools: vise grips, 0.75-in. wrench, scissors
Extension cord	Two measuring cups
Portable generator or other power source	Tubing for vacuum box
Granular bentonite	Vacuum box and vacuum pump
Teflon and/or Teflon-lined tubing	Summa canister

3. PROCEDURES

3.1 SOIL GAS POINT INSTALLATION

Installation of soil gas points includes the following steps:

1. Assemble clean probe sections to the desired sampling depth.

2. Cut polyethylene tubing to at least 1 foot (ft) longer than the depth of the hole.

3. Insert one end of the tubing approximately 0.25 in. inside of aluminum shield point. Crimp the shield point tightly around the tubing with vise grips and insert the tube and shield point inside of the clean probe.

4. Soil gas points should be installed using a rotary drill, Geoprobe® direct-push, or Macro-Core.

5. Using a rotary drill and 36-in. drill bit, bore down 30 in. at the desired depth for sampling. Be sure to clear the hole well so that soil does not fall back into the hole.

6. Drive stainless steel probe and attached shield point and polyethylene tubing down the hole with a rotary hammer to approximately 5 ft, or above the saturation zone. (It is desired to obtain a sample of the soil gas, not the groundwater.) If samples are needed

from greater than 5 ft, drive the steel probe with a solid tip to the desired depth, extract, and insert a probe fitted with a disposable shield point and tubing.

7. Use Geoprobe® direct-push or Macro-Core technologies to install stainless steel drive points to approximately 5 ft below ground surface (assuming no homes in the area have basements). If basements are identified, the steel drive points will be installed to the approximate depth of the basement floor.

   Once the sampling depth is reached, the 6-in. stainless steel sampling screen attached to a dedicated section of 0.25-in. diameter Teflon or Teflon-lined tubing (identified as laboratory or food grade) will be installed and used to collect the soil gas samples.

8. The borehole will then be backfilled with sand/glass beads to a minimum of 6 in. above the screened interval. Granular bentonite pellets will then be placed from approximately 6 in. above the screen to the ground surface hydrating concurrently with placement. Sufficient time will then be provided for the bentonite to set (approximately 24 hours). Pour 0.5 cup bentonite down sampling hole, add 0.25 cup distilled water, add another 0.5 cup bentonite down hole, and another 0.25 cup water. Continue until bentonite seal reaches the surface.

9. Collect sample (Section 3.2).

10. Remove probe and backfill hole with bentonite.

3.2 SOIL GAS SAMPLE COLLECTION USING TEDLAR BAGS[1]

The following steps summarize the collection of a soil gas sample using Tedlar bags:

1. Cut at least 1 in. off the end of the tubing to ensure a clean sample.

2. Attach tubing to the vacuum box and pump.

3. Open valve on a clean, dry Tedlar bag, and attach inside the vacuum box.

4. Close the vacuum box, close stopcock (3-way valve) between vacuum box and pump, and then turn the pump on.

5. Allow Tedlar bag to fill 90 percent (do not overfill bag), shut off, crimp Tygon tubing (to prevent release of sample back down hole), open stopcock, and remove Tedlar bag from box.

---

[1] Summa canisters are also acceptable and are generally used for projects requiring analytical data with a lower detection limit. An equivalent SOP for Summa canisters (SOP No. 006) and offsite analysis will be submitted prior to sampling.

— If the bag is filled with air only, squeeze the air out completely to purge air that was in the tubing and sand and reattach inside the box. Repeat Bullets 4 and 5. Close the valve on the Tedlar bag upon removal; label it accordingly; and put it in a cool, dark area. NOTE: Not so cool as to cause condensation.

— If Tedlar bag is filled with water and air, be sure to close valve on Tedlar bag before removing it; label the bag accordingly; and put it in a cool, dark area. NOTE: Not so cool as to cause condensation.

— If water is pulled into the Tedlar bag, Tygon tubing inside the vacuum box must be replaced.

6. Remove and decontaminate probes.

7. Repeat the above procedures for each additional soil gas point.

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

- Sample location will be noted, including the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor ambient air sample locations (if applicable), and compass orientation (north).

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

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

The field sampling team will maintain a soil gas sample log sheet summarizing the following:

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

3.3 SOIL GAS SAMPLE COLLECTION USING SUMMA CANISTERS

Soil gas samples will be collected in the same manner at all locations to minimize possible discrepancies. The following procedures should be followed when sampling soil gas:

1. At least 24 hours after the installation of the temporary soil gas points, 2-3 implant volumes (i.e., the volume of the sample probe and tube) will be purged prior to collecting the samples to ensure that representative samples are collected.

2. Flow rates for both purging and collecting will not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling.

3. Samples will be collected using conventional sampling methods and appropriate containers, which meet project data quality objectives (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), and meet the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters, which are certified clean by the laboratory, using an appropriate U.S. Environmental Protection Agency Method). The sample duration for these samples normally will be 2 hours.

4. A tracer gas (e.g., helium, butane, or sulfur hexafluoride) will be used at each location before collecting soil gas samples to verify that adequate sampling techniques are being implemented (i.e., to verify infiltration of outdoor air is not occurring). Once verified, continued use of the tracer gas may be reconsidered.

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

- Sample location will be noted, including the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor ambient air sample locations (if applicable), and compass orientation (north).

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

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

The field sampling team will maintain a soil gas sample log sheet summarizing the following:

- Sample identification
- Date and time of sample collection
- Sampling depth
- Identity of samplers

- Sampling methods and devices
- Purge volumes
- Volume of soil vapor extracted
- Canister and associated regulator identification
- Helium leak test results
- Vacuum before and after samples collected
- Apparent moisture content (dry, moist, saturated, etc.) of the sampling zone
- Chain-of-custody protocols and records used to track samples.

After the sample collection period, the Summa® canisters will be sent for subsequent laboratory analysis. The soil gas samples will then be analyzed for target constituents at an approved laboratory in accordance with the Sampling and Analysis Plan.

Upon completion of the sampling, the sample tubing will be removed and the temporary soil vapor point location will be backfilled with bentonite and marked with a stake/flag that will be labeled with the proper sample identification and illustrated on the site map so it can be located by the site surveyor or Global Positioning System operator. Borings performed in paved or concrete areas will be backfilled and refinished at the ground surface with concrete or cold patch.

4. MAINTENANCE

No maintenance is required.

5. FIELD QUALITY CONTROL MEASURES

To ensure that the equipment is free of volatile contaminants, collect at least two quality control samples per day by drawing uncontaminated air through an unused representative sampling apparatus (assembled shield point and tubing). One sample should be taken at the beginning of the day, prior to collecting any samples, and the other at the end of the day, after decontaminating the equipment. Ambient air may usually be assumed to be uncontaminated. If site ambient air is assumed to be contaminated, it should be sampled for contaminant levels.

To ensure that the analyzed samples are representative of the collected samples, and that the Tedlar bags are not losing volatile samples, spiked samples of known volatile concentration will be prepared. These samples will be stored and handled in the same manner as other field samples. Spiked samples will be the first collected and last analyzed. Selected low level samples should also be duplicated at a different time and analyzed immediately to verify that analyte loss is not occurring. Alternatively, samples may be analyzed in the field, using either Tedlar bags or syringe samplers to collect and transport the samples to the gas chromatograph.

Note sampling times for each sample in a field logbook and on the sample bag (if bags are used). No more than 4 hours should elapse between sampling and analysis; 15 minutes is preferable.

6. REFERENCES

Not applicable.

Standard Operating Procedure No. 021
for
Sedimen Sampling

Prepared by

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Revision: 2
March 2019

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PROJECT-SPECIFIC VARIANCE FORM

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☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 021	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
2	28 March 2019	Systematic review and update	Caryn Kiehl-Simpson Peggy Derrick	Matthew Bowman

1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) delineates protocols for sampling sediments from streams, rivers, ditches, lakes, ponds, lagoons, and marine and estuarine systems.

EA recognizes that other protocols have been developed that meet the criteria of quality and reproducibility. Clients may have their own sediment sampling protocols, which may contain methodologies and procedures that address unique or unusual site-specific conditions or may be in response to local regulatory agency requirements. In such cases, EA will compare its and the client's protocols. The goal is to provide the client with the most quality; therefore, if the client's protocols provide as much or more quality assurance than EA's protocols for the particular site or project, EA will adopt those particular protocols and this SOP will be superseded in those respects. If EA is required to implement the client's protocols in lieu of EA's protocols, EA will make the client formally aware of any concerns regarding differences in protocols that might affect data quality and will document such concerns in the project file.

2. PROCEDURES

The water content of sediment varies. Sediments range from soft to dense and fine to rocky. A variety of equipment may be necessary to obtain representative samples, even at a single site. Factors to consider in selecting the appropriate sampling equipment include sample location (edge or middle of the waterbody), depth of water and sediment, grain size, water velocity, and analytes of interest.

3. GENERAL PROCEDURES

1. All samples must be handled in a manner that satisfies the project Quality Assurance Project Plan, SOPs, and data quality objectives. Prior to a field effort, verify general sample requirements such as sample numbers, volume requirements, holding times, sample preservation requirements, and duplicate and other quality assurance/quality control sample requirements. Verify general sampling logistics such as site access, access to temporary and secure field storage, designated sample transport procedures, laboratory shipping address(es), and points of contact.

2. Comply with the Health and Safety Plan specifications for proper personal protective equipment (steel-toed boots, safety glasses, hard hats, splash shields, and Tyvek as appropriate and designated in the site-specific Health and Safety Plan). Wear chemically-protective gloves when collecting samples appropriate for the potential constituents to be sampled. Complete review of emergency plans and equipment. If sampling from a boat or near waterbodies with depths of 4 feet or more, the sampling team will wear life jackets. Review and comply with SOP Number (No.) 035 Small Boat Operations, if applicable.

3. Verify local One Call service has been contacted prior to sampling activities and proper utility clearance has been obtained. Verify site access, dockage, other required communications (e.g., U.S. Coast Guard, local authorities, etc.) have been secured.

4. Review specific responsibilities of each field team member and conduct daily safety briefings as specified by the site-specific Safety and Health Plan.

5. Confirm sampling equipment and supplies are adequate for the field effort. In addition to the sampling equipment and vessel requirements, verify that support equipment including, but not limited to, spatulas, scoops, spoons, pans, buckets, bowls, gloves, measuring implements, plastic sheeting, data forms, and logbooks are available. Appropriate sample storage and transport equipment may include a refrigeration unit, ice chests, dry ice or ice, insulation or other stabilization material to protect sample containers, custody seals, sampling containers, and shipping paperwork. Confirm decontamination supplies and equipment are sufficient for the duration of the field effort.

6. Collect samples first from areas suspected of being the least contaminated to minimize the risk of cross-contamination.

7. If surface water and sediment samples are to be collected at the same location or co-located (if both are required in the project-specific Sampling and Analysis Plan), collect the surface water sample first (refer to SOP No. 007 for surface water sampling). Sediment sampling usually results in disturbance of the sediments, which may influence the analytical results of the surface water samples.

8. Water quality measurements may be required at the same locations as the surface water and/or sediment sample locations. Collect the water quality measurements before the collection of surface water or sediment samples (refer to SOP No. 043 for water quality measurement collection).

9. Minimize the potential for sediment disturbance prior to sampling. Care should be taken when wading into a waterbody and/or during vessel operations prior to sampling. These activities can disturb the sediment. Move slowly and cautiously, approach the sample location from downstream. If flow is not strong enough to move entrained particles away from the sample location, wait for the sediment to resettle before sampling.

10. Collecting samples directly into sample containers is not recommended. Sediment samples should be placed in Teflon®, stainless steel, or glass trays, pans, or bowls for sample preparation and processing.

11. Use the proper equipment and material construction for the analytes of interest. For example, for volatile organic compound analysis, the sampling material in direct contact with the sediment or surface water must consist of Teflon, polyethylene, or stainless steel.

12. Refer to EA SOP No. 005 (Field Decontamination) for proper decontamination methods before and after sampling and between samples.

13. Collect samples for volatile organic compound analysis and acid volatile sulfide analysis first. Do not mix such samples before placing them in the sample containers. For composite volatile organic compound and acid volatile sulfide samples, place equal aliquots of each subsample in the sample container with no headspace. To maintain sample integrity, exposure to oxygen/air should be limited to the extent possible.

14. Sediment that will be analyzed for other constituents should be prepared as follows:

    - Place the sediment in a mixing container.
    - Divide the sediment into equal quarters by volume.
    - Mix each quarter separately and thoroughly.
    - Combine the quarters and mix thoroughly.
    - For composite samples, mix each subsample as described above. Place equal aliquots of each subsample in a mixing container and follow the procedure described above.
    - Sediment preparation activities should be performed where the potential of contamination from external sources (e.g., running engines) can be minimized or eliminated.

15. Mark the sampling location on a site map. Record sampling location coordinates with a Global Positioning System unit, photograph (optional, recommended), describe each location, and place a numbered stake above the visible high water mark on the bank closest to the sampling location (if appropriate). The photographs and description must be adequate to allow the sampling station to be relocated at a future date.

16. Dispose of investigation-derived wastes according to applicable rules and regulations.

4. CORERS

A corer provides a vertical profile of the sediment that may be useful in tracing historical contaminant trends, geological characterization and dating, and characterizing the depth of impacts at a site. Because displacement is minimal, a corer is particularly useful for maintaining the integrity of the vertical sediment profile. Core samplers are also useful when it is important to maintain an oxygen-free environment as they limit oxygen exchange with the air more effectively than grab samplers. Corers can be constructed out of a variety of materials.

4.1 EQUIPMENT

The following list of equipment may be needed during the collection of sediment core samples. Depending upon the actual collection method used and the analyses that will be conducted in the samples, not all equipment on the list may be used.

- Probing equipment for pre-sampling testing for utilities
- Sampling vessel, floating platform (properly equipped and sized barge or boat), and waders and plan for collecting samples by hand (may significantly limit sample depth)
- Winch
- Crane, boom arm or A-frame
- Sediment core sampler (Vibracore, piston tube, Wildco tube sampler, etc.)
- Core liners, core catchers, liner caps, etc.
- Saw, knife, and cutters to open or split core liners
- Sampling vessel
- Propulsion method for sampling vessel or floating platform
- Containers, buckets, and tubs
- Small trays
- Calibration bucket
- Wash box
- Glassware
- Logbook
- Labels
- Coolers
- Spoons
- Water filters
- Gloves for sampling
- Gloves for other sampling activities such as cutting, equipment handling, etc.

- Measuring device
- Decontamination chemicals and de-ionized water.

4.2 PROCEDURE

4.2.1 Manual Sampling

When sampling manually, a polyvinyl chloride pipe (commonly 2-inch in diameter) with a Teflon or polyethylene liner (as an example) can be lowered into the sediment; a well cap can be used to form an airtight seal and negative pressure as the pipe is withdrawn.

1. Ensure that the corer and (optional) liner and other sampling equipment are properly cleaned.
2. Position downstream of the sample location.
3. Force the corer into the sediment with a smooth continuous motion. Rotate (not rock) the corer if necessary to penetrate the sediment.
4. Twist the corer to detach the sample; then withdraw the corer in a single smooth motion. If the corer does not have a nosepiece, place a cap on the bottom to keep the sediment in place.
5. Remove the top of the corer and decant the water in a slow controlled manner (into appropriate sample containers for surface water analysis, if required).
6. Remove the nosepiece or cap and begin sample description, logging, and processing per the work planning documents.
7. Decontaminate the sediment coring apparatus as described in SOP No. 005 or work planning documents.
8. Repeat the process at an offset location until sufficient sample quantity has been recovered. Additional cores may need to be obtained if the core recovery is insufficient to achieve the required volume. Verify recovery limits are in accordance with work planning documents and data quality objectives.
9. Process the core samples as described in work planning documents.

4.2.2 Sampling from a Vessel

1. Select a sediment core sampler (Vibracore, piston tube, Wildco tube sampler, etc.) suitable for the bottom conditions, water depth expected, water velocity, the volume of material needed, and the planned/targeted depth of sampling.

2. Select sediment coring tools of sufficient diameter and length to obtain the needed sample volume and depth of penetration. Depending on the volume of sediment needed, multiple sediment cores may be required. To the extent possible, predetermine the number of cores required to avoid having to return to a location for additional cores/sample volume.

3. Set up the sediment coring tool and install the core liner tube, drive head, drive shoe, and/or core catcher, piston, and piston line, as appropriate for the specific sampler chosen and the proposed depth of sample/penetration.

4. Securely attach the core sampler to a winch with cable or line of sufficient length and strength to accommodate the weight of the sampler and sample (Vibracore) or other sampler (piston tube or Wildco tube sampler) to sufficient pipe to reach the maximum proposed sample depth.

5. A measurement system should be in place capable of documenting the depth to the sediment surface, depth of penetration, and depth of recovery. Location coordinates should be collected at each sample location (if a vessel navigation system will be used to collect the location coordinates, an offset may be required between the antenna and the sampler deployment location).

6. Slowly lower the sampler through the moon pool or over the side until the sampler reaches the water/sediment interface. The sampler may be lowered using a crane or on a winch cable and A-frame or other mechanical mechanism capable of carry/control the weight of the sampler. The crane, A-frame, or boom arm must have enough clearance to accommodate the length of the sample and sampling apparatus and enough strength to safely accommodate the weight of the sample and sampling apparatus. Note the depth to the top of sediment.

7. Advance the sediment core sampler into the sediment to the proposed depth or refusal, whichever comes first. Vibracore samplers will be advanced by the vibrating head. Vibracore samplers will continue to be attached to the winch line and the rate of descent will be controlled during penetration into the sediment. Piston tube or Wildco tube samplers will be advanced manually. If necessary, a piston tube or Wildco tube sampler may be advanced by tapping the top of the pipe with a rubber mallet. These samplers are intended for soft sediment and will not tolerate heavy abuse from pounding in an attempt to penetrate through debris, shell beds, or consolidated material.

8. Slowly retrieve the sediment coring tool. As soon as possible, cap the bottom of the sample tube to prevent loss of sample. Secure the sampling apparatus.

9. Remove the sediment core liner from the sampling apparatus.

10. Allow the core to drain or siphon water, taking care not to disturb the surface of the sediment. At the first sign of sediment in the drained water sample, cease draining and tie or cap the sample liner to ensure that the surficial layer remains intact in the sample.

11. Cut off any empty core liner to eliminate headspace. Measure core recovery. Acceptable core recoveries may be specified in the work planning documents. Typically, recoveries of 70 or 80 percent are favorable for results interpretation and data evaluations. Lesser recoveries may not sufficiently represent the sediment column. The data quality objectives of a specific project will dictate the selected recoveries. If the sampler meets refusal above the proposed depth, offset the initial location and make up to the required number of attempts. Work planning documents should specify the maximum number of attempts to be made to obtain a core with sufficient recovery. If sufficient recovery cannot be obtained, other drilling and sampling methods and/or location abandonment may be appropriate.

12. If sufficient recovery was obtained in the interval penetrated, process the core and obtain samples from that interval.

13. Write the location identification and orientation (up arrow) on the outside of the core tube with a permanent marker. Write the location identification, date, and time of collection on the core tube cap.

14. The location (Global Positioning System coordinates), collection date and time, penetration depth, recovery depth, and identification for each core should be recorded in the field logbook.

15. Transport sediment cores to the onshore processing area throughout the day, if possible. Data quality objectives and work planning documents may require that core tubes be maintained in a vertical orientation. When possible, transport sediment cores to shore after each location or at an interval that will maintain the integrity of the samples. Cores should be stored under refrigeration or iced on the sampling vessel to maintain sample integrity.

16. Decontaminate the sediment coring apparatus as described in SOP No. 005 or work planning documents.

17. Repeat the process at an offset location until sufficient sample quantity has been recovered. Additional cores may be needed if the core recovery is insufficient to achieve the required volume. Debris and obstructions are possible that may prevent the full penetration and recovery of all of the advanced cores. Observation of debris, obstructions, or hard bottom conditions that preclude advancement of the sampler should be documented in the field logbook.

18. Water quality measurements may be required at each coring location or locations specified in the project work plan. The measurements should be conducted on the same day as the core collection, and prior to the core collection, if possible.

19. Verify that all field measurements and documentation are complete prior to moving off location.

20. Process the core samples as described in work planning documents.

5. SCOOPS AND SPOONS

When sampling at the margins of a waterbody or in shallow water, scoops and spoons may be the most appropriate sampling equipment. For sample collection several feet from shore or in deeper water, the scoop or spoon may be attached to a pole or conduit. Equipment will be a subset of that described above in Section 4.1.

- Stand downstream of the sample location.
- Collect the sample slowly and gradually to minimize disturbing the fine particles.
- Decant the water slowly to minimize the loss of fine particles.
- Transfer the sediment to sample containers or mixing trays, as appropriate.
- Process the samples as indicated by the project work plan.
- Verify that all field measurements and documentation are complete prior to moving off location.

6. DREDGES

Three types of dredges are most frequently used: Peterson, Ponar, and Eckman. Many other dredge types are available; their applicability will depend upon site-specific factors. Equipment will be a subset of that described above in Section 4.1.

6.1 PETERSON, VAN VEEN, AND PONAR DREDGES

These dredges are suitable for hard, rocky substrates, deep waterbodies, and streams with fast currents. Ponars have top screens and side plates to prevent sample loss during retrieval.

- Open the jaws and place the cross bar into the proper notch.
- Lower the dredge to the bottom in a controlled manner, making sure it settles flat.
- When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.

- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval through incomplete closure due to rocks, shells, or other debris; penetration at an angle; or tilting during retrieval. The sampler should not be overfilled such that the sediment surface is touching the top of the sampler. Overlying water should be present indicating minimal leakage; this water should be siphoned off, not decanted, prior to sample processing. The sediment water interface should be intact with no signs of washout or channeling.

- Open the jaws and transfer the sediment to sample containers or to a mixing tray.

- Verify that all field measurements and documentation are complete prior to moving off location.

6.2 ECKMAN DREDGE

The Eckman dredge works best in soft substrates in waterbodies with slow or no flow.

- Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.

- Lower the dredge to the bottom in a controlled manner, making sure it settles flat.

- Holding the line taut, send down the message to close the jaws.

- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval through incomplete closure due to rocks, shells, or other debris; penetration at an angle; or tilting during retrieval. The sampler should not be overfilled such that the sediment surface is touching the top of the sampler. Overlying water should be present indicating minimal leakage; this water should be siphoned off, not decanted, prior to sample processing. The sediment water interface should be intact with no signs of washout or channeling.

- Open the jaws and transfer the sediment to sample containers or to a mixing tray.

- Verify that all field measurements and documentation are complete prior to moving off location.

7. REFERENCES

Not applicable.

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Standard Operating Procedure No. 022
for
Sediment and Benthic Macroinvertebrate Sampling with Eckman Grab

Prepared by

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1. SCOPE AND APPLICATION

This Standard Operating Procedure covers the protocol for obtaining qualitative or quantitative samples of soft sediments and macroinvertebrates inhabiting soft sediments in lakes, reservoirs, and other waterbodies. The Eckman grab sampler is well suited to collecting samples in deeper (up to 100 ft) waterbodies.

Use of brand names in this Standard Operating Procedure is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable standard operating procedures for the maintenance and calibration of same.

2. MATERIAL

The following materials may be required:

Eckman grab sampler: a box-shaped device with two scoop-like jaws	Sample containers
Boat	Sieve – 500 µ (U.S. Standard No. 30)
Personal protective equipment	Stainless steel spoon or trowel
Personal flotation devices	

3. PROCEDURES

The following is a summary of procedures on use of the Eckman grab sampler:

- Cock the sampler by raising each jaw upward into the cocked position using the attached able and secure the cable to the catch pin located at the top of the sampler.

- Once cocked, lift the sampler overboard and lower slowly but steadily to the bottom.

- Once on the bottom, indicated by a slack line, the weighted messenger is sent down the line tripping the catch mechanism, causing the spring loaded jaws to close the bottom of the sampler, containing the sediment.

- Raise the sample at a slow but steady rate to prevent sample loss or washout.

- Once the sample is on board, empty the sample into a stainless steel, polytetrafluoroethelyne, or polytetrafluoroethelyne-lined bowl or tray for processing.

  — If the sediment will be analyzed for volatile organic compounds, transfer the sample into the appropriate sample containers immediately.

- If the sediment will not be analyzed for volatile organic compounds, use Stainless steel spoon to thoroughly homogenize sample, then transfer sample into appropriate containers. Add preservative (if required) and place in ice-filled chest.
  - If benthic macroinvertebrates are to be collected, sieve sample and transfer macroinvertebrates into appropriate container.
- Thoroughly decontaminate the device.

4. MAINTENANCE

Maintain according to manufacturer's suggestions.

5. PRECAUTIONS

The following precautions should be taken while using an Eckman grab sampler:

- Inspect the device for mechanical deficiencies prior to its use.
- This sampler is inefficient in waters deeper than approximately 75-100 ft, under adverse weather conditions, and in waters of moderate to strong currents or wave action.
- Exercise caution at all times once the grab is loaded or cocked because a safety lock is not part of the standard design.
- Operate the sampler from a boat with a winch and cable.
- Wear gloves when collecting sediment samples. Be sure to consult the health and safety plan for the proper dermal and respiratory protection prior to collecting any samples.
- Higher levels of personal protective equipment may be required by the Health and Safety Plan.
- While sampling from a boat in waterbodies with a depth of 5 ft or more, the sampling team will wear personal flotation devices (life jackets).
- Collect samples first from those areas that are suspected of being the least contaminated, thus minimizing the risk of cross-contamination.

6. REFERENCES

American Society for Testing and Materials. Standard 2.1. D4387 Guide for Selecting Grab Sampling Devices for Collecting Benthic Macroinvertebrates.

U.S. Environmental Protection Agency. 1990. Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters. Office of Research and Development. EPA/600/4-90/030. November.

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Standard Operating Procedure No. 025
for
Soil Sampling

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for sampling surface and subsurface soils. Soil samples give an indication of the area and depth of site contamination, so a representative sample is very important.

2. MATERIALS

The following materials may be required:

Bucket auger or push tube sampler	Split-spoon, Shelby tube, or core barrel sampler
Drill rig and associated equipment	Stainless steel bowl
Personal protective equipment as required by the Health and Safety Plan	Stainless steel spoon, trowel, knife, spatula (as needed)

3. PROCEDURE

3.1 SUBSURFACE SAMPLES

Don personal protective equipment. Collect split-spoon, core barrel, or Shelby Tube samples during drilling. Upon opening sampler, or extruding sample, immediately screen soil for volatile organic compounds using either a photoionization detector or flame ionization detector. If sampling for volatile organic compounds, determining the area of highest concentration, use a stainless steel knife, trowel, or laboratory spatula to peel and sample this area. Log the sample in the Field Logbook while it is still in the sampler. Peel and transfer the remaining sample in a decontaminated stainless steel bowl. Mix thoroughly with a decontaminated stainless steel spoon or trowel. Place the sample into the required number of sample jars. Preserve samples as required. Discard any remaining sample into the drums being used for collection of cuttings. Decon sampling implements. All borings will be abandoned.

NOTE: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same, except that two split-spoon samples will be mixed together. The Field Logbook should clearly state that the samples have been composited, which samples were composited, and why the compositing was done.

Samples taken for geotechnical analysis will be undisturbed samples, collected using a thin-walled (Shelby tube) sampler.

3.2 SURFICIAL SOIL SAMPLES

Don personal protective equipment. Remove vegetative mat. Collect a sample from under the vegetative mat with a stainless steel trowel, push tube sampler, or bucket auger. If a representative sample is desired over the depth of a shallow hole or if several shallow samples are to be taken to represent an area, composite as follows:

- As each sample is collected, place a standard volume in a stainless steel bowl.
- After all samples from each hole or area are in the bucket, homogenize the sample thoroughly with a decontaminated stainless steel spoon or spatula.

If no compositing is to occur, place sample directly into the sample jars. Place the leftover soil in the auger borings and holes left by sampling. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas. Samples for volatile organic compounds will not be composited. A separate sample will be taken from a central location of the area being composited and transferred directly from the sampler to the sample container. Preserve samples as required. Decon sampling implements.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Refer to the Health and Safety Plan.

Soil samples will not include vegetative matter, rocks, or pebbles, unless the latter are part of the overall soil matrix.

6. REFERENCES

ASTM International. Method D1586-84, Penetration Test and Split-Barrel Sampling of Soils.

———. Method D1587-83, Thin Walled Sampling of Soils.

Department of the Army, Office of the Chief of Engineers. 1972. Engineer Manual 1110-2-1907 Soil Sampling. 31 March.

Standard Operating Procedure No. 026
for
Active Soil Gas Analysis

Prepared by

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedures is to describe protocols for using the Sentex Scentograph Portable Gas Chromatograph (GC) to analyze soil gas samples for volatile organic compounds. The primary method described here for introducing samples into the GC uses an absorbent tube to concentrate samples prior to analysis, although sample loop and direct injection methods may also be used. Operation of the GC should not be attempted without first reading the operation manual.

Use of brand names in this Standard Operating Procedure is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable standard operating procedures for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

Argon (high purity) carrier gas	Sample loop assembly and loops
Battery charger for Scentograph GC	Sentex Scentograph Portable GC with argon ionization detector/electron capture detector
Battery charger for Toshiba PC	Spare analytical column
Calibration gases, as needed	Spare preconcentrator assembly
Copper gas transfer tubing and fittings	Spare Septa
Industrial Solvents Calibration Library software and empty data disks	Syringe cleaner
Multimeter	Syringes (1 µL, 5 µL, 10 µL, 100 µL, 1 mL, 5 mL, and 50 mL)
Other spare parts (e.g., tubing, swagelock fittings)	Three 1L Tedlar bags
Paperwork (applicable regulations and NRC license, Scentograph Operators' Manual, GC log book, table of ionization potentials)	Tools (Allen wrench, large adjustable wrench, small adjustable wrench, 0.25-in. wrench, small screwdrivers)
Regulator for calibration gas	Toshiba T 1200 laptop personal computer
Regulator for carrier gas	Vacuum pump for syringe cleaner

3. SETUP

The GC should preferably be operated in a clean environment, without significant concentrations of volatile organic compounds in the atmosphere. Batteries and internal gas canisters allow self-contained operation of up to 6-8 hours, but longer continuous operation requires a 110-V power supply and external source of ultra-high-purity argon carrier gas. After each portable operation, the instrument must be recharged for at least 8 hours, preferably overnight, before resuming operations. When the instrument is not in use, it should be connected to the battery charger.

Install regulator on the carrier gas cylinder, attach copper tubing to the outlet of the regulator, and briefly purge the tubing by carefully opening the cylinder valve slightly. Connect the free end of the copper tubing with quick connector to the fitting marked carrier on the back of the GC, being careful to insert the connector straight. Open cylinder valve and carrier gas valve on GC to fill the internal tank. The maximum pressure is 1,800 psi, and severe damage can result from over pressuring the internal tanks. Repeat this process for calibration gas, connecting tubing to fitting marked calibration. Do not operate the GC if the carrier gas pressure is less than 200 psi.

Set column pressure to desired value (typically 30 psi) by adjusting carrier gas regulator inside the GC with an Allen wrench. Do not use a column pressure of less than 10 psi. After at least 5 minutes, turn on the PC (with Sentex software disk in A drive and blank data disk in the B drive) and set initial conditions at the operating parameters menu. For the industrial solvents calibration library, the operating conditions should be as follows:

Sample time:	Adjust as needed, generally 10-20 seconds
Delay time:	0.5 seconds
Desorption time:	4.0 seconds
Inhibit time:	80 seconds
Oven temperature:	100°C
Chart duration:	20 minutes
Analyses/calibration:	Adjust as needed (used in automatic mode only)
Column:	12 ft 10 percent SP1000
Column pressure:	30 psi
Retention time window:	Typically 3 percent
Noise threshold:	Typically 50-100

Other operating conditions should be selected as needed depending on project needs if the Industrial Solvents Calibration Library is not being used.

4. CALIBRATION

Using the Industrial Calibration Library software, it is only necessary to calibrate with benzene. Otherwise, calibration gases containing the compounds of interest are needed. A calibration standard near the expected sample concentration should be used.

At the operating parameters menu, name the calibration mixture, identify the peaks, and specify their concentrations. Recheck operating parameters.

Calibration gas from the internal cylinder or from an external source may be used. If using the internal tank, turn on the calibration gas valve on the rear of the GC. If an external source is used, turn off the carrier gas valve, run calibrations until the calibration gas pressure is zero, and attach the carrier gas source (at atmospheric pressure) to the calibration port on the side of the GC.

Initiate the calibration run by pressing 4 [enter] at the main menu. If using the industrial solvents calibration library, the benzene peak must be the first peak and must fall between 230 and 242 seconds. If not, make small adjustments to the temperature or column pressure and repeat.

5. OPERATION

After satisfactory calibration of the instrument, attach a Tedlar bag or similar sample container to the analysis port on the instrument and open the inlet valve on the container. Type 3 followed by a return at the main menu to initiate a sample run. If manual operation is selected after a change in operating parameters before a calibration run, the instrument will automatically start a calibration cycle before the analysis run.

The instrument will match observed peaks with those in the calibration gas and in the calibration library (if used), identify the peaks, and calculate concentrations based on peak area. Peak data as well as operating conditions are stored on a data disk in the B drive.

6. QUALITY CONTROL

At a minimum, a quality control sample containing constituents of interest should be analyzed at the beginning and end of each batch of samples. The instrument should be calibrated before each sample batch, after any change in operation conditions, and when any changes in instrument response is noted. Duplicate samples should be analyzed every 10-20 samples.

7. RECALL AND DISPLAY OF RESULTS

To recall results, type 5 followed by a return at the operations menu. The analysis summary, listing trace number, analysis date, analysis time, peak identification, concentration, retention time, peak area, and sample (or calibrant) name, will be displayed. To view a particular trace, type 6 followed by a return at the operation menu, then specify the trace number.

8. SHUTDOWN

After the last analysis, turn off the PC. Allow the column and detector to cool before shutting off the carrier gas supply. Turn off carrier and calibration gas valves on the back of the GC and turn off cylinder valves. Bleed excess pressure from the copper tubing and disconnect from the GC.

9. PRECAUTIONS

The argon ionization detector uses a 150-mCi tritium source on a thin metal foil. The source is sealed in a steel cylinder. Any repairs of the detector must be made by the manufacturer. The detector housing and the sealed source must never be opened.

To prevent damage to the instrument, the following precautions must be observed:

- Do not operate the GC with less than 200 psi carrier gas pressure.
- Do not fill the internal tanks to over 1,800 psi.
- Allow at least 5 minutes of carrier gas flow through the column before turning off the instrument.
- Do not replace the preconcentrator assembly without instructions from the manufacturer.
- Do not select a column pressure less than 10 psi or greater than 30 psi.
- Use only carrier grade argon as a carrier gas (at least 99.995 percent, preferably 99.999 percent pure). Industrial grade argon (e.g., from a welding shop) will cause contamination.
- Use only high purity regulators for the gas supply.
- If problems occur, call Sentex Technical Support.

Standard Operating Procedure No. 027A
for
Passive Soil Gas Surveys
– Gore Sorbers

Prepared by

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1. SCOPE AND APPLICATION

The steps and information herein are the Standard Operating Procedures (SOPs) for conducting a GORE-SORBER Screening Survey. GORE-SORBER® Screening Modules and organic analyses will be supplied/conducted by:

W.L. Gore & Associates, Inc.
101 Lewisville Road
P.O. Box 1100
Elkton, Maryland 21922-1100
(410) 392-3300

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. COLLECTOR DESCRIPTION

The sorbent containers and insertion/retrieval cords are constructed solely of inert, hydrophobic, microporous GORE-TEX® expanded polytetrafluoroethylene (ePFTE, similar to Teflon) with no fillers or plasticizer introduced during manufacturing. The unique feature of this construction is that the entire sorbent container surface area, as well as the surrounding insertion/retrieval "cord," facilitates vapor transfer. Sorbent containers (sorbers) are typically filled with TENAX®.

3. FIELD OPERATIONS

3.1 MATERIALS

The following materials may be required for field operations:

Cooler(s) with chilled ice packs or ice	Knife, scissors, and needle nose pliers
Corks with screw eyes	Latex surgical gloves or equivalent
Correctly scaled site map	Measuring tape, transit, or other distance measuring device
Electric power source (AC power outlet or generator)	Paper towels and American Society for Testing and Materials Type II water or equivalent
Electric rotary, hammer-action, or combination hammer with 1-in. carbide-tipped bit (31-36 in. long)	Patching compound for concrete and/or asphalt holes (if required)
Extension cord	Pen, clipboard, field notebook, chain-of-custody (COC) form, and SOP
Fiberglass staff flags or some other means of location marking	Slide hammer/tile probe
GORE-SORBER® Screening Modules and Vials	Small shovel
Insertion rod	Trash bags

3.2 LOCATING SAMPLE SITES

Lay out sampling grid using point spacing specified in Work Plan. From a known survey point, locate and mark all screening module location sites to the nearest inch using fiberglass staff flags.

Note on field maps and/or field log any deviations to the sample grid as presented in the Work Plan.

Drill Hole—A 9/16- to 1-in. hole is cored to a depth of 2-3 ft below ground surface (installation depth is held constant for a given survey). This depth has been selected to keep the modules below the daily effects of atmospheric temperature changes. Coring is accomplished using a variety of tools depending on the nature of the material being cored. The holes should be vertical and as free from debris as possible.

Prepare Sorber Unit and Note the Unique Serial Number—Immediately after the hole is cored, a GORE-SORBER® Screening Module is removed from its sealed container. Note that each module has a unique serial number recorded on top of the module vial and a metal tag attached to the module. Each vial is also individually numbered. **Record this number on the site map and/or field notebook immediately**.

Insert Sorber Unit—Insert the stainless steel insertion rod into the pocket in the bottom of the module, and lower it into the hole. Ensure that the module goes the entire way down the hole. If a large resistance is felt during insertion, remove the module and re-drill the hole. Re-insert the module. When the module is completely inserted in the hole, press the insertion rod against the side of the hole. Twist the rod and pull the rod out.

Seal Hole—Attach the end of the module to the screw eye in the cord. **Do not remove the metal ID tag**. Coil the excess retrieval cord and push it with the metal tag into the hole. Cork the hole to prevent the intrusion of rain and atmospheric gasses during exposure. If the cork does not fit snugly into the hole, and wrap a short length of the module retrieval cord around the cork and re-insert the cork into the hole.

Decontaminate the auger and insertion rod. After each use, decontaminate all intrusive equipment using decontamination procedures specified in Section 3.3.2 of SOP No. 005.

3.3 EXPOSURE TIME

Exposure times, typically 14 days, are defined in the site Work Plan. Exposure times should be sufficient to allow equilibration of the modules with subsurface conditions. Actual subsurface exposure time and conditions will be measured and recorded.

3.4 FIELD QUALITY CONTROL BLANKS

3.4.1 Temperature Control Blank

Water temperature control blanks are normally supplied by Gore with one blank supplied with each cooler of shipped modules. Temperature control blanks consist of a small vial of American Society for Testing and Materials Type I water that is used to determine the temperature of the modules upon arrival at the laboratory. One temperature control blank must be included with each cooler shipped to Gore for analysis.

3.4.2 Trip Blanks

The trip blank is a set of sorbent modules used to detect volatile organic compound (VOC) contamination during sample shipping and handling. Trip blanks travel to the site with the sampling modules and are returned to the laboratory with the sampling modules. The trip blank will not be exposed to field conditions. The trip blank will be used to assess whether or not any chemical detected by the sorbers are the result of sources other than the study sites. One trip blank is to accompany each cooler containing VOCs. Trip blanks will be kept in sample refrigerators during the course of field work.

3.4.3 Field Duplicates

The collection of field duplicate samples provides for evaluation of overall sampling and laboratory precision by comparing analytical results of two samples of the same matrix from the same location. Two sorber units will be installed into one hole for a duplicate sample. The additional modules will allow for duplicate analysis of several modules from the same hole. If there is a wide difference in analytical results between duplicate samples, it can indicate poor precision of analytical technique and suggest increased evaluation of the data may be warranted. Field duplicates will be collected at a frequency of 10 percent of the samples collected per event.

3.5 SORBER RETRIEVAL

Evaluate the Sample Site—Note any site disturbance that may have occurred since the sorber module was installed. Note any stains on the ground, cork removal, or other such features that might indicate tampering. Remove cork.

Remove Sorber Unit from Hole—Wearing surgical gloves, and wrap retrieval cord once or twice around your hand. Using slow, steady tension, pull the cord straight out of the ground. **Double check the Module ID number on the sample module, sample vial, and COC/Field Logbook to ensure that the correct module is retrieved from the correct grid position**. Cut off the cork and discard.

Place Sorber Unit in Vial—Put the entire retrieval cord, including the metal tag, back into the correctly labeled vial. Tightly reseal the vial. Immediately place the vial in a cooler with blue ice. Sorbers will be stored onsite in a freezer until shipped to the laboratory.

3.6 SORBER SHIPMENT

Sample packing procedures will follow the steps outlined in SOP No. 004. The sorbers should be packed in the blue ice certified by W.L. Gore to be volatile free. Do not use Styrofoam "peanuts" or any other packing material which may contain volatiles or out-gas and contaminate sorbers during shipment. Bubble packing is acceptable. Receive clearance from SciTech to ship samples.

Carefully cut three modules from each sorber unit, one sorber at a time. Care must be taken at this point to ensure that the serial number for each sorber unit is transposed to the sample vial and COC. Do not start a new sorber unit until the transfer of modules from the previous sorber unit is completed in full. Place these three modules in a clean bottle supplied by the contract laboratory.

Note the serial number of the sorber unit tag on the bottle label. Place this number on the contract laboratory COC. Seal the bottle. Place bottle in cooler and pack the samples following the steps in SOP No. 004.

Using the vial racks, coolers, and ice substitutes supplied by the contract laboratory, return the exposed vials and COC document to the contract laboratory via overnight carrier service. Return the remaining sorber module to the GORE vial and seal. Place vials in cooler and pack the samples following steps in SOP No. 004.

Using the vial racks, coolers, and ice substitutes supplied by Gore, return the exposed vials and COC document to Gore's analytical laboratory via overnight carrier service.

4. ANALYTICAL AND DATA PRESENTATION

4.1 SAMPLE RECEIVING

Upon receipt at the W.L. Gore and contract laboratories, all soil gas samplers are inspected and sample labels are cross-referenced against the COC form. Any anomalies observed during the inspection are noted on the COC. When all anomalies, if any, are resolved, the samplers are ready for analysis.

4.2 VOLATILE ORGANIC COMPOUND ANALYSIS

W.L. Gore will analyze for VOCs and report the results of this work directly to the organization conducting the soil gas survey.

4.3 SAMPLE HOLDING

There are no holding time limitations.

4.4 INSTRUMENTATION

Instrumentation at W.L. Gore consists of a Hewlett-Packard 5890-II gas chromatograph, 5971A mass selective detector, and 7673 liquid autosampler. A 25-m, 0.2-mm bore, 0.5 µm "HP-5" 95 percent dimethyl, 5 percent diphenyl polysiloxane capillary column is normally used. A typical temperature program developed for analyzing the sorbers is: initial temperature 40°C for 4 minutes, ramp 20 C/minute to 320°C, final temperature 2 minutes. Injection port temperature (for method extraction) is 250°C, detector transfer line is 380°C. A Perkin-Elmer ATD-400 Automated Thermal Desorption unit is the extraction device used by Gore for sites with low concentrations of gasoline and solvent contamination. By cryofocusing the sample extract prior to sample injection into the gas chromatograph column, Gore has achieved greatly increased sensitivity to all compounds, and superior separation of VOCs compared to solvent or headspace extraction methods.

4.5 ANALYTICAL PARAMETERS

Table SOP027A-1 includes proposed analytical parameters. The soil gas contractor will also conduct a library search to identify and report up to 100 organic chemical constituents present in each module if requested.

4.6 LABORATORY QUALITY ASSURANCE PROCEDURES

W.L. Gore will conform to its Quality Assurance Plan (1994) to be appended to the project-specific Quality Assurance Project Plan with regard to quality control sample type, frequency, handling, preparation, and analytical procedure.

4.7 MAPPING/REPORTING

Graphic presentation of the data extracted from the GORE-SORBER® Screening Modules is presented by overlaying the contamination patterns detected during the analysis onto computer-aided design maps supplied by the field investigator.

5. REFERENCES

W.L. Gore. 1994. Quality Assurance Plan.

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TABLE SOP027A-1 PROPOSED ANALYTICAL PARAMETERS PASSIVE SOIL GAS SURVEY

Analytes	Limit (µg/sorber)
Acetone	(a)
Benzene	0.04
2-Butanone	(a)
Carbon Tetrachloride	0.06
Chlorobenzene	0.03
Chloroform	0.03
Chloromethane	(a)
1,4-Dichlorobenzene	0.04
1,1-Dichloroethane	(a)
1,2-Dichloroethane	(a)
1,1-Dichloroethylene	(a)
trans-1,3-Dichloroethylene	(a)
1,2-Dichloropropane	(a)
cis-1,3-Dichloropropene	(a)
trans-1,3-Dichloropropene	(a)
Ethylbenzene	0.03
Methyl tert-Butyl Ether	0.07
Methylene Chloride	0.23
2-Methylnapthalene	0.03
2-Methylphenol	0.04
Naphthalene	0.03
Octane	0.02
Pentadecane	0.06
Phenanthrene	0.015
Phenol	0.05
Styrene	(a)
1,1,2,2-Tetrachloroethane	(a)
Tetrachloroethylene	0.07
1,2,4,5-Tetramethylbenzene	0.02
Toluene	0.03
1,1,1-Trichloroethane	0.06
1,1,2-Trichloroethane	(a)
Trichloroethylene	0.04
Tridecane	0.04
1,2,4-Trimethylbenzene	0.03
1,3,5-Trimethylbenzene	0.03
Undecane	0.04
Vinyl Chloride	(a)
m-Xylene	0.02
o-Xylene	0.03
Total Xylenes	(a)

(a) Method detection limit studies currently being conducted.

Standard Operating Procedure No. 027B
for
Passive Soil Gas Surveys
– Petrex Technique

Prepared by

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1. SCOPE AND APPLICATION

The steps and information herein are the Standard Operating Procedures (SOPs) for carrying out a Petrex environmental survey. Possible deviations from SOPs may occasionally be implemented onsite by EA field staff to adjust for unique survey conditions. The Petrex technique is also frequently used for oil and gas, geothermal, and mineral exploration which force slight variations on this SOP. Surveys performed in winter in frozen ground offer a unique situation and slightly different field practices.

The fact that the SOPs may occasionally be altered is done to maintain quality service while using the Petrex technique. It must also be understood that the ion flux data from one survey at a given site and a given time interval should not be compared to the flux numbers from another survey. Since the data are semi-quantitative, only the flux patterns of a survey or the relative difference between flux values of two samples from the same survey should be considered during interpretation.

If any questions arise upon review of this document, please address questions to Northeast Research Institute, Inc. (NERI) technical staff at:

Northeast Research Institute, Inc.
309 Farmington Avenue, Suite A-100
Farmington, Connecticut 06032
(203) 677-9666

– OR –

Northeast Research Institute, Inc.
605 Parfet Street, Suite 100
Lakewood, Colorado 80215
(303) 238-0090

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. SAMPLE PRODUCTION AND PREPARATION

2.1 CHARCOAL SIEVING

The static volatile organic compound (VOC) collector is prepared by applying pre-sieved activated charcoal to the end of a ferromagnetic wire.

2.2 CHARCOAL BONDING

The details of the procedure for preparing the activated charcoal are proprietary information. The procedure results in the production of a collector consisting of size-sorted activated charcoal bonded to the area within 1 cm of the end of a ferromagnetic wire with a Curie point of 358°C.

2.3 COLLECTOR CONTAINERS

Culture tubes, measuring 25 mm × 125 mm and having a screw cap closure, are washed in a biodegradable detergent, rinsed in methanol, and baked at 180°C for 1 hour.

2.4 WIRE CLEANING

The previously constructed wires are cleaned by heating in a special apparatus at 358°C a total of 35 times under high vacuum. The wires are cleaned in lots of 32 wires. From each lot, two wires are removed for immediate analysis to verify the cleanliness of the lot. The remaining 30 wires are then sealed in one clean culture tube under an inert atmosphere and placed in inventory.

2.5 PACKAGING FOR CLIENT

Immediately prior to shipping the wires to the field, the tubes containing 30 wires are removed from inventory and the wires are repackaged under an inert atmosphere in individual tubes. All of the repackaged tubes contain two wires. Ten percent of these have three wires. The collectors are packaged by bagging in zipseal plastic bags in an inert atmosphere. These bags are then placed in inventory in a temperature-controlled room. The basis for having two wires in each tube is that it allows NERI to analyze one wire by standard Thermal Desorption-Mass Spectrometry while the second sample is available for Thermal Desorption-Gas Chromatography/Mass Spectrometry or as a backup to the Thermal Desorption-Mass Spectrometry. The third wire in selected samples from each survey is used to establish optimum instrument parameters.

2.6 QUALITY CONTROL AND QUALITY ASSURANCE

Prior to releasing stocked wires for a field survey, two single wires from each lot are checked for cleanliness and collecting potential. This quality assurance/quality control phase measures and documents collector preparedness when leaving the laboratory. One of these wires is analyzed without exposure in order to demonstrate that the lot is clean, and the other wire is exposed to hexane vapor for two seconds and then analyzed in order to verify that the charcoal is highly adsorptive. The triplicate wires are used when the wires return from the field. These wires help determine the required machine sensitivity and act as a measure of reproducibility.

2.7 CUSTODY DOCUMENT

A “custody document” accompanies each group of collectors leaving the laboratory and remains with the group until the collectors have been exposed, analyzed, and disposed of.

3. FIELD OPERATIONS

3.1 LOCATING SAMPLE SITES

Sample placement sites, usually predetermined on an accepted survey proposal, are located from a nearby, surveyable landmark using a compass and pacing or some other measuring device (e.g., pacing wheel, hip chain, or tape measure). A transit may be used for more accurate placement, but such accuracy is seldom required.

3.2 SOIL CORING

Once a sample site has been established, a hole is cored to a predetermined depth (sample placement depth is held constant for a given survey). This is accomplished using a variety of tools depending on the nature of the material to be cored. The holes should be vertical and as free from debris as possible. When the sampling is performed in areas covered by asphalt or concrete, a generator-powered rotary hammer drill with a carbide-tipped bit is used to drill a 1.5-in. diameter hole in the cover. A hand auger is used to remove the cuttings and road base from the hole.

3.3 COLLECTOR PLACEMENT

Immediately after the hole is cored, a collector tube is removed from the zipseal plastic bag and the bag is resealed. The cap is then removed from the tube, and the tube is placed vertically, open end down, into the hole. The hole is then backfilled with the soil core which was removed. The cap is placed in a clean zipseal plastic bag and stored until collector retrieval. Collectors placed under asphalt or concrete are treated the same as those in uncovered soil, except for modifications to permit easy retrieval and to avoid potential down-hole contamination from surface cuttings. To allow retrieval of these collectors, a piece of galvanized wire is twisted around the neck of the tube and run to the surface so that the sample may be recovered by pulling the retrieval wire. An aluminum plug is then placed near the top of the hole, and the remainder of the hole is plugged with quick setting hydraulic cement.

3.4 SITE IDENTIFICATION

Each site is flagged using pin flags, spray paint, or ribbon flagging, and the site location is marked and numbered on a base map. A field logbook is used to record the date, collector number, site location description, soil type, and general observations.

3.5 EXPOSURE TIME

Time calibration collectors are included as part of every survey. These are quality assurance collectors used to monitor sample loading during the survey. These collectors are placed in an area of known or suspected contamination, and sets are retrieved and analyzed at intervals to indicate the appropriate residence time for survey samples. Separate “travel blank” collectors are also included as a quality control measure in every survey. These collectors are transported along with the survey collectors but the tubes are never opened. These control collectors monitor for potential contamination during transport or placement.

3.6 COLLECTOR RETRIEVAL

The collectors are retrieved when the time calibration collectors reveal that there has been sufficient loading of gases on the charcoal absorbent. In the field, the soil is removed until the tube is exposed. A cap is taken from the sealed zipseal plastic bag. The Viton seal is checked to make sure it is seated inside the cap. The culture tube is removed from the hole and any dirt that is on the threads of the tube is wiped off with a clean cloth. In the event the tube is broken or cracked, the collector wire is transferred to a new tube using forceps. The tube is capped and sealed. All flagging material is retrieved.

3.7 COLLECTOR NUMBERING

Each tube is immediately numbered according to the scheme established in the field notes and on the base map. The collector number is written on adhesive labels which are applied to the tube cap. No two sites may have the same number.

3.8 COLLECTOR SHIPMENT

Once the collectors have been retrieved, they are sealed in zipseal plastic bags and then wrapped with bubble packing. Materials such as styrofoam peanuts or newsprint can introduce possible contaminants to the collectors and should not be used for packaging. The collectors, field notes, base map, and chain-of-custody document are either hand carried back to NERI’s analytical laboratories or shipped by overnight carrier service.

3.9 DECONTAMINATION

All down-hole equipment and tool parts which contact excavated soil are constructed of heavy gauge steel and have no natural or synthetic components that could absorb and retain most soil-borne organic contaminants. These tools are decontaminated between use at each sampling location by rotation through a four-step cleaning process:

1. Immersion and vigorous scrubbing in a mild solution of laboratory grade detergent until all visual accumulations of soil are removed

2. Thorough rinsing with potable water
3. Spray rinsing with methyl alcohol
4. Air dry.

All derived liquids (and sediment) are contained in dedicated disposable vessels.

4. COLLECTOR ANALYSIS

4.1 NUMBERING CHECK

Upon receipt of the collectors, the number on each tube is recorded and any missing or duplicated numbers are noted. A missing number generally indicates that the collector could not be retrieved. Samples with identical numbers generally cannot be used unless their true site location can be established.

4.2 SAMPLE HOLDING

A Petrex soil gas sample consists of a minute quantity of various volatile organic compounds sorbed onto a charcoal element and enclosed in a protective container with a near impervious Viton seal.

Maximum sample holding time is a function of both the chemical stability of the sorbed compounds and the integrity of the seal of the container.

It has been the experience of NERI that Petrex soil gas samples that are properly repackaged after retrieval from the field and stored under environmentally controlled conditions typically remain compositionally and quantitatively unchanged through periods of greater than 4 months.

All samples scheduled for analysis via Curie-point pyrolysis/mass spectrometry are analyzed within 3 weeks of retrieval from the field.

4.3 INSTRUMENTATION

Thermal desorption is accomplished using a Fisher radio frequency power supply and a Curie point pyrolizer designed by NERI and Extrel. The mass spectrometer used is an Extrel Spectrel quadrapole mass spectrometer. The analysis is controlled and recorded by a DEC PDP 11/23 microcomputer. Following the analysis, all data are collected and archived on a PDP 11/73 microcomputer. Data for all active jobs are stored on both of the PDP 11 computers, as well as on magnetic tape. Data for all completed jobs are stored on magnetic tape in perpetuity.

4.4 CALIBRATION

An Extranuclear Quadrupole Spectrometer equipped with a Curie-point pyrolysis/thermal desorption inlet is used for collector analysis. Mass assignment and resolution are manually adjusted using a perfluorotributylamine (PFTBA) standard. A linear correction, based on the known spectrum of PFTBA, is calculated. This correction is applied to a second PFTBA spectrum. If correct mass (M/Z) values are obtained, the operator proceeds to the next turning step. If not, Step 1 is repeated until correct masses are obtained.

Peak intensity ratios are set from the major peaks in the PFTBA spectrum using the following values:

Mass (M/Z)	Spectrum Intensities
69	100%
131	25%±5%
219	35%±5%
502	5%±2%

At the standard mass (M/Z = 69), PFTBA is measured at a preset sample pressure and detector voltage and compared to previous values at the same setting.

Electron energy is set to 70 electron volts and emission is set at 12 milliseconds. All other operating parameters, such as scans, scan range, and mass offset, are established in the computer program. These values may only be changed by the laboratory manager.

Tuning is performed at the beginning of a run so that an individual survey is analyzed at the same set of instrument conditions. The samples are analyzed in random order.

4.5 INSTRUMENT PARAMETERS

The instrument is operated with the following parameters:

Vacuum	<3 × 10-6 torr
Ionization Energy	70.0 eV
Ionization Current	12.0 mA
Desorption Time	5.0 sec
Desorption Temperature	358°C
Number of Scans/Sample	30
Scan Rate	1,250 amu/sec

4.6 MASS SPECTROMETER ANALYSIS AND QUALITY ASSURANCE/QUALITY CONTROL

Each collector wire is analyzed in random order. The entire group of survey collectors is analyzed as one run without interruption from other surveys.

The organic gases adsorbed on the carbon are thermally desorbed from the carbon, separated according to ion mass, counted, and a mass spectrum of masses from 29 to 240 is obtained.

Periodic (approximately every 20 samples) machine background analyses are performed as a quality control measure to assure minimal influence from internal communication. If there are peaks that are not related to atmospheric gases, the supervisor is notified and the mass spectrometer is shut down and cleaned as necessary.

A written sample number record is kept during the analysis to prevent accidental cross numbering.

The mass spectrometer control program prompts the operator with a warning if a sample number is entered that has already been used. The operator then checks the current number, along with the disk storage location of the previously entered number, to resolve the true numbering situation.

4.7 DATA FILING

The raw data file generated by the sample analysis is labeled and stored under a unique file name.

4.8 SCHEDULE OF MAINTENANCE

1,000 Samples:	Cleaning of sample introduction area, ion source, and expansion chamber by in-house technicians.
4,000 Samples:	Above noted procedures plus cleaning of lenses and quadrapoles
Annually:	Preventative maintenance program conducted by manufacturer's service representative.

5. DATA INTERPRETATION AND PRESENTATION

5.1 MAP GENERATION

The sample location maps are created by placing the field base map on a digitizing board and entering each site as an X-Y coordinate relative to an origin. The relative ion counts for each compound can then be plotted at the sample locations. Cultural and topographic features can also be digitized onto the map as reference points.

5.2 COMPOUND IDENTIFICATION

The mass spectrum that is drawn for each sample is compared to a library of mass spectra derived from known volatile organic compounds. Several thousand pure compound spectra have been developed by the Bureau of Standards and are available for spectra comparison. NERI has also developed its own library of spectra through headspace analysis of pure compounds using the Petrex wires. Once a compound has been identified in this manner, the ion current or "flux" for this compound is defined as the total ion current for the “parent peak” or least interfered peak of that compound.

5.3 RELATIVE FLUX DETERMINATION

The process of determining ion currents (relative intensities) of indicator peaks is computerized. All ion current data are extracted from the original data file and processed for identification.

The relative ion current intensity (relative intensities) of the gases that are desorbed from the collectors is matched with sample locations on a map of the survey area. These relative intensities are useful for inferring the areal extent of contamination and relative differences in the concentrations of compounds in the soil or groundwater. This can aid in determining the location of source areas or direction of movement of contamination.

These surface collections and analyses **cannot** be used to determine the depth to the source contaminants or the precise concentration at depth.

Because compounds can be differentiated by their spectra, analyses from the carbon collectors can be used to help differentiate multiple compounds and multiple source areas within a single survey.

5.4 DATA INTERPRETATION

Once the relative intensities for a compound are mapped, the data can be contoured to reveal those areas with “hot spots” and the orientation of plume migration. All other available data, such as geologic setting, soil types, groundwater conditions, type of contaminant, site history, and other factors, are taken into account as the interpreter draws his/her conclusions.

5.5 ADDITIONAL USES OF PETREX COLLECTORS

Some of the other uses of the Petrex Technique that are utilized in surveys are headspacing of soil and water samples and depth profiling.

5.5.1 Headspace

A headspace soil sample is analyzed by collecting approximately 25 g of soil, which are transferred to a thermochemically cleaned headspace container. Several adsorption wires are added and the headspace container is sealed and allowed to equilibrate for up to 24 hours, depending on the level of contamination. The wires are then removed and prepared for desorption mass spectrometric analysis as described earlier. An identical process is performed for screening water samples.

5.5.2 Depth Profiling

In order to determine if the source of the soil gas signal is near surface or in a deeper vadose/saturated zone, depth profiling can be used.

At each selected location, shallow boreholes are drilled a few feet apart to depths such as 1, 2, 4, and 6 ft deep. After the loose cuttings and carvings have been removed from the bottom of the hole, a core of soil may be taken for headspace analysis. Next, a Petrex collector is lowered into the hole and backfilled. The collectors remain in place for the same length of time as the survey wires.

Each of the sampling methods addresses a different aspect that will help indicate the nature of the VOC source. In the case of composite soil sampling, detection of VOCs during analysis implies that the VOCs are actually contained within the soil matrix. When the VOC is anthropogenic in nature, the VOC presence is indicative of soil contamination of that depth interval.

When performing an *in situ* time-integrated sampling program with Petrex collectors, the collector serves as both an extended headspace sampler relative to the soil matrix in its immediate vicinity, as well as measuring the soil gas flux through that zone during the exposure period.

Soil gas movement through the vadose zone is theorized to be a diffusion process. If the headspace data indicate that the VOC is not present in the soil matrix, then the *in situ* depth profiling collectors should show a relative increase of ion counts as the depth increases. By combining both pieces of data, the nature of the VOC source (near surface or deep vadose/saturated) can be inferred.

5.6 DATA PRESENTATION

Once the data have been compiled, interpreted, and mapped, a report is produced for the client's use. The maps are printed which display the relative intensity of the compounds of the client's specifications. These reports and maps are for the client's use only, and no report or map is released to anyone else without prior written consent of the client. This confidentiality policy is never breached.

6. INTERPRETATION OF PETREX MAPS

The policies outlined in this SOP are strictly followed on each survey. It should be noted that the relative intensities for any compound at one sample location can only be compared to another location within the same survey for the same compound. Relative intensities of different compounds cannot be compared to each other. The relative intensities of one survey cannot be compared to the relative intensities of any other survey, even between two surveys at different times of the year over the same site. However, the same "hot spots" and plumes should contour in the same place over multiple surveys at a given site, allowing for migration.

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Standard Operating Procedure No. 028
for
Well and Boring Abandonment

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to establish the protocols by which all wells and borings will be safely abandoned. The primary objective of well abandonment is to ensure that the abandoned well or boring does not provide a conduit for the vertical migration of contamination between aquifers.

2. MATERIALS

The following materials may be required:

Drill rig	Bentonite pellets (seal)
Filter pack material	Cement (Portland Type II)
Pure sodium bentonite with no additives (bentonite) powder (grout)	Approved water

3. PROCEDURE

The procedures used in boring abandonment will ideally accomplish two objectives: (1) protect aquifers from cross-contamination by sealing the borehole, and (2) restore the strata in the borehole to nearly original conditions by selective placement of fill material.

Any casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, grout will be placed from the bottom of the hole to within 3 ft of the ground surface, and allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site or cluster.

If the hole is within 10 ft of a monitoring well in the same aquifer, or a replacement well is to be installed within 10 ft of the well, any temporary casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, the hole will then be backfilled with filter pack material opposite sand strata and bentonite or grout opposite substantial (2 ft or thicker) clay and silt strata. Where sand as backfill approaches the ground surface, 2 ft of bentonite will be placed above the sand and a 3-ft concrete plug will be placed at the surface. Otherwise, backfill materials will be placed from the bottom of the hole to within 3 ft of the ground surface. These materials will be allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site cluster.

If the well is not within 10 ft of another monitoring well, or if there are no substantial, continuous sand bodies, and no replacement well is planned within 10 ft of the original well location, then the hole may be grouted from the bottom to the top.

3.1 GROUT

Grout used in construction will be composed by weight of:

- 20 parts cement (Portland cement, Type II or V)
- 0.4-1 part (maximum) (2-5 percent) bentonite
- 8 gal (maximum) approved water per 94-lb bag of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

All grout material will be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump prior to placement.

Grout placement will be performed using a commercially available grout pump and a rigid tremie pipe removal and grouting will be accomplished in stages, aquifer by aquifer, sealing the boring from the bottom to ground surface. This will be accomplished by placing a grout pipe to the bottom and pumping grout through the pipe until undiluted grout reaches the bottom of the next higher section of casing or, for the top-most section, until grout flows from the boring at ground surface. Efforts will be made to grout incrementally as the temporary casing is removed.

After 24 hours, the abandoned drilling site will be checked for grout settlement. On that day, any settlement depression will be filled with grout and rechecked 24 hours later. This process will be repeated until firm grout remains at the ground surface.

3.2 BORINGS

The term “Borings” as used in this Standard Operating Procedure applies to any drilled hole made during the course of a remedial investigation which is not completed as a well. This includes soil test borings, soil sampling borings, and deep stratigraphic borings. Whether completed to the planned depth or aborted for any reason prior to reaching that depth, borings will be grouted and normally closed within 4 hours, or within 4 hours or completion of logging of completion of logging.

3.2.1 Shallow Borings not Penetrating Water Table

Shallow borings made for the collection of subsurface soil samples will be abandoned by backfilling the hole with cuttings from the hole, **if and only if the boring does not penetrate the water table.** Clean sand will be used to make up any volume not filled by the cuttings.

3.2.2 Borings Penetrating the Water Table

Shallow borings made for the collection of subsurface soil samples **which penetrate the water table** will be abandoned by grouting the hole from the bottom to the top.

3.2.3 Deep Stratigraphic Borings

Deep stratigraphic borings will normally be located in areas which, by virtue of the historical record, are presumed relatively uncontaminated. Therefore, these borings are usually over 100 ft from any sampling well locations. Any boring located within 10 ft of a proposed well location, or located directly upgradient or downgradient (on anticipated flow line) of a proposed well location, will be abandoned by placing clean sand in the aquifer intervals and bentonite or grout in aquitard intervals as described above. If the boring is over 10 ft from and/or not upgradient of a proposed well location, the boring will be completely filled with grout.

3.3 WELLS

The following procedure applies to wells aborted prior to completion and existing wells determined to be ineffective or otherwise in need of closure.

Prior to abandoning any developed well, the proper well licensing body will be provided written notification along with an abandonment plan for that well.

If the well is within 10 ft of another monitoring well in the same aquifer, or a replacement well is to be installed within 10 ft of the well, casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, the hole will then be backfilled with filter pack material opposite sand strata and bentonite or grout opposite substantial (2 ft or thicker) clay and silt strata. Where sand as backfill approaches the ground surface, 2 ft of bentonite will be placed above the sand and below the concrete plug near the surface. Backfill materials will be placed from the bottom of the hole to within 3 ft of the ground surface. These materials will be allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site cluster.

If the well is not within 10 ft of another monitoring well, and is not to be replaced by another well within 10 ft of the original location, casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, grout will be placed from the bottom of the hole to within 3 ft of the ground surface, and allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site cluster.

4. REPLACEMENT WELLS

Replacement wells (if any) will normally be offset at least 10 ft from any abandoned well in a presumed upgradient or crossgradient groundwater direction. Site-specific conditions may necessitate variation to this placement.

5. PRECAUTIONS

None.

Standard Operating Procedure No. 032
for
Piezometer Installation

Prepared by

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CONTENTS

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to define acceptable piezometer types and installation techniques. For the purposes of this SOP, a piezometer is defined as a well installation designed to determine and/or monitor groundwater level rather than to acquire environmental samples. The objective of the selected installation technique is to ensure that the piezometer provides representative data while minimizing subsurface contamination, cross-contamination, and installation costs.

A piezometer may typically consist of a 2-in. diameter casing with attached screen. This installation may differ from a typical monitoring well installation in one of several ways. The screen may be stainless-steel, a stainless steel drive-point, slotted polyvinylchloride, or continuously wire-wrapped slotted polyvinylchloride. The piezometer screen may either be driven into place or set in a drilled, open hole. If the screen is driven into place, an engineered filter pack is omitted.

Regardless of the screen and casing material, and the method in which the piezometer is installed, proper care will be taken to avoid providing a vertical conduit for contaminants between aquifers. This will be accomplished by the use of bentonite and/or grout seals as appropriate.

Piezometers may be installed singly or in clusters to monitor one or more piezometric surface(s). Piezometers may not be located within 15 ft of an existing monitoring well. Piezometers should not be installed upgradient of monitoring wells. It is recommended that multiple (nested or clustered) piezometers be located 10-15 ft apart.

2. MATERIALS

The following materials may be required:

Casing	**— OR —**	Bentonite pellets (SOP No. 019)
Large stand-mounted hammer with attached leveling device		Cement (SOP No. 019)
Large wooden mallet		Drill rig
Hand-held level		
Personal protective equipment as required by contractor's Health and Safety Plan		
Stainless steel piezometer drive-points — or — stainless steel or slotted polyvinyl chloride well screens[1]		
Steel measuring tape		

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[1] Piezometer screen and casing should be inert with respect to the groundwater; therefore, the selection of screen and casing material will be based on select field tests of aquifer chemistry and potential contaminants.

3. INSTALLATION

Three options for the installation of piezometers are discussed in the following sections: installation of a well screen in an open hole (Section 3.1), installation of a driven sampling point (e.g., Geoprobe, Hydropunch, etc.) below a drilled hole (Section 3.2), and shallow installation of a driven point from the surface (Section 3.3).

Driven screens/sampling points are, by their design, point source samplers and their placement must be determined by a qualified geologist or geotechnical engineer onsite. Estimated depths of placement should be included in the work plans for piezometer installation. The maximum depth to which a given point can be driven is a function of a number of parameters, such as the degree of induration and friction coefficient of the material(s) through which it is being advanced, the rigidity of the rod(s), and the driving force available.

3.1 WELL SCREEN IN OPEN HOLE

If the piezometer is to be installed in a drilled, open hole, refer to SOP No. 019 for appropriate drilling and installation protocol. In this case, the piezometer will differ from a monitoring well only in the diameter of the casing. All other provisions for preventing vertical migration of contaminants will be observed.

3.2 DRIVEN POINT BELOW OPEN HOLE

If the piezometer will employ a drive-point screen driven through a hole which is pre-drilled to the top of the target aquifer, follow the drilling procedures detailed in SOP No. 019, set the drive point according to the procedures below, and grout the hole according to SOP No. 019.

3.3 DRIVEN POINT FROM SURFACE

If the piezometer is to be driven from the surface, the installation should be considered as temporary. The contractor’s work plan must include a timetable for, and details of the abandonment plan (refer to SOP No. 028 [Well and Boring Abandonment] for details) for these piezometers. Follow the installation steps below:

- Drill or hand auger small hole to a maximum depth of 2 ft to serve as a guide for the drive point.

- Assemble and set the drive point, screen (typically a 2-ft length), and an appropriate number of threaded stainless steel casing extensions into this pilot hole.

- If a drill rig is used, the hydraulic system may be used to press the drive point downward or the drop hammer may be used to drive the point downward. If the piezometer site is inaccessible by drill rig, a tripod-mounted drop hammer may be used to drive the point. Threaded stainless steel casing (typically 2-ft lengths) extensions may be added as needed until the piezometers are driven to the desired depth.

- At sites where the sediment is relatively soft and the desired screen depth is no greater than 2 ft, a large mallet may be used to pound the piezometer to the desired depth directly from the surface.

- Add additional threaded casing onto the top of piezometer if needed so that piezometer extends 2-3 ft above ground surface. Place protective cap on top of piezometer.

- Measure height of the piezometer casing above ground surface. Record site number, screen depth, and height above ground surface.

- If a shallow pilot hole was used, fill the hole to ground surface with bentonite pellets.

- Decontaminate soil augers before moving onto another site.

- Complete drilled holes according to procedures detailed in SOP No. 019.

- Develop piezometers according to procedures in SOP No. 019.

Refer to SOP Nos. 003 (Field Logbook), 005 (Field Decontamination), 010 (Water Level and Well Depth Measurements), and applicable parts of 019 (Monitoring Well Installation).

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Water, soil, and vapors at the sites may be contaminated with solvents, petroleum, chemical agents, explosives, and heavy metals or their respective byproducts. Therefore, extreme care will be taken to avoid skin contact with potentially contaminated material.

Refer to the site-specific Health and Safety Plan for discussion of hazards, preventive measures, and personal protective equipment to be used during piezometer installation and development activities.

If piezometers are being installed from boats or piers over bodies of open water, personal flotation devices (life jackets) will be required as part of the personal protective equipment.

6. REFERENCES

Aller, L., et al. 1989. Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells, National Water Well Association.

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Standard Operating Procedure No. 033
for
Aquifer (Hydraulic) Testing

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to define various hydraulic test methods which may be used, to specify how these tests are to be performed, and to provide appropriate methodologies for data reduction and interpretation. This SOP assumes a high degree of technical competency on the part of the investigator, in that certain assumptions and interpretations must be made in the selection of the test and data analysis to achieve valid results.

Aquifer testing is a process performed on selected wells to characterize the **Hydraulic Conductivity**, **Transmissivity**, and **Storativity** of the aquifer into which those wells are installed. Aquifer tests fall into two broad categories: pumping tests and slug tests. Pumping tests and slug tests are relatively inexpensive when compared to the remedial investigation budget as a whole, but it should be noted that, as with many *in situ* tests, aquifer tests may yield non-unique solutions.

Pumping tests are typically performed on wells installed in highly permeable materials, confined aquifers, and in areas of little or no suspected contamination in the groundwater. The principle of pumping tests is to remove water from the aquifer at a sufficient rate and for a sufficiently long period of time to stress the aquifer and cause measurable drawdown in the pumped well and adjacent (10 to several hundreds of feet) observation well(s). The aquifer characteristics can then be calculated by substituting inter-well distances, drawdown and well discharge data into appropriate equations, employing curve matching techniques, or using computer programs to reduce the data.

- Advantages of performing pumping tests are: (1) they encompass large areas, (2) test results are more accurate, (3) they can resolve complex aquifer conditions (e.g., boundaries), (4) time periods and pump rates can be varied, and (5) pumping tests represent remedial actions.

- Disadvantages of pumping tests are: (1) large quantities of potentially contaminated water are generated, (2) the contaminant plume may be moved by the test, (3) they are very costly, and (4) the data produced are averages over large areas.

Single-Well Permeability Tests (Slug Tests) are conducted to determine the characteristics of an aquifer in materials whose conductivity is too low to perform a pumping test, or in aquifers which are highly contaminated. Slug tests consist of inserting and/or removing either a slug of inert material of known volume, or a “slug” of water of known volume. Either method will cause an instantaneous rise or fall and subsequent recovery of the water table within the aquifer.

- Advantages of slug tests are: (1) they provide location-specific data, (2) they are small-scale and unlikely to move the contaminant plume, (3) no contaminated water (other than decontaminated solutions) is generated, (4) they are low cost, therefore (5) high data density is feasible, and (6) they can be used as an aid in selecting an appropriate area to perform pumping test(s).

- Disadvantages of performing slug tests are: (1) they provide less precise estimates of parameters; (2) they may not yield values for storativity; (3) they cannot resolve complex geometries; and (4) since they are short-term tests, they cannot resolve long-term events.

2. MATERIALS

2.1 ALL TESTS

The following materials may be required for all tests:

Copy of the site Health and Safety Plan	Health and Safety monitoring equipment, and personal protective equipment as required by the Health and Safety Plan
Calculator	Portable computer[1]
Containers for investigation-derived materials	Program diskettes
Data diskettes	Stopwatches
Decontamination equipment and supplies	

2.2 PUMPING TESTS

The following materials may be required for pumping tests:

Generators (2), fuel, extension cords and/or other source of onsite electrical power	Stainless steel submersible pump with associated tubing, clamps, and wiring
Logbook	Steel register flowmeter or stopwatch and bucket, graduated cylinder, or rain gauge
Pump	Transducer or other water level indicator[1]
Recording barometer or other source of local barometric readings (e.g., local airport or National Weather Service recording station)	Type curves for curve-matching analyses
Semilogarithmic paper-arithmetic vertical scale and logarithmic horizontal scale, or log-log paper	

2.3 SLUG TESTS

The following materials may be required for slug tests:

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1. Although removal (or insertion) of larger volumes of water may increase the recovery time(s) of the aquifer to the point that use of electrical water level meters or steel tapes is feasible, piezometers and data loggers are preferred because they tend to provide more complete records with less maintenance and operator error.

Test Conducted with Inert Cylinder	
Transducer[2]	Inert, negatively buoyant cylinder of known volume
Logbook and/or field data sheets (examples provided in SOP No. 016)	Type curves for curve-matching analyses
Semilogarithmic paper-arithmetic vertical scale and logarithmic horizontal scale	Slug device (solid stainless steel or a sealed polvyinyl chloride cylinder filled with sand or similar material)
Test Conducted with Input/Output of Water	
Teflon bailer with Teflon-coated stainless steel leader and rope or pump	
— OR —	
Stainless-steel submersible pump or centrifugal pump	Pump wiring
Teflon or polyethylene flexible piping	Steel register flowmeter
Generator and fuel or other onsite source of electricity	American Society for Testing and Materials (ASTM) Type II water
Stainless-steel hose clamps	
— AND —	
Logbook	Type curves for curve-matching analyses
Semilogarithmic paper	Approved water and/or containers for removed water as required in SOP No. 042
Transducer or other water level indicator[1]	

3. PROCEDURE

Regardless of the test method chosen, the following general procedures must be considered:

- All well intrusive equipment must be decontaminated prior to and after use.
- All water removed from the test wells is considered, and must be treated, as purge water.
- The accuracy of the reading(s) from pressure transducer (piezometer) and data logger output should be verified prior to beginning any test, periodically during the test, and immediately after the test by measuring the groundwater level with one of the aforementioned mechanical devices.
- All water level tapes and meters should be calibrated against one master tape which is traceable to the National Institute of Standards and Technology. This calibration should be recorded in the field logbook.
- Repeated measurements at any one well should be made using the same tape.

3.1 SELECTION OF TEST METHOD

Before beginning any aquifer test, the investigator should have a good conceptual model of the site's hydrogeologic condition. This is essential because of the assumptions made in each

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[2] Field portable computer and associated equipment are considered as optional. Access to a computer will be required to down-load dataloggers.

analysis method. If the site conditions do not correspond with the assumptions in a given model, the analysis will be invalid. The conceptual understanding of the hydrogeology of the site can be developed from driller's logs and/or borehole geophysical logs of the wells to be tested, or from previous reports on the hydrogeology of the area. Table SOP033-1 is a decision tree which can be used with this conceptual model to determine the appropriate test/analysis method(s) which may be used at a given site.

3.2 PUMPING TESTS

Pumping tests can be divided into two broad categories: (1) those in which the pumping (discharge) rate is kept constant, and (2) those in which the pumping rate varies over time. All water removed from pumping wells must be disposed of appropriately.

3.2.1 Constant Discharge

These methods require that the discharge or injection rate in the pumping well be kept constant. Of these, the Theis method is the most widely referenced and applied, and serves as the basis for the solution of other, more complex boundary condition problems. Both the Cooper & Jacob and the Jacob modifications to the Theis method recognize that if pumping times are long and/or the distances to control wells are small, the Theis solution will yield a straight line plot on semilogarithmic paper, thereby simplifying the Theis equation. The Thiem method, unlike the Theis/Modified Theis methods, assumes that steady-state (equilibrium) conditions can be achieved in a confined aquifer.

The Theis method is detailed in Section 5.1.1 and ASTM D4106, the modified Theis method in Section 5.1.2 and ASTM D4105, and the Thiem method in Section 5.1.3.

The preceding methods assume that the aquifer being tested is confined. If the aquifer is unconfined or semi-confined (leaky), the preceding methods are invalid. DeGlee developed an equation which assumes that the tested aquifer is either overlain or underlain by a continuous, leaky confining layer which has uniform properties, and that leakage from the aquitard is proportional to the hydraulic gradient across the aquitard. Hantush and Jacob derived the same equation. Hantush later observed that a simpler approximation is possible if the ratio of the distance to monitoring well/leakage across the aquitard is <0.05. As in all preceding cases, radial flow is assumed. The Hantush-Jacob method assumes that no storage occurs in the aquitard. The DeGlee equation and Hantush approximation is provided in Section 5.3.2.

Both Neuman and Witherspoon, and Hantush have proposed methods that take into account storage in the aquitard. The Neuman/Witherspoon method is provided in Section 5.3.1.

3.2.1.1 Field Operations

1. Arrange for all nearby extraction wells and automatic pump controls to be inoperative during the test period.

2. Measure and record the distance(s) between observation well(s) and pumping well.

3. Install pressure transducers in the pumping well and each observation well; submerge the transducer in the well to a sufficient depth to provide effective performance. Well bottom sediment plugging of the transducer must be avoided.

4. Perform a two-point calibration of each device as part of the installation, cross-checking data with a calibrated manual tape measure. Note that water levels must be noted and recorded to the nearest 0.01 ft.

5. Start dataloggers at each well several days before the test to record background fluctuations in the groundwater table. It is recommended that one observation well be selected beyond the expected influence of the test to monitor these background water table fluctuations during the actual test.

6. Using either the field barometer of data from a local meteorological station (Section 2.2), record precipitation and barometric pressure before, during and after the test.

7. Calibrate pump, flowmeter, and any other field instruments such as pH meters, etc.

8. Suspend pump at mid-point of pumping well screen and record water level.

   - If the recharge rate of the well is not known, conduct a step-drawdown test (Section 3.2.3) to determine the sustainable yield for the constant discharge test.

   - If the previous step is performed, the aquifer must be allowed to recover prior to performing the constant discharge test. At a minimum, the recovery period between step-test and pump test must be equal to the duration of the step test.

   - Manually check and record the water levels in all test wells before conducting the step test, at the end of the step test, and at 4-hour intervals (minimum) during the recovery period; recording these values in the field logbook.

9. Program the datalogger data acquisition rate as follows:

   - If the only mode of data acquisition is a fixed rate, program the datalogger(s) to record water levels every 5 seconds.

   - If a logarithmic data acquisition rate is possible, use this option.

   - If the data acquisition rate is programmable on the data logger, record data at incrementally lengthening frequencies. The following table is provided as an example, the actual rates at which data are acquired at a given site should be determined based on prior field tests.

Time after Aquifer Test Begins	Frequency of Measurements
0-60 minutes	Every 5-10 seconds
61-65 minutes	Every 15 seconds
65-75 minutes	Every 30 seconds
75-120 minutes	Every 5 minutes
120-180 minutes	Every 10 minutes
180 minutes – end of test	Every 30 minutes

10. Collect a complete round of static water levels, verifying transducer readings with a tape or electric water level meter.

11. Start data logger(s).

12. Start pump at previously selected rate. Monitor flow rate using flowmeter or stopwatch and bucket (rain gauge, graduated cylinder, etc.) half-hourly. Record this flow rate and adjust as necessary. Minimize fluctuations in flow rate, especially during the early stages of the test.

13. Periodically download data from the loggers and plot drawdown as a function of time to assess the status of the test in real time. Under no circumstances should the flow rate be varied during the test.[3] If drawdown is either falling substantially above or below predicted levels, then a decision should be made to continue the test at that pumping rate, terminate the test, allow the aquifer to recover, or restart the test at a different pumping rate.

14. Continue pumping and recording water levels for a total period of 72-96 hours (3-4 days). After the drawdown portion of the test, download the data onto data diskettes using the portable computer.

15. Reprogram the dataloggers to record a reading every 5 seconds or a logarithmic or variable interval if available on the datalogger.

16. Turn off the pump and allow the groundwater to recover to within 90 percent of static conditions. The pump should be equipped with a foot valve to prevent backflow of the column pipe fluid.

17. Periodically download data from the logger and plot recovery as a function of time to assess the status of the test in real time.

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[3] After a period of at least 12 hours into the test, brief interruptions (less than 5 minutes) in pumping due to mechanical failure are acceptable without re-starting the test. All critical equipment should have onsite backups as a contingency against equipment failures. Inasmuch as refueling an onsite generator every 4-10 hours while it is running is considered an unsafe practice, two generators should be provided at the pumping well site to maintain power to the pump during the test.

18. After recovery to 90 percent of static conditions, remove the dataloggers, pressure transducers, and cables from all the observation wells. Download the data onto data diskettes using the portable computer.

19. Collect a complete round of water levels from all wells in the monitoring network.

3.2.2 Variable Discharge

Variable discharge methods have been presented by numerous researchers. These methods are performed as a series of constant-rate, stepped changes in discharge rate. These changes in discharge rate may be linear or exponential. Type curves are derived for control wells. These methods can be applied in extensive leaky aquifers, but are generally used in confined aquifers. The only requirement is that the response to a unit stress be known. The step-test is incorporated as a preliminary measure to determine the optimal sustainable discharge rate for a given aquifer (Section 3.2.1.1). Otherwise, variable discharge methods are included herein for the sake of completeness. They are not widely used outside the research environment for aquifer characterization. No further details on variable pump rate tests are provided in this SOP.

Install a variable speed submersible pump and a pressure transducer into the pumping well.

Install pressure transducers into the nearby (closest) observation wells to provide preliminary indications of expected drawdown during the constant-discharge test.

Allow water level(s) to stabilize to original water level after installing the pump and transducer(s).

Program a datalogger to collect readings at 5- to 10-second intervals. If logarithmic programming is available, this collection period may be expanded to 1-minute increments by the completion of each step, where upon 5- to 10-second intervals will again be required to coincide with the start of the next step.

Measure static water levels from all wells expected to be influenced by the test, and calibrate pressure transducers. Record this information in the field logbook and field data sheets.

Select the pumping rates for the step-test. Four 100-minute steps should be run at steadily increasing flow rates. The flow rates should be selected, based on a preliminary estimate of a sustainable rate (ESR) as follows:

Step	Duration (minutes)	Pumping Rate (%)
1	100	25
2	100	50
3	100	100
4	100	125

Program the dataloggers, calibrate the pump to the initial flow rate, and initiate the test at 25 percent ESR. At the completion of the first step, increase the pumping rate to 50 percent ESR as instantaneously as possible. The pump should not be shut off between steps. At the completion of the second step, increase the flow rate to 100 percent ESR as instantaneously as possible. At the completion of the third step, increase the flow rate to 125 percent ESR as instantaneously as possible. At the completion of the fourth step, shut off the pump and record the recovery of water levels to at least 90 percent of static conditions.

During the test, plot drawdown in the pumping well on both arithmetic and semi-logarithmic graph paper to assess the performance of the test in real time. Make any adjustments to the test as appropriate, i.e., the addition of a fifth step at a higher rate if the aquifer does not appear to be adequately stressed, or termination of the test if the well is drawn dry.

At the conclusion of the test, analyze the data and select a pumping rate for the constant-discharge test. This rate should be sustainable for the anticipated duration of the test, and place the maximum stress on the aquifer.

Calibrate the variable speed pump to the selected rate so that at the start of the constant discharge test early fluctuations in flow rates will be minimized.

Allow the aquifer to fully recover for a period equal to or greater than the duration of the step-test prior to initiating the constant-discharge test.

3.3 SLUG TESTS

Slug tests involve the use of a single well, and evaluating its response to an instantaneous raising and/or lowering of the water level within the casing. If the well is poorly designed or poorly developed, the test may end up evaluating the performance of the well screen and/or filter pack rather than the aquifer.

Slug tests are usually of short duration, usually less than 5 minutes. The first 30 seconds are the most important in respect to data collected. Piezometers and digital data loggers are, therefore, a must.

3.4 DATA REDUCTION

If the data were recorded by the datalogger as feet of water above the pressure transducer, reduce these data to potentiometric head (in feet), relative to the initial water level as measured from the top of the casing. Record this with the respective changes in time. For each piezometer or well, tabulate the pre- and post-test water levels, dates, clock times, and times since pumping started or stopped.

Tabulate measurements of the rate of discharge at the control well, date, clock time, time since pumping started, and method of measurement.

Prepare a written description of each well, describing the measuring point, giving its elevation and the method of obtaining the elevation, and the distance of the measuring point above the mean land surface.

Once the data are collected and reduced, a variety of methods may be used to calculate aquifer parameters from pumping test data. Refer to Section 5 for analytical methods applied to test data.

Data can also be reduced electronically when downloaded from the transducers into software such as AQTESOLV®; this is software designed to calculate hydraulic conductivity, storativity and other aquifer properties from data sets collected during slug and aquifer (pumping) tests.

Text files, which are generated by commonly used pressure transducers, can be imported into the software and data can also be manually entered or pasted from a spreadsheet. After importing, the raw data can be manipulated using mathematical functions. For example, hydraulic head data can be converted to drawdown data. The program will also produce visual and automatic curve matching methods for confined, unconfined and leaky aquifers. Visual curve matching is analogous to traditional methods of aquifer test analysis with graph paper and type curves. The software is also capable of producing error logs which enable the user to quickly identify any deficiencies or inconsistencies detected in the data set.

4. FIELD DATA RECORDS

4.1 LOGBOOK

Only one site or installation per logbook, and only one slug test per data table (see below). The first page must include the well number, location, date of test, persons conducting the test, and reference plane for drawdown measurements. Next page(s) must be in table format with the columns designating time/date, water volume withdrawn/added or displaced by inert cylinder, water levels, etc.

Test data must be entered in a table as data are acquired. Data must include sufficient information to indicate that the water level was stable before the test, during equilibrium, and after the test(s).

5. INTERPRETATION OF DATA

5.1 CONFINED AQUIFER METHODS

5.1.1 Theis Method

The Theis test method involves pumping a well (pumped well) at a constant rate (Q) and measuring drawdown (s) in an adjacent observation well. Theis assumed that groundwater flow in an aquifer is analogous to heat flow in a solid and derived the following equation:

$$s=\frac{Q}{4\pi T}\int_{r^2\frac{S}{4T\,t}}^{\infty}\left(\frac{e^{u}}{u}\right)du \qquad \text{Equation 1}$$

where

s = Drawdown.
r = Radial distance to observation well.
Q = Pumping (discharge) rate.
T = Transmissivity (K × aquifer thickness).
K = Conductivity.
S = Storativity.
t = Time (since pumping began).

and $$u=\frac{r^2S}{4T\,t} \qquad \text{Equation 2}$$

If the integral is expressed as the well function W(u), then the equation can be written as:

$$s=\frac{Q}{4\pi T}W(u) \qquad \text{Equation 3}$$

which can be also written as:

$$T=\frac{Q}{4\pi s}W(u) \qquad \text{Equation 4}$$

or

$$S=\frac{4Tt}{r^2}u \qquad \text{Equation 5}$$

5.1.1.1 Assumptions

To permit an analytical solution for non-steady, radial flow into the well, the Theis method makes the following assumptions. Most of these assumptions are incorporated in the other analysis methods detailed herein. Only exceptions or additions to these assumptions will be noted in each method.

- The aquifer has seemingly infinite areal extent compared to the well, whose diameter is assumed infinitesimally small.
- The aquifer is homogeneous, isotropic, of uniform thickness, and horizontal.
- The head is uniform and constant prior to the test.
- Darcy's Law is valid.
- The well is pumped at a constant rate.
- Water is discharged from storage instantaneously.
- The well screen fully penetrates the aquifer.
- Flow within the aquifer is radial to the well and strictly horizontal.
- Drawdown data are taken from an adjacent observation well.

One additional assumption is made in this SOP, which was not made by Theis: The pumping well has been previously sampled and analysis of the groundwater at that site is not grossly contaminated (e.g., no non-aqueous phase liquids).

5.1.1.2 Procedure (see also ASTM D4106-91 and D4050-91)

Field Operations – Constant Discharge Test (Refer to Section 3.2.1)

Data Plots

1. Prepare a type curve of W(u) over 1/u on log-log paper. Figure SOP033-1 is an example of a type curve. Tables of data used to generate this curve may be found in ASTM D4106-91, ASTM D5270-92, or in most hydrology texts such as Fetter or Dominico[4]. It is recommended that this plot be copied onto tracing paper, drafting film, or an overhead viewer film copy be made to facilitate later steps. NOTE: W(u) over u can be plotted if preferred, but will require additional computational steps if used.

2. Plot drawdown over time for each observation well on log-log paper which has the same scale as the type curve (above). Note that for a single observation well, drawdown can be plotted as a function of time (t). However, for multiple observation wells, drawdown can be plotted as a function of t/r2, where r = radial distance from the pumping well to the observation well in which the measurements were made. This is done to normalize the data and allow comparison between wells.

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[4] See Section 6 for complete citations of these references.

3. Superimpose the type curve and the plot of observation well data. **Keeping both the X and Y axis of each plot parallel**, position the two curves to obtain the best match when overlain. NOTE: If only paper copies of both plots are available, a light table or brightly lit window will be required for this step.

4. Select a match point on the overlapping portion of the two graph papers such that the values for that point simplify the calculations (e.g., even log cycles of [W(u), 1/u] — [1,1]; [1,10] etc.).

5. Read coordinates for W(u), 1/u, s, and t.

6. Substitute the match point values for the appropriate variable in Equations 3, 4, and 5.

7. Repeat for each observation well.

5.1.2 Modified Theis (Cooper & Jacob; Jacob) Method (see also ASTM D4105-91)

5.1.2.1 General

From Equation 1, we have:

$$\int_u^{\infty}\left(\frac{e^{u}}{u}\right)du = W(u) = -0.577216 - \log_e u + u - \frac{u^2}{2!2} + \frac{u^3}{3!3} - \frac{u^4}{4!4} + \ldots$$

Equation 6.

Jacob noted that as values of u become small, the value of the series to the right of logeu becomes insignificant. That is the series becomes equal to or less than 0.01. The value of u decreases as the value of t (time) increases, and as the value of r (radial distance to observation well) decreases. Therefore, for long pumping times and/or observation wells reasonably close to the pumping well, the Theis equation can be stated as:

$$s = \frac{Q}{4\pi T}\left[-0.577216 - \ln\left(r^2\frac{S}{4Tt}\right)\right]$$

Equation 7.

Lohman was then able to show the following relationships:

$$T = \frac{2.3Q}{4\pi\Delta s/\Delta\log_{10}t}$$

Equation 8

and

$$T = \frac{2.3Q}{4\pi\Delta s/\Delta\log_{10}r}$$

Equation 9

where

Δs/Δlog10t = The drawdown (measured or projected) over one log cycle of time.
Δs/Δlog10r = The drawdown (measured or projected over one log cycle of radial distance from the control well.

5.1.2.2 Procedure

Field Operations (see Field Operations under Section 3.2.1.1)

Data Plots

1. Plot drawdown over time (log scale) on semilog paper.

2. Draw a best fit straight line through the later portion of the data and project it back to s = 0.

3. Read t0 as the time corresponding to the s = 0 point.

4. Solve for T using:

$$T=\frac{2.3Q}{4\pi\Delta s}$$

Equation 10

5. Solve for S using:

$$S=\frac{2.25Tt_0}{r^2}$$

Equation 11

where

t0 = the intercept of the line when extended to the zero drawdown axis.

6. Solve for K (K = T/aquifer thickness). Aquifer thickness = screened interval (see assumptions in Section 5.1.1.1).

7. Repeat for each monitoring well.

5.1.3 Thiem (Steady State Flow) Method

5.1.3.1 Assumptions

All of the Theis assumptions hold except that equilibrium has been reached between discharge and drawdown. Note that this condition is theoretically impossible in a confined aquifer where all discharge is derived from storage.

5.1.3.2 Equations

When these assumptions are met, the following equation expresses groundwater flow in the confined aquifer:

$$Q=\frac{2\pi T(s_1-s_2)}{\ln(\frac{r_2}{r_1})}$$

Equation 12

where

Q = Well discharge.
T = Aquifer transmissivity.
r1 and r2 are respective distances of OW-1 and OW-2 from the pumping well.
s1 and s2 are respective steady-state drawdowns in the observation wells.

Note that the Thiem equation is designed to solve for transmissivity only, and cannot be used to solve for storativity.

5.1.3.3 Procedure

Field Operations

1. Follow Steps 1 through 9 in Section 3.2.1.

2. Continue pumping until steady-state conditions are reached. This equilibrium is defined as the time when variations of drawdown with respect to time are negligible. Note that this may require considerably more time than with either the Theis or Modified Theis methods described above.

Data Plots Method 1

1. Substitute the steady-state drawdown of the two observation wells into Equation 12 along with the values of r and Q. Solve for T.

2. Repeat with all possible combinations of observation wells to obtain the mean transmissivity of the aquifer.

Data Plots Method 2

1. Plot the observed steady-state drawdown of each observation well over distance (log scale) to the pumping well.

2. Construct a best-fit straight line through the plotted points.

3. Determine the maximum drawdown per log cycle.

4. Substitute this value of (s1 - s2) in Equation 12 along with Q and solve. Note that the term ln(r2-r1) is taken to ln(10) equal to 2.30.

5.2 BOUNDED, NON-LEAKY, CONFINED AQUIFER

The test methods described in this section are essentially duplicates of the Theis and Modified Theis methods which are detailed above. The principal differences are that, by definition, a bounded aquifer is limited in its areal extent by a fully-penetrating linear boundary, which is either a constant head (e.g., stream or lake) or a no-flow boundary (e.g., impermeable, or significantly less permeable geologic formation). These conditions are illustrated on Figure 2.

As stated, the equations used to evaluate data derived from bounded wells are modifications to the basic Theis equations. Drawdown(s) at any point in the aquifer is defined as the sum of the drawdown due to the real ($_r$) and image ($_i$) wells such that:

$$s_0 = s_r \pm s_i$$

Equation 13

so that Equation 1 can be rewritten as:

$$s = \frac{Q}{4\pi T}[W(u_r) \pm W(u_i)] = \frac{Q}{4\pi T}\sum W(u)$$

Equation 14

where

$$u_r = \frac{r_r^2 S}{4Tt}$$

Equation 15

and

$$u_i = \frac{r_i^2 S}{4Tt}$$

Equation 16

so that:

$$u_i = \left(\frac{r_i}{r_r}\right)^2 u_r$$

Equation 17

or

$$u_i = k_i^2 u_r$$

Equation 18

where

$$K_l = \frac{r_i}{r_r}$$

Equation 19.

NOTE: K_1 is a constant of proportionality and should not be confused with the hydraulic conductivity.

5.2.1 Assumptions

All assumptions listed under the Theis method apply with these exceptions:

- The non-leaky aquifer is of infinite areal extent except where limited by linear boundaries.
- The boundaries are vertical planes of infinite length, which fully penetrate the aquifer.
- The hydraulic boundaries are perfect. Impermeable boundaries yield no water to the aquifer; recharge boundaries are in perfect hydraulic connection with the aquifer.

5.2.2 Procedure (see also ASTM D5270-92)

Field Operations (see Section 3.2.1.1)

Data Plots

1. Generate a family of type curves for the solution of the modified Theis formula (Kl). This family of curves should include curves for both discharging and recharging image wells. Plot the coordinates of ∑W(u) on the vertical axis and 1/u (Figure 3). It is recommended that this plot be copied onto tracing paper, drafting film, or an overhead viewer film copy be made to facilitate later steps.

2. Plot drawdown (s) over t/r2 for each observation well on log-log paper which has the same scale as the type curve (above). NOTE: **t=time, r=radial distance from pumping well.**

3. Superimpose the type curves and the plot of observation well data. **Keeping both the X and Y axis of each plot parallel**, position the two curves to obtain the best match when overlain. NOTE: If only paper copies of both plots are available, a light table or brightly lit window will be required for this step.

4. Select a match point on the overlapping portion of the two graph papers such that the values for that point simplify the calculations (e.g., even log cycles of [∑W(u), 1/up] — [1,1]; [1,10] etc.).

5. Read coordinates for ∑W(u), 1/up, s, and t/r2.

6. Substitute the match point values for the appropriate variable in the equations below:

Transmissivity = $$T=\frac{Q}{4\pi s}\sum W(u)$$

Equation 20

Storativity = $$S=4T\left(\frac{t}{r^2}\right)u$$

Equation 21

7. For each OW, determine the distance from the image well (r_i) using the following:

$$r_i=K_f r_r$$

Equation 22

8. Repeat for each observation well.

5.2.3 Modified Theis Non-Equilibrium Method

As in the case of a non-bounded aquifer, the hydraulic parameters can also be determined using a Modified Theis equation and a straight line (semi-log) plot of s and log10t.

5.2.3.1 Procedure

1. Refer to Section 5.1.2 (above) and ASTM D4105-91 for details on plotting the data and the equations to be used in calculating transmissivity and storativity using this method. Note that the data will define two rather than one straight line portions. This is due to the image well effect of the boundary conditions.

2. Select a convenient value of s within the initial straight-line part of the plot. Drawdown represented by this portion of the curve has not been affected by the boundary. Therefore, s = sr and the corresponding value of tr corresponds to sr.

3. Graphically extend the initial straight-line part of the curve to the right. The departure of the measured drawdown from the extended line represents the drawdown due to the presence of the boundary. This effect is also referred to as the image well drawdown, si.

4. Select a point on the second straight-line such that si = sr. Note the value of time ti which corresponds to si.

5. Since tr and ti are selected such that si = sr, then ur = ui and (Equation 23)

$$\frac{r_r^2 S}{4Tt_r} = \frac{r_i^2 S}{4Tt_i}$$

so that:

$$K_i = \frac{r_i}{r_r} = \sqrt{\frac{t_i}{t_r}} \qquad \text{(Equation 24)}$$

6. Determine the distance to the image well using Equation 22.

7. Repeat this calculation for each observation well.

Determine the location of the boundary as follows:

- Accurately plot the locations of the control and observation wells on a map.

- With a compass, using each observation well as the center point, draft a circle which has a radius equal to the distance from that well to the boundary.

- The image well is located at the intersection of these circles. If the circles do not intersect exactly, the probable well location is at the centroid of the intersections, or the polygonal area bounded by the circles in the case of no overlap.

- Draw a straight line from the pumping well to the image well. The boundary is defined as the perpendicular bisector to this line at the image well.

5.2.4 Limitations

The following caveats apply to either of the above two methods:

- In cases where this test method is employed to locate an unknown boundary, a minimum of three observation wells is required to accurately locate the image well which is the boundary. Two observation wells will yield two possible locations for the image well. One observation well will indicate the presence of a boundary, and the distance (radius) from the observation well, but the image well will be located somewhere on that surface.

- The effects of a constant head (recharging) boundary are indistinguishable from those of a leaky aquifer. It is, therefore, imperative that care be taken in developing the conceptual model of the geohydrologic system being studied prior to testing.

5.3 SEMI-CONFINED (LEAKY) AQUIFER

In some instances, the confining beds either above or below the aquifer will not be completely impermeable. In these cases, the aquifer is said to be “leaky.” This condition can be readily determined from the Theis s over t plot on log-log paper. In the initial phase of pumping, the plot will look like the Theis “type” curve. As pumping continues and the aquifer is depressurized (piezometric head decreases), a gradient within the overlying and/or underlying aquitard(s) is induced. Instead of the expected type curve, the plot will be somewhat flattened, and values for s may actually decrease over time if the vertical component of groundwater flow through the aquitard(s) is sufficiently high. The log-log plot will yield a considerably flattened curve. This is one of the reasons it is recommended that these log-log plots be done in the field, so that such conditions can be detected early, and steps be taken to minimize any adverse environmental impact of aquifer cross contamination.

5.3.1 Neuman and Witherspoon Method

The Neuman and Whitherspoon approach to solving the problem of evaluating a leaky aquifer is two-fold. First, they assumed that if the distance between observation well and pumping well is minimized, the area of aquitard subjected to stress and possible leakage is minimized, and the Theis method could be employed. Next, they assumed that if only early time drawdown data were used, the effects of leakage could be further reduced. This is accomplished by closely monitoring the response curve(s) for transducers both in the aquifer and in the aquitard(s) themselves. When the s over t curve begins to flatten, indicating leakage, this is defined as the end of valid aquifer data. Data acquired beyond that point contains components of horizontal (aquifer) flow, and vertical (aquitard) flow. In order to accurately calculate the aquitard parameters, an undisturbed sample of the aquitard must be taken (ASTM D1587-83). The laboratory tests will provide values for storage of the aquitard(s). Conductivity within the aquitard(s) is provided from the s over t plots for transducers located within the aquitard.

5.3.1.1 Assumptions

The same assumptions as in the Theis method hold with the following differences:

- The aquifer is leaky.
- The aquifer and aquitard both have a seemingly infinite areal extent.
- Flow in the aquitard is vertical.
- Drawdown is negligible in both aquifer and aquitard.
- The aquitard has storage.
- The overlying and/or underlying aquifer(s) is capable of releasing water to the pumped aquifer through a decline in head.

5.3.1.2 Procedure

Field Operations

1. See field operations in Section 3.2.1.1.

2. In addition, set piezometers within the aquitard at 0.25 and 0.50 aquitard thickness. These should be set at essentially the same location as the observation well, either in the observation well or in a separate borehole adjacent to the observation well, and the same radial distance from the pumping well.

Data Plots

1. Prepare log-log plots of s over t for the observation well and transducers placed in the aquitard.

2. Use the valid early-time data and the Theis method to calculate the pumped aquifer parameters.

3. Calculate several s'/s ratios for the early time period used in b above.

4. Calculate the parameter tD — a "dimensionless" time parameter — using the following equation:

$$t_D = \frac{Kt}{Sr^2}$$

Equation 25

where

t = Time.
r = Radial distance to observation well (and transducers).
K = Pumped aquifer hydraulic conductivity.
S = Pumped aquifer storativity.

5. Using the value tD calculated in d (above), and s'/s, determine a value for t'D using Figure 4.

5.3.2 DeGlee Method and Hantush Approximation

DeGlee developed the following equation for steady-state drawdown within an aquitard with leakage from an aquitard proportional to the hydraulic gradient across the aquitard:

$$s=\frac{Q}{2\pi T}(K_0)\frac{r}{L}$$

Equation 26

where

T = Transmissivity.
s = Steady-state drawdown in observation well at distance r from pumping well.
Q = Discharge rate of pumping well.
L = Tc = leakage factor.
c = D'/K = hydraulic resistance of the aquitard.
D' = Saturated thickness of the aquitard.
K' = Hydraulic conductivity of the aquitard for vertical flow.
K0(x) = Modified bessel function of the second kind and of zero order (Hankel function).

Hantush observed that if r/L is small (0.05), Equation 14 can be estimated by:

$$s=2.30\frac{Q}{2\pi T}(\log 1.12\frac{L}{r})$$

Equation 27

5.3.2.1 Assumptions

See Section 5.3.1.1.

- Flow to the pumping well is in steady state.
- L is greater than 3D, where D is the saturated thickness of the aquifer.

5.3.2.2 Procedure

Field Operations

Field methods are identical to the Thiem method in Section 5.13.

Data Plots

Plot s over r (log scale) on semi-log paper where r/L is small, the points fall in a straight line plot. Where r/L is large, the curve approaches the zero-drawdown axis asymptotically.

5.3.3 Other Methods for Calculating Leaky Aquifer Parameters

The Neuman and Witherspoon Unsteady-state flow method, the Hantush Curve-Fitting Method, the Hantush Inflection Point Method, and the Walton Method. As before, these are mentioned for the sake of completeness, but not detailed herein.

5.4 UNCONFINED AQUIFERS

Flow to a pumping well in an unconfined (phreatic or water table) aquifer occurs in three phases. In the first phase, pumping has just begun, and the aquifer acts like a confined aquifer. Water is derived from storage (expansion of the water, compression of the aquifer). The time over drawdown plot for this phase closely mimics the Theis type curve. During the second phase, delayed yield occurs. This phenomenon results as water remaining in the pores is drained by gravity (specific yield), replenishing the portion of the aquifer supplying water to the well during the first phase, and results in a reduction in rate of drawdown over the first phase, and a flattening of the time-drawdown plot. The third phase brings equilibration in the rate of drawdown and the time-drawdown plot again looks like the Theis curve.

The duration of the first two phases is a function of the ratio of storage (S) to specific yield (Sy). If the ratio is in the range of 10-1 to 10-2, S is relatively large and the first phase drawdown should be significant. This condition is typical of saturated fine-grained sediments such as silts, clays, and fine-grained sands. If the ratio S/Sy is in the range of 10-4 to 10-6, Sy is relatively large, the second phase phenomenon is expected to be dominant, and coarser-grained sediments (sands and gravels) are indicated.

In addition to S/Sy, the distance between pumping well and observation well also affects the time-drawdown plot. As the distance to the observation well increases, the effects of S decrease.

5.4.1 Neuman Method

Flow to a pumping well in an unconfined (phreatic, or water table) aquifer occurs in three stages. During the first stage, the phreatic aquifer behaves like a confined aquifer, instantaneously releasing water from storage (expansion of the water, compression of the aquifer). This is illustrated in Figure 5, where the early portion of the family of drawdown curves closely matches the Theis curve (1/uA). The second phase is termed a period of "delayed yield" or "delayed response," in which the rate of drawdown is lower than that predicted by the Theis curve. During this phase, specific yield, or gravity drainage of water remaining in the pore spaces in the vicinity of the pumping well replenishes the water being removed. During the third phase, the rates of yield and drawdown equilibrate, and the time-drawdown plots again converge on the Theis solution (1/uB).

5.4.1.1 Assumptions

- The same assumptions as listed in Section 5.1.1.1.

- At least one observation well located at $r/b \leq 1$, where r = distance between pumping well and observation well, and b = aquifer thickness.

Drawdown in the observation well $s \leq 0.25$ b.

5.4.1.2 Procedure

Field Operations

See Section 3.2.1.

Data Plots

1. Prepare A and B curves (Figure 5); tables of these values can be found in many hydrology texts such as Fetter

2. Plot s over t on log-log paper at the same scale as the Type A and B curves

3. Superimpose the late-time drawdown data over the B curves. Note the value for the curve which best matches the field data.

4. Select a match point which has a value of 1 for as many of the variables as possible.

5. At the selected match point, read values for s, t, W(uB,β) and 1/uB

6. Repeat steps a-e, superimposing the early time data over the A curve which has the same β value as the B curve.

7. Read values for s, t, W(uA,β) and 1/uA

8. Substitute these values in the following equations:

$$T_B = \frac{Q}{4\pi s}(W(u'_B \beta))$$

Equation 28. Transmissivity B curve.

$$T_A = \frac{Q}{4\pi s}(W(u_A', \beta))$$

Equation 29. Transmissivity A curve.

$$S_y = \frac{4T_B t u_B}{r^2}$$

Equation 30. Specific Yield.

NOTE: Transmissivities should be within ±10 percent of each other. If they are, their average should be used in the remaining equations, otherwise use the T value from the B curve.

5.5 SLUG TESTS

5.5.1 Preliminary to Operation (All Slug Tests)

Prior to conducting any tests, water level meters, transducers, dataloggers, and other materials should be examined for cleanliness and checked for defects.

Batteries should be checked in the calculator(s), water level meter(s), and datalogger(s).

Decontaminate all intrusive equipment prior to and after use at each location.

Lay plastic sheeting on the ground around the well casing.

Record the well number and other project and site information in the field logbook.

Check the well headspace for the presence of volatile organic compounds using applicable instruments. Record the results in the field logbook.

Measure and record the initial water level in the well and total depth of the well.

NOTE: If the static water level and water levels caused during testing are above the top of the screened, or the well consists of an open hole with no casing, then both rising-head and falling-head tests should be conducted.

If the static water level is at or below the top of the screened or open-hole interval, a rising-head test only should be conducted (i.e., falling-head slug tests are invalid for this situation).

5.5.2 Option 1 – Inert Object Insertion

This procedure describes the use of a solid slug to change the water level in a well.

Select an appropriate transducer for the range of water level change anticipated in the slug test.

Submerge the transducer in the well to a sufficient depth to provide effective performance. The range of the transducer must be considered in the determination of the submersion depth. Well bottom sediment plugging of the transducer must be avoided as well as transducer interference by the inert object.

Monitor water level until it returns to original level as measured in Section 5.5.2 before initiating the test.

Tie off the line to a decontaminated, inert cylinder (slug) prior to lowering it into the well. All intrusive equipment must be decontaminated.

"Instantaneously," but smoothly, lower the cylinder into the well, displacing the water and thereby raising the water level.

Measure and record water levels in the well initially. Record the water level response during cylinder insertion and every 5-10 seconds with the cylinder in place. Record the falling water level and time of each measurement in the field logbook and/or Field Permeability Test Data Sheet.

NOTE: If transducer and datalogger are employed, care must be taken to create backup copies and/or hardcopies of these data as soon as practicable.

Record data until water level has stabilized, or approximately 90 percent of the change in the water level has dissipated. The time for this to occur may range from less than 1 minute to more than a day. Usually, it is not necessary to continue measurements for more than a few hours because longer periods indicate extremely low hydraulic conductivity. Choose the time interval between measurements according to how rapidly the water level approaches the static level. From 10 to 30 measurements should be obtained at approximately equal time intervals during the recovery.

"Instantaneously," but smoothly, remove the cylinder from the well.

Conduct a rising head slug test by measuring the response of the water level to the removal of the cylinder. Record water levels and time until the water level equilibrates to 90 percent of the initial level, and record data as in Section 5.5.2.

Calculate the aquifer hydraulic conductivity using appropriate equations.

Decontaminate the slug and the tape or meter.

5.5.3 Option 2 – Adding or Removing Water

This procedure describes the use of a pump to change water level in a well and a datalogger and pressure transducer to measure the water level. The technique is intended for use in wells installed in highly permeable materials where the use of a slug may not induce a measurable change in the water level. However, this technique can also be used in wells installed in low permeability materials. The methods described for the transducer/datalogger are also appropriate when using a solid slug or bailer for inducing a change in the water level in a well.

Select an appropriate transducer for the range of water level change anticipated in the slug test.

Submerge the transducer in the well to a sufficient depth to provide effective performance—usually this is to a depth at which its pressure rating is not exceeded but no less than 5 ft of water is above the transducer. The range of the transducer must be considered in selection of the submersion depth.

Check the transducer calibration at two different depths in the well. The transducer should be at least 1 ft above the bottom of the well to prevent bottom sediment from fouling the transducer and preventing accurate readings.

Turn on the datalogger to view the water level value (either in depth of submergence or depth to water).

IF REMOVING WATER: Insert the pump piping with check valve (if using a centrifugal pump) or submersible pump with check valve into the well at least 4 t below the water table but above the transducer. Attach pump discharge to treatment system, portable tanks, or drums to containerize the effluent if it is known or suspected to be contaminated.

— OR —

IF ADDING WATER: Insert piping from water source to a depth of about 1 ft below the surface of the water table (this will prevent undue aeration of the water column and possible anomalous readings).

Monitor water level until it returns to original level as measured in Section 3.1.2 before initiating the water addition/extraction test.

View water level value on datalogger. Values (either depth of submergence or depth to water) should be stable and approximately the same range as in Step C; if not, wait until the water level equilibrates to the initial value.

Begin logging and record the time.

Turn pump on until 4-5 ft of drawdown occurs or the well (at the depth of the poly pipe or pump) goes dry.

— OR —

Turn on water at supply tank until the water level in the well rises a minimum of 5 ft.

Shut off pump or water supply at the tank. Remove piping or pump to a position above the initial water level (water removal) or remove from the well (water addition or removal).

Record water levels and water volumes removed/added during the entire test.

Record water levels until approximately 90 percent of the change in the water level has dissipated. The time for this to occur may range from less than 1 minute to more than a day. Usually, it is not necessary to continue measurements for more than a few hours, because longer periods indicate extremely low hydraulic conductivity.

Periodically collect water levels manually using an electronic water level meter of tape to verify the datalogger values.

End logging and record the time. Remove the poly pipe and/or pump and pressure transducer and transfer data in datalogger to a computer disk. Make a backup copy of the file and record the file information in the field logbook.

Decontaminate intrusive equipment.

Calculate the aquifer hydraulic conductivity using appropriate equations.

5.5.4 Data Plots

Record the water level in the well immediately after the inert object emplacement/withdrawal (Option 1) or at the equilibrium of the water table (Option 2). This is the initial water level reading.

Following the initial water level reading, the water level in the well is continuously recorded along with the time of the level measurement.

The ratio of the initial water level to the change in head is plotted with respect to time.

The ratio is plotted on the arithmetic scale and time is plotted along the logarithmic scale.

The relationships of the initial water level to changes in the water level are a function of parameters shown on Figure 6 and the formation transmissivity. The values of the function relationship are plotted for a series of transmissivities and are depicted in Figure 5.

The resulting field data plot (curve) is compared to a series of type curves (Figure 5). The field-data curve is placed over the type curves with the arithmetic axis coincident. The field data curve is matched to the type curve that has the same curvature.

The formation transmissivity is determined.

The value of storativity is calculated.

6. REPORTS

After performing hydrologic tests, the contractor will generate a report which must contain a minimum of the following elements:

- A field data report including a site description, plots of water level and discharge with time, and a precursory analysis of data.

- The introduction should include the purpose of the test, dates and times water-level measurements were begun, dates and times discharge or injection was begun and ended, and the average rate of discharge or injection.

- Well logs (including construction diagrams) of all control wells, observation wells, and piezometers.

- Site map showing all well locations, distances between wells, and locations of all geologic boundaries or surface waterbodies which might affect the test.

- The locations of wells and boundaries which may affect the test generally need to be accurate within a radial distance of ±0.5 percent. For large-scale studies, it may be sufficient to locate wells from maps or aerial surveys. Small-scale studies require that well locations be surveyed. Additionally, other features such as faults, streams, and canals should be located. Well deviation surveys, which determine true horizontal distance between well screens, may be necessary if test wells are deep relative to their spacing.

7. MAINTENANCE

The transducers must be kept clean, operable, and thoroughly tested before emplacement in the well. A plugged or malfunctioning piezometer will give erroneous responses or fail to give any response.

8. PRECAUTIONS

In the case of slug tests, care should be exercised to maximize the efficiency of the well. If there is a great disparity between the conductivity of the aquifer and that of the well screen/filter pack, one may find that the slug test has accurately measured the conductivity of the well screen/filter pack rather than the aquifer.

Transducers should be double checked to ensure that they are calibrated in the correct water level range. Water level and well depth should be checked with an electronic water level meter or steel tape before and after placing the transducers.

Be sure that the wells used are well developed.

If the water removed is contaminated and cannot be discharged at the surface, a tank of sufficient size to hold the effluent of the pumping test must be available.

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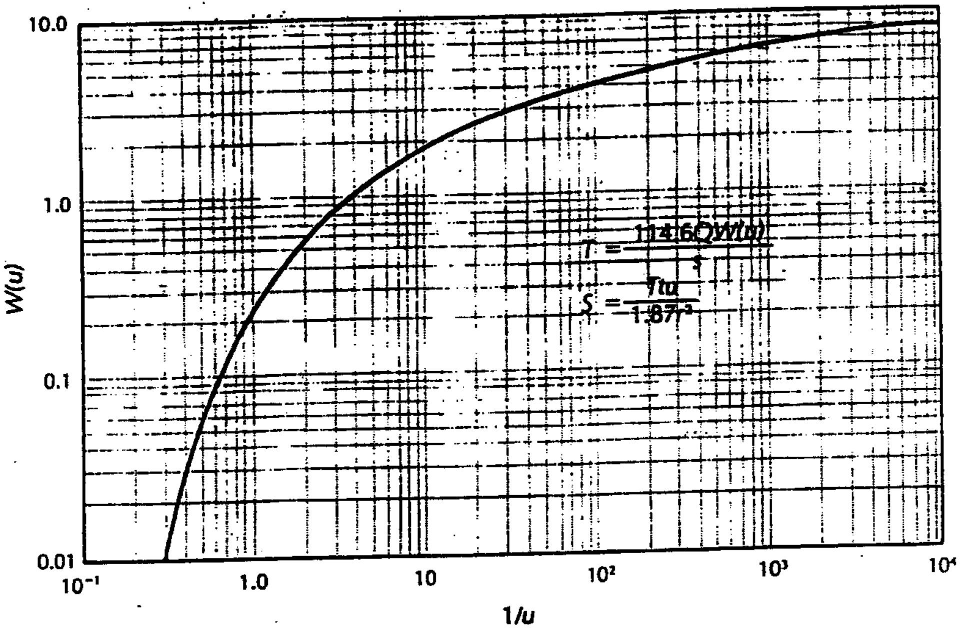

Figure SOP033-1. Theis type curve (after Fetter).

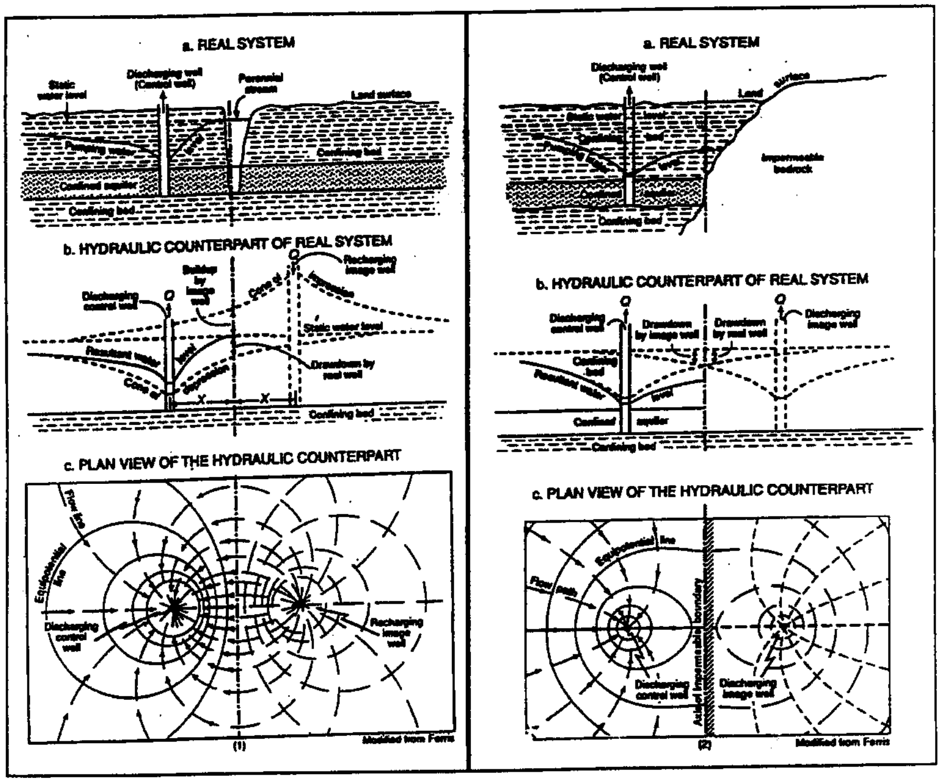

Figure SOP033-2. Illustration of boundary conditions
(after ASTM D-5270-92).

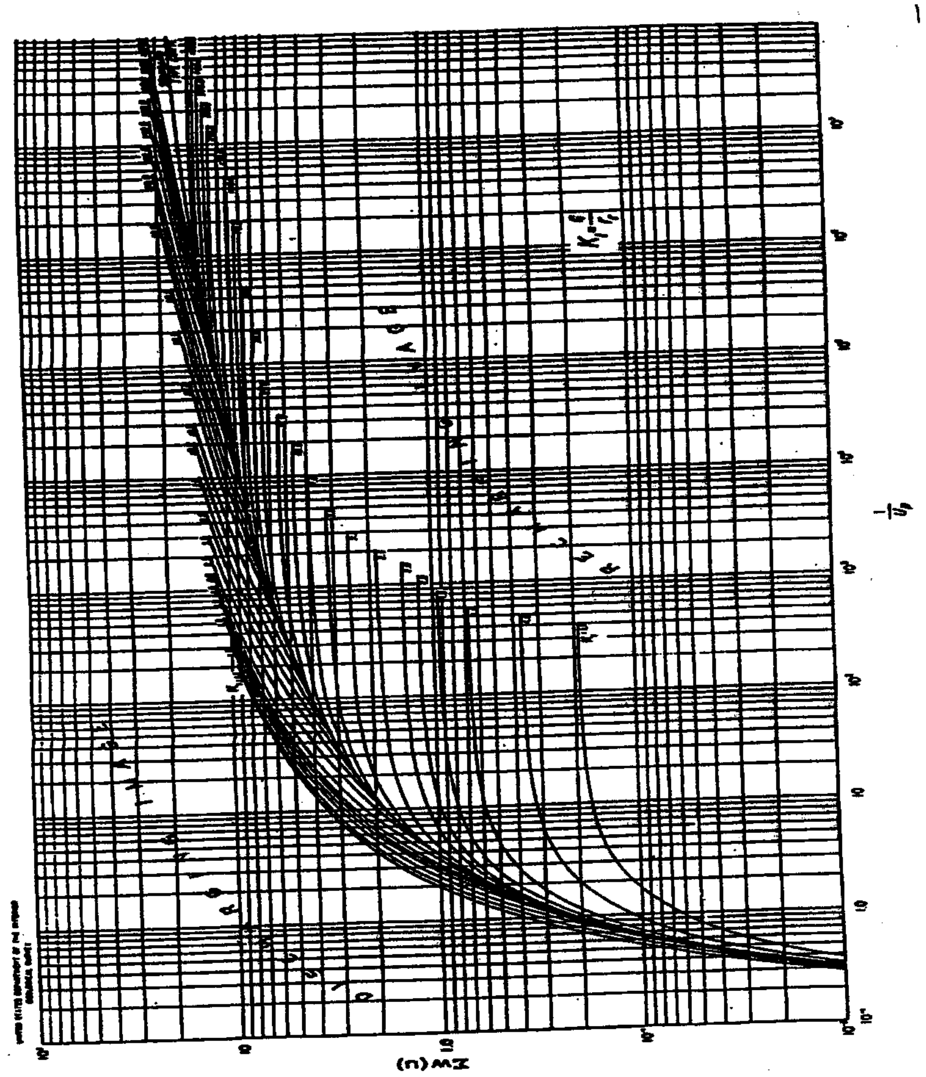

Figure SOP033-3. Family of type curves for the solution of the Modified Theis formula (after ASTM D-5270-92).

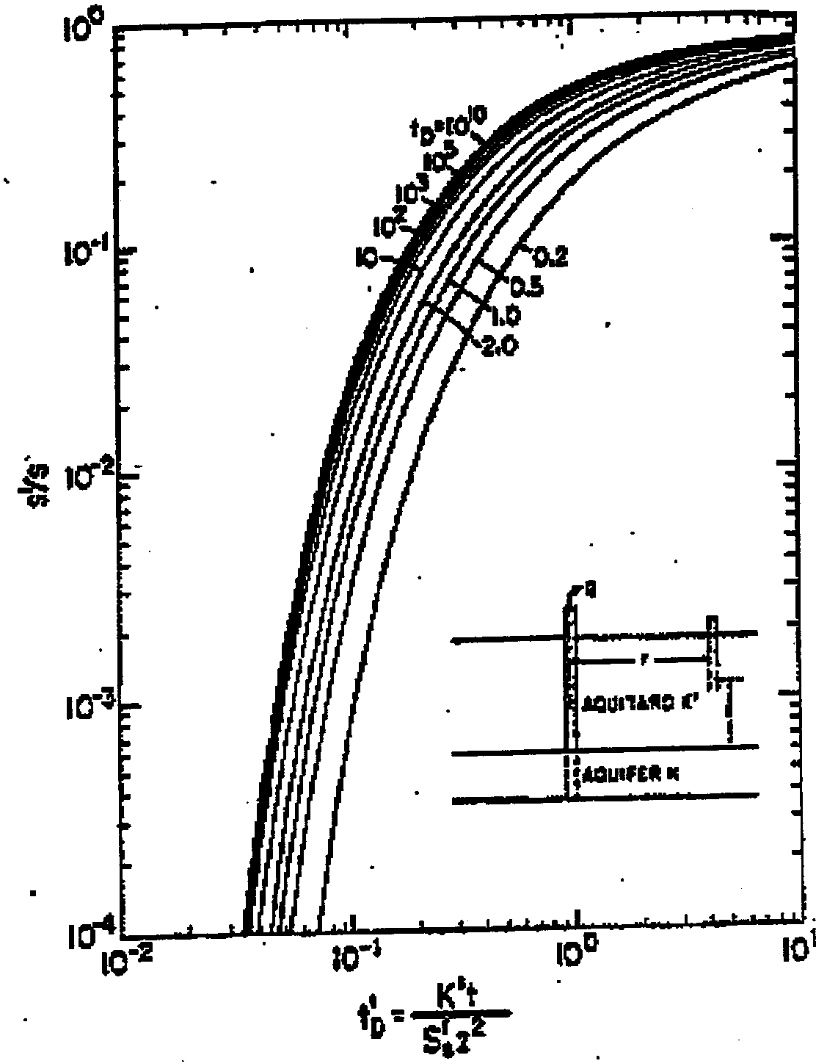

Figure SOP033-4. Variation of s'/s with t'_d for a Semi-Infinite Aquitard (after Reynolds).

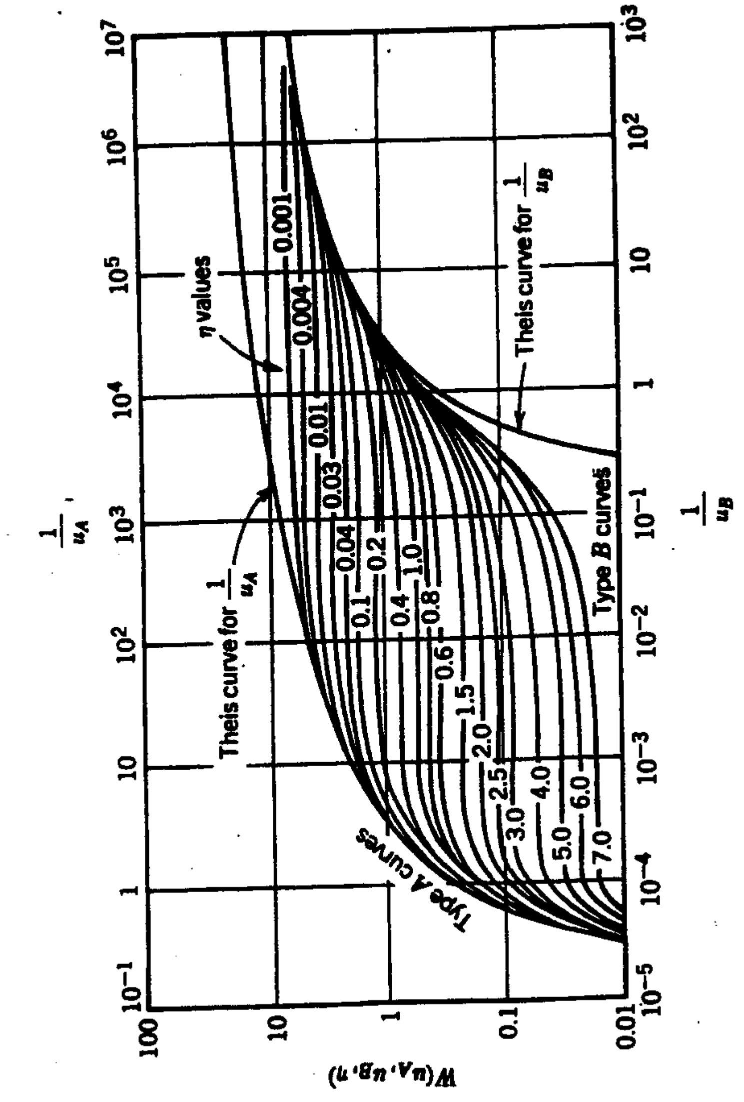

Figure SOP033-5. A and B type curves (after Dominico).

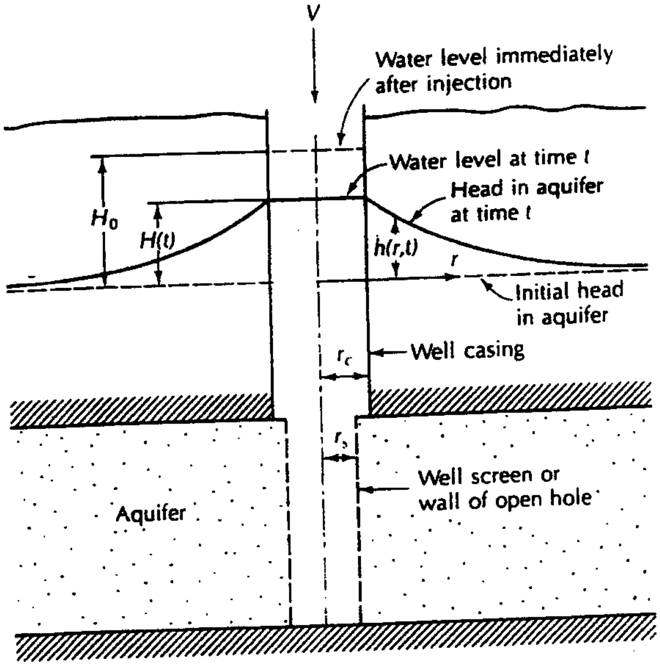

Figure SOP033-6. Well parameters – slug tests (after Fetter).

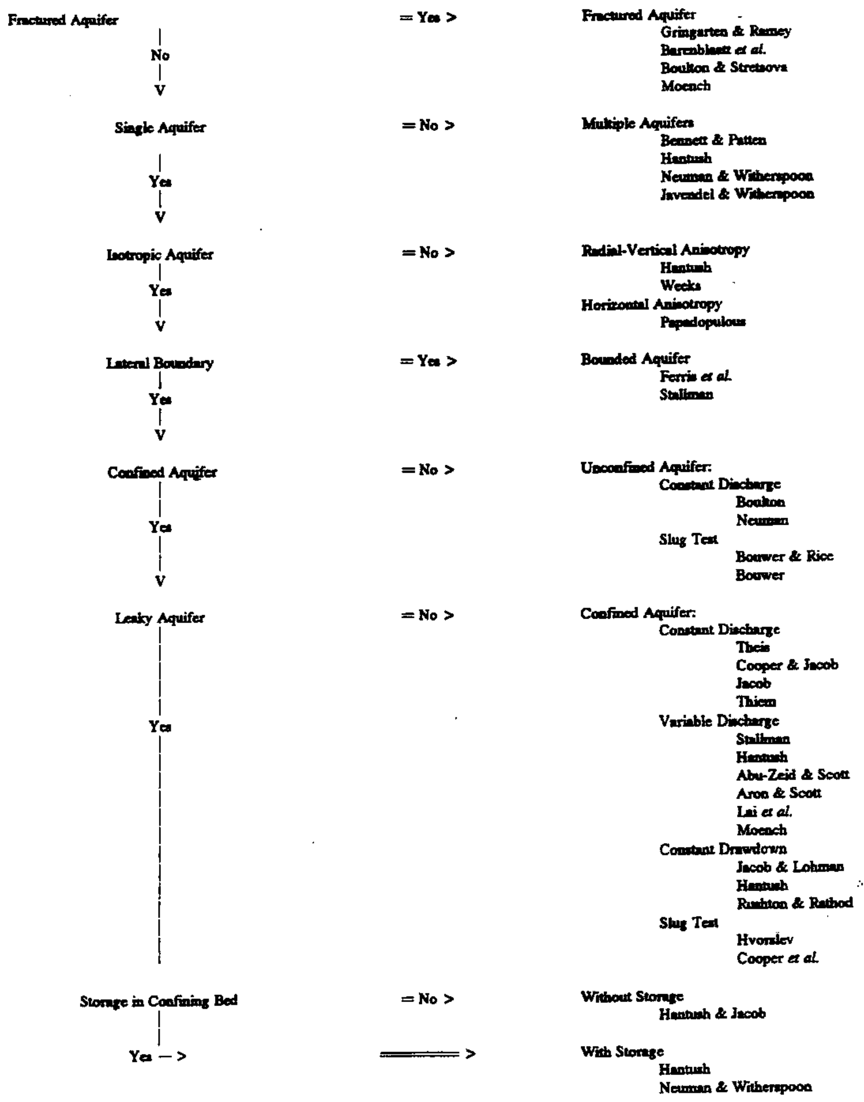

Table SOP033-1. Decision tree for selection of aquifer test method (after ASTM D-4043-91).

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Standard Operating Procedure No. 035
for
Small Boat Operations

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 2
March 2019

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 035	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
2	28 March 2019	Systematic review and update	John Morris Pete Garger	Matthew Bowman

1. BACKGROUND

The threat from working on or near surface water bodies comes from both chemical hazards and physical hazards such as drowning. When there is a need for sampling to be conducted using small boats, EA will provide the necessary safety gear (i.e., life vests, nets, and other floating devices) and appropriate training.

EA field staff and team members supporting field planning for projects involving small boat operations should be aware that individual states have different certification, training, and safety requirements. These requirements should be identified early in project planning and incorporated into field preparation efforts. The National Association of State Boating Law Administrators maintains a website (www.nasbla.org) that provides an online reference guide for state boating laws. In states where boating certification is required, the operator should have their certification card in their position whenever conducting small boat operations.

1.1 PURPOSE

This Standard Operating Procedure (SOP) establishes the operating requirements for small boats conducting inland and coastal marine work.

1.2 SCOPE

This SOP applies to the operation of small boats, including launches, motorboats, working platforms, and skiffs, for inland (rivers, lakes, and bays) and coastal marine work. This SOP applies to EA personnel operating a small boat or working on a subcontractor-operated small boat. This SOP covers small boat requirements, work over or near bodies of water, personal flotation devices (PFDs), lifesaving and safety skiffs, severe weather precautions, and cold water and drowning hazards. This SOP is mandatory for EA personnel. Subcontractors are responsible for analyzing the hazards of activities they control and for preparing job hazard analysis and maintaining equivalent safety requirements.

1.3 DEFINITIONS

Small Boat—Includes dinghies, 1- or 2-man rowboats, up to and including larger vessels typically up to 30 feet (ft) in length, and work barges.

Float Plan—A written summary of the details of the trip, including route, type of vessel, persons aboard, and other salient information that may be useful in the event of an emergency.

Job Hazard Analysis—A concise analysis of the specific task considering the body of water, vessel, unique job requirements, training and experience of crew, and other circumstances as may be appropriate.

1.4 RESPONSIBILITIES

The Project Health and Safety Officer is responsible for review and approval of small boat operations as described in the Health and Safety Plan. The Project Health and Safety Officer provides any necessary safety requirements to the project team. The Project Health and Safety Officer will review the job hazard analysis prepared by project personnel.

Health and Safety Officer—The Health and Safety Officer is responsible for ensuring the proper use of small boats at field locations. The Health and Safety Officer ensures that only trained personnel operate small boats, subcontractors implement safety programs, and that all equipment is properly maintained. The Onsite Safety Officer is responsible for filing or maintaining a float plan.

Small Boat Operators—Certified (as appropriate by the state where the project is located) EA personnel working on small boats will follow this procedure and any applicable health and safety procedures identified in the Health and Safety Plan and the vessel rules. Small boat operators will identify any conflicts in procedures or any problems or equipment failures to the Health and Safety Officer. Small boat operators will demonstrate training, experience, and compliance with state requirements for operator education and licensing prior to operating any vessel. For larger bodies of water, or rapidly moving water, knowledge of local conditions shall be obtained prior to embarkation.

2. SMALL BOAT REQUREMENTS

All small boats used by EA personnel must meet the minimum requirements in the U.S. Army Corps of Engineers Safety and Health Requirements Manual Engineer Manual (EM) 385-1-1 and the applicable Occupational Safety and Health Administration or state plan requirements, as well as meeting applicable U.S. Coast Guard Regulations. These requirements include the following:

- Small boats will meet the minimum flotation requirements of the U.S. Coast Guard, and must have a certification tag affixed to the hull.
- Small boats will have valid proof of registration.
- The maximum number of passengers and weight that may be safely transported must be posted on all small boats.
- The number of personnel on the small boat cannot exceed the number of Type I PFDs onboard.
- Each small boat will have sufficient room freeboard, and stability to safely carry the allowable number of personnel and cargo.

- Each small boat shall have an appropriate complement of hand tools onboard to address boat maintenance and emergency repair.

- Each motored boat measuring less than 26 ft in length will carry a minimum of one 1A-10 BC fire extinguisher; motored boats measuring greater than 26 ft will carry a minimum of two 1A-10 BC fire extinguishers.

Operators and occupants of small craft will review Federal Requirements and Safety Tips for Recreational Boats (U.S. Coast Guard 1994) before engaging in work from rafts, dinghies, canoes, rowboats, or Jon boats.

2.1 WORK OVER OR NEAR WATER

Work over or near water, where the potential exists for personnel to fall in and possibly drown, will be conducted in accordance with the requirements of applicable Occupational Safety and Health Administration standards and the U.S. Army Corps of Engineers EM 385-1-1 standards. This includes work from shore, bridges, work platforms, and vessels. Work within 15 ft of unobstructed access to water is within the requirements of this section. Personnel will follow the guidelines listed below except where personnel are protected by continuous guardrails, safety belts, or nets, or are conducting work along beaches or similar shorelines:

- Personnel will use the buddy system at all times.

- Swimming is prohibited, with the following exceptions: (1) certified divers performing their duties, and (2) personnel entering water to prevent injury or loss of life.

- All personnel will wear a U.S. Coast Guard-approved PFD of the type able to support an unconscious person (Type III) continuously. Type I PFDs must be available for all personnel on the vessel.

- At least one Type IV throwable device (e.g., ring buoy or horseshoe buoy) will be available on the small boat. Throwable devices should be U.S. Coast Guard-approved and equipped with 150 ft of 600-pound capacity rope.

- If specified in the Health and Safety Plan, at least one person will provide a dedicated safety watch/look-out.

2.2 PERSONAL FLOTATION DEVICES

All EA personnel will wear a U.S. Coast Guard-approved, Type III PFD when working over or near bodies of water. PFDs should meet the following requirements:

- Before and after each use, the PFD will be inspected for defects that would alter its strength or buoyancy.

- All PFDs will be equipped with retro reflective tape.

PFDs need not be donned when working on larger craft (>26 ft) when working within the boat's cabin. PFDs should be worn at all times when working on smaller craft.

2.3 SAFETY EMERGENCY DRILL

The vessel operator shall provide a list of crew duties for normal operations and emergencies. Emergencies that will be covered include man-overboard, vessel fire, and vessel emergency.

The vessel operator will provide an orientation and emergency drill. An emergency drill will be conducted at the start of each task, and monthly thereafter, or as provided for in U.S. Coast Guard regulations.

2.4 FLOAT PLAN

A float plan provides essential information to enable the U.S. Coast Guard or other emergency search and rescue teams to initiate a search in the event of personnel not reporting in on schedule. The vessel operator will file a project-specific daily float plan with the designated on shore individual and with the project health and safety representative listed in the Health and Safety Plan. Upon daily completion of on-water work, the vessel operator will check in with the designated on shore individual. The float plan form is provided in Attachment A.

2.5 EMERGENCY PLAN

The emergency plan should list a main dock and an alternate dock, and provide emergency medical support contact for each location.

2.6 COMMUNICATIONS

For open water, tidal environments, or industrial waterways, a marine very high frequency (VHF) radio will be maintained onboard and in operable condition. Mobile telephones can be substituted for a marine VHF radio at the discretion of the Health and Safety Officer on sites with minimal boat traffic on inland rivers, ponds, and lakes.

2.7 OCEAN AND NIGHTTIME REQUIREMENTS

These operations require a specialized skillset, experience, and additional training. Contact the Corporate Health and Safety Officer and Project Health and Safety Officer prior to planning any work that requires work in open ocean or nighttime operations.

2.8 SEVERE WEATHER PRECAUTIONS

During field operations involving small boats, EA personnel will make provisions for severe weather conditions in advance. Severe weather includes sudden and locally severe storms, lightning, high winds, waves, hurricanes, and floods. Before beginning work over water, the Health and Safety Officer and Small Boat Operators will evaluate and track weather reports and conditions to ascertain local weather and prevent personnel exposure to severe weather. In the event that severe weather is encountered, personnel will cease field operations and immediately return to shore. Designation of multiple sheltering locations should be planned in advance.

2.9 COLD WATER AND DROWNING HAZARDS

EA personnel conducting field operations with a small boat may be exposed to cold water and drowning hazards. When water temperature is below 45 degrees Fahrenheit, hypothermia is a serious hazard. A person can lose feeling in extremities within 5 minutes, loss of consciousness in 10 minutes, and loss of life in 20 minutes. Under no circumstances will EA personnel enter the water from a small boat unless conducting diving operations or performing a rescue.

Symptoms of hypothermia are discussed during standard first aid training and in the EA Health and Safety Program Plan. If a person who has fallen into the water displays symptoms of hypothermia, he or she should be treated immediately and the field operations canceled. Under no circumstances should the victim be given hot liquids, since they can accelerate shock. Drinks no warmer than body temperature are acceptable. If symptoms are severe and rapid evacuation is not possible, remove the victim’s wet clothing and cover the victim with a blanket. Continue to treat the victim for shock.

When a high risk of cold water and drowning hazards exists, all field staff members should be familiar with cold water survival techniques. If a team member falls into the water, he or she should not remove any clothing in the water because all clothing will provide insulation. Although clothing creates added drag while swimming, the added insulation of the clothing outweighs the disadvantage of the additional drag.

If a team member falls into the water, another team member should try to reach the person in the water with an oar, paddle, pole, or similar object. The victim should try to grab the extended item. If the victim is unconscious, the rescuer should try to hook the victim’s PFD, clothing, or hair and pull him or her toward the boat. Once the victim is retrieved, the other team members should begin any necessary emergency medical procedures. A minimum of one team member on the vessel should be certified for cardiopulmonary resuscitation/first aid. If no emergency medical procedures are necessary, the victim should change into dry clothing.

An additional consideration that must be evaluated related to small boat operations associated with cold weather conditions is the presence of ice. Immediately prior to launch, ice and potential icing conditions should be assessed. Boat ramps can become very hazardous in icy conditions and can cause trucks to lose tracking when launching or removing a boat from the water.

2.10 JOB HAZARD ANALYSIS

The requirements for preparing a job hazard analysis apply specifically to all on-water operations. Attachment B provides a sample job hazard analysis; however, an actual job hazard analysis will consider the specific task including the body of water, vessel type, unique job requirements, training and experience of crew, and other circumstances such as tides, weather, water temperature, access of rescue craft, and other factors as may be appropriate. Job hazard analyses must be prepared specifically for each task and crew in accordance with the U.S. Army Corps of Engineers Safety and Health Requirements Manual EM 385-1-1.

3. REFERENCES

U.S. Coast Guard. 1994. Federal Requirements and Safety Tips for Recreational Boats.

Attachment A

Float Plan Form

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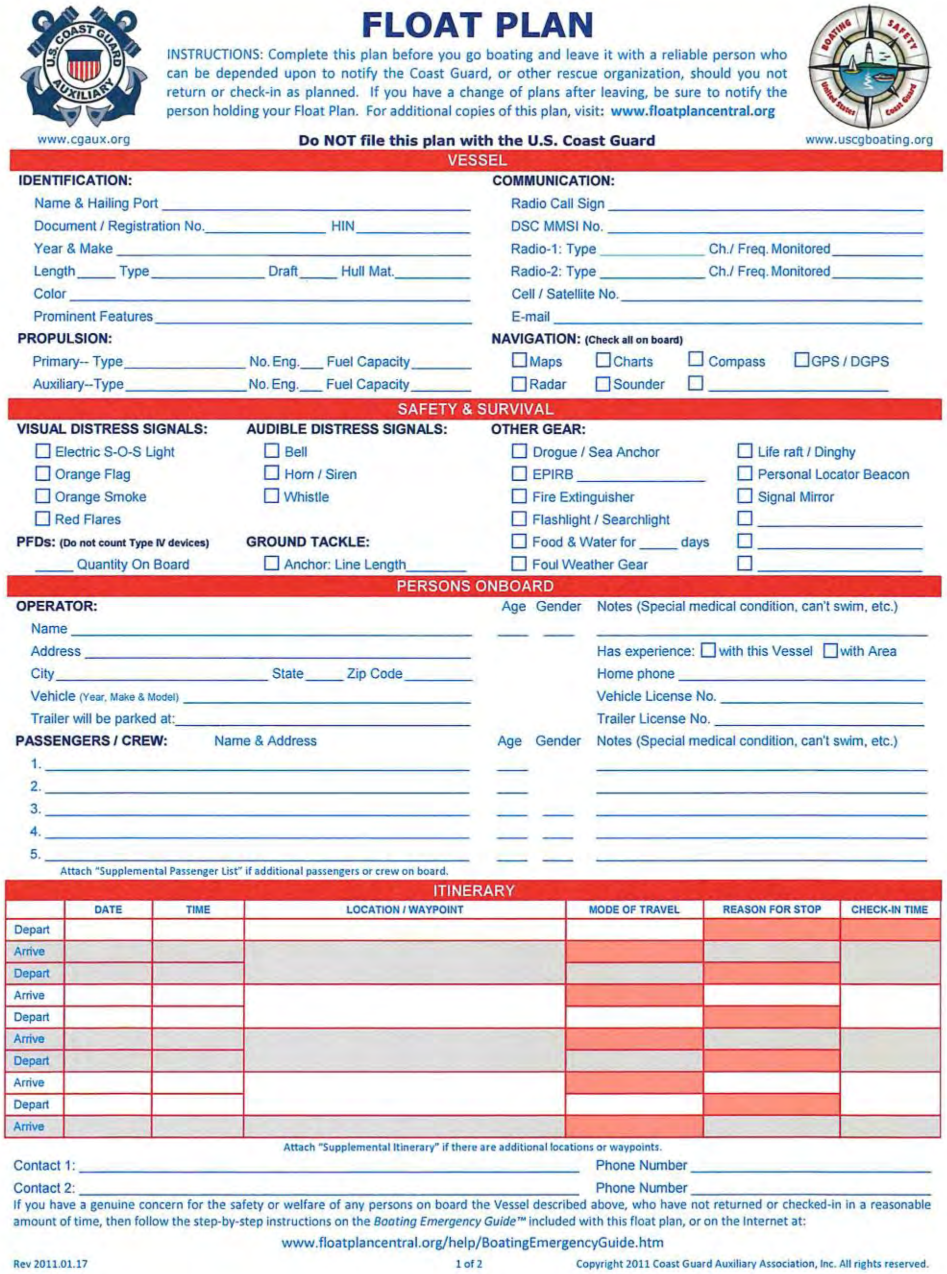
ATTACHMENT A
FLOAT PLAN FORM



FLOAT PLAN

INSTRUCTIONS: Complete this plan before you go boating and leave it with a reliable person who can be depended upon to notify the Coast Guard, or other rescue organization, should you not return or check-in as planned. If you have a change of plans after leaving, be sure to notify the person holding your Float Plan. For additional copies of this plan, visit: **www.floatplancentral.org**

www.cgaux.org

Do NOT file this plan with the U.S. Coast Guard

www.uscgboating.org

VESSEL

IDENTIFICATION:

Name & Hailing Port ____________________
Document / Registration No.__________ HIN __________
Year & Make ____________________
Length_____ Type__________ Draft____ Hull Mat.__________
Color ____________________
Prominent Features ____________________

PROPULSION:

Primary-- Type__________ No. Eng.___ Fuel Capacity_______
Auxiliary--Type__________ No. Eng.___ Fuel Capacity_______

COMMUNICATION:

Radio Call Sign ____________________
DSC MMSI No. ____________________
Radio-1: Type __________ Ch./ Freq. Monitored__________
Radio-2: Type __________ Ch./ Freq. Monitored__________
Cell / Satellite No. ____________________
E-mail ____________________

NAVIGATION: **(Check all on board)**

☐ Maps ☐ Charts ☐ Compass ☐ GPS / DGPS
☐ Radar ☐ Sounder ☐ ____________________

SAFETY & SURVIVAL

VISUAL DISTRESS SIGNALS:

☐ Electric S-O-S Light
☐ Orange Flag
☐ Orange Smoke
☐ Red Flares

PFDs: (Do not count Type IV devices)

_____ Quantity On Board

AUDIBLE DISTRESS SIGNALS:

☐ Bell
☐ Horn / Siren
☐ Whistle

GROUND TACKLE:

☐ Anchor: Line Length_______

OTHER GEAR:

☐ Drogue / Sea Anchor
☐ EPIRB __________
☐ Fire Extinguisher
☐ Flashlight / Searchlight
☐ Food & Water for _____ days
☐ Foul Weather Gear
☐ Life raft / Dinghy
☐ Personal Locator Beacon
☐ Signal Mirror
☐ ____________________
☐ ____________________
☐ ____________________

PERSONS ONBOARD

OPERATOR:

Name ____________________ Age ____ Gender ____ Notes (Special medical condition, can't swim, etc.) ____________________
Address ____________________
City__________ State_____ Zip Code________
Vehicle (Year, Make & Model) ____________________
Trailer will be parked at:____________________

Has experience: ☐ with this Vessel ☐ with Area
Home phone ____________________
Vehicle License No. ____________________
Trailer License No. ____________________

PASSENGERS / CREW: Name & Address Age Gender Notes (Special medical condition, can't swim, etc.)

1. ____________________ ____ ____________________
2. ____________________ ____ ____________________
3. ____________________ ____ ____ ____________________
4. ____________________ ____ ____ ____________________
5. ____________________ ____ ____ ____________________

Attach "Supplemental Passenger List" if additional passengers or crew on board.

ITINERARY

	DATE	TIME	LOCATION / WAYPOINT	MODE OF TRAVEL	REASON FOR STOP	CHECK-IN TIME
Depart						
Arrive						
Depart						
Arrive						
Depart						
Arrive						
Depart						
Arrive						
Depart						
Arrive						

Attach "Supplemental Itinerary" if there are additional locations or waypoints.

Contact 1: ____________________ Phone Number ____________________
Contact 2: ____________________ Phone Number ____________________

If you have a genuine concern for the safety or welfare of any persons on board the Vessel described above, who have not returned or checked-in in a reasonable amount of time, then follow the step-by-step instructions on the *Boating Emergency Guide™* included with this float plan, or on the Internet at:

www.floatplancentral.org/help/BoatingEmergencyGuide.htm

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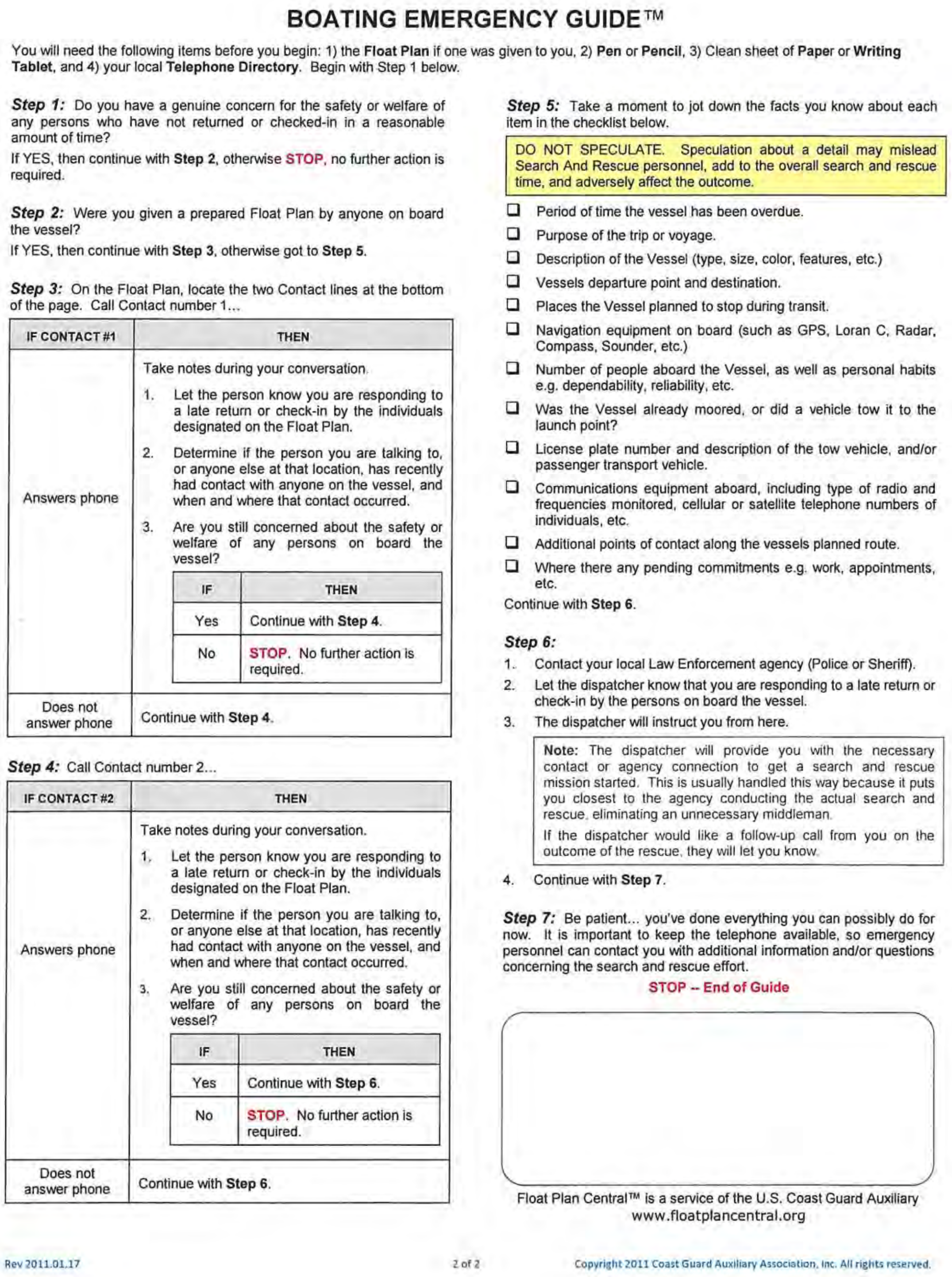

BOATING EMERGENCY GUIDE™

You will need the following items before you begin: 1) the **Float Plan** if one was given to you, 2) **Pen** or **Pencil**, 3) Clean sheet of **Paper** or **Writing Tablet**, and 4) your local **Telephone Directory**. Begin with Step 1 below.

Step 1: Do you have a genuine concern for the safety or welfare of any persons who have not returned or checked-in in a reasonable amount of time?

If YES, then continue with **Step 2**, otherwise **STOP**, no further action is required.

Step 2: Were you given a prepared Float Plan by anyone on board the vessel?

If YES, then continue with **Step 3**, otherwise got to **Step 5**.

Step 3: On the Float Plan, locate the two Contact lines at the bottom of the page. Call Contact number 1...

<table>
<tr><th>IF CONTACT #1</th><th>THEN</th></tr>
<tr><td>Answers phone</td><td>Take notes during your conversation.
1. Let the person know you are responding to a late return or check-in by the individuals designated on the Float Plan.
2. Determine if the person you are talking to, or anyone else at that location, has recently had contact with anyone on the vessel, and when and where that contact occurred.
3. Are you still concerned about the safety or welfare of any persons on board the vessel?
<table>
<tr><th>IF</th><th>THEN</th></tr>
<tr><td>Yes</td><td>Continue with Step 4.</td></tr>
<tr><td>No</td><td>STOP. No further action is required.</td></tr>
</table></td></tr>
<tr><td>Does not answer phone</td><td>Continue with Step 4.</td></tr>
</table>

Step 4: Call Contact number 2...

<table>
<tr><th>IF CONTACT #2</th><th>THEN</th></tr>
<tr><td>Answers phone</td><td>Take notes during your conversation.
1. Let the person know you are responding to a late return or check-in by the individuals designated on the Float Plan.
2. Determine if the person you are talking to, or anyone else at that location, has recently had contact with anyone on the vessel, and when and where that contact occurred.
3. Are you still concerned about the safety or welfare of any persons on board the vessel?
<table>
<tr><th>IF</th><th>THEN</th></tr>
<tr><td>Yes</td><td>Continue with Step 6.</td></tr>
<tr><td>No</td><td>STOP. No further action is required.</td></tr>
</table></td></tr>
<tr><td>Does not answer phone</td><td>Continue with Step 6.</td></tr>
</table>

Step 5: Take a moment to jot down the facts you know about each item in the checklist below.

DO NOT SPECULATE. Speculation about a detail may mislead Search And Rescue personnel, add to the overall search and rescue time, and adversely affect the outcome.

- ☐ Period of time the vessel has been overdue.
- ☐ Purpose of the trip or voyage.
- ☐ Description of the Vessel (type, size, color, features, etc.)
- ☐ Vessels departure point and destination.
- ☐ Places the Vessel planned to stop during transit.
- ☐ Navigation equipment on board (such as GPS, Loran C, Radar, Compass, Sounder, etc.)
- ☐ Number of people aboard the Vessel, as well as personal habits e.g. dependability, reliability, etc.
- ☐ Was the Vessel already moored, or did a vehicle tow it to the launch point?
- ☐ License plate number and description of the tow vehicle, and/or passenger transport vehicle.
- ☐ Communications equipment aboard, including type of radio and frequencies monitored, cellular or satellite telephone numbers of individuals, etc.
- ☐ Additional points of contact along the vessels planned route.
- ☐ Where there any pending commitments e.g. work, appointments, etc.

Continue with **Step 6**.

Step 6:

1. Contact your local Law Enforcement agency (Police or Sheriff).
2. Let the dispatcher know that you are responding to a late return or check-in by the persons on board the vessel.
3. The dispatcher will instruct you from here.

> **Note:** The dispatcher will provide you with the necessary contact or agency connection to get a search and rescue mission started. This is usually handled this way because it puts you closest to the agency conducting the actual search and rescue, eliminating an unnecessary middleman.
>
> If the dispatcher would like a follow-up call from you on the outcome of the rescue, they will let you know.

4. Continue with **Step 7**.

Step 7: Be patient... you've done everything you can possibly do for now. It is important to keep the telephone available, so emergency personnel can contact you with additional information and/or questions concerning the search and rescue effort.

STOP -- End of Guide

Float Plan Central™ is a service of the U.S. Coast Guard Auxiliary
www.floatplancentral.org

Attachment B

Job Hazard Analysis Form

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APPENDIX B

JOB HAZARD ANALYSIS FORM

Activity Hazard Analysis		
Task	**Potential Hazards**	**Hazard Control Measures**
MOBILIZATION/ DEMOBILIZATION	Physical Hazards (slips, trips, falls, cuts, etc.)	• Clear walkways/work areas of equipment, tools, and debris. • Watch for accumulation of water and ice on work surfaces. • Mark, identify, or barricade obstructions. • Wear cut-resistant work gloves when the possibility of lacerations or other injury caused by sharp or protruding objects occurs.
	Physical Hazards (material handling moving, lifting)	• Observe proper lifting techniques. • Obey sensible lifting limits (50-pound maximum per person manual lifting). • Use mechanical lifting equipment (hand carts, trucks, etc.) to move large awkward loads. • Use two or more persons for heaving bulk lifting.
	Physical Hazards (vehicle and pedestrian traffic)	• Use orange traffic cones where necessary. • Use reflective warning vests if exposed to vehicular traffic. • Locate staging areas in locations with minimal traffic.
	Physical Hazards (cold/heat stress)	• Monitor cold/heat stress as recommended in Section 6 of the Generic Health and Safety Plan. • Workers should wear appropriate clothing and sunscreen to protect from potential sun and wind exposure. • Drink adequate water to avoid dehydration.
	Munitions and Explosives of Concern (MEC) Hazard	• Practice site reconnaissance with a trained, experienced MEC specialist capable of recognizing MEC hazards. • If MEC are discovered, use existing access roads to retract from the MEC.
	Biological Hazards (insects, poisonous plants, ticks)	• Wear protective outer clothing and insect repellant to avoid insect bites and ticks. • Wear long sleeve shirts when working in areas with poison ivy or oak. • Workers with allergies should carry antidote kits, if necessary.
SAMPLING ACTIVITIES	Physical Hazards (slips, trips, falls, cuts, etc.)	• Clear walkways/work areas of equipment, tools, and debris. • Watch for accumulation of water and ice on work surfaces. • Mark, identify, or barricade obstructions. • Wear cut-resistant work gloves when the possibility of lacerations or other injury caused by sharp or protruding objects occurs.
	Physical Hazards (electrical)	• Identify electrical utility hazards prior to sampling. • Inspect work areas for spark sources, maintain safe distances, properly illuminate work areas, and provide barriers to prevent inadvertent contact. • Maintain minimum clearance distances for overhead energized electrical lines as specified in the Generic Health and Safety Plan.
	Physical Hazards (weather)	• Monitor radio and/or cell phone for up-to-date severe weather forecasts. • Discontinue work during thunderstorms and severe weather events.
	Physical Hazards (vessel traffic)	• Coordinate with commercial vessel traffic. • Identify the location navigation buoys and lanes for vessel traffic. • Use reflective warning vests if exposed to vessel traffic.

Activity Hazard Analysis		
Task	**Potential Hazards**	**Hazard Control Measures**
SAMPLING ACTIVITIES (continued)	Physical Hazards (cold/heat stress)	• Monitor cold/heat stress as recommended in Section 6 of the Generic Health and Safety Plan.
	MEC Hazards	• Follow established MEC avoidance protocols when performing intrusive sampling activities. • If MEC are discovered or suspected, use existing access roads to retract from the MEC.
	Chemical Hazards (including MEC)	• Perform environmental monitoring as required in the Site-Specific Health and Safety Plan. • Where appropriate, personal protective equipment as indicated in the Site-Specific Health and Safety Plan.
	Biological Hazards (bloodborne pathogens)	• Wear proper personal protective equipment, including nitrile gloves and a face shield or goggles when sampling sludge. • Wash with soap and water as soon as personal protective equipment is removed or when contact or exposure has occurred.
	Biological Hazards (insects, poisonous plants, and ticks)	• Wear protective outer clothing and insect repellant to avoid insect bites and ticks. • Wear long sleeve shirts when working in areas with poison ivy or oak. • Worker with allergies should carry antidote kits, if necessary.
BOATING ACTIVITIES	Physical Hazards (weather)	• Monitor radio and/or cell phone for up-to-date severe weather forecasts. • Boat operators will be trained by the site supervisor and/or the senior boat operator. • Discontinue work during thunderstorms and severe weather events.
	Physical Hazard (slips, trips, and falls, including falls overboard)	• Boat operator will inspect the boat prior to operation. The operator will ensure the number of personal flotation devices is equal to or greater than the number of passengers onboard. • No personnel will embark or disembark the vessel without the direction of the vessel operator. Vessel operator will ensure passengers are wearing personal flotation devices while on deck. At the request of the operator, personnel will be seated. • Passengers will stay seated until boat is docked. Ensure three-point contact whenever possible or practical. • A Type IV throwable device will be readily available onboard.

Standard Operating Procedure No. 037
for
Dissolved Oxygen Measurements
(YSI Model 57)

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 0
December 2014

CONTENTS

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring the dissolved oxygen (DO) of all types of aqueous solutions, including drinking water, saline water, and industrial and domestic wastes. DO is a measurement of the amount of soluble oxygen in an aqueous solution. It is a general indication of an aerobic/anaerobic condition of a water sample.

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

DO meter (YSI Model 57 or equivalent)
Self-stirring biological oxygen demand bottle probe
Membrane standards
Biological oxygen demand bottle

3. PROCEDURE

3.1 SETUP

It is important that before the meter is prepared for use and calibrated, it should be placed in the intended operating position, i.e., vertical, tilted, or horizontal. The instrument may need readjustment if the operating position is altered. The setup procedures should be as follows:

- With the switch set to **OFF**, adjust the meter pointer to zero with the screw in the center of the meter panel.

- Switch to **RED LINE** and adjust the **RED LINE** knob until the meter needle aligns with the red mark if necessary.

- Switch to **ZERO** and adjust to 0 mg/L scale with the **ZERO** control knob.

- Attach the prepared probe to the **PROBE** connector of the instrument and adjust the retaining ring finger tight.

- Before calibrating, allow 15 minutes for optimum probe stabilization. Repolarize whenever the instrument has been **OFF** or the probe has been disconnected.

3.2 CALIBRATION

Calibration is accomplished by exposing the probe to a known oxygen concentration, such as water-saturated air (%), or water of a known oxygen content (mg/L), and then adjusting the calibration controls so the display shows a reading matching the oxygen concentration of the known sample. Calibration can be disturbed by physical shock, touching the membrane, and fouling of the membrane or drying out of the electrolyte. Calibration will be checked after each series of measurements. Calibration of the DO meter will be performed on a daily basis as follows:

1. Place the probe in moist air. Biological oxygen demand probes can be placed in partially filled (50 ml) biological oxygen demand bottles. Wait 10 minutes for temperature to stabilize ± 2°C.

2. Switch to **TEMPERATURE** and read. Refer to Table SOP037-1 for solubility of oxygen in fresh water (calibration value).

3. Determine altitude or atmospheric correction factor from Table SOP037-2.

4. Multiply the calibration value from Table SOP037-1 by the correction factor from Table SOP037-2 to obtain the correct calibration value.

   EXAMPLE: Assume a temperature of 20°C and an altitude of 1,100 ft. From Table SOP037-1, the calibration value of 20°C is 9.09 mg/L. From Table SOP037-2, the correction factor for 1,100 ft is 0.96. Therefore, the corrected calibration value is 9.09 mg/L × 0.96 = 8.73 mg/L.

5. Switch to the appropriate mg/L range, set the **SALINITY** knob to zero and adjust the **CALIBRATE** knob until the meter reads the calibration value from Step 4. Wait 2 minutes to verify calibration stability. Readjust if necessary.

3.3 DISSOLVED OXYGEN MEASUREMENT

- With the instrument prepared for use and the probe calibrated, place the probe in the sample.

- Turn the **STIRRER** knob **ON**.

- Adjust the **SALINITY** knob to the salinity of the sample if appropriate.

- Allow sufficient time for the probe to equilibrate to the sample temperature and DO.

- Read DO on appropriate scale.

- Before measuring the DO of the next sample, rinse probe and sample bottle with distilled water and then with next water sample.

Follow steps above for the next sample(s).

The DO meter should normally be left on during the working day to avoid the delay of waiting for probe repolarization.

4. MAINTENANCE

The following steps will be taken to maintain the DO meter:

- Replace the batteries when the **RED LINE** knob is at its extreme adjustment or at least annually.

- In the **BATT CHECK** position on the **STIRRER** knob, the voltage of the stirrer batteries is displayed on the red **0-10** scale. Do not permit them to discharge below 6 volts.

- Replace membrane every 2 weeks depending on application. Probes will be stored in a humid environment to prevent drying out.

5. PRECAUTIONS

The DO meter case is water resistant when properly closed. As a precaution against damaged gaskets or loose fittings, the instrument case will be opened and inspected for moisture whenever the instrument has been subjected to immersion or heavy spray. The case is opened by removing the screws on the rear cover an lifting the cover off.

6. REFERENCES

Manufacturer’s handbook.

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TABLE SOP037-1 SOLUBILITY OF OXYGEN IN WATER EXPOSED TO WATER SATURATED AIR AT 760 mm Hg PRESSURE

Temperature (°C)	**Solubility (mg/L)**	**Temperature (°C)**	**Solubility (mg/L)**	**Temperature (°C)**	**Solubility (mg/L)**
0	14.62	17	9.67	34	7.07
1	14.22	18	9.47	35	7.95
2	13.83	19	9.28	36	7.84
3	13.46	20	9.09	37	6.73
4	13.11	21	8.92	38	6.62
5	12.77	22	8.74	39	6.52
6	12.45	23	8.58	40	6.41
7	12.14	24	8.42	41	6.31
8	11.84	25	8.26	42	6.21
9	11.56	26	8.11	43	6.12
10	11.29	27	7.97	44	6.02
11	11.03	28	7.83	45	5.95
12	10.78	29	7.69	46	5.84
13	10.54	30	7.56	47	5.74
14	10.31	31	7.43	48	5.65
15	10.08	32	7.31	49	5.56
16	9.87	33	7.18	50	5.47

NOTE: Derived from 17th Edition, Standard Methods for the Examination of Water and Wastewater.

°C = Degree Celsius.
mg/L = Milligram per liter.

TABLE SOP037-2 CALIBRATION VALUES FOR VARIOUS ATMOSPHERIC PRESSURES AND ALTITUDES

Pressure			Altitude		Calibration Value (Percent)
Inches Mercury	**Millimeter Mercury**	**Kilopascal**	**Feet**	**Meter**	
30.23	768	102.3	-276	-84	101
29.92	760	101.3	0	0	100
29.61	752	100.3	278	85	99
29.33	745	99.3	558	170	98
29.02	737	98.3	841	256	97
28.74	730	97.3	1126	343	96
28.43	722	96.3	1413	431	95
28.11	714	95.3	1703	519	94
27.83	707	94.2	1995	608	93
27.52	699	93.2	2290	698	92
27.24	692	92.2	2587	789	91
26.93	684	91.2	2887	880	90
26.61	676	90.2	3190	972	89
26.34	669	89.2	3496	1066	88
26.02	661	88.2	3804	1160	87
25.75	654	87.1	4115	1254	86
25.43	646	86.1	4430	1350	85
25.12	638	85.1	4747	1447	84
24.84	631	84.1	5067	1544	83
24.53	623	83.1	5391	1643	82
24.25	616	82.1	5717	1743	81
23.94	608	81.1	6047	1843	80
23.62	600	80.0	6381	1945	79
23.35	593	79.0	6717	2047	78
23.03	585	78.0	7058	2151	77
22.76	578	77.0	7401	2256	76
22.44	570	76.0	7749	2362	75
22.13	562	75.0	8100	2469	74
21.85	555	74.0	8455	2577	73
21.54	547	73.0	8815	2687	72
21.26	540	71.9	9178	2797	71
20.94	532	70.9	9545	2909	70
20.63	524	69.9	9917	3023	69
20.35	517	68.9	10293	3137	68
20.04	509	67.9	10673	3253	67
19.76	502	66.9	11058	3371	66

NOTE: Derived from 17th Edition, Standard Methods for the Examination of Water and Wastewater.

Standard Operating Procedure No. 038
for
Redox Potential Measurements

Prepared by

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Revision 0
December 2014

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for measuring the redox of flooded sediment and soil. Redox is an indication of the reduction of oxidation intensity of an anaerobic system. Redox will be expressed in mV. A complete anaerobic system redox potential is -150 Mv. A positive value indicates an aerobic system.

Redox measurement in a natural system is difficult to obtain due to the absence of true equilibria, heterogeneity of media, and pH effects deprived redox measurements in natural media of precise thermodynamic significance (Ponnamperuma 1972). Despite the difficulties involved in the redox measurements in natural media, it is widely accepted that redox readings in natural anaerobic systems can provide valuable environmental information. Whitfield found redox useful as a semi-quantitative indicator of the degree of stagnation of a particular aquatic environment as did Ponnamperuma for flooded soils and sediments. The redox measurements of natural waters are not representative of that median, since natural waters are in a highly dynamic state rather than in or near equilibrium, according to Stumm and Morgan 1970. It is generally recognized that redox measurements in oxygenated natural waters are invalid.

2. MATERIALS

The following materials may be required:

pH meter	Sample bottle
Combination pH electrode	Standard solution (pH 4 and 7 buffers saturated with quinhydrone)
Lint-free laboratory wipes (Kimwipes, or equivalent)	Wash bottle
Distilled water	

3. PROCEDURE

Calibration of the pH meter will be calibrated on a daily basis as follows.

- Prepare beaker of standard solution with known voltage(s)
- Connect electrodes to instrument
- Turn on and clear
- Rinse electrode with distilled water blot excess with laboratory wipes
- Immerse probe in beaker of standard solution
- Press mV key
- After the reading stabilizes, the absolute mV of solution is displayed.
- Rinse electrode and blot excess.

Redox will be measured after calibration as follows:

- Prepare sample in a beaker
- Rinse electrode and blot excess water
- Immerse electrode in sample and stir briefly
- Press mV switch
- Record the reading after it stabilizes
- For next sample(s), follow above steps.

4. MAINTENANCE

Check the batteries each time the meter is used.

Keep the probe stored in a 0.1 M KCL solution when not in use. Alternatively, the electrode may be rinsed with deionized water and trapping any residual water inside the protective cap.

5. PRECAUTION

Remove coatings of oil material or particulate matter that can impair electrode response by gentle wiping or detergent washing, followed by distilled water rinsing.

6. REFERENCES

Beckman Instruments, Inc. User Manual for 10, 11, and 12 pH/ISE meter.

Ponnamperuma, F.N. 1972. The Chemistry of Submerged Soils, Advances in Agronomy. Vol. 24.

Stumm, W. and J.J. Morgan. 1970. Aquatic Chemistry, Wiley, New York.

Whitfield, M. 1969. Eh as an Operational Parameter in Estuarine Studies. *Limnol. Oceanogr.*, Vol. 14.

Standard Operating Procedure No. 039
for
Sample Preservation and Container Requirements

Prepared by

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Revision 2
September 2018

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PROJECT-SPECIFIC VARIANCE FORM

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☐ **B. No variances**

SOP No. 039	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
2	25 September 2018	Add notes about incremental sampling and minor changes	Daniel Hinckley, Sanita Corum	Matthew Bowman

1. PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to define the preservatives and techniques to be employed in preserving environmental samples between collection and analysis.

2. MATERIALS

The following materials may be required:

- Containers (Section 3 provides a description)
- Nitric acid
- Sulfuric acid
- Sodium hydroxide
- Ice chests
- Ice.

3. DEFINITION OF CONTAINER TYPES

Listed below are the definitions of various container types.

Type	Container	Closure	Septum
A	80-ounce amber glass, ring handle bottle/jug, 38-millimeter (mm) neck finish	White polypropylene or black phenolic, baked polyethylene cap, 38-430 size, 0.015-mm polytetrafluoroethelyne (PTFE) liner	
B	40-milliliter glass vial, 24-mm neck finish	White polypropylene or black phenolic, open top, screw cap, 15-mm opening, 24-400 size	24-mm disc of 0.005-inch) PTFE bonded to 0.120-inch silicon for total thickness of 0.125 inches
C	1-liter high density polyethylene, cylinder-round bottle, 28-mm neck finish	White polyethylene cap, white ribbed, 28-410 size; F217 polyethylene liner	
D	120-milliliter wide mouth glass vial, 48-mm neck finish	White polyethylene cap, 40-480 size; 0.015-mm PTFE liner	
E	250-milliliter Boston round glass bottle	White polypropylene or black phenolic, open top, screw cap	Disc of 0.005-inch PTFE bonded to 0.120-inch silicon for total thickness of 0.125 inches
F	8-ounce short, wide mouth, straight-sided, flint glass jar, 70-mm neck finish	White polypropylene or black phenolic, baked polyethylene cap, 48-400 size; 0.030-mm PTFE liner	
G	4-ounce tall, wide mouth, straight-sided, flint glass jar, 48-mm neck finish	White polypropylene or black phenolic, baked polyethylene cap, 48-400 size; 0.015-mm PTFE liner	

Type	Container	Closure	Septum
H	1-liter amber, Boston round, glass bottle, 33-mm pour-out neck finish	White polypropylene or black phenolic, baked polyethylene cap, 33-430 size; 0.015-mm PTFE liner	
K	4-liter amber glass ring handle bottle/jug, 38-mm neck finish.	White polypropylene or black phenolic, baked polyethylene cap, 38-430 size; 0.015-mm PTFE liner	
L	500-milliliter high-density polyethylene, cylinder bottle, 28-mm neck finish	White polypropylene, white ribbed, 28-410 size; F217 polyethylene liner	

4. PROCEDURE

All containers described in Section 3 must be certified clean (SOP Number [No.] 031), with copies of laboratory certification furnished upon request. There may be circumstances when alternative containers will be used (e.g., aluminum foil around tissue samples placed in plastic bags, plastic buckets or bags for large soil/sediment samples, etc.) for which laboratory certification may not be available. Such containering should be appropriately decontaminated or verified appropriately clean prior to using.

Water samples will be collected into pre-preserved containers appropriate to the intended analyte as documented in the Quality Assurance Project Plan. Samples taken for volatile organic compounds will be collected in accordance with SOP No. 003, Section 3.3.8. Samples taken for metals analysis will be verified in the field to a pH <2. The container should be tightly capped, then swirled to thoroughly mix the sample. The cap will then be loosened to release any excess pressure that this operation may have generated. Samples taken for total phosphorous content will be verified in the field to a pH <2. The container should be tightly capped and swirled to thoroughly mix the sample. The cap will then be loosened to release any excess pressure that this operation may have generated. Samples taken for cyanide will be verified for a pH >12. Most other samples do not require added preservation; however, there are analytes that may require special preservation, (i.e., sulfide that requires a zinc acetate preservation). Preservation must be performed as documented in the project-specific Quality Assurance Project Plan. These samples will be immediately placed on ice and cooled to 4±2 degrees Celsius (°C).

Soil and sediment samples will be collected into containers appropriate to the intended analyte as documented in the Quality Assurance Project Plan. Samples taken for volatile organic compound analysis will collected in accordance with the site-specific SOP. Samples taken for metals analysis will be tightly capped, placed on ice, and maintained at a temperature of 4°C. Samples taken for total phosphorous content will be tightly capped, placed on ice, and maintained at a temperature of 4°C. Large (1-2 kilograms) soil/sediment samples taken for incremental samples (SOP No. 057) can be placed in pre-cleaned (SOP No. 005) gallon plastic bags or plastic buckets. Under most circumstances, no preservatives will be added to soil or sediment samples; follow project-specific requirements as documented in the Quality Assurance Project Plan. These samples will be immediately placed on ice and cooled to 4±2°C.

5. MAINTENANCE

Not applicable.

6. PRECAUTIONS

Note that acidifying a sample containing cyanide may liberate hydrogen cyanide gas.

- Avoid breathing any fumes emanating from acidified samples.
- Acidify samples only in the open, rather than in closed spaces (i.e., a vehicle).
- Hold suspected hydrogen cyanide-generating sample away from body and downwind while manipulating it.
- See the Health and Safety Plan for other safety measures.

7. REFERENCES

U.S. Environmental Protection Agency (EPA). 1986. Test Methods for Evaluating Solid Waste, SW-846.

———. 1987. A Compendium of Superfund Field Operations Methods, EPA 540-P87-001.

———. 1991. A Compendium of ERT Soil Sampling and Surface Geophysics Procedures.

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Standard Operating Procedure No. 040
for
Confined Space Entry

Prepared by

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Revision 1
July 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 040	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	6/28/2018	Systematic review and update	Pete Garger	Matt Bowman

1. PURPOSE AND SCOPE

This Standard Operating Procedure provides the instructions necessary for entering a confined space. Always consult with Safety Program Management prior to conducting a job that involves entering a confined space.

A “confined space” means any space having a limited means of access or egress or so enclosed that adequate dilution ventilation is not obtained by natural air movement, or mechanically induced movement; and is subject to the accumulation of toxic or combustible agents or an oxygen deficiency. Confined spaces include but are not limited to any of the following areas: a storage tank, tank car, process vessel, bin, tank trailer, or any other tank-like compartment usually having one or more manholes for entry; an open-topped space more than 4 feet deep, such as a bin, silo, pit, vat, vault, vessel, or floating roof storage tank; a ventilation or exhaust duct, manhole, sewer, tunnel, pipeline, and similar structure; and an oven, furnace, kiln, or similar structure.

Whenever personnel are to enter a confined space, due consideration must be given to the safety of the person entering the space (entrant) and to the person serving as the confined space attendant. The Project Manager, Field Operations Manager, and site workers will consider all possible options to ensure worker safety. At a minimum, consideration will be given to using lifelines, the buddy system, and standby safety personnel.

2. RESPONSIBILITIES

2.1 SAFETY PROGRAM MANAGER

The Safety Program Manager will:

- Provide guidance and assistance to field personnel in the preparation of procedures and the identification and classification of confined spaces
- Approve or disapprove entry procedures and standard operating procedures for entry into confined spaces
- Recommend engineering controls necessary to ensure a safe working environment.

2.2 PROJECT MANAGER/FIELD OPERATIONS MANAGER

The Project Manager/Field Operations Manager will:

- Complete all necessary confined space permits in coordination with the entrants and attendants

- Ensure all field personnel have read and understand the confined space entry procedure and have appropriate and documented confined space entry training

- Ensure team composition is adequate to safely perform tasks

- Ensure personnel entering confined spaces and the personnel serving as attendants are properly trained in rescue and cardiopulmonary resuscitation procedures

- Provide for constant communication between employees inside the confined space and employees outside the confined space.

2.3 CONFINED SPACE ENTRANT

Duties of Entrant:

- Know hazards that may be faced during entry, including information on mode, signs, or symptoms and consequences of exposure

- Properly use equipment as required by 29 Code of Federal Regulations (CFR) 1926.1204(d)

- Communicate with attendant as necessary to enable attendant to monitor entrant status and enable attendant to alert entrants of need to evacuate space as required by 29 CFR 1926.1209(f)

- Alert attendant whenever:

    — Entrant recognizes any warning sign or symptom of exposure to dangerous situation
    — Entrant detects prohibited condition

- Exit from permit space as quickly as possible whenever:

    — Order to evacuate is given by attendant or entry supervisor
    — Entrant recognizes any warning sign or symptom of exposure to a dangerous situation
    — Entrant detects prohibited condition
    — Evacuation alarm activated.

2.4 CONFINED SPACE ENTRY ATTENDANT

Duties of Attendant:

- Know hazards that may be faced during entry

- Be aware of possible behavioral effects of hazard exposure in authorized entrants

- Continuously maintains accurate count of authorized entrants
- Remain outside permit space during entry operations until relieved by another attendant
- Communicate with authorized entrants
- Monitor activities inside and outside space
- Summon rescue and other emergency services
- Perform non-entry rescues as specified by employer's rescue procedure
- Perform no duties that might interfere with primary duty to monitor and protect authorized entrants.

3. EQUIPMENT

The following equipment may be required:

Oxygen analyzer
Explosimeter
Organic vapor monitor
Personal protective equipment

4. PREREQUISITES

Personnel working in confined spaces are properly trained in safe entry and rescue procedures. A confined space entry attendant is available to remain outside the confined space to give assistance as needed. The attendant will be equipped with a self-contained breathing apparatus if conditions warrant.

5. PRECAUTIONS AND LIMITATIONS

If, for any reason, a hazardous or unsafe condition presents itself for which there is no clear procedure or guideline, work will cease until Program Safety Management can be notified and the condition rectified.

No person will enter a confined space without an emergency response attendant outside the confined space.

A ladder will be provided for any trench that is deeper than 4 feet or when appropriate in other confined spaces.

6. PERFORMANCE STEPS

1. Evaluate the work area against the definition of a confined space.

2. Notify the Project Manager or Program Safety Management of any work spaces not previously identified that are suspected of meeting the definition of a confined space.

3. Contact the designated confined space entrant and attendant prior to entry and verify requirements for entry.

4. Obtain positive identification of the materials that are (or have been) present in the space.

    a. Evaluate the hazards presented by the materials and byproducts
    b. Determine if any atmospheric monitoring will be required.

5. Enter a confined space.

    a. Prepare a confined space entry permit. Include the following as a minimum:

        (1) Identity of the space
        (2) Purpose of the entry
        (3) Date of authorized entry
        (4) Authorized entrants
        (5) Eligible attendants
        (6) Personnel eligible to be in charge of entry
        (7) Substances stored in the confined space
        (8) Potential hazards
        (9) Permitted work
        (10) Personal protective equipment requirements
        (11) Safety equipment requirements
        (12) Signature and printed name of authorizing person

    b. Ensure that any line, except for a fire suppressant or extinguishing system that enters the space and carries a harmful agent, is physically disconnected from the space or blocked by a device capable of ensuring complete closure.

    c. Render inoperable by disconnection any fixed mechanical device or equipment that, if operated, might endanger personnel.

    d. Except for lighting, padlock or tag out-of-service electrical service equipment.

    e. Select a suitable entrance point that will be safe for the entrant to pass through. Open the entrance.

f. Survey the entrance to the confined space for oxygen levels, combustible vapors, and other hazards.

g. Verify, based on levels obtained from Step f above, that all precautions are sufficient to permit entry. Ensure entrant is properly suited in required personal protective equipment. Allow entrant to enter the confined space.

h. Conduct atmospheric monitoring inside the confined space to determine the presence of combustible, toxic gases, or an oxygen deficient atmosphere.

    (1) Determine oxygen levels prior to any other testing.

    (2) Draw test air from lowest to highest elevations of the confined space: 12-18 inches off the floor, mid-levels, and within 12-18 inches of the top (if possible).

    (3) For spaces greater than 500 cubic feet, draw test air from additional sample points in sufficient number to categorize the atmosphere in the confined space.

i. Once inside, verify any communication equipment used is properly working.

j Monitor for oxygen levels, combustible vapors, and any other identified hazards on a continuous basis while working in Class A confined spaces. Continuous monitoring will include all instruments on with the alarms functioning and set, or a second attendant whose only purpose is to monitor the work environment for the identified hazards.

k. Proceed to Step 6.

6. Exit confined space.

7. Close off confined space to prevent unauthorized access.

8. Cancel confined space permit (if appropriate).

7. DOCUMENTATION

Document the entry and results of all atmospheric monitoring in the field logbook. Maintain a copy of the confined space entry permit (if appropriate) in the project files.

8. REFERENCES

Occupational Safety and Health Administration 29 Code of Federal Regulations 1926 Subpart AA, Confined Spaces in Construction.

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Standard Operating Procedure No. 041
for
Sludge/Lagoon Sampling

Prepared by

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Hunt Valley, Maryland 21031

Revision 1
March 2019

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 041	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	28 March 2019	Systematic review and update	John Morris Peggy Derrick	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for sampling sludges. Sludges include solid matter derived from waste materials that are suspended in or settled from a liquid. This procedure can be applied to the collection of sludge samples from areas of deposition such as tanks, sumps, landfills, ditches, ponds, and lagoons. It is important to collect a representative sample of the waste material.

EA recognizes that other protocols have been developed that meet the criteria of quality and reproductivity. Clients may have their own sludge/lagoon sampling protocols, which may contain methodologies and procedures that address unique or unusual site-specific conditions or may be in response to local regulatory agency requirements. In such cases, EA will compare its and the client's protocols. The goal is to provide the client with the most quality; therefore, if the client's protocols provide as much or more quality assurance than EA's protocols for the particular site or project, EA will adopt those particular protocols and this SOP will be superseded in those respects. If EA is required to implement the client's protocols in lieu of EA's protocols, EA will make the client formally aware of any concerns regarding differences in protocols that might affect data quality and will document such concerns in the project file.

2. MATERIALS

The following materials may be required:

Plastic sheeting	Stainless steel hand core sludge sampler and extensions
Polypropylene rope	Stainless steel dip sampler, scoops, trowels, spoons, and ladles
Sample bottles	Utility knife
Stainless steel or Teflon® tray	

3. PROCEDURES

The liquid content of the sludge sample may vary from nearly all liquid to a dense, nearly liquid-free material. It may be necessary to use a variety of equipment to obtain the required samples, even at a single site.

3.1 GENERAL

1. Upon arrival at the site, immediately establish staging areas/work zones and organize the equipment.

2. Establish background levels of airborne organic compounds using a photoionization detector or a flame ionization detector (if applicable).

3. Cut a section of 6-mil plastic sheeting of approximately 6 feet × 6 feet. Place the sheeting on the upgradient side of the sample area.

4. Arrange the sample containers, sampler(s), and decontamination equipment on the plastic sheeting.

5. Don personal protective equipment (including chemical resistant gloves and safety glasses) in accordance with the Site Safety and Health Plan.

6. Collect the sample(s). The preferred method of collecting sludge samples will be by hand corer; refer to Section 3.2. If using a scoop, trowel, spoon, or ladle, refer to Section 3.3.

3.2 HAND CORER

1. Ensure that the corers and liners are properly decontaminated prior to use.

2. Force the corer into the sludge with a smooth, continuous motion to the target sample depth.

3. Twist the corer to detach the sample, then withdraw the corer in a single smooth motion.

4. Remove the top of the corer and, if excess liquid is present, decant the liquid into a sample bottle. This liquid may be labeled and analyzed separately.

5. Remove the nosepiece of the corer and extrude the sample into a stainless steel or Teflon tray. Sample material should be homogenized prior to placement in the sample container (unless indicated otherwise in the project Sampling and Analysis Plan.

6. Transfer the sample into sample bottles using a stainless-steel laboratory spoon or equivalent object as described in the project-specific Sampling and Analysis Plan.

7. Ensure that each sample bottle is properly labeled, noted on the chain-of-custody form, and placed in the sample cooler with ice packs.

8. Decontaminate sampling equipment according to SOP Number (No.) 005.

9. Dispose of all sampling wastes in properly labeled containers.

3.3 SCOOP, TROWEL, SPOON, OR LADLE

1. Ensure that the sampling equipment is properly decontaminated prior to use.

2. Insert the sampling device into the material at the selected point and slowly remove the sample. Care should be taken to retain as much of the solid component as possible.

3. Transfer the sample into the appropriate sample bottles.

4. Ensure that each sample bottle is properly labeled, noted on the chain-of-custody form, and placed in the sample cooler with ice packs.

5. Decontaminate sampling equipment according to SOP No. 005.

6. Dispose of all sampling wastes in properly labeled containers.

3.4 SAMPLING LOCATION

For all samples, mark the sampling location on a site map. Photograph (optional, recommended) the sampling site and material. Describe each sampling location in the field logbook. Establish the sampling coordinates using a Global Positioning System or other three-dimensional system (as appropriate). Record the coordinates for each sample in the field logbook.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

The following precautions should be noted:

1. Sludges may contain high levels of contaminants.

2. It is extremely important to continually monitor the levels of contaminants, using the appropriate survey instruments (e.g., photoionization detector, indicator tubes) in the breathing zone of the sampler(s) and other field team members.

3. Refer to the Site Safety and Health Plan for appropriate personal protective equipment.

4. Field team members should consult with the Site Safety and Health Coordinator for all safety and health questions or concerns relating to sampling activities.

6. REFERENCES

Not applicable.

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Standard Operating Procedure No. 042
for
Disposal of
Investigation-Derived Material

Prepared by

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to define the required steps for disposing of investigation-derived material (IDM) generated during field activities.

IDM, as used herein, includes soil cuttings, drilling muds, extraneous sediment, purged groundwater, decontamination fluids, and disposable personal protective equipment. For the sake of clarity and ease in use, this Standard Operating Procedure is subdivided into procedures for disposal of liquid IDM and solid IDM as follows:

- Liquid IDM (Section 3.2) includes the following materials:
  - Water from initial development of new wells and the redevelopment of existing wells
  - Purge water from groundwater sampling
  - Decontamination fluids (Section 3.4)
- Solid IDM (Section 3.3) consists of the following materials:
  - Soil drill cuttings from monitoring well installation
  - Sediment remaining after collection of the required sample volume
  - Grout, a mixture of cement and bentonite, generated during installation of monitoring wells
  - Disposable personal protective equipment (Section 3.4).

2. MATERIALS

The following materials may be required:

Any additional equipment that may be dictated by project or site-specific plans	Hazardous waste labels
Bar codes	Permanent marker
Chain-of-custody forms	Field logbook (bound)
Department of Transportation 17C specification metal containers	Waste identification labels

3. PROCEDURE

3.1 GENERAL

No container will be labeled as a “Hazardous Waste” unless the contents are in fact known to be hazardous as defined by 40 Code of Federal Regulation 261.

IDM may be disposed onsite if it is: (1) initially screened, or evaluated to determine whether it is contaminated; (2) not abandoned in an environmentally unsound manner; and (3) not inherently waste-like.

IDM is to be considered contaminated if: (1) it is visually or grossly contaminated; (2) it has activated any field monitoring device that indicates that the level exceeds standard Level 1; (3) it has previously been found to exhibit levels of contamination above environmental quality standards; and (4) the responsible party and/or appropriate regulator deem(s) that records of historical uses indicate that additional testing of the IDM is needed, or additional caution is warranted handling IDM from a given site.

3.2 PROCEDURES FOR LIQUID INVESTIGATION-DERIVED MATERIAL DISPOSAL

Listed below are the procedures for the disposal of liquid IDM:

1. All water from the initial development of new wells, and purge water generated during the first round of groundwater sampling, will be containerized in Department of Transportation approved 55-gallon drums. Decontamination fluids may be bulk-containerized until completion of the field task.

2. Label all containers as to type of media, date the container was sealed, point-of-generation, and points-of-contact. The well number and container number will be identified on the container.

3. The contractor/support personnel will log all media generated onsite into a bound Field Logbook. Media information should include the following: date of generation, contents of containers, number of containers with the same contents (if applicable), location of containers, well number the media is associated with, personnel sampling the media, sampling dates, and sampling results.

4. Containers of well development water and purge water may be stored at the well site pending the first round analytical results.

5. Laboratory turnaround time must be no greater than 30 days. Upon receipt of the analytical results, a copy will be furnished to the client within 3 working days. Both the client and contractor will evaluate the data to determine disposal requirements, per state and local regulations. A disposal decision is required within 10 days of receipt of sampling results. Appropriate disposal must be performed no later than 50 days from the

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1. This value is defined as two times background, where “background” values are to be determined as follows: (1) regional background values will be used where they are available; and (2) if regional values are not available, background may be empirically determined at uncontaminated sampling sites using onsite sensors such as organic vapor analyzers (photoionization detector or flame ionization detector), scintillometers, etc.

decision date unless prevented by inclement weather (e.g., rain and muddy conditions may preclude site access, freezing weather may freeze media).

Dispose of media in accordance with Steps 6 and 7 of this procedure, as appropriate.

6. If the first round analytical data of the liquid media are below the Maximum Contaminant Levels established by the Federal Safe Drinking Water Act, the water may be gradually infiltrated into the ground at least 50 feet downgradient of the well.

   If the well location has no downgradient area, the water will be infiltrated into the ground in an area deemed appropriate by the client and the contractor/support personnel.

   Disposal locations must allow percolation of the water and prohibit "ponding."

   Upon completion of water discharge to ground, enter type of media, amount of media, date of disposal, and discharge point(s) in a bound Field Logbook and provide this information to the client.

   Empty containers are to be properly decontaminated, stored, and reused by the appropriate personnel.

   If the liquid media sampling results do not meet the required Maximum Contaminant Levels and cannot be discharged to the ground, then determine if the waste meets the sanitary sewer discharge criteria (National Pollutant Discharge Elimination System standards).

7. If, at any time, visual contamination of purge/development water is observed, or if organic vapor monitor readings (HNu, photoionization detector) register more than 5 parts per million above background and/or radiological meters register more than twice the background mrems, then the liquid will be drummed and a composite sample will be taken that day. A disposal decision will be based on the analytical results of this sample rather than the first round of analytical results.

3.3 PROCEDURES FOR SOLID INVESTIGATION-DERIVED MATERIAL DISPOSAL

Listed below are the procedures for the disposal of solid IDM:

1. If the conditions outlined in Section 3.1 are met, proceed to Section 3.3, Step 2; otherwise, proceed to Section 3.3, Step 7.

2. During soil drilling operations or sediment sampling, the resulting cuttings, mud, and/or extraneous sediment will be discharged onto the ground (or waterbody for sediment) near the well (or sample location for sediment) if the following conditions are met: (1) no visual contamination is observed, (2) organic vapors are less than 5 parts per million

above background, (3) radiological meter readings (if applicable) are under two times background, and (4) the medium has been screened and found to be less than two times background if the potential for contamination exists.

Proper sediment and erosion control measures will be implemented as follows:

- Soil drill cuttings will be uniformly spread and contoured to blend with the surroundings of the site.
- If amount of solid IDM exceeds 5,000 square feet or 100 cubic yards of material, a sediment and erosion control plan is required.
- If the amount of solid IDM is under 5,000 square feet or 100 cubic yards, the site will be stabilized as soon as possible. Stabilization includes mulch, seed, and tack.
- Critical areas require stabilization within 7 days from the date of well completion. Critical areas include swales, water sources, drainage ditches, etc.
- All other disturbed areas require stabilization within 14 days from the date of well completion.

3. If the well location is in or near a wetland, the soil drill cuttings will be drummed and transported away from the site for spreading.

4. Label all IDM containers that will not be spread on the day of generation. Each container should be labeled with the type of media, date the container was sealed, point-of-generation, and name of the contact person. The well number or sample location and container number should be identified on the container.

5. The contractor/support personnel will log all media generated onsite into a bound Field Logbook. Media information should include: date of generation, contents in containers, number of containers with the same contents, location of containers, and well number or sample location the media is associated with.

6. Containers will be staged at the well site until contractor/support personnel spread the cuttings in the appropriate locations, using proper sediment and erosion control measures per Section 3.3.

7. If soil drilling mud, cuttings, or sediment show visible contamination, or organic vapor readings are more than 5 parts per million above background levels, or radiological meter readings (if applicable) show greater than two times background levels, or if the potential for contamination exists (levels greater than two times background), media will immediately be containerized, labeled appropriately (Section 3.2), and sampled on the same day.

8. The solid IDM should be sampled and appropriate Toxicity Characteristic Leaching Procedure analyses conducted prior to determining disposition. Laboratory turn-around time must be no greater than 30 days. Upon receipt of analytical results, a copy will be furnished to the client within 3 working days. The contractor will evaluate the data to determine disposal requirements within 10 days. Appropriate disposal must be performed no later than 50 days after the decision date if weather permits (Section 3.2).

   - If the solid IDM is determined to be non-hazardous and uncontaminated, proceed to Section 3.3.

   - If the solid IDM is determined to be non-hazardous but contaminated, proceed to Section 3.3.

   - If the solid IDM is found to be hazardous wastes, proceed to Section 3.3.

9. If the solid IDM is not a hazardous waste **and** analytical data show contaminant concentrations below the U.S. Environmental Protection Agency Region 3 (or applicable Region where work is being performed) Risk-Based Concentrations, contact the appropriate federal, state, or local agency for approval to discharge onto the ground or back to the waterbody near the site of generation.

   - Follow steps detailed in Section 3.3, Step 2 (above) pertaining to sediment and erosion control.

   - Upon completion of the solid IDM discharge to the ground or waterbody (for sediment), enter type of media, amount of media, date of disposal, and discharge point(s) in a bound Field Logbook. This information must be provided to the client.

   - Empty containers are to be properly decontaminated, stored, and reused by appropriate personnel.

10. If the intrusive media is not a hazardous waste but analytical data show concentrations above the screening criteria, dispose of the IDM according to state and local regulations.

   - Ensure that the waste containers are properly labeled as applicable in accordance with Section 3.3, Step 4.

   - Inform the client of the type and amount of waste, and location of the waste.

   - When the waste is removed, enter the type of waste, amount of waste, date of pickup, and destination of the waste in a bound Field Logbook. This information must be provided to the client.

3.4 PROCEDURES FOR DECONTAMINATION SOLUTION AND PERSONAL PROTECTIVE EQUIPMENT DISPOSAL

Decontamination solutions include catch water from steam-cleaning operations performed on large sampling equipment, drill rigs, and drums, as well as smaller quantities of soapy water and rinse solutions used in decontaminating field sampling equipment. At the completion of the field event, a composite sample of the decontamination solution will be taken. The decontamination solution will be treated as liquid IDM pending results (Section 3.2).

Personal protective equipment will be containerized onsite, appropriately labeled, and disposed in a designated trash receptacle.

4. MAINTENANCE

The waste manifest document and bill of lading should be uploaded to the project file as soon as possible in either hard copy or electronic format. Refer to EA's Records Retention Policy for archiving information.

5. REFERENCES

Environment Article Section 7-201(t).

U.S. Environmental Protection Agency. 1991. Management of Investigation-Derived Wastes during Site Inspections PB91-921331, OERR Directive 9345.3-02. Office of Emergency and Remedial Response U.S. Environmental Protection Agency, Washington, D.C. May.

Standard Operating Procedure No. 043 for Multi-Probe Water Quality Monitoring Instruments

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1. PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure is to delineate protocols for field operation of multi-probe water quality instruments. The instrument can monitor a variety of basic parameters including dissolved oxygen, percent saturation, temperature, pH, specific conductance, resistivity, salinity, total dissolved solids, oxidation reduction potential (ORP), level, and depth.

Use of brand names in this Standard Operating Procedure is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable standard operating procedures for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

- Multi-probe instrument
- Probe/sonde with appropriate cables
- Appropriate standards
- Accessories (batteries, charger, case, etc.)
- Instrument logbook
- Manufacturer's Operations Manual.

3. CALIBRATION PROCEDURE

Calibration must be performed daily at a minimum before using the instrument. Calibration may be performed in the laboratory or in the field. Detailed step-by-step calibration procedures for the equipment described below are provided in the most recent version of the manufacturer's Operations Manual. Documentation includes at a minimum: time, date, analyst, standard, primary standard lot number, secondary standard lot number, and expiration dates of standards.

Fill the calibration cup with the appropriate standard as follows:

- Temperature: None required
- Specific Conductance: Conductivity standards
- pH: pH 7 buffer plus pH 4 and/or pH 10 buffer
- Dissolved Oxygen: Saturated air or saturated water
- ORP: Quinhydrone (Zobell's Solution)
- Turbidity: Nephelometric turbidity unit (NTU) standards
- Salinity: Calibration for specific conductance
- Depth/Level: Set zero in air.

3.1 CONDUCTIVITY CALIBRATION

Conductivity meters are calibrated at least once per day to at least one standard. The standard should be selected in accordance with the range expected to be measured (e.g., 1.0 µS/cm standard should not be used to calibrate meters being used in saltwater). See manufacturer's recommendations in the Operations Manual for additional information on calibration standard selection. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.2 pH CALIBRATION

The pH meters are calibrated at least once per day to a minimum of two standard buffers (pH 4 and 7, or pH 7 and 10) in accordance with the range expected to be measured. The calibration is verified using a fresh solution of pH 7 buffer post-calibration. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.3 DISSOLVED OXYGEN CALIBRATION

Dissolved oxygen meters are air calibrated at least once per day. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.4 OXIDATION REDUCTION POTENTIAL CALIBRATION

ORP meters are calibrated at least once per day to at least one standard. It is recommended that Zobell's Solution is used; however, another solution can be used as long as it meets the manufacturer's specifications for calibration. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.5 TURBIDITY CALIBRATION

The turbidity meters are calibrated at least once per day to a minimum of two standards (0 NTU and 100 or 126 NTUs recommended) in accordance with the range expected to be measured. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.6 DEPTH/LEVEL CALIBRATION

The depth and level calibration is performed with the depth sensor module in the air and not immersed in any solution. The appropriate correction for height above the water surface is inputted into the meter. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.7 ADDITIONAL CALIBRATIONS

Additional measurements may be taken with the multi-probe water quality instruments. For any of these measurements, the calibration procedures will be conducted in accordance with the manufacturer's specifications. Calibration information is recorded in conjunction with the data collected for that sampling event.

4. FIELD OPERATION

4.1 SETUP OF MULTI-PROBE WATER QUALITY INSTRUMENT

Post-calibration and prior to sampling, the multi-probe water quality instrument will be set up for data collection. If the cables have been unattached, they will be reconnected to the transmitter (if applicable) and the display. Once all cables are attached, the meter will be turned on and allowed to warm up for a few seconds in order to allow the display screen to load.

4.2 SURFACE WATER

Prior to sampling, check the condition of the probes before each deployment. When sampling in surface water, the sensor must be in an amount of water sufficient for all probes to be submerged. Data values displayed on the display screen are recorded in the field logbook and accepted into the instrument's data logger. Post-data collection, the sensor will be retrieved and rinsed for use at the next sample location. If travel time between sample locations is great, the display is to be turned off. When all sampling is completed, disconnect all equipment and return it to its proper storage location.

4.3 GROUNDWATER

Prior to sampling, check the condition of the probes before each deployment. When sampling groundwater, mount sampler on a flow-through sampler cup. Start sampler pump and allow pump/hose system to be purged of air bubbles. Sampling rate should be set to record all parameters each time 1-3 liters (unless otherwise specified in the sampling plan) have been removed from the well. Record all the monitored values in the appropriate field logbook to ensure against inadvertent data loss.

5. MAINTENANCE

All maintenance should be performed in accordance with the manufacturer's Operations Manual.

6. PRECAUTIONS

Check the condition of the probes frequently between sampling. Do not force pins into connections, note keying sequence. If field readings are outside the expected range, check for bubbles on, or damage to, the probes. If there are no bubbles or damage, recalibrate the sensor.

7. REFERENCES

Manufacturer's Operations Manual.

Standard Operating Procedure No. 044
for
Assessment of Existing Wells Using Downhole Geophysics

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to establish protocol for using downhole surveys to evaluate the integrity of older, existing wells at the site for which details of construction are not known. Numerous wells exist within the remedial investigation study area which predate the current remedial investigation efforts. Some of these wells were installed in locations which might yield valuable data. Unfortunately, construction records for these wells are frequently incomplete or missing. If the wells could be determined to be sufficient quality, they could be sampled, and the cost of installing new wells (possibly in less than optimal locations due to the exclusion zones mandated in SOP No. 019) would be avoided.

Selected downhole geophysical techniques could prove effective in determining the integrity of these older wells. This SOP describes four techniques: natural gamma logs, caliper logs, sonic logs, and downhole video camera, which, employed individually or together should yield data about well construction and/or integrity. These data can then be factored into the decision to use or replace the well.

2. MATERIALS

The following materials may be required:

Sonde(s) for gamma log and/or sonic log and/or caliper log and/or video camera	Field notebook
Associated hoisting mechanism(s)	Decontamination supplies (SOP No. 005)
Data logger(s)	Personal protective equipment as required by the contractor's Health and Safety Plan

3. PROCEDURE

The specific procedure for each logging technique will be detailed in the manufacturer's manuals and specifications sheets for a given instrument. Rather than attempt to cover these specific procedures, this SOP will characterize and describe the instruments, and the type and applications for the data each will yield.

The following steps are general procedures which must be followed regardless of the instrument:

- Become thoroughly acquainted with the manufacturer's manual.
- Review the procedures outlined therein with an experienced operator to verify that all procedures are understood.
- Just prior to testing, as part of the safety briefing, review instrument procedures.

- Record the well location, site characteristics, sketch map(s), and other pertinent data in the field logbook.

- Perform all steps in SOP No. 010 and note the readings in the field logbook.[1]

- Lower instrument(s) into hole. Use centralizers set to the hole diameter as needed to ensure the instrument(s) is/are centered, and run smoothly in the hole.

- Run test(s) in well. Multiple runs may be required to optimize data quality.

- If broken or missing well casing is encountered, the instrument(s) should not be advanced past the broken section. There is a danger of losing the instrument in the hole due to lodging and/or cave-in, and the broken casing (or screen) would preclude using that well for sampling in any case.

- Attach a wiper to the cable when withdrawing the instrument(s) to remove excess moisture from the cable. Decontaminate all downhole equipment before insertion and after use according to SOP No. 005.

- Review the data and procedures with the experienced operator to determine where refinement of technique may be required.

- Final data interpretation should be performed by experienced personnel.

3.1 GAMMA LOG

The gamma log is also called the natural gamma, gamma ray, or radioactivity log. This instrument measures the naturally occurring radioactivity in the geologic materials found in the borehole. Clays and clay-rich soils tend to be gamma emitters. Gamma particles are very active and can easily penetrate the well casing, thereby making this a good tool for determining stratigraphy.

3.2 SONIC LOG

Sonic logs, also called continuous velocity logs, rely on emitted pulses of sound which impinge upon the borehole walls and traverse the wall materials to one or more receivers which are mounted at known distances from the emitter. By comparing the travel time (velocity) and signal strength of the return signal, one can determine the relative densities of the wall materials. Cement and grout are more dense and, therefore, have higher velocities than do soil, voids and filter pack materials. This means that sonic logging is an excellent tool for determining the

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[1] Note that non-aqueous phase liquids may foul some instruments. Video cameras are particularly sensitive to lens fouling by light non-aqueous phase liquids. If non-aqueous phase liquids are found in the hole, use of downhole video may be omitted. If used, do not coat the lens with detergent, as recommended by some manufacturers, as this would introduce further contaminants into the hole.

integrity of the grout seal around the hole. The following table provides typical travel times for various materials:

Material	Sonic Velocity (ft/sec)	Transit Time (sec/ft)
Oil	4,300	232
Water	5,000-5,300	200-189
Neoprene	5,300	189
Shale	6,000-16,000	167-62.5
Rock salt	15,000	66.7
Sandstone	Up to 18,000	55.6
Anhydrite	20,000	50.0
Limestone (carbonates)	21,000-23,000	47.6-43.5
Dolomites	24,000	42

3.3 CALIPER LOG

Caliper logs use a set of spring calipers to make mechanical contact with the walls of the borehole or casing and provide a very sensitive means to determine the hole diameter, and to some extent, the roughness of the borehole or casing walls. A caliper log can often detect each joint in the well casing and will accurately locate the depth and length of the well screen(s).

3.4 DOWNHOLE VIDEO CAMERA

The downhole video camera is the only technique which gives the investigator a firsthand look at the borehole and/or well casing walls. In addition to the procedures outlined above in Section 3, before inserting the video camera, slowly pan the camera around the site to photographically record the site features. Also, if the recorder has voice recording capabilities, a commentary of the field operator's onsite interpretation of the scene should be recorded as the survey is run. Downhole, the camera may be stopped for additional commentary, detailed examination of a feature, and/or still photography.

If multiple lens capabilities are available, the downhole video should be run first with a forward-looking lens, to determine hole conditions, then with an off-axis (e.g., right angle) lens to record sidewall details.

4. MAINTENANCE

See manufacturer's manuals.

5. PRECAUTIONS

All wells should be considered contaminated unless proven otherwise. Appropriate personal protective equipment must be worn.

All safety checks required in SOP No. 010 must be performed.

As with any intrusive technique, each instrument must be properly decontaminated before and after each use. See SOP No. 005 for details.

6. REFERENCES

Krumbein, W.C. and L.L. Sloss. 1963. Stratigraphy and sedimentation. 2nd Edition. W.H. Freeman and Company, San Francisco. 660 pp.

Lahee, F.H. 1961. Field Geology, 6th Edition, McGraw-Hill Book Company, New York. 926 pp.

Standard Operating Procedure No. 046
for
Aqueous Diffusion Samplers

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1. SCOPE OF APPLICATION

The purpose of this Standard Operating Procedure is to establish the protocol for collecting groundwater samples using aqueous diffusion samplers. The procedure is designed to permit the collection of representative groundwater samples for analysis of volatile organic compounds (VOCs).

2. CONSTRUCTION OF AQUEOUS DIFFUSION SAMPLERS

The aqueous diffusion samplers are constructed by sealing de-ionized water in a 2-in. diameter × 1-mil thick polyethylene tubing. The de-ionized water is sealed in the poly tubing by using a heat seal device. One end of the poly tube is rolled over onto itself several times, then heat is applied to seal this end. The poly tube is then filled with de-ionized water. The top end (unsealed end) of the tube is then rolled over onto itself until there is no headspace in the poly tube; heat is then applied to seal this end. Care is taken to ensure that no headspace or air bubbles are present in the tube prior to sealing the top end. Each diffusion sampler is approximately 2 ft in length. The samplers are weighted with stainless steel bolts enclosed in 4-mil polyethylene tubing attached to the bottom of the sampler, and a string is attached to the top of the sampler for placement and retrieval.

3. EQUIPMENT/MATERIALS

3.1 AQUEOUS DIFFUSION SAMPLER PLACEMENT

- Well construction data, location map, and field data from the previous sampling event.

- Field logbook and Field Record of Well Gauging, Purging, and Sampling form (Figure SOP046-1).

- Electronic water level measuring device, 0.01-ft accuracy for monitoring water level prior to installation of the diffusion sampler.

- Diffusion sampler constructed of 2 ft length × 2 in. width 1-mil polyethylene lay-flat tubing filled with de-ionized water and weight attached to bottom.

- Twine, string, or rope. The depth of each sampler should be established prior to field placement so enough twine, string, or rope is available for installation.

3.2 AQUEOUS DIFFUSION SAMPLER RETRIEVAL

- Volatile organic analyte sample bottles and sample preservation supplies (as required by the analytical methods) needed for diffusion sampler retrieval.

- Sample tags or labels.

- Cooler with bagged ice for storage of sample bottles during shipment to a laboratory.

3.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing aqueous diffusion sampler installation and retrieval. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and installation and retrieval form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Check well for damage or evidence of tampering, and record pertinent observations in field logbook and field sampling form.

- Unlock well and remove well cap (if applicable).

- Measure VOCs with a photoionization detector instrument at the rim of the well and in the breathing zone, and record the readings in the field logbook and the field sampling form.

- Measure and record the height of protective casing above the concrete pad or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.

- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before installation of the aqueous diffusion sampler begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will be measured prior to installation of the sampler.

3.4 SAMPLING PROCEDURE

The following general procedures should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and field sampling form, as appropriate, prior to installation of the diffusion sampler: date and time of sampler installation, depth of sampler, and total depth of well.

- Prepare the diffusion sampler by attaching weight at the base of the sampler and a string to the top of the sampler.

- Install the sampler at the predetermined depth. Depth of sampler will be determined on a well-by-well basis based on previous low-flow sampling data, or previously collected aqueous diffusion samplers.

- Allow the diffusion to equilibrate for approximately 21 days. Return after approximately 21 days to retrieve the sampler.

- Enter the following information in the field logbook and field sampling form, as appropriate, during retrieval of diffusion sampler: date and time of sampler retrieval, analytical method, and quality assurance/quality control as necessary.

- Retrieve the diffusion sampler from the well.

- After retrieval is complete, remove string and weight, and make a diagonal cut towards the top of the sampler. The diagonal cut allows easier filling of the sample containers.

- Begin filling the sample containers from the diagonal cut, allowing the water to fill the volatile organic analyte sample containers by allowing the water to flow gently down the inside of the container with as little agitation or minimal aeration as possible.

- Label each sample as it is collected. Samples will be placed into a cooler with ice for delivery to a laboratory.

- After collection of the samples, the wells will be capped and locked.

- Complete remaining portions of field sampling form after each well is sampled, including sample date and time (time of retrieval from the well), well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of the sampling event.

3.5 SAMPLE PRESERVATION

- **VOCs**—Fill the sample bottle pre-preserved with hydrochloric acid, seal with a teflon-lined cap, and place in a cooler with ice for shipment to a laboratory. Cooler will maintain a temperature of 4°C for shipment to the laboratory.

Note that aqueous diffusion samplers are not submitted for other laboratory analytical parameters.

3.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. Field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each sample delivery group (a sample delivery group may not exceed 20 samples) at the frequency noted:

- ***Equipment Blank***—One aqueous diffusion sampler will be constructed and submersed in a sealed container with de-ionized water for the 21-day equilibration period. This equipment duplicate should be analyzed the same as the other samplers to determine if materials used for aqueous diffusion samplers may have outgased VOCs, or otherwise affected laboratory analytical results.

- ***Field Duplicate***—Required at a frequency of 10 percent per sample delivery group, as per the site Long-Term Monitoring Plan.

- ***Matrix Spike/Matrix Spike Duplicate***—Required at a frequency of 5 percent, as per the site Long-Term Monitoring Plan.

- ***Trip Blank***—Required for VOC samples at a frequency of one per sample shipment, as per the site Long-Term Monitoring Plan.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name:
Project Number:
Well ID:
Well Lock Status:
Well Condition:
Weather:

Gauge Date:
Gauge Time:
Sounding Method:
Measurement Ref:
Stick Up/Down (ft):
Well Diameter (in.):

Purge Date:
Purge Time:
Purge Method:
Field Personnel:
Ambient Air VOCs (ppm):
Well Mouth VOCs (ppm):

WELL VOLUME

A. Well Depth (ft):
D. Well Volume/ft (L):
B. Depth to Water (ft):
E. Well Volume (L) (C*D):
C. Liquid Depth (ft) (A-B)
F. Three Well Volumes (L) (E*3):
G. Measurable LNAPL? Yes ________ /ft No ________

Parameter	Beginning	1	2	3	4	5
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Total Quantity of Water Removed (L):
Samplers:
Sampling Time (Start/End):
Sampling Date:
Decontamination Fluids Used:
Sample Type:
Sample Preservatives:
Sample Bottle IDs:
Sample Parameters:

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Standard Operating Procedure No. 047
Direct-Push Technology Sampling

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1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) establishes the protocol for using direct-push technology (DPT) in media sampling and performing subsurface characterization. This SOP includes the following DPT methods: Geoprobe®, Hydropunch®, Cone Penetrometer Testing (CPT), and Site Characterization and Analysis Penetrometer System (SCAPS).

2. MATERIALS

The following materials may be required:

Appropriately sized, all-terrain vehicle-skid-or track-mounted; DPT equipment; and supplies (i.e., hydraulic derrick and hammer assembly)	Personal protective equipment
Bentonite grout and clean sand for DPT hole abandonment	Phosphate-free, laboratory-grade detergent (e.g., Liquinox, Alconox, etc.)
DPT stainless steel rods	Source of approved water
Heavy plastic sheeting	Steam cleaner/sprayer and water obtained from approved source for decontaminating DPT equipment
Logbook	Steel drums for intrusion derived wastes (e.g., contaminated personal protective equipment, decon solutions, etc.)
Long-handled bristle brushes	Wash and rinse tubs
Mini-bailer or tubing and peristaltic pump (groundwater sampling only)	

3. GEOPROBE® AND HYDROPUNCH®

3.1 MATERIALS

Water sources for Geoprobe® and Hydropunch® activities, grouting, sealing, filter placement, well installation, and equipment decontamination must be approved by the Project Manager prior to arrival of the Geoprobe® and Hydropunch® equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analysis over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives will be the only additive allowed, and its use must be approved by the Project Manager prior to the arrival of the Geoprobe® and Hydropunch® equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer's address and telephone number, product number, product description, and intended use for the product.

Portland Type II cement will be used for grout (refer to SOP No. 019).

3.2 GROUNDWATER – HYDRAULIC PUSHING AND SAMPLING

The objective of the selected DPT sampling technique is to allow grab samples to be taken at a selected site to facilitate aquifer characterization and analysis of potential contaminants. The analytical results from sampling can also be used to determine the placement of monitoring wells.

A site geologist will be present during all sampling and installation procedures, and will fully document all procedures and soil characteristics in the Field Logbook (refer to SOP No. 016).

The site geologist will have on hand, at a minimum, a copy of the approved Health and Safety Plan, this SOP, the Field Investigation Work Plan, a hand lens (10X), a standard color chart, and a grain size chart.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole Geoprobe® and Hydropunch® equipment.

Surface runoff or other fluids will not be allowed to enter any DPT location or well during or after DPT activities.

The subcontractor will use the equipment specific guidelines for installation of the Geoprobe® DPT equipment. Probe rods will be forced into the ground by hydraulic means.

- Drive the sampler to the desired groundwater sampling interval. At the desired depth, insert extension rods down the inside diameter of the probe rods until the extension reaches the bottom of the screen. Remove the probe rods and sampler sheath while holding the screen in place.

- Collect the groundwater sample in the screen interval with a mini-bailer, peristaltic or vacuum pump, or other acceptable small diameter sampling device.

- The head of the rod may be equipped with a sensing device for characterization of soil properties or the contaminant content.

The subcontractor will use the equipment-specific guidelines for installation of the Hydropunch® equipment. Rods will be forced into the ground by hydraulic means.

- The Hydropunch® tool is a double cylinder, designed to be sealed until the desired sampling depth is reached. Upon reaching the desired sampling depth, the outer cylinder is pulled back, exposing a perforated, stainless steel sampling barrel covered with filter material.

- The water sample enters the barrel and the sample is retrieved by pulling the probe rods from the hole with the hydraulic derrick and hammer assembly. Groundwater is the only media that is sampled by Hydropunch® equipment.

- The head of the rod may be equipped with a sensing device for characterization of the soil properties or the contaminant content.

- The sample volume collected with this technique is approximately 500-1,000 ml. Larger sample volumes can be collected by inserting tubing attached to a peristaltic pump into the rods to obtain water samples.

If desired, a small diameter monitoring well may be installed at this point. Refer to SOP No. 019 (Monitoring Well Installation).

If a well will not be installed, the rods will be removed as the borehole is simultaneously filled with a bentonite/grout mixture. A polyvinyl chloride (PVC) tube fed into the rod casing will allow the addition of grout.

3.3 SUBSURFACE SOIL – HYDRAULIC PUSHING AND SAMPLING

The objective of the selected DPT sampling technique is to allow grab samples to be taken at a selected site for characterization of the stratigraphy and for analysis of potential contaminants. The analytical results from sampling can also be used to determine the placement of monitoring wells.

A site geologist will be present during all DPT sampling and soil characterization. All procedures and soil characteristics will be fully documented in the Field Logbook (refer to SOP No. 016).

The site geologist will have on hand, at a minimum, a copy of the approved Health and Safety Plan, this SOP, the Field Investigation Plan, a hand lens (10X), a standard color chart, and a grain-size chart.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole Geoprobe® equipment.

Surface runoff or other fluids will not be allowed to enter any DPT location or well during or after DPT activities.

The subcontractor will use the equipment specific guidelines for installation of the Geoprobe® DPT equipment. Probe rods will be forced into the ground by hydraulic means. Additional rods will be added in 3- to 4-ft increments until the leading edge of the sampler reaches the top of the desired sampling interval.

Once the desired sampling depth has been reached, insert extension rods down the inside diameter of the probe rods until it reaches the top of the sampler assembly. Attach the extension rod handle to the top extension rod. Turn the handle clockwise until the stop-pin detaches from the drive head. Remove the extension rods and the stop-pin. Attach a drive cap to the probe and drive the sampler approximately 2 ft using hydraulic derrick.

The DPT sampler can be retrieved by pulling the probe rods from the hole with the hydraulic derrick and hammer assembly.

The liner will be capped with Teflon® tape and vinyl end caps. The liners can be split open to remove samples for composition analysis or for transfer to other containers for shipment to the laboratory for analysis.

The head of the rod may be equipped with a sensing device for characterization of the soil properties or the contaminant content.

3.4 DECONTAMINATION

All Geoprobe® and Hydropunch® DPT equipment must be thoroughly cleaned before and after each use to allow retrieval of representative groundwater samples. Geoprobe® soil sample liners are disposed of after each use. Scrub all metal parts with a stiff, long bristle brush and a non-phosphate soap solution. Steam cleaning may be substituted where available. Rinse with distilled water and allow to air-dry before assembly.

After decontamination, a new clean liner will be installed and all parts will be inspected for wear or damage.

Refer to SOP No. 005 (Field Decontamination).

3.5 ABANDONMENT

Pure bentonite or a bentonite/grout mixture (20:1) will be used to fill the resulting borehole if the water table is penetrated. Boreholes that do not penetrate the water table will be backfilled with cuttings from the hole and topped with a bentonite seal. Clean sand will be used to fill any remaining volume in the borehole.

Abandonment of Geoprobe® and Hydropunch® generated DPT boreholes will meet the standards established under SOP No. 028 (Well and Boring Abandonment).

4. CONE PENETROMETER TESTING

4.1 MATERIALS

A CPT rig typically consists of an enclosed 20- to 40-ton truck equipped with vertical hydraulic rams that are used to force a sensor probe into the ground. The weight of the CPT rig is dependent upon the thrust required at the site. The majority of CPT rigs are mounted in heavy-duty trucks that are ballasted to a total dead weight of approximately 15 tons. Screw anchors are utilized to develop the extra reaction to reach the maximum thrust of 20 tons. The rig is separated into two separate workspaces: data acquisition and hydraulic push areas.

Water sources for CPT activities and decontamination must be approved by the Project Manager prior to arrival of the CPT equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analysis over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives will be the only additive allowed, and its use must be approved by the Project Manager prior to the arrival of the DPT equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer’s address and telephone number, product number, product description, and intended use for the product.

Portland Type II cement will be used for grout (refer to SOP No. 019).

4.2 SUBSURFACE CHARACTERIZATION

The objective of this technology is to collect stratigraphic information using CPT equipment to determine subsurface stratigraphy and geotechnical properties at a particular site. CPT activities will be in accordance with American Society for Testing and Materials D 3441-86 and American Society for Testing and Materials D 5778-95. The stratigraphic information gathered can be used to facilitate the selection of DPT sampling screen intervals. At the same time, it is possible to install a 0.25-in. diameter pre-packed PVC monitoring well.

CPT rods are used to hydraulically push the CPT probe into the subsurface. Probes cannot be pushed into hard rock, and significant gravel or cobble content in the formation may impede or preclude penetration of the probe. The depth of penetration achievable depends on the type of formation, type of sampling probe, and size of the hydraulic equipment used.

The CPT probe includes the following components:

- A conical tip to measure vertical resistance beneath the tip.
- A friction sleeve to measure frictional resistance on the side of the probe, as a function of depth.

- Two internal strain gauge-type load cells, which independently measure the vertical resistance and side friction.

- A cone pressure gauge to measure the water pressure as the probe is pushed into the ground.

- Inclinometer to determine potential drifting of the probe (optional).

- Seismic transducers to perform downhole seismic surveys (optional). Therefore, stratigraphic data collected with the CPT include: tip resistance, local friction, friction ratio, pore pressure, and resistivity.

Data will be transferred from the probe to the data acquisition system or logger through an electrical cable. The hole will be advanced continuously at a rate of 0.6-1.0 in. per second. The data will be logged at every 0.4-0.8 in. of penetration. Monitor the probe's stratigraphic position will be monitored as it advances downward. Perform pore water pressure dissipation tests in representative hydrostratigraphic intervals. Record dissipated pore water pressures to represent hydraulic head values.

Once the confining unit underlying the surficial aquifer or the required depth has been reached, the CPT is pulled from the ground. Target interval samples can be collected during CPT hole advancement using direct push sampling techniques, i.e., Geoprobe® or Hydropunch® (Section 3).

4.3 DECONTAMINATION

All CPT equipment must be thoroughly cleaned before arrival at the work site, between test holes, and prior to being moved out of a work area. Scrub all metal parts with a stiff, long bristle brush and a non-phosphate soap solution. Steam cleaning may be substituted where available. Rinse with distilled water and allow to air-dry before assembly.

Refer to SOP No. 005 (Decontamination).

4 .4 ABANDONMENT

If the push hole was developed for the stratigraphic test only, once the testing is completed, grout the hole from bottom to top. If the hole has not collapsed after removing the CPT, PVC piping will be used to grout the hole. If the hole has collapsed after removing the CPT, then hollow CPT rods and a sacrificial tip will be used to grout the hole. The PVC pipe or CPT rods will be pushed to the bottom of the hole. Grout will then be pumped to the bottom of the hole as the PVC pipe or CPT rods are withdrawn.

Refer to SOP No. 028 (Well and Boring Abandonment).

5. SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM

5.1 MATERIALS

SCAPS cone penetrometer and laser induced fluorescence (LIF) technology requires the use of a specialized 20-ton truck. The truck has two separate enclosed compartments. Each compartment is temperature controlled and monitored for air quality. The two rooms are the data acquisition and processing room, and the hydraulic ram/rod handling room. Approximately 20 ft of overhead clearance is required to fully extend the hydraulic ram and allow for leveling jack movement.

All materials required to complete SCAPS analysis are provided by the subcontractor to include cone penetrometer equipment. All hydraulic equipment, SCAPS rods, nitrogen lasers, etc. are included within the vehicle. A decontamination water source and a source of water for mixing the grout are required.

Water sources for equipment decontamination must be approved by the Project Manager prior to arrival of the SCAPS equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analysis over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives will be the only additive allowed, and its use must be approved by the Project Manager prior to the arrival of the SCAPS equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer’s address and telephone number, product number, product description, and intended use for the product.

Portland Type II cement will be used for grout (refer to SOP No. 019).

5.2 HYDRAULIC PUSHING AND SAMPLING

The objective of the SCAPS technique is to allow grab samples and stratigraphic information to be collected at a selected site to facilitate subsurface characterization and for analysis of potential contaminants. The analytical results obtained can also be used to determine the placement of monitoring wells. At the same time, it is possible to install a small diameter well for sampling purposes. Refer to SOP No. 019 (Monitoring Well Installation). If a well will not be installed, the borehole can be grouted as the equipment is removed.

A site geologist will be present during all installation and sampling procedures and will fully document all procedures and soil characteristics in the Field Logbook (refer to SOP No. 016).

The site geologist will have on hand, at a minimum, a copy of the approved Health and Safety Plan, this SOP, the Field Investigation Work Plan, a hand lens (10X), a standard color chart, and a grain-size chart.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole SCAPS equipment.

Surface runoff or other fluids will not be allowed to enter any DPT location or well during or after direct-push activities.

The subcontractor will use the equipment specific guidelines for installation of the SCAPS DPT equipment. Prior to SCAPS field activities, calibration soil samples will be collected and analyzed in order to determine the LIF sensor fluorescence threshold and detection limits for the site.

SCAPS LIF technology uses a pulsed nitrogen laser coupled with an optical detector to make fluorescence measurements via optical fibers. The LIF sensor is mounted on a cone penetrometer probe so that soil classification data and fluorescence data are collected simultaneously. The laser consumes nitrogen gas, which is supplied from cylinders stored on the accompanying trailer.

The SCAPS CPT sensors are used to gather stratigraphic information. See Section 4 for CPT operating procedures.

Target interval samples can be collected during SCAPS hole advancement using direct push sampling techniques such as Geoprobe® or Hydropunch® (Section 3).

5.3 DECONTAMINATION

Decontamination of SCAPS equipment is automated after initialization by a field team member. A pressurized hot water system is used to decontaminate the push rods as they are retracted from the ground. The SCAPS vehicle is equipped with a decontamination collar mounted to the bottom that cleans the rods. The decontamination water is removed by vacuum and transferred to a storage drum prior to disposal or treatment. A trailer attached to the back of the vehicle contains the water pump, heater for decontamination, and decontamination water containment drum.

Worker exposure is reduced by minimizing contact with contaminated media.

Refer to SOP No. 005 (Decontamination).

5.4 ABANDONMENT

SCAPS automatically grouts the penetrometer cavity as the rods are removed. The grout is pumped at high pressure through a 0.25-in. diameter tube in the center of the penetrometer rods. The tip is sacrificed at the bottom of the cavity to allow release of the grout.

A trailer attached to the back of the vehicle contains the 300-gal grout mixing bin and pump.

If the automatic grout feed does not work, the cavity will be manually filled with grout.

Abandonment of SCAPS generated borehole will meet the standards established under SOP No. 028 (Well and Boring Abandonment).

6. MAINTENANCE

Not applicable.

7. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for discussion of hazards and preventive measures during intrusive activities.

8. REFERENCES

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Standard Operating Procedure No. 048
for
Low-Flow Sampling

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1. GROUNDWATER SAMPLING BY LOW-FLOW PURGE AND SAMPLING METHOD USING DEDICATED PUMPS

1.1 SCOPE OF APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to establish the protocol for collecting groundwater samples using dedicated pump systems. The procedure is designed to permit the collection of groundwater samples with minimum turbidity.

1.2 EQUIPMENT/MATERIALS

- Work Plan.
- Well construction data, location map, and field data from last sampling event.
- Field logbook and Field Record of Well Gauging, Purging, and Sampling forms (Figure SOP048-1).
- Electric water level measuring device, 0.01 ft accuracy for monitoring water level during pumping operations.
- Pumps: adjustable rate, submersible pumps constructed of stainless steel and Teflon®.
- Tubing: Teflon or Teflon-lined polyethylene must be used to collect samples for organic analysis. For samples collected for inorganics analysis, Teflon or Teflon-lined polyethylene tubing will be used.
- Flow measurement supplies (e.g., graduated cylinder and stop watch).
- Power source (generator, etc.).
- Water quality indicator parameter monitoring instruments—pH, turbidity, specific conductance, and temperature. Optional indicators—Eh and dissolved oxygen.
- Flow-through cell (preferred) or clean container for water quality probes.
- Decontamination supplies (for monitoring instrumentation).
- Sample bottles and sample preservation supplies (as required by the analytical methods).
- Sample tags or labels.
- Cooler with bagged ice for sample bottles.
- Drum for purge water containment.

1.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing well purging and groundwater sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Check well for damage or evidence of tampering, record pertinent observations in field logbook and sampling form.

- Lay out sheet of polyethylene for monitoring and sampling equipment.

- Unlock well and remove well cap (if applicable).

- Measure VOCs with an ionization detector (flame or photo) instrument at the rim of the well and in the breathing zone, and record the readings in the field logbook and the sampling form.

- Measure and record the height of protective casing above the concrete pad or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.

- Dedicated sampling pumps should be positioned with the pump intake mid-point in the screened interval. If non-dedicated equipment is used, care will be taken to position pump or sampling hose intake at the screen mid-point.

- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before purging begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. If a reference point is made, it will be noted in the field logbook. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will be measured following the completion of sampling because of the potential to stir up sediment at the bottom of the well.

- Prepare the pump by checking electrical connections, discharge tubing, and motor (Grundfos Redi-Flo2). Locate the generator (if applicable) downwind of the well; connect the power converter to the generator and to the pump.

1.4 WELL PURGING AND SAMPLING PROCEDURE

The following general procedure should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to purging: purge date and time, purge method, and total well depth.

- Connect the flow-through cell or clean container containing the instrumentation header to the pump discharge and begin purging the well at 0.2-0.5 L/min, unless a different purge rate has been previously established for that well. Fill the flow cell completely. Care should be taken not to cause entrapment of air in the system. Record the purge start time and purge rate.

- Establish that the water level has not dropped significantly such that the pump is dry (bubbles in discharge) or water is heard cascading down the inside of the well. Ideally, the pump rate should cause little or no water level drawdown in the well (>0.5 ft and the water level should stabilize). The water level should be monitored every 3-5 minutes (or as appropriate) during pumping. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump (e.g., 0.1-0.2 L/min) to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If water levels continue to drop with the pump on the lowest flow rate, the pump will be shut off and the well will be allowed to recharge to prevent the well from going dry. **The well will not be purged to dryness prior to sampling to prevent erroneous field parameters and groundwater samples.** Sampling will commence as soon as the well has recharged to a sufficient level to collect the appropriate volume of samples with the pump.

- During purging of the well, monitor the water quality indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every 3-5 minutes (or as appropriate). Record purge rate, volume purged, depth to water, water quality indicator parameters values, and clock time at 3- to 5-minute intervals in field logbook and sampling record. Purging of the standing well water is considered complete when three consecutive readings of the water quality indicator parameters agree within approximately 10 percent. Turbidity readings consistently below 10 nephelometric turbidity units (NTU) are considered to represent stabilization of discharge water for this parameter. If the parameters have stabilized, but the turbidity is not in the range of the 10 NTU goal, the pump flow rate should be decreased and measurement of the parameters should continue every 3-5 minutes.

- Purge water at a well will be containerized if a well has exceeded the MEG or MCL in previous sampling events. Any purge water that is collected will be treated at the groundwater treatment plant.

- Prior to sampling, disconnect the discharge tubing from the flow-through cell. If the water discharged by the pump is silty, wait for the water to clear before sampling. Ensure that bubbles are not observed in the discharge tubing. Record pertinent observations in field logbook and sampling records.

- Begin filling sample containers by allowing the pump discharge to flow gently down the inside of the container with as little agitation or aeration as possible. Collect the samples in the order below, as applicable:

  - VOCs
  - Inorganics.

- VOC samples requiring pH adjustment will have their pH checked to assure that the proper pH has been obtained. This will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling. Details on sample preservation are discussed in Section 1.5.

- Label each sample as collected. Those samples (VOCs, etc.) requiring cooling will be placed into an ice cooler for delivery to the laboratory. Inorganic samples, after preservation, do not need to be cooled.

- After collection of the samples, restore the dedicated pumping assembly to the well by hanging the tube, electric line, and support cable inside the well by the specially-designed PVC well cap assembly. Lock well.

- Complete remaining portions of Field Record of Well Gauging, Purging, and Sampling form (Figure SOP048-1) after each well is sampled, including sample date and time, total quantity of water removed, well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

1.5 SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Pre-preserved bottles will be used if possible. Minimum sample preservation requirements for each parameter group are summarized below:

- **VOCs**—Aqueous VOC samples must be collected as specified below. Each VOC sample is taken in duplicate:

  - Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.

  - Fill a sample bottle, preserve with HC1, and check the pH. Adjust the volume of HC1 to assure pH<2.

- Add the amount of HC1 determined in the above step, and fill the sample vial slowly from the tubing, minimizing air entrainment, until the vial slightly overflows.

- Place the Teflon-faced silicon rubber septum on the convex meniscus, Teflon side (shiny side) down and screw cap on.

- Invert the bottle, tap lightly, and check for air bubbles.

- If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.

- Place samples on ice until shipment.

- **Inorganics**—Fill the sample bottle, preserve the sample to $pH<2$ with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Disposable pipettes should be used to introduce chemicals into the samples if necessary. Chemicals used for preserving should be poured into a 150-ml beaker. They should not be drawn directly from the preservative bottles because the bottle may become contaminated. Measurements for pH and temperature should not be taken from the sample containers. When preserving samples to a required pH, pH paper should be used to check the resultant pH. The sample should be poured across the pH paper. Never place pH paper directly into sample.

NOTE: Shipping regulations limit the amount of preservative which can be added. For a 1-L sample, this is generally 1.5 ml of acid preservative.

1.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each sample delivery group (SDG) (an SDG may not exceed 20 samples) at the frequency noted:

- Field Duplicate—Required at a frequency of 10 percent per SDG.

- Matrix Spike/Matrix Spike Duplicate—Required at a frequency of 5 percent.

- Equipment Rinsate Blank—Required once prior to installation of dedicated pump systems.

- Source Water Blank—Required at a frequency of once per source per sampling event when equipment (rinsate) blank is required.

- Trip Blank—Required for VOC samples at a frequency of one per sample shipment.

1.7 DECONTAMINATION

Non-dedicated sampling equipment and field monitoring equipment will be decontaminated prior to use and following sampling of each well. This equipment will be decontaminated by the procedure listed below. Alternative procedures must be approved by the Project Manager prior to sampling event. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

2. GROUNDWATER SAMPLING BY LOW-FLOW PURGE AND SAMPLING METHOD USING PERISTALTIC PUMPS

2.1 SCOPE OF APPLICATION

The purpose of this SOP is to establish the protocol for collecting groundwater samples using peristaltic pump systems. The procedure is designed to permit the collection of groundwater samples with minimum turbidity, and is intended to be used in conjunction with the analyses for the most common types of groundwater contaminants (VOCs and inorganic compounds).

2.2 EQUIPMENT/MATERIALS

- Work Plan.

- Well construction data, location map, field data from last sampling event.

- Field logbook and Field Record of Well Gauging, Purging, and Sampling forms (Figure SOP048-1).

- Water level measuring device, 0.01 ft accuracy (electronic preferred) for monitoring water level drawdown during pumping operations.

- Peristaltic pump.

- In-well tubing: Teflon or Teflon-lined polyethylene must be used to collect samples for organic analysis. For samples collected for inorganics analysis, Teflon or Teflon-lined polyethylene, PVC, Tygon, or polyethylene tubing may be used.

- Pump head tubing: Silicon tubing must be used to in the pump head assembly.

- Flow measurement supplies (e.g., graduated cylinder and stop watch).

- Power source (battery, etc.).

- Water quality indicator parameter monitoring instruments – pH, turbidity, specific conductance, and temperature. Optional indicators – Eh and dissolved oxygen.

- Flow-through cell (preferred) or clean container for water quality probe.

- Decontamination supplies (for monitoring instrumentation).

- Sample bottles and sample preservation supplies (as required by the analytical methods).

- Sample tags or labels.

- Cooler with bagged ice for sample bottles.

- Drum for purge water containment.

2.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing well purging and groundwater sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Check well for damage or evidence of tampering, record pertinent observations in field logbook and sampling form.

- Unlock well and remove well cap (if applicable).

- Measure VOCs with an ionization detector (photo or flame) instrument at the rim of the well and in the breathing zone and record the readings in the field logbook and the sampling form.

- Measure and record the height of protective casing above the concrete pad, or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.

- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before purging begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. If a reference point is made, it will be noted in the field logbook. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will not be measured following the completion of sampling because of the potential to stir up sediment at the bottom of the well.

- Position the intake of the sampling hose at the mid-point of the screened interval.

- Prepare the pump by checking electrical connections and discharge tubing. Locate the battery downwind of the well; connect the peristaltic pump to the battery.

2.4 WELL PURGING AND SAMPLING PROCEDURES

The following general procedure should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to purging: purge date and time, purge method, and total well depth.

- Measure the water level with the pump in well before starting the pump. Begin purging the well at 0.3-0.5 L/min, unless a different purge rate has been previously established for that well.

- If well diameter permits, establish that the water level has not dropped significantly such that the pump is dry (air in discharge) or tubing suction is broken. Ideally, the pump rate should cause little or no water level drawdown in the well (>0.5 ft and the water level should stabilize). The water level should be monitored every 3-5 minutes (or as appropriate) during pumping. Care should be taken not to cause pump suction to be broken, or entrainment of air in the pump system. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump (e.g., 0.3 L/min) to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If water levels continue to drop with the pump on the lowest flow rate, the pump will be shut off and the well will be allowed to recharge to prevent the well from going dry. **The well will not be purged to dryness prior to sampling to prevent erroneous field parameters and groundwater samples.** Sampling will commence as soon as the well has recharged to a sufficient level to collected the appropriate volume of samples with the pump.

- During purging of the well, monitor the field indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every 3-5 minutes (or as appropriate). Purging of the standing well water is considered complete when three consecutive readings of the water quality indicator parameters agree within approximately 10 percent. Turbidity readings consistently below 10 NTU are considered to represent stabilization of discharge water for this parameter. If the parameters have stabilized, but the turbidity is not in the range of the 10 NTU goal, the pump flow rate should be decreased and measurement of the parameters should continue every 3-5 minutes.

- Purge water at a well will be containerized if a well has exceeded the MEG or MCL in previous sampling events. Any purge water that is collected will be treated at the groundwater treatment plant.

- Prior to sampling, disconnect the sample discharge tubing from the flow-through cell. If the water discharged by the pump is silty, wait for the water to clear before sampling. Ensure that bubbles are not observed in the discharge tubing.

- Collect groundwater samples directly from the silicon tubing into preserved (when appropriate) sample containers. Begin filling sample containers from the pump discharge, allowing the water to fill the containers by allowing the pump discharge to flow gently down the inside of the container with as little agitation or aeration as possible. Collect the samples in the order below, as applicable:

  — VOCs
  — Inorganics.

- VOC samples requiring pH adjustment will have their pH checked to assure that the proper pH has been obtained. This will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling. Detail on sample preservation are discussed in Section 2.5.

- Label each sample as collected. Those samples (VOCs, etc.) requiring cooling will be placed into an ice cooler for delivery to the laboratory. Inorganic samples, after preservation, do not need to be cooled.

- After collection of the samples, restore the dedicated tubing assembly to the well by hanging the tube inside the well by the specially-designed PVC well cap assembly. Lock well.

- Complete remaining portions of Field Record of Well Gauging, Purging, and Sampling form (Figure SOP048-1) after each well is sampled, including: sample date and time, total quantity of water removed, well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

- The silicon tubing used in the peristaltic pump will be changed after use at each well.

2.5 SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Pre-preserved bottles will be used if possible. Minimum sample preservation requirements for each parameter group are summarized below:

- **VOCs**—Aqueous VOC samples must be collected as specified below. Each VOC sample is taken in duplicate:
  - Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.
  - Fill a sample bottle, preserve with HCL, and check the pH. Adjust the volume of HCL to assure pH<2.
  - Add the amount of HCL determined in the above step, and fill the sample vial slowly from the tubing, minimizing air entrainment, until the vial slightly overflows.
  - Place the Teflon-faced silicon rubber septum on the convex meniscus, Teflon side (shiny side) down, and screw cap on.
  - Invert the bottle, tap lightly, and check for air bubbles.
  - If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.
  - Place samples on ice until shipment.
- **Inorganics**—Fill the sample bottle, preserve the sample to pH<2 with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Disposable pipettes should be used to introduce chemicals into the samples if necessary. Chemicals used for preserving should be poured into a 150-ml beaker. They should not be drawn directly from the preservative bottles because the bottle may become contaminated. Measurements for pH and temperature should not be taken from the sample containers. When preserving samples to a required pH, pH paper should be used to check the resultant pH. The sample should be poured across the pH paper. Never place pH paper directly into sample.

NOTE: Shipping regulations limit the amount of preservative which can be added. For a 1-L sample, this is generally 1.5 ml of acid preservative.

2.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each SDG (an SDG may not exceed 20 samples) at the frequency noted:

- Field Duplicate—Required at a frequency of 10 percent per SDG

- Matrix Spike/Matrix Spike Duplicate—Required at a frequency of 5 percent

- Equipment (Rinsate) Blank—Required once prior to installation of dedicated sample tubing

- Source Water Blank—Required at a frequency of one per source per sampling event

- Trip Blank—Required for VOC samples at a frequency of one per sample shipment.

- Temperature Blank—Required at a frequency of once per sample shipment container.

2.7 DECONTAMINATION

Non-dedicated sampling and field monitoring equipment will be decontaminated prior to use and following sampling of each well. This equipment will be decontaminated by the procedure listed below. Alternate procedures must be approved by the Project Manager prior to the sampling event. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

3. SURFACE WATER AND LEACHATE SEEP SAMPLING PROCEDURE

3.1 SCOPE OF APPLICATION

The purpose of this SOP is to establish the protocol for collecting surface water and leachate seep samples. The procedure is designed to permit the collection of representative surface water and leachate seep samples, and has been adapted from the procedure outlined in the Work Plan. This SOP is suitable for collecting surface water and seep samples requiring analyses for the most common types of surface water contaminants (VOCs and inorganic compounds).

3.2 EQUIPMENT/MATERIALS

- Work Plan.
- Location map, field data from last sampling event.
- Field logbook and Field Record of Surface Water and Sediment Sampling forms (Figure SOP048-2).
- Water quality indicator parameter monitoring instruments – pH, turbidity, specific conductance, and temperature. Optional indicators – Eh and dissolved oxygen.
- Decontamination supplies (for monitoring instrumentation).
- Dedicated, pre-cleaned 1-L wide-mouth or volatile organic analyte sample container (for sample collection).
- Sample bottles and sample preservation supplies (as required by the analytical methods).
- Sample tags or labels.
- Cooler with bagged ice for sample bottles.

3.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing surface water or leachate seep sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, sample station identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Visually inspect sample station for evidence of changes in physical condition; record pertinent observations in field logbook and sampling form.

- Measure VOCs with a flame ionization detector instrument in the breathing zone and record the reading in the field logbook and sampling form.

3.4 SAMPLING PROCEDURE

The technique for surface water and leachate seep sampling must be selected after addressing such items as:

- Depth of waterbody
- Depth of sample
- Stratification
- Seasonal variations
- Analytical parameters of interest.

The following general procedure should be used to obtain representative surface water and leachate seep samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to sampling: date and time, sample method, and sample depth.

- Collect the sample from the surface water, within several tenths of a foot of the streambed, by immersing a new, dedicated 1-L glass or volatile organic analyte sample container into the waterbody. If a stream is being sampled, collect the sample upstream of the sampler with the opening of the sampling device oriented upstream but avoiding floating debris.

- Directly fill the appropriate sample containers from the 1-L or volatile organic analyte sampling device.

- Collect the samples in the order below, as applicable:

  — VOCs
  — Inorganics.

- Water sample containers are generally filled directly from the source or sampler without special considerations. The exception is the collection of aqueous VOC samples requiring pH adjustment. VOC samples will have their pH checked to assure that the proper pH has been obtained. This will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling. Details on sample preservation methods are discussed in Section 3.6.

- Label each sample as collected. Those samples (VOCs, etc.) requiring cooling will be placed into an ice cooler for delivery to the laboratory. Inorganic samples, after preservation, do not need to be cooled.

- Measure water quality indicator parameters, if possible, by direct immersion of instrument probes into the waterbody immediately following sample collection. If direct measurement is not possible, measure these parameters from water remaining in the sampling device or another sample bottle. Record this information in the field logbook and sample data record.

- Complete remaining portions of the Field Record of Surface Water and Sediment Sampling form (Figure SOP048-2) after each station is sampled, including: time of sample collection, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

3.5 SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Minimum sample preservation requirements for each parameter group are summarized below:

- **VOCs**—Aqueous VOC samples must be collected as specified below. Each sample is taken in duplicate:

  — Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.

  — Fill a sample bottle, preserve with HC1, and check the pH. Adjust the volume of HC1 to assure pH<2.

  — Add the amount of HC1 determined in the above step, and fill the sample vial slowly from the 1-L container, minimizing air entrainment, until the vial slightly overflows.

  — Place the Teflon-faced silicon rubber septum on the convex meniscus, Teflon side (shiny side) down and screw cap on.

  — Invert the bottle, tap lightly, and check for air bubbles.

  — If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.

  — Place samples on ice until shipment.

- **Inorganics**—Fill the sample bottle, preserve the sample to $pH<2$ with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Disposable pipettes should be used to introduce chemicals into the samples. Chemicals used for preserving should be poured into a 150-ml beaker. They should not be drawn directly from the preservative bottles because the bottle may become contaminated. Measurements for pH and temperature should not be taken from the sample containers. When preserving samples to a required pH, pH paper should be used to check the resultant pH. The sample should be poured across the pH paper. Never place pH paper directly into sample.

NOTE: Shipping regulations limit the amount of preservative which can be added. For a 1-L sample, this is generally 1.5 ml of acid preservative.

3.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the surface water and leachate seep samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each SDG (an SDG may not exceed 20 samples) at the frequency noted:

- Field Duplicate—Required at a frequency of 10 percent per SDG.

- Matrix Spike/Matrix Spike Duplicate—Required at a frequency of 5 percent.

- Equipment (Rinsate) Blank—Required at a frequency of once per day per media sampled.

- Source Water Blank—Required at a frequency of once per source per sampling event when equipment (rinsate) blank is required.

- Trip Blank—Required for VOC samples at a frequency of one per sample shipment.

3.7 DECONTAMINATION

Field monitoring equipment will be decontaminated prior to use and following sampling of each station by the procedure listed below. Laboratory pre-cleaned, dedicated 1-L glass sample collection containers are used once and discarded and, therefore, do not undergo any decontamination. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

4. REFERENCES

U.S. Environmental Protection Agency. 1996. Groundwater Issue-Low Flow Sampling (Minimal Drawdown) Groundwater Sampling Procedures. April.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: ____________ Project Number: ____________
Well ID: ____________ Well Lock Status: ____________
Well Condition: ____________ Weather: ____________

Gauge Date: ____________ Gauge Time: ____________
Sounding Method: ____________ Measurement Ref: ____________
Stick Up/Down (ft): ____________ Well Diameter (in.): ____________

Purge Date: ____________ Purge Time: ____________
Purge Method: ____________ Field Personnel: ____________
Ambient Air VOCs (ppm): ____________ Well Mouth VOCs (ppm): ____________

WELL VOLUME

A. Well Depth (ft): ____________ D. Well Volume/ft (L): ____________
B. Depth to Water (ft): ____________ E. Well Volume (L) (C*D): ____________
C. Liquid Depth (ft) (A-B) ____________ F. Three Well Volumes (L) (E*3): ____________
G. Measurable LNAPL? Yes ________ /ft No ________

Parameter	Beginning	1	2	3	4	5
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Total Quantity of Water Removed (L): ____________
Samplers: ____________ Sampling Time (Start/End): ____________
Sampling Date: ____________ Decontamination Fluids Used: ____________
Sample Type: ____________ Sample Preservatives: ____________
Sample Bottle IDs: ____________
Sample Parameters: ____________

Figure SOP048-1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: ______________________ Project Number: ____________________ Date: ______________

Well ID: Field Personnel:

Parameter	6	7	8	9	10	11
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Parameter	12	13	14	15	16	17
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Comments and Observations:

Figure SOP048-1.

FIELD RECORD OF SURFACE WATER AND SEDIMENT SAMPLING

Site Name:			Project Number:
Sample Location ID:			Date:
Time:	Start:	End:	Sample Team Members:

SURFACE WATER INFORMATION

Type of Surface Water:
( ) Stream ( ) River
( ) Pond/Lake ( ) Seep

Water Depth and Sample Location _________ (ft)

Depth of Sample from Top of Water ________ (ft)

Equipment Used for Collection:
( ) None, Grab into Bottle
( ) Bomb Sampler
( ) Pump _____________

Decontamination Fluids Used:
( ) Isopropyl Alcohol
( ) ASTM Type II Water
( ) Deionized Water
( ) Liquinox Solution
( ) Hexane
( ) HNO_3 Solution
( ) Potable Water
( ) None

Water Quality Parameters
( ) Temperature ____
( ) Conductivity ___ μmhs/cm
( ) pH ____ units
( ) Dissolved oxygen _____ mg/L
( ) Turbidity ____ NTU
( ) Eh ____ mv

Velocity Measurements Obtained? ( ) No ( ) Yes, See Flow Measurement Data Record
____

Field QC Data: ( ) Field Duplicate Collected
Duplicate ID ____________
( ) MS/MSD

Sample Location Sketch:
( ) Yes
( ) No

Method Used:
( ) Winkler
( ) Probe

SEDIMENT INFORMATION

Type of Sample Collected:
( ) Discrete
( ) Composite

Sediment Type:
( ) Clay
( ) Sand
( ) Organic
( ) Gravel

Equipment Used for Collection:
( ) Gravity Corer
( ) Stainless Steel Split Spoon
( ) Dredge
( ) Hand Spoon/Trowel
( ) Aluminum Pans
( ) Stainless Steel Bucket
( ) ____________________________

Decontamination Fluids Used:
( ) Isopropyl Alcohol
( ) ASTM Type II Water
( ) Deionized Water
( ) Liquinox Solution
( ) Hexane
( ) HNO_3 Solution
( ) Potable Water
( ) None

Sample Observations:
( ) Odor ____
( ) Color

Field QC Data: ( ) Field Duplicate Collected ( ) MS/MSD
Duplicate ID ___________________________

SAMPLES COLLECTED

Check if Required at this Location	Matrix		Check if Preserved with Acid/Base	Volume Required	Check if Sample Collected	Sample Bottle IDs			
	Surface Water	Sediment							

NOTES/SKETCH

Figure SOP048-2.

Standard Operating Procedure No. 051
for
Low Flow Purge and
Sampling with Dedicated Pumps

Prepared by

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Revision: 1
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1. SCOPE OF APPLICATION

The purpose of this Standard Operating Procedure is to establish the protocol for collecting groundwater samples using dedicated pump systems. The procedure is designed to permit the collection of groundwater samples with minimum turbidity, and is intended to be used in conjunction with the analyses for the most common types of groundwater contaminants (volatile organic compounds and semivolatile organic compounds, pesticides, polychlorinated biphenyls, metals, and inorganic compounds). This Standard Operating Procedure was prepared based on draft guidance prepared by the U.S. Environmental Protection Agency Region 1 and conforms to the procedures described in the Long-Term Monitoring Plan.

2. EQUIPMENT/MATERIALS

- Long-Term Monitoring Plan.

- Well construction data, location map, and field data from last sampling event.

- Field logbook, Field Record of Well Gauging Form (Figure SOP051-1), and Field Record of Well Gauging, Purging, and Sampling Form (Figure SOP051-2).

- Electronic water level measuring device, 0.01 ft accuracy for monitoring water level during pumping operations.

- Pumps: adjustable rate, submersible pumps constructed of stainless steel and Teflon.

- Tubing: Teflon or Teflon-lined polyethylene must be used to collect samples for organic and inorganic analyses.

- Flow measurement supplies (e.g., graduated cylinder and stop watch).

- Power source (generator, etc.).

- Water quality indicator parameter monitoring instruments—pH, turbidity, specific conductances, and temperature. Optional indicators—Eh and dissolved oxygen. Water quality indicator parameters will be measured in the field in accordance with EPA-600/4-79-020 (1983) using the following methods: temperature (Method 170.1), pH (Method 150.1), turbidity (Method 180.1), specific conductance (Method 120.1), and dissolved oxygen (Method 360.1).

- Flow-through cell for water quality parameters.
- Decontamination supplies (for monitoring instrumentation).
- Sample bottles and sample preservation supplies (as required by the analytical methods).
- Sample tags or labels.
- Cooler with bagged ice for sample bottles.

3. PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing well purging and groundwater sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.
- Check well for damage or evidence of tampering; record pertinent observations in the field logbook and sampling form.
- Lay out sheet of polyethylene for monitoring and sampling equipment.
- Unlock well and remove well cap (if applicable).
- Measure volatile organic compounds with a photoionization detector instrument at the rim of the well and in the breathing zone, and record the readings in the field logbook and the sampling form.
- Measure and record the height of protective casing above the concrete pad or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.
- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before purging begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will be measured following completion of the sampling because of the potential to stir up sediment at the bottom of the well.

- Prepare the pump by checking electrical connections, discharge tubing, and motor (Grundfos Redi-Flo2). Locate the generator (if applicable) downwind of the well; connect the power converter to the generator and the pump.

4. SAMPLING PROCEDURE

The following general procedure should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to purging: purge date and time, purge method, and total well depth.

- Connect the flow-through cell containing the instrumentation header to the pump discharge and begin purging the well at 0.2-0.5 L/min, unless a different purge rate has been previously established for that well. Fill the flow-through cell completely. Care should be taken not to cause entrapment of air in the system. Record the purge start time and purge rate.

- Establish that the water level has not dropped significantly such that the pump is dry (bubbles in discharge) or water is heard cascading down the inside of the well. Ideally, the pump rate should cause little or no water level drawdown in the well (<0.5 ft and the water level should stabilize). The water level should be monitored every 3-5 minutes (or as appropriate) during pumping. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump (e.g., 0.1-0.2 L/min) to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If the water level continues to drop with the pump on the lowest flow rate, the pump will be shut off and the well allowed to recharge to prevent it from going dry. **The well will not be purged to dryness prior to sampling to prevent erroneous field parameters and groundwater samples.** Sampling will commence as soon as the well has recharged to a sufficient level to collect the appropriate volume of samples with the pump.

- During purging of the well, monitor the water quality indicator parameters, including pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity, every 3-5 minutes (or as appropriate). Record purge rate, volume purged, depth to water, water quality indicator parameters values, and clock time at 3- to 5-minute intervals in the field logbook and sampling record. Purging of the standing well water is considered complete when three consecutive readings of the water quality indicator parameters agree within the following: ± 0.1 for pH, ± 3 percent for conductivity, ± 10 mV for redox potential, and ± 10 percent for turbidity and dissolved oxygen. Temperature readings should also be recorded along with the aforementioned water quality indicators. Although it is not critical in determining the stabilization of the discharge water, it is important for data interpretation and should also be measured.

Additionally, turbidity readings consistently below 10 nephelometric turbidity units (NTUs) are considered to represent stabilization of discharge water for this parameter. If the parameters have stabilized but the turbidity is not in the range of the goal of 10 NTUs, the pump flow rate should be decreased and measurement of the parameters should continue every 3-5 minutes; however, it is important to note that natural turbidity levels in groundwater at some sites may exceed 10 NTUs.

- Prior to sampling, disconnect the discharge tubing from the flow-through cell. If the water discharged by the pump is silty, wait for the water to clear before sampling. Ensure that bubbles are not observed in the discharge tubing. Record pertinent observations in the field logbook and sampling records.

- The purging rate will be controlled so that the well is not purged dry before sampling. If necessary, purging will be temporarily halted to permit recharge rather than allowing the well to be purged dry.

- Begin filling sample containers from the pump discharge, allowing the water to fill the containers by allowing the pump discharge to flow gently down the inside of the container with as little agitation or aeration as possible.

- Label each sample as collected. Those samples requiring cooling will be placed into an ice cooler for delivery to the laboratory.

- After collection of the samples, restore the dedicated pumping assembly to the well by hanging the tube, electric line, and support cable inside the well by the specially-designed PVC well cap assembly. Lock well.

- Complete remaining portions of Field Record of Well Gauging, Purging, and Sampling form (Figure SOP051-2) after each well is sampled, including sample date and time, total quantity of water removed, well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

5. SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Minimum sample preservation requirements for each parameter group are summarized below and in Table 3-1 of the Quality Assurance Project Plan:

- **Pesticides and Herbicides**—Fill the sample bottle, seal with a Teflon-lined cap, and place on ice for shipment.

6. FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each sample delivery group (a sample delivery group may not exceed 20 samples) at the frequency noted:

- ***Field Duplicate***—Required at a frequency of 10 percent per sample delivery group

- ***Matrix Spike/Matrix Spike Duplicate***—Required at a frequency of 5 percent

- ***Equipment Rinsate Blank***—Required once prior to installation of dedicated pump systems

- ***Source Water Blank***—Required at a frequency of once per sampling event when equipment rinsate blank is required.

- ***Trip Blank***—Required for volatile organic compound samples at a frequency of one per sample shipment.

NOTE: The dedicated pumps remain in the wells between sampling events.

7. DECONTAMINATION

Non-dedicated sampling equipment and field monitoring equipment will be decontaminated prior to use and following sampling of each well. This equipment will be decontaminated by the procedure listed below. Alternative procedures must be approved by the Project Manager prior to sampling event. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

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Project Name:
Project No:
Date:
Weather/Temperature:
EA Personnel:
Equipment:

Well Number	Well Elevation	Depth to Water	Depth to LNAPL	LNAPL Thickness	Corrected Water Table Elevation[(a)]

(a) Based on an assumed specific gravity of 0.80 for LNAPL.

NOTE: All measurements in feet.
LNAPL = Light, non-aqueous phase liquid.

Figure SOP051-1. Field record of well gauging.

Site Name:		Project Number:	
Well ID:		Well Lock Status:	
Well Condition:		Weather:	

Gauge Date:		Gauge Time:	
Sounding Method:		Measurement Ref:	
Stick Up/Down (ft):		Well Diameter (in.):	

Purge Date:		Purge Time:	
Purge Method:		Field Personnel:	
Ambient Air VOCs (ppm):		Well Mouth VOCs (ppm):	

WELL VOLUME			
A. Well Depth (ft):		D. Well Volume/ft (L):	
B. Depth to Water (ft):		E. Well Volume (L) (C*D):	
C. Liquid Depth (ft) (A-B)		F. Three Well Volumes (L) (E*3):	
G. Measurable LNAPL? Yes ________ /ft No ________			

Parameter	Beginning	1	2	3	4	5
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Total Quantity of Water Removed (L):			
Samplers:		Sampling Time (Start/End):	
Sampling Date:		Decontamination Fluids Used:	
Sample Type:		Sample Preservatives:	
Sample Bottle IDs:			
Sample Parameters:			

Figure SOP051-2. Field record of well gauging, purging, and sampling.

Standard Operating Procedure No. 054
for
Collection of Fish Tissue for Chemical Analysis

Prepared by

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Hunt Valley, Maryland 21031

Revision 1
March 2019

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 054	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	28 March 2019	Expanded alternative fishing methods and strengthened need for scientific permits	Daniel Hinckley Sanita Corum Martha McCauley	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for the collection of fish samples for tissue analysis.

2. MATERIALS

The primary instrument for collecting fish in freshwater environments is electrofishing, either by boat or by wading in a stream/shallow river. A Smith-Root VVP-15 or similar model electrofishing unit will be employed at deep water locations using an 18-foot (ft) boat platform. In shallow depths where a smaller electrofishing unit is necessary, a Smith-Root 1.5-kilovolt ampere unit mounted in a 14-ft Jon boat will be used. For streams and small rivers where wading is possible, a Smith-Root or similar model portable backpack electrofishing unit will be utilized. The electrofishing units will be used in the pulsed direct current mode.

Other equipment used in fish collection studies may include:

- Hand nets (dip nets)
- 5-gallon buckets
- A Global Positioning System unit (for marking collection areas or navigating to previously sampled locations)
- Glass or polytetrafluoroethylene (PTFE) cutting board
- Stainless-steel filet knife
- Aluminum foil
- Large zip-lock bags
- Indelible markers
- Sample labels
- Project Scope of Work, Site Safety and Health Plan, and this Standard Operating Procedure for Fish Tissue Analysis
- U.S. Environmental Protection Agency (EPA) Guidance for Assessing Chemical Contamination Data for Use in Fish Advisories Volume 1 Fish Sampling and Analysis – Third Edition (November) (EPA 823-B-00-007) (EPA 2000)

- Copy of the Scientific Collector's Permit
- Location map
- Field logbook and datasheets
- Chain-of-custody (COC) form(s)
- Coolers and ice
- Live well and aerator
- Appropriate weight measurement device
- Appropriate length measuring device
- Scissors and pliers to cut fish spines
- Digital camera
- Deionized water
- Nitric acid solution.

Additional gear may be employed if electrofishing is inappropriate for use at the project site and to supplement the electrofishing method. These may include seine net, gill net, Fyke net, jug line, eel traps, minnow traps, crab traps, or rod and reel.

In marine environments (salt water with high conductivity), electrofishing is not used since the conductivity carries the electric current around the fish. In marine fish tissue surveys, other equipment is employed. This may include gill nets, seine nets, trawl nets, jug lines, or rod and reels.

3. COLLECTION PROCEDURE

The purpose of this section is to provide a broad description of selected methods of collection so that there are several routes by which to obtain field samples.

The primary method for fish collections will be boat electrofishing. This method is effective at collecting all trophic levels of fish to be analyzed at each of the selected locations, while reducing negative impacts to non-targeted fauna. The boat operator will move the boat slowly through likely fish habitat, including areas providing cover (e.g., snags, submerged aquatic vegetation, and other forms of structure). The primary collector stands on the bow of the boat and initiates the electric current using a "deadman's" switch foot peddle and collects stunned fish using a long-handled dip net. The duration of the current can be adjusted by the collector based on the number of stunned fish observed and the rate at which they recover and escape. The second collector will stand in the mid-section of the boat using a dip net to capture fish drifting past the boat. Alternatively, if space allows, two collectors will stand side-by-side on the bow, collecting both fish off the bow and the sides of the vessel, with each collector focusing on the side they are nearest. One collector will be designated to operate the "deadman's" switch foot peddle prior to the sampling effort.

In order to assess the relative availability of target species versus the need to consider targets of opportunity, all stunned fish captured will be placed in live wells; the water will be refreshed periodically to minimize stress to the captured fish resulting from depletion of dissolved oxygen. At such a point when it becomes clear that target species are available in adequate numbers to meet the sample quotas, only target species will be captured and held.

When sampling marine waters and other circumstances for which electrofishing is inappropriate, traps should be checked regularly and non-target fish released. Target fish should be processed as necessary (fileting and compositing) and placed in coolers, as soon as possible.

During project planning and field sampling documentation (work plans and quality assurance project plans), it is important to include all potential methods for catching fish that may be used for the project. In addition, it is common for targeted species to not be present; consequently, alternative species should be considered during project planning.

4. COLLECTION PERMIT

Permission is required to conduct these studies, and approval must be granted by the regulatory authority within the state where the study will be conducted. A Scientific Collector's Permit must be applied for and the study plan approved by the proper agency or agencies prior to initiating the study. Be sure to apply for the Scientific Collector's Permit ahead of time to allow the paperwork to be completed and provided. Under no circumstances, should fish collections be performed without the required Scientific Collector's Permit. Copies of Scientific Collector's Permits should be carried with the field crew to provide documented evidence as needed to authorities.

5. DOCUMENTING SAMPLE LOCATION

The location of samples will be noted in a field logbook and on a map used in the field. Coordinates will be obtained using a hand-held Global Positioning System and recorded in the field logbook. Fish collection efforts are conducted over a general area that is sampled; therefore, specific coordinates collected will relate to the approximate center point of the collection effort for a specific location. The location should also be marked on a field map relative to a position on the shoreline. Significant events, observations, and measurements during the field investigation will also be recorded in the field logbook.

Field logbook entries will include, at a minimum, the following information:

- Author, date and time of entry (use 24-hour military time), and physical/environmental conditions during the field activity.
- Names and titles of field crew.
- Names and titles of any site visitors.
- Type of sampling activity.
- Location of sampling activity, sampling time, water temperature, dissolved oxygen, conductivity, and pH.
- Field observations.
- For each submitted fish sample, the number of fish included, and the species name, weight, and size of each fillet, whole body, or other appropriate measures included in the composite analytical sample. Also, whole body characteristics should be included for each fish fillet collected.
- Any deformities (lesions, sores, etc.) observed on any of the fish.
- Any photos taken and their reference numbers
- Analyses to be performed on these fish samples.
- If any page is not completely filled in, a line drawn through the unused portion and initialed by the person keeping the log.
- Decontamination procedures.
- Documentation of any deviations from the Field Sampling Plan.
- Unusual incidents or accidents.

Original data recorded in these field logbooks, field data sheets, sample labels, or COCs should be made using indelible dark blue or black ink. None of these documents will be destroyed or discarded, even if they are illegible or contain inaccuracies.

If an error is made on any of these documents, the error will be corrected by crossing a line through the error and entering the correct information, then initialing and dating the cross-out. Any subsequent error discovered on one of these documents will be corrected by the person who made the entry, and will be initialed and dated as appropriate.

Photographs will be taken of field activities. Each photograph will have an entry in the field logbook indicating the location, date, and time it was taken. Photographs of activities such as biota sampling locations will be taken to record activities.

6. FIELD HANDLING AND DATA COLLECTION

Individual fish used for a sample will be measured for total length and weighed. Each fish will be rinsed with water to remove any sediment or detritus and inspected for anomalies and the information recorded in the field logbook and representative datasheet if applicable. Targeted species that will be used for sample preparation will be evaluated for their suitability as part of a composite sample.

Sample preparation will be specific to the laboratory conducting the tissue analysis. Selected specimens will be either wrapped in aluminum foil then bagged in plastic bags or directly bagged in plastic bags. All samples will be labeled with sample number, location, number of fish in composite, date, taxa, initials of the sampling crew, and disposition (i.e., fillet or whole body) and placed in a cooler of ice. Each sample will be provided with an internal label that is in the bag with the specimen and an external label on the bag containing the sample. At the end of each day, fish will be processed (be it filleted or whole body), composited, and either frozen and held for shipping at a later date or shipped to the laboratory immediately.

A composite sample will consist of a minimum of 3 fish collected at a specific location and of a specific trophic level (predator, bottom feeder). The number of specimens included in the composite should satisfy the tissue mass requirement by the analytical laboratory. All information regarding sample contents will be recorded in the field logbook and a representative datasheet.

7. SAMPLE HANDLING

If the project study plan specifies fillets, then samples of target species will be cut either by the field crew at the end of each day or, if preferred, by the analytical laboratory. This decision will be dictated by the laboratory prior to the initiation of the field sampling effort. Fillet samples will be prepared according to the EPA Guidance for Assessing Chemical Contamination Data for Use in Fish Advisories Volume 1 Fish Sampling and Analysis – Third Edition (November) (EPA 823-B-00-007) (EPA 2000).

Fish should be scaled prior to being filleted; do not remove the skin. To scale fish, place on a clean glass or PTFE cutting board. Run the edge of the knife blade from the tail toward the head to scrape off the scales. Cross-contamination can be avoided by rinsing the cutting board and knife with acid and distilled water. After scaling, rinse the fish with distilled water and place on a clean cutting board; the fish is then ready for filleting.

Prior to filleting, hands should be washed and rinsed with distilled water and, if gloves are worn, they should be talc-free and dust-free. Place fish on a clean glass or PTFE cutting board. Care should be taken to avoid puncturing internal organs because the fillet tissue can become contaminated from materials released from the organs. If organs are punctured, the fillet tissue should be rinsed in contaminant-free deionized distilled water and blotted dry.

Fillets should be cut as follows:

- Make a diagonal cut from the base of the cranium following just behind the gill to the ventral side just behind the pectoral fin.
- Remove the flesh and ribcage from one side of the fish by cutting from the cranium along the spine and dorsal rays to the caudal fin.
- The skin should be scored prior to homogenizing the entire fillet.

Fillets should be weighed and recorded to the nearest gram. Sample weights will vary according to project specifications. Residue from the filleting process should be placed in a double-bagged plastic trash bag and disposed of properly in a dumpster.

8. COMPOSITING TECHNIQUES AND RECOMMENDATIONS

The sample weight/size is project specific. Following is the compositing technique assuming a 200-gram (0.44-pound) sample weight. The composited sample should contain, at a minimum, three individuals of similar size. The number and length of individuals or fillets should be recorded for each composite sample.

All samples in a composite sample should be similar in length such that the product of the length of the smallest individual divided by the length of the largest individual multiplied by 100 is greater than or equal to 75 percent:

$$\frac{Minimum\,Size}{Maximum\,Size} \times 100 = \underline{\qquad} \geq 75\%$$

This will ensure similarities in age and exposure to the area in question (EPA 2000).

9. SAMPLE CONTAINERS AND PRESERVATION TECHNIQUES

Composite fillet samples will be individually labeled and placed in the appropriate container; the container type will be dictated by the analytical laboratory and/or client scope of work. Whole-body fish composites will be individually labeled with both a label in the bag and an external label, wrapped in aluminum foil, and double-bagged in clean plastic, zip-lock airtight bags as preferred by the analytical laboratory and/or client scope of work. Individual sample labels will contain the following information:

- Project number
- Sample location and station number
- Species (genus and specific epithet)
- Individual sample number
- Total number of individuals in composite
- Sampler’s initials
- Date and time of sample processing.

For shipping to the analytical laboratory, a 3-inch layer of inert cushioning material (bubble wrap) will be placed on the bottom of a waterproof cooler or ice chest. The samples will then be placed on the cushioning material and surrounded with ice double bagged in plastic bags to maintain a temperature of 4 degrees Celsius or lower. Review shipping and packing requirements with the receiving laboratory prior to sample collection to identify project- or analysis-specific requirements (e.g., use of dry ice).

A temperature blank should be included in each cooler. COC records will be completed at the time of sample preparation and compositing. All samples will be sent by overnight express to the laboratory or hand-delivered the day after collection. The COC must be signed showing any sample transfer and placed in a plastic bag taped to the inside lid of the cooler. Each cooler should have a COC for those samples contained in that cooler. The cooler/ice chest drain should be taped shut. Appropriate shipping labels are attached to the top of the cooler and “This Side Up” labels placed on all four sides of the cooler/ice chest. Lastly “Fragile” labels should be placed on at least two locations of the cooler/ice chest. Be aware of any weight limitations that a shipper may have for shipping the cooler/ice chests.

10. REFERENCES

U.S. Environmental Protection Agency (EPA). 2000. *EPA Guidance for Assessing Chemical Contamination Data for Use in Fish Advisories Volume 1 Fish Sampling and Analysis – Third Edition* (EPA 823-B-00-007). November.

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Standard Operating Procedure No. 055
for
Continuous Multi-Channel Tubing
Groundwater Sample Collection

Prepared by

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Revision 0
December 2014

CONTENTS

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the collection of groundwater samples from monitoring wells with continuous multi-channel tubing (CMT). CMT monitoring wells are used to collect groundwater samples from many discretely isolated zones within a single monitoring well. This SOP will cover groundwater sampling protocol for dedicated CMT systems that have already been installed in a monitoring well, in accordance with the manufacturer recommendations. For general protocols for groundwater sample collection, consult SOP No. 013 – Collection of Monitoring Well Samples.

2. MATERIALS

The following materials may be required:

Air compressor (12V)	Personal protective equipment
Contractor garbage bags	Phosphate-free, laboratory grade detergent (e.g., Liquinox, Alconox, etc.)
Drum for purge water	Photoionization detector
Gas source (nitrogen)	Pump (peristaltic, mini-inertial, or double valve)
Heavy plastic sheeting	Stiff bristle brush
Log book	Tubing (pump specific)
Multi-parameter meter	Wash and rinse tubs

3. PROCEDURE

3.1 GENERAL

Groundwater sampling will follow these general steps:

- Arrive onsite
- Set up apparatus (compressors, pumps, etc.)
- Glove
- Use photoionization detector to collect organic vapor readings
- Collect water level and well depth measurements
- Purge well
- Collect samples (see SOP No. 013 – Collection of Monitoring Well Samples for specifics)

- — Using a peristaltic pump to sample (Section 3.3)
- — Using a mini-inertial pump to sample (Section 3.4)
- — Using a double-valve pump to sample (Section 3.5)

- Decontaminate/reglove

- Decontaminate/dispose of wastes and move equipment to next site.

3.2 WELL PURGING GENERAL RULES

Water within the casing of a well will stagnate, de-gas, loose volatiles, possibly precipitate metals due to changes in redox potential, and may react with the screen and/or casing material. It is, therefore, necessary to purge a sufficient volume of this stagnant water from the well and/or casing to ensure that a representative sample of formation water can be obtained. Monitoring of select chemical and physical properties of the sample medium will be used to determine when a representative sample may be taken from a well.

Acceptable purge/sampling devices for CMT sampling include: peristaltic pumps, mini-inertial pumps, or double valve pumps. It is recommended to purge and sample at similar rates with one type device per well. For shallow wells (<25 ft deep), peristaltic pumps are sufficient for purging. In situations where the water level is >25 ft deep but <150 ft deep, then a mini-inertial pump is recommended; if the well is >150 ft deep, a double valve pump shall be used for purging. If the well is fast recharging, then a high discharge double valve pump shall be used to purge the well, and a peristaltic or mini-inertial pump shall be used to sample the same well. However, peristaltic and mini-inertial pumps can cause volatilization; therefore, when sampling for volatile organic compounds, double valve pumps will be used for sample collection.

Due to the small diameter tubing used for CMT (0.5-inch [in.], 3/8-in., or 0.25-in. inner diameter), water levels cannot usually be monitored using a water level indicator while the pump is installed; therefore, the well is usually purged until three consecutive readings of the following selected in-line water quality stabilization parameters vary by 10 percent or less: temperature, conductivity, pH, turbidity, redox potential, and dissolved oxygen level. In the case of relatively large diameter tubing, narrow diameter water level indicators can be used to monitor water level before and after purging for hydraulic influence from purging.

Purge water will be containerized (per project-specific Work Plan) until analysis of samples is completed. Based on sample results, accumulated purge water will be properly disposed (per project-specific Work Plan).

3.3 CONTINUOUS MULTI-CHANNEL SAMPLING WITH PERISTALTIC PUMP

The peristaltic pump will draw a sample of water if the water level is within an estimated 25 ft of ground surface at sea level. The peristaltic pump is most often used with 0.25-in. diameter low density polyethylene (LDPE) tubing that is lowered into the channel of the CMT. Once the

LDPE tubing is lowered to the desired sampling depth, connect it to flexible tubing[1] that has been placed into the linear or circular pump casing (dependent upon model of peristaltic pump in use). Once that connection is made, connect another piece of LDPE tubing to the other end of the flexible tubing, which will discharge into the sampling bottle. The rate of pump speed can be manually adjusted to the desired purge/sample frequency, per the manufacturer's guide for the type of peristaltic pump in use.

After stabilization (Section 3.1), collect samples for laboratory analysis. Filtration of metal samples will be accomplished using an in-line filter attached to the tubing discharging into the sample bottle (Section 3.1 and SOP No. 013). This sampling method is not appropriate for the collection of volatile organic compound samples as peristalsis introduces air into the sample; thereby affecting the sample results.

3.4 CONTINUOUS MULTI-CHANNEL SAMPLING WITH MINI-INTERTIAL PUMP

Where the water level is too deep for a peristaltic pump (>25 ft below ground surface [bgs]), but no deeper than 150 ft bgs, the mini-inertial pump is recommended. The mini-inertial pump consists of a length of polyethylene tubing with a check valve placed at its base.

The mini-inertial pump tubing is 0.25-in outer diameter × 0.17-in. inner diameter LDPE, or Teflon-lined LDPE can be used for applications up to 50 ft bgs. At depths ranging from 50 to 150 ft bgs, pure Teflon should be used to reduce the friction effects encountered at greater depths. The check valve assembly will be pushed into the base of the 0.25-in. tubing using an insertion tool that is similar to a short, narrow diameter screwdriver. The tubing is then lowered into the CMT port within the well to the desired sampling depth, and the sample is collected by raising and lowering the system, usually by hand and approximately 1 ft; a pulse or slug of groundwater migrates up the tubing and can be collected at the surface.

3.5 CONTINUOUS MULTI-CHANNEL SAMPLING WITH DOUBLE VALVE PUMP

The double valve pump can be used for deep or shallow wells and is ideal for volatile organic compound sampling at sites where peristaltic or mini-inertial pumps are not considered appropriate. The double valve pump is connected directly to each tubing port. Polyethylene or Teflon® tubing of the pump connects directly to the CMT ports at the wellhead. Purging and sampling of groundwater from some or all CMT levels can be accomplished simultaneously by double valve pumps equipped with multi-purge manifolds, a feature not common to every automatic double valve pump.

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[1] It is important to select tubing with appropriate chemical resistance toward the liquid being pumped. Types of tubing commonly used in peristaltic pumps include: polyvinyl chloride, silicone rubber, and fluoropolymer.

Sampling setup:

- Push the double valve pump tubing inserts into the CMT. The double valve pump tubing should be fed into the drive and sample compression fittings of the double valve pump. The compression fitting nuts may have to be loosened before the tubing is inserted.
- Lower the assembled double valve pump to the wellhead.
- Connect the "air in" line from the 12V air compressor (connected to the battery in the truck or portable battery) or gas source (i.e., nitrogen) to the quick connect fitting on the electric control unit.
- Connect the "air out line" to the quick connect fitting on the side of the pump head manifold.
- This feeds air or nitrogen to the drive line, which is the larger diameter tubing.
- The smaller inner tube is the sample line.

Sample collection:

- Insert the sample line at surface into the sample container.
- Adjust the control unit "Pressure Regulator" to the appropriate value.
- Adjust the Drive and Vent times on the electric control unit to adjust the sampling flow rate to the desired amount.
- During the Drive period on the control unit, the sample line will produce the water sample. During the Vent period on the control unit, the Drive Line is filling again under hydrostatic pressure.
- Select the desired flow rate from the pre-set screens. Use the flow regulator to adjust flow to the desired rate. If a higher flow is required, slowly increase the Drive time to increase the flow rate. If air is expelled, decrease the Drive time. To further optimize the flow rate, increase or decrease Vent time until the highest flow rate is achieved.
- Once optimum flow rates have been achieved, record the pressure, flow rate, and timer settings for subsequent sampling dates in the field log book. For example, with an 85 ft double valve pump assembly, a static water level of 60 ft bgs, and a pump pressure of 50 psi ([85 ft × 0.4] + 10 psi), a suitable drive of 11 seconds and vent of 9 seconds will produce a flow rate of approximately 150 milliliter/minute.

- Monitor water quality stabilization parameters beginning immediately, using an in-line monitoring system not exposed to the atmosphere. When these parameters stabilize to within 10 percent over three consecutive readings, begin collecting samples per SOP No. 013 – Collection of Monitoring Well Samples.

- Upon completion of sample collection, remove and decontaminate water level probe and pump.

3.6 DECONTAMINATION

All non-dedicated CMT sampling equipment must be thoroughly cleaned before and after each use to allow retrieval of representative groundwater samples. Scrub all metal parts with a stiff, long bristle brush and a non-phosphate soap solution. Steam cleaning may be substituted where available. Rinse with distilled water and allow to air-dry before assembly.

Refer to SOP No. 005 – Field Decontamination for additional information.

4. MAINTENANCE

Refer to manufacturer's requirements for maintenance of pumps and compressors and specific sampling techniques or requirements.

5. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for appropriate personal protective equipment.

6. REFERENCES

EA Engineering, Science, and Technology, Inc., PBC (EA). 2014a. Standard Operating Procedure No. 005 – Field Decontamination. December.

EA. 2014b. SOP No. – 013 Collection of Monitoring Well Samples. December.

(U.S.) Environmental Protection Agency (EPA). 1993. Subsurface Characterization and Monitoring_Techniques, Volume 1, Appendices A and B. May.

Website: *http://www.solinst.com/* – Bladder Pump Operating Instructions.

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Standard Operating Procedure No. 056
for
X-Ray Fluorescence Analysis of Soil

Prepared by

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Revision 1
January 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

A. ☐ **Variances required; cite section(s) of the SOP to which there is a variance (add additional pages if necessary)**

B. ☐ **No variances**

SOP No. 056	
SOP Section	**Variance**

Project Manager (Name) Date

Project Manager (Signature) Date

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CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	Revision Date	Revision Summary	Revised By	Reviewed By
1	January 2018	Updated protocols/information in Sections 2, 3, 4, 5, and 7.	Caron Mierczak	Amy Sponaugle Steve Yankay Pete Garger Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe protocols for using an Innov-X Systems Alpha 4000SL or Niton XL3t GOLDD tube-based x-ray fluorescence (XRF) analyzer for field analysis of soil samples for metals. Quality control protocols in this SOP are consistent with the protocols identified in U.S. Environmental Protection Agency (EPA) Method 6200 (EPA 2007). Client-specific quality control protocols regarding sample preparation and analysis for the U.S. Army Corps of Engineers (USACE)–Omaha District have been included in this SOP.

Any client-, project-, or site-specific variances to this SOP (if any) are documented on the Project-Specific Variance Form, located immediately after the SOP title page. Prior to using this SOP, field personnel should refer to the Project-Specific Variance Form to verify whether any variances are required.

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternative equivalent brands of detectors, sensors, meters, etc. are acceptable.

2. MATERIALS

The following materials may be required:

Innov-X Systems x-ray tube-based XRF with Compaq personal data assistant (PDA) that includes appropriate expansion card and Innov-X Software OR ThermoScientific/Niton XL3t GOLDD XRF with Mini-USB to USB cable	
Laptop computer	Plastic zipper-type bags (1-mil thickness)
Battery for XRF	Containers (for sample collection and storage)
Battery charger for personal computer	2-mm mesh sieve(s)
Standard Reference Material (SRM) for calibration check of XRF	Silicon blank
Soil test stand/bulk sample analyzer sled	Paper towels
Mylar, Kapton, Spectroleen, polypropylene, or equivalent film	Paperwork (applicable regulations and licenses, XRF Operators' Manual, and emergency contacts)
Polyethylene sample cups (31- to 40-millimeters [mm] in diameter with collar)	Proper site-specific personal protective equipment and dosimetry

3. GENERAL

Procedures for handling and control of company-owned and rented equipment containing radioactive materials and x-ray tubes are specified in the EA Engineering, Science, and Technology, Inc., PBC (EA) Radiation Protection Program (EA 2014), which is administered by the Radiation Safety Officer (RSO), under direct supervision of EA's Corporate Health and Safety Director. Personnel using this SOP must be familiar with the procedures identified in the Radiation Protection Program (EA 2014).

The use of radioactive materials and x-ray generating equipment is highly regulated by federal and state agencies. Licensees of radioactive materials and x-ray generating equipment are required to follow regulatory requirements and are subject to periodic inspections. Licensees may face disciplinary action by federal or state agencies if determined to be out of compliance with regulations. The RSO must be informed about any XRF usage (rental or company-owned) prior to use, including the scheduled timeframe of use; the state within which the XRF will be used; and the safety and security measures that will be enforced during transportation (either over land or by air), storage, and use of the instrument. Licensing, registration, or reciprocity may be required prior to using the XRF (i.e., a certificate of reciprocity or license/registration might be required from the destination state). In addition, per EA policy, the RSO will assign dosimetry badges to the operators (regardless of whether the instrument is EA-owned or rented) to measure potential radiation dose. Dosimetry is personnel-specific (i.e., cannot be shared by multiple personnel), and must be replaced every 3 months.

The XRF shall be operated by a trained operator, knowledgeable in aspects of radiation safety. Operators need to complete the manufacturer's-specific operator's training, transport of lithium-ion batteries training, and EA's Radiation Safety Training and Hands-On XRF Operational Training. All certificates of training completion must be received and documented by the RSO prior to using the XRF.

The XRF should be operated in a clean environment, out of direct sunlight, and without significant concentrations of dust.

The XRF shall be in direct control of a trained XRF operator at all times. When not in use, the XRF shall be placed within a locked case, and stored in a locked storage area (i.e., cabinet), in a locked room or building when not in use ("triple locked").

Batteries are provided for portable operation of the XRF; however, the batteries have a limited operating time. It is highly recommended to connect the unit to an alternating current power source, especially for operating times exceeding 4 hours. Failure of the batteries during a screening session may result in data loss. After each portable operation, the instrument batteries must be recharged before resuming operations.

4. QUALITY CONTROL

The RSO will ensure that the XRF adheres to manufacturer's specifications for calibration. Onsite calibration verification checks will be performed by the operator. The quality control protocols specified in this section are consistent with the protocols identified in EPA Method 6200 (EPA 2007).

The accuracy of the XRF can be evaluated by performing calibration verification checks. These checks are performed by analyzing SRMs traceable to the National Institute of Standards and Technology (NIST). A minimum of two SRMs will be analyzed daily: once at the beginning of the day and end of the day, or at the beginning of the day and after every 20th sample, whichever occurs first. The actual (NIST-certified) concentration of the SRM as well as the concentration displayed by the XRF will be recorded (NIST certified concentrations can be obtained from the RSO or the NIST website: https://www-s.nist.gov/srmors/viewTableH.cfm?tableid=86).

The relative percent difference (RPD) between the actual and displayed concentrations will be calculated as follows:

$$RPD = [2(SRM-R)/(SRM+R)] \times 100$$

where

SRM = Concentration of the standard reference material.
R = Displayed concentration from XRF.

The result will be compared to the project data quality objectives (DQOs), if applicable, to evaluate if the XRF accuracy is within project limits. A typical DQO for this indicator is +/20 percent. Note that a site-specific sample with a known concentration of the compound(s) of interest may be used in lieu of an SRM to perform the calibration verification checks; however, this SOP deviation should be noted on the Project-Specific Variance Form.

To assess the precision of the XRF, a precision analysis may be performed. If project DQOs do not require a precision analysis, it will be noted on the Project-Specific Variance Form. The precision analysis is performed by running 10 replicate analyses on the same site sample and calculating the relative standard deviation (RSD) of the sample mean as follows:

$$RSD = (SD/Mean\ Concentration) \times 100$$

where

RSD = Relative standard deviation for the precision measurement for the analyte.
SD = Standard deviation of the reported analyte concentration for the precision sample.
Mean Concentration = Mean analyte concentration of the seven replicate analyses.

The site sample should have detectable concentrations of metals (i.e., above the instrument's detection limits). Precision analysis should be performed at a minimum of once per day, but may be required more often depending upon the project DQOs (the Project-Specific Variance Form will document if this analysis is not required). A typical DQO for this indicator is <20 percent.

Duplicate analysis (or triplicate) is another quality control check that may be performed on the XRF (the Project-Specific Variance Form will document if this analysis is not required). A typical duplicate analysis scheme would require the preparation and analysis of a duplicate sample at a rate of 1 per every 20 normal site samples. A duplicate is a second sample collected and prepared as a normal sample would be. The duplicate is analyzed and the results compared to the normal sample by calculating the RPD. The DQO for duplicate samples is project specific; however, a typical objective is an RPD of no more than 30 percent.

An alternative to duplicate sample analysis would be replicate sample analysis. Replicate sample analyses are two analyses of the same prepared sample. Generally, the sample is moved/rotated; re-homogenized; or, if prepared in a sample cup, inverted (on a double open-ended cup) for the second analysis. This approach assesses comparability between results without interference from field sampling variability. The replicate sample results are compared to the normal sample results in the same manner as a duplicate sample analysis.

Blank analyses may be performed to assess whether equipment cross contamination is occurring. Two types of blank sample analyses are typical: instrument blank and method blank.

The instrument blank is performed by analyzing silicon dioxide (or clean sand), a Teflon block, or a quartz block. The frequency of blank analysis is dependent upon project DQOs but is typically performed twice daily, prior to and after sample analyses for that day (the Project-Specific Variance Form will document if this analysis is not required). Typically, the instrument blank analysis is performed concurrently with the SRM calibration verification analysis. Instrument blanks may also be performed after every 20 samples; again, depending on project DQOs. Results should be below detection.

Method blanks are performed to monitor decontamination efficiency on equipment that is not dedicated. The blank is performed by substituting clean sand in the sample preparation process, and analyzing in the same manner as a site sample. Results should be below the instrument's detection limits.

5. SITE SAMPLE PREPARATION AND ANALYSIS

Sample preparation is dependent upon project DQOs and may be different than the preparation described herein (the Project-Specific Variance Form will document any deviations to this protocol). More rigorous sample preparation protocols are available (e.g., EPA Method 6200 [EPA 2007]). The project planning document and DQOs should be referenced to determine if the method described herein is adequate for any specific project.

- Don appropriate personal protective equipment as required by the project health and safety plan; at a minimum, gloves and radiation dosimetry will be utilized.

- Collect soil sample as described in the project planning documents, including a minimum of 50 grams of soil for XRF analysis.

- If the sample is noticeably wet (>20 percent moisture), dry the sample in an oven. Alternatively, the samples may be dried with paper towels and/or by allowing the sun to evaporate the moisture. Microwave drying is not recommended; field studies have shown that microwave drying can increase variability between XRF data and confirmatory analysis, and metal fragments in the sample can cause arcing to occur in a microwave.

- Inspect the sample to ensure no foreign (non-soil) materials are present in the sample (i.e., paint chips, lead shot, concrete chips, leaves, rocks, or asphalt). Note the presence of foreign matter in the project log. If the quantity of foreign material is such that removal is impractical, note in the project log that the foreign material could not be removed.

- Pass soil through a decontaminated 2-mm mesh sieve collecting the soil in a dedicated zipper-type plastic bag, labeled with the sample identification. This step may be eliminated in lieu of hand processing (removal of stone, debris, lead shot, paint chips, and organic material) of the sample simultaneously with the following step, but should be noted on the Project-Specific Variance Form if this method is performed.

- Homogenize the soil by rolling the soil within the bag, being sure to break up large clumps of soil.

- Assemble a sample cup, label with sample identification, and pack the soil tightly into the cup. Cover the cup with polypropylene (or equivalent) film and use the collar to secure in place. This step may be eliminated for the analysis of the sample through the zipper-type plastic bag, but should be noted on the Project-Specific Variance Form if this method is performed.

- Place the sample cup/zipper-type bag onto the soil test platform. Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases as the distance from the radioactive source increases. This error is minimized by maintaining the same distance between the window and each sample. For the best results, the window of the probe should be in direct contact with the sample, which means that the sample should be flat and smooth to provide a good contact surface.

- Initiate the XRF reading using the trigger or start button on the PDA.

- Allow the analyzer to run and collect data for a nominal sample time of 60 seconds; a project-specific variation to the nominal sample time will be noted on the Project-Specific Variance Form.

- Record the sample designation and result(s) in either a field logbook or on appropriate data sheets.

- Retain the cupped/bagged sample for possible laboratory confirmatory analysis.

- Use the same procedure for the analysis of method blank, duplicate, replicate, SRMs, and precision analysis samples.

- Download the XRF data daily to a computer (if possible). Back up the data to a server, disc, or compact disc.

The comparability and quality of the XRF analysis are determined by submitting XRF-analyzed samples for confirmatory analysis to a laboratory. The confirmatory samples must be splits of the homogenized sample material. A minimum of 1 sample for each 10 XRF-analyzed samples should be submitted for confirmatory analysis (for USACE–Omaha projects, they request a minimum of 12 samples for confirmation). Note on the Project-Specific Variance Form if there is a deviation from this frequency. The confirmatory samples should be selected from the lower, middle, and upper range of concentrations measured by the XRF. They should also include samples with analyte concentrations at or near the site action levels or project remedial goals. The results of the confirmatory analysis and XRF analyses should be evaluated with a least-squares linear regression analysis. If the measured concentrations span more than one order of magnitude, the data should be log-transformed to standardize variance that is proportional to the magnitude of measurement. The correlation coefficient (r) for the results should be 0.7 or greater for the XRF data to be considered screening level data (EPA 2007). If the r is 0.9 or greater and inferential statistics indicate the XRF data and the confirmatory data are statistically equivalent at a 99 percent confidence level, the data could potentially meet definitive level data criteria.

6. PRECAUTIONS

The XRF produces ionizing radiation in the x-ray spectrum. This SOP and the precautions herein are applicable to the Innov-X Systems Alpha 4000SL or the ThermoScientific/Niton NL3t GOLDD tube-based instruments. Additional precautions not contained herein are necessary if utilizing a radioactive source-based XRF (e.g., cadmium-109). The tube-based instrument is capable of producing x-rays when the instrument is powered and an analysis initiated. The instrument has a red light near the shutter that will flash when the instrument is emitting x-rays. When the shutter is open, and the light is flashing, the instrument is emitting x-rays. At this time, the following must be observed:

- Always be aware of the location of the tube and direction of the x-ray beam.
- Open the shutter only to conduct a test.
- The person conducting the XRF analysis must be a trained operator in accordance with the requirements in Section 3 and is required to wear dosimetry.

The XRF is able to function as a handheld screening tool by wielding the detector by hand and pressing it to the sample for analysis. For soil screening, this action has the potential of exposing the operator to inadvertent x-ray radiation. For this reason, it is highly recommended that the operator make use of the manufacturer-specific stand that incorporates x-ray shielding, automatic x-ray beam shut-off safety features, and protects the operator from exposure. Any deviation from use of the soil test stand must be approved by the RSO.

EA's emergency procedures for the XRF (in the event that the XRF unit is damaged, destroyed, lost, or stolen) are provided to authorized users and will be used in the event of an emergency.

Decontamination of the soil test stand is to be restricted to wiping the test stand with a damp cloth. Any additional decontamination procedures must be approved by the RSO.

7. REFERENCES

EA Engineering, Science, and Technology, Inc. (EA). 2014. Radiation Protection Program. August.

U.S. Environmental Protection Agency (EPA). 2007. Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment. Method 6200. February.

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Standard Operating Procedure No. 059
for
Field Logbook

Prepared by

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Revision: 1
December 2014

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1. SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording field survey and sampling information in the Field Logbook.

2. MATERIALS

The following materials may be required:

- Field Logbook (Teledyne 415 Level Book, or equivalent)[1]
- Indelible ink pen (e.g., Sharpie®).

3. PROCEDURE

All information pertinent to a field survey or sampling effort will be recorded in a bound logbook. Each page/form will be consecutively numbered, dated, and signed. All entries will be made in indelible ink, and all corrections will consist of line-out deletions that are initialed and dated. The person making the correction will provide a brief explanation for the change. Entries are factual only. No personal opinions should be entered.

There should be no blank lines on a page. A single blank line or a partial blank line (i.e., at the end of a paragraph) should be lined to the end of the page. If only part of a page is used, the remainder of the page should have an "X" drawn across it. The bottom of each page must be signed and dated by the field personnel entering the information.

At a minimum, entries in the Field Logbook will include but not be limited to the following:

- Date.

- Project number and project name.

- Name and address of field contact.

- Identification of sample crew members.

- Documentation should include model numbers of equipment used (e.g., drilling rigs) and calibration (if applicable). Each day's entry should begin with time onsite, who is onsite (including observers other than the sampling crew), brief description of what work will be performed that day and how, and the weather.

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[1] Pre-printed, bound forms are approved as well. See SOP No. 016 for recommended content and format.

- If samples are being taken in or near tidal waters, the time of high and low tide for the site should be determined from local gauges or tables and recorded.

- References such as maps of the sampling site.

- Times of key daily milestones should be entered (e.g., time borings began, times personnel arrived and left site, times subcontractors arrived and left site, etc.). Time should be recorded in the left-hand margin on the page in military time.

- Sample-specific information:

  — Unique, sequential field sample number

  — Purpose of sampling

  — Location, description, and log of photographs of each sampling point

  — Details of the sample site (e.g., elevation of the casing, casing diameter and depth, integrity of the casing, etc.)

  — Documentation of procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., filters and absorbing reagents)

  — Type of media of sample (e.g., groundwater, surface water, soil, sediment, and product)

  — Suspected waste composition

  — Number and volume of sample taken

  — Sampling methodology, including distinction between grab and composite sample

  — Sample preservation

  — Date and time of collection

  — Collector's sample identification number(s)

  — Sample shipment (e.g., name of the laboratory and cartage agent: Federal Express, United Parcel Service, etc.)

  — Field observations (e.g., oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, moisture content, layering, Unified Soil Classification System classification, etc.)

- Any field measurements made (e.g., pH, conductivity, explosivity, water depth, organic vapor analyzer readings, etc.)
- Signature and date by the personnel responsible for observations
- Decontamination procedures.

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a Field Logbook. However, records should contain sufficient information so that someone can reconstruct the sampling activity without relying on the sampler's memory. Further, the project work plan or field sampling plan should be reviewed to identify additional specific information or requirements that should be included in the Field Logbook.

The Project Manager will keep a master list of all Field Logbooks assigned to the Sampling Team Leaders. One Field Logbook kept by the Project Manager will be a master site log of daily activities and will contain the list of Field Logbooks assigned to Sampling Team Leaders.

Project name and number should be clearly marked on the outside cover using indelible ink. If more than one Field Logbook exists for the project, then the number of the Field Logbook should also be clearly marked on the outside cover.

4. MAINTENANCE

At the end of the field sampling effort, the Field Logbook should be scanned and filed in the electronic file for the project and maintained according to the EA Records Retention Policy or contract requirements.

5. PRECAUTIONS

None.

6. REFERENCES

EA Engineering, Science, and Technology, Inc., PBC. 2014. Standard Operating Procedure No. 016 for Surface Water, Groundwater, and Soil/Sediment Field Logbooks. December.

U.S. Environmental Protection Agency. 1980. *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, QAMS-005/80.

———. 1990. *Sampler's Guide to the Contract Laboratory Program*. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C. December.

———. 1991. *User's Guide to the Contract Laboratory Program*. EPA/540/O-91/002, Directive 9240.0-01D. Office of Emergency and Remedial Response. January.

Standard Operating Procedure No. 073
for
Sampling for Per- and Polyfluorinated Alkyl Substances

Prepared by

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Revision 1
June 2019

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**check Box A**), or if this SOP is being used with no changes (**check Box B**). This form should be archived with the project files.

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 073	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	June 2019	Note regarding water-tight lids	F. Barranco	F. Barranco

1. SCOPE AND APPLICATION

The objective of this Standard Operating Procedure (SOP) is to delineate protocols for collecting environmental samples for analysis of per- and polyfluorinated alkyl substances (PFAS), also known generally as perfluoroalkyl compounds or chemicals (PFCs).

This SOP includes sampling procedures and requirements specific to analysis of PFAS, which are ubiquitous and have a high potential for cross-contamination from common consumer products and sampling materials, even when new and clean. This SOP should be used in combination with appropriate SOPs applicable to the target medium and sampling methodology (e.g., but not limited to SOP No. 007 Surface Water Sampling, SOP No. 013 Collection of Monitoring Well Samples, SOP No. 21 Sediment Sampling, SOP No. 25 Soil Sampling, or SOP No. 047 Direct-Push Technology Sampling).

This SOP was developed primarily based on guidance from the U.S. Army Corps of Engineers (2016) and the Interstate Technology Regulatory Council (ITRC 2018).

2. ACCEPTABLE MATERIALS

Table 1 provides a summary of Prohibited Items that should NOT be used or present during sampling for PFAS because they may contain PFAS, along with Acceptable (PFAS-free) Alternatives that may be used if appropriate for project requirements. In general, in the context of sampling events, PFAS are commonly found in waterproof and nonstick materials (including food packaging, rain gear, and anything containing Teflon®), personal care products, and certain plastics (e.g., low-density polyethylene [LDPE]) and synthetic fibers.

Table 1. Prohibited Items and Acceptable Alternatives for Use during PFAS Sampling

Prohibited Items	Acceptable Alternatives
Field Equipment	
Teflon-containing or LDPE materials (including tubing, bailers, tape)	HDPE or silicone materials
Waterproof field books, plastic clipboards, binders, or spiral hard cover notebooks	Loose paper (non-waterproof) on aluminum or Masonite clipboards
Sharpies®/markers, waterproof pens	Non-waterproof pens or pencils
Sticky notes (e.g., Post-It®) and glues	Not applicable
Re-usable chemical (blue) ice packs	Regular ice in polyethylene bags (double bagged)
Aluminum foil	Thin HDPE sheeting
Plastic spoons used in soil/sediment sampling	Stainless steel trowels/spoons
Reusable core liners	Single-use PVC or acetate liners
LDPE HydraSleeve	HDPE HydraSleeve
Field Clothing and Personal Protective Equipment	
New cotton clothing; synthetic water resistant, waterproof, or stain- treated clothing; clothing containing Gore-Tex™	Well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase, made of natural fibers (preferably cotton)
Clothing laundered using fabric softener	No fabric softener
Boots (e.g., steel-toed or waders) containing Gore-Tex™ or waterproof coatings	Boots made with polyurethane or PVC with no waterproof coating

Prohibited Items	Acceptable Alternatives
Coated Tyvek® suits	Uncoated/plain Tyvek suits not containing PFAS
Cosmetics, shampoo, conditioner, body gel, moisturizers, hand cream, waxed dental floss, or other personal care products used on the day of sampling.	Use bar soap not containing moisturizers and rinse well on the day of sampling (including for hand washing). Use any other required products the night before (rather than the day of) sampling.
Paper towels	Air dryers (for hand drying)
No sunscreens or insect repellents except approved 100% natural products such as those noted in the Alternatives column.	**Acceptable Sunscreens:** Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss My Face, "free" or "natural" sunscreens for babies **Acceptable Insect Repellents:** Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect Repellant, Herbal Armor, California Baby
Sample Containers	
LDPE or glass containers	HDPE containers (or polypropylene if required)
Teflon-lined caps	Unlined HDPE (or polypropylene if required) caps
Rain Events	
Rain gear that has been treated to make it waterproof/resistant and breathable (e.g., Gore-Tex™ treated)	PVC or polyurethane- or wax-coated rain gear that is confirmed not to contain PFAS, or utilize a gazebo tent that is only touched or moved prior to and following sampling activities.
Equipment Decontamination	
Decon 90	Alconox®, Liquinox®, and/or Citranox®
Water from an onsite well	Potable water from municipal drinking water supply (not containing PFAS), and "PFAS-free" deionized water for final rinse
Food Considerations	
All food and drink, with exceptions noted in the Alternatives column. Paper food packaging (e.g., fast food wrappers, drink cups, paper bags) and foil, in particular, often contain PFAS.	Bottled water and hydration drinks (i.e., Gatorade® and Powerade®) to be brought and consumed only in the staging area
NOTES: HDPE = High-density polyethylene. PVC = Polyvinyl chloride.	

If a plastic product or chemical not included in the Acceptable Alternatives column of Table 1 is proposed for use, it is recommended that Safety Data Sheets and other references be reviewed prior to use to confirm that the material does not contain PFAS. Indications of potential PFAS ingredients, in addition to the items listed in Table 1, include the following materials (ITRC 2018):

- Polytetrafluoroethylene (fluorocarbon solids such as Teflon)
- Fluorinated ethylene propylene
- Ethylene tetrafluoroethylene
- Polyvinylidene fluoride
- Generally, any other ingredient names containing the prefix "fluoro."

Specific to the use of HDPE sample containers, note that the associated lids are not typically "water-tight." Therefore, HDPE sample containers should be individually placed in water-tight bags prior to placement in shipping containers loaded with ice.

3. PROCEDURES

As stated above, this SOP includes procedures specific to analysis of PFAS, and should be used in combination with the appropriate SOPs applicable to the target medium and sampling methodology.

3.1 GENERAL CONSIDERATIONS

Materials listed in the Prohibited Items column of Table 1 and other materials containing PFAS ingredients should not be used. However, in some cases, these materials must be used due to factors outside the control of the scope of the work or utility of the project team (e.g., health and safety requirements where other hazardous chemicals are present, or where the sampling requirements are prescriptive, unexpected, or time-sensitive). In these cases, the sampling team should purge/rinse equipment adequately with PFAS-free water where available, and collect additional quality control samples (Section 3.7) to assess the degree of cross-contamination associated with the use of known or suspected PFAS-containing materials during sampling.

NOTE: Most steel-toed boots are made from coated leather and synthetic fibers. PVC or polyurethane are preferred PFAS-free materials for boots. If not possible to obtain PFAS-free footwear that comply with specified health and safety requirements for personal protective equipment, then field personnel should minimize contact with footwear while in the sampling area, and always change gloves after touching footwear.

Disposable nitrile gloves shall be worn at all times during PFAS sampling activities. A new pair of nitrile gloves shall be donned after contacting potential contaminants including all non-decontaminated surfaces. New gloves shall also be donned before touching containers used for storage of PFAS samples, decontaminating re-usable sampling equipment, or handling quality control samples (Section 3.7).

Food shall not be eaten within 10 meters of any sampling area. Before eating or drinking, sampling personnel shall remove their gloves and any outer garments (e.g., coveralls) and leave the work area. When finished, sampling personnel shall wash their hands, remove any visible residue, and put new gloves and any outer garments back on prior to returning to the work area.

PFAS-containing stain resistant products are often applied to vehicle seats that have fabric upholstery. Therefore, if no outer garments (e.g., coveralls) will be worn, or if the outer garments will be worn in the field vehicle then, if feasible, the seats of the vehicle should be covered in a well-laundered cotton blanket to avoid contact between clothing and the seats.

Visitors to the sampling area shall remain at least 10 meters at a distance.

As indicated in Table 1, sampling personnel shall not use the personal care products or cosmetics (other than bar soap) prior to or during sample collection on any day. Additionally, clothes worn during sampling should be well-washed natural fibers.

Other personnel who come within 2-3 meters of the sample collection area should follow the guidelines above and in Table 1.

Fluids used during laboratory- or fieldwork (e.g., drilling for monitoring well installation or for deep soil sampling) should be confirmed PFAS-free.

When sampling on a surface water body, associated gear (e.g., waders, life preservers) should be confirmed PFAS-free.

3.2 EQUIPMENT DECONTAMINATION

Wherever possible, dedicated or disposable equipment shall be used to avoid the need for decontamination, which introduces additional potential for cross-contamination.

Large field equipment (e.g., drill rigs) should be decontaminated with potable water using steam or high-pressure water. Laboratory-certified "PFAS-free" water should be used to perform a final rinse of portions of the sampling equipment that will be in direct contact with samples, wherever practical.

Hand-held, non-dedicated sampling equipment, which is used at multiple field sampling locations, shall be decontaminated using the following procedure:

- Rinse with a non-PFAS-containing detergent (e.g., Alconox, Liquinox, or Citranox)
- Rinse with laboratory-provided, "PFAS-free" water (Grade 3 distilled, Millipore deionized)
- Rinse with methanol
- Rinse with laboratory-provided, "PFAS-free" deionized water.

The Safety Data Sheet for the selected detergent should be reviewed to ensure that it does not contain fluoro-surfactant ingredients.

Wherever possible, equipment should be rinsed with "PFAS-free" water immediately prior to use at each sampling location.

3.3 SAMPLE COLLECTION AND PRESERVATION

The sampling team shall coordinate with the analyzing laboratory regarding requirements for sample bottle, volume, and preservation requirements for samples for PFAS analysis, and the laboratory should provide certified "PFAS-free" containers. HDPE bottles with unlined caps are typically used for collection of samples for PFAS analyses. Polypropylene may also be used for specific applications (e.g., collection of drinking water samples to be analyzed for the short list of PFASs by Method 537) (Department of Defense Environmental Data Quality Workgroup 2017).

Containers for collection of PFAS samples shall never be left uncapped, either before or after sample collection, and the lid/cap shall be kept in a gloved hand and not be set down while removed from the container.

Sampling personnel shall put on a clean pair of nitrile gloves immediately prior to collection of each sample for PFAS analyses, prior to removing the lid from the sampling container. After the sample is collected and the container is closed, pens or pencils, but not markers, shall be used in completing sample labels or in the vicinity of samples during collection.

Following sample collection and addition of preservative (if required), sample containers for PFAS analyses shall be placed in coolers with new, double-bagged ice and not re-usable chemical ice packs unless confirmed PFAS-free and regulatorily accepted, such that meltwater does not contact sample containers during transport.

3.4 SOIL/SEDIMENT SAMPLING CONSIDERATIONS

Surface soil and sediment samples for PFAS analyses should be collected using a clean, stainless-steel tool (e.g., a trowel or Ponar grab sampler).

For field collection of soil and sediment cores, single-use PVC, HDPE, or acetate liners shall be used, and samples for PFAS analysis should be collected from the cores directly or using a stainless-steel tool.

3.5 GROUNDWATER SAMPLING CONSIDERATIONS

It is recommended that, where feasible, measurements of monitoring well water levels and well depths be performed after sampling for PFAS to avoid possible cross-contamination.

HDPE or silicone tubing shall be used for purging and sample collection, where applicable. Teflon and LDPE shall NOT be used. During sampling, sampling personnel shall ensure that no tubing or other equipment contacts the inside or rim of the sample bottle. Any foaming observed in the sample during collection should be noted on the chain-of-custody form that accompanies the samples to the analytical laboratory.

If analyses to be performed by the laboratory include less common PFAS chemicals that have relatively high volatility (including fluorotelomers and sulfonamide/alcohols such as fluorotelomer alcohols, fluorotelomer acrylates, and methyl/ethyl fluorosulfonamides and sulfonamidoethanols), then precautions should be taken during sample collection to minimize loss of volatiles (e.g., minimizing turbulence in water as it flows into the sample container).

If use of passive/no-purge sample collection technology is to be utilized, it is critical to confirm that the sampling device does not contain LDPE (e.g., HydraSleeves made of HDPE rather than LDPE may be requested for PFAS sampling).

Filtration is not recommended because the filter may sorb PFAS or be a source of PFAS contamination.

3.6 SURFACE WATER AND POREWATER SAMPLING CONSIDERATIONS

Capped surface water sample containers shall be rinsed multiple times with site surface water prior to sampling.

Because PFAS tend to accumulate at the air/water interface, specific procedures for surface water sampling shall be followed. After rinsing, the capped container shall be lowered into the surface water, with the top pointed down. The container shall then be reoriented with the top pointed upward and opened under water at the depth targeted for sampling, ideally at least 10 centimeters from both the sediment surface and the water surface. During sample collection, the sample collection point shall be positioned upstream of the sampler, gloves, etc. If an extension rod must be used due to the depth of sampling, the rod shall be made of clean, PFAS-free material.

For porewater sampling, the common stainless-steel and PVC samplers, with HDPE and silicone tubing, are acceptable. The samplers should not be reused at multiple sampling locations.

As for groundwater samples, filtration is not recommended.

3.7 FIELD QUALITY CONTROL SAMPLES

It is recommended that field blanks and equipment (i.e., rinsate) blanks be collected at least daily, using laboratory supplied “PFAS-free” water, to detect any cross-contamination that occurred despite precautions taken during sampling. If a peristaltic pump is used for sample collection, then at least one equipment blank should be collected by pumping “PFAS-free” water through the pump with clean HDPE tubing.

Field duplicates should also be collected to assess the precision of the results.

Analysis of trip blanks may be advisable on a project-specific basis, particularly if relatively volatile PFAS chemicals will be analyzed.

The same precautions taken during collection of specified samples should be taken during the collection of quality control samples (Section 3.7).

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

See detailed precautions noted above.

6. REFERENCES

Department of Defense Environmental Data Quality Workgroup. 2017. *Bottle Selection and other Sampling Considerations When Sampling for Per-and Poly-Fluoroalkyl Substances (PFAS)*. Revision 1.2. July.

Interstate Technology Regulatory Council (ITRC). 2018. *Fact Sheet: Site Characterization Considerations, Sampling Precautions, and Laboratory Analytical Methods for Per- and Polyfluoroalkyl Substances (PFAS).* March.

U.S. Army Corps of Engineers. 2016. *Standard Operating Procedure 047: Per/Poly Fluorinated Alkyl Substances (PFAS) Field Sampling*. March.

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Appendix B

Field Forms

- Fish Sampling Log
- Indoor Air Sampling Form
- Monitoring Well Development Log
- New York State Department of Health Indoor Quality Questionnaire and Building Inventory Center for Environmental Health
- Well Purging and Sampling Record
- Sediment Sampling Log
- Soil Boring Log
- Soil Vapor Sampling Log
- Surface Soil Sampling Log
- Surface Water Sampling Log
- Test Pit Log

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FISH SAMPLING LOG

page ______ of ______

Project and Site Name ____ DEC Region ________

Collections made by (names) ____

Sampling Method: ☐Electrofishing ☐Gill netting ☐Trap netting ☐Trawling ☐Seining ☐Angling ☐Other ________________

Preservation Method: ☐Freezing ☐Other ______________ Notes (SWFDB survey number): ________________________

FOR LAB USE ONLY- LAB ENTRY NO.	COLLECTION OR TAG NO.	SPECIES	DATE TAKEN	LOCATION	AGE	SEX &/OR REPROD. CONDIT	LENGTH ( )	WEIGHT ( )	REMARKS

Field form adapted from NYSDEC format. richter: revised 2011, 5/7/15, 10/4/16, 3/20/17; becker: 3/23/17

INDOOR AIR SAMPLING FORM

EA Engineering, P.C. and Its Affiliate
EA Science and Technology

Project No.

Project Name:

Location:

Project Manager:

Sample Location Information:

Site ID Number:		Sampler(s):	
PID Meter Used: (Model, Serial #)		Building I.D. No.:	

SUMMA Canister Record:

INDOOR AIR - FIRST FLOOR	INDOOR AIR - BASEMENT	SUBSLAB SOIL GAS	OUTDOOR AIR
Flow Regulator No.	Flow Regulator No.	Flow Regulator No.	Flow Regulator No.
Canister Serial No.	Canister Serial No.:	Canister Serial No.:	Canister Serial No.:
Start Date/Time:	Start Date/Time:	Start Date/Time:	Start Date/Time:
Start Pressure: (inches Hg)	Start Pressure: (inches Hg)	Start Pressure: (inches Hg)	Start Pressure: (inches Hg)
Stop Date/Time:	Stop Date/Time:	Stop Date/Time:	Stop Date/Time:
Stop Pressure: (inches Hg)	Stop Pressure: (inches Hg)	Stop Pressure: (inches Hg)	Stop Pressure: (inches Hg)
Sample ID:	Sample ID:	Sample ID:	Sample ID:

Other Sampling Information:

Story/Level		Story/Level		Basement or Crawl Space?		Direction from Building	
Room		Room		Floor Slab Thickness (inches) *[if present]*		Distance from Building	
Indoor Air Temp (^{o}F)		Indoor Air Temp		Potential Vapor Entry Points Observed?		Intake Height Above Ground Level (ft.)	
Barometric Pressure?		Barometric Pressure?		Ground Surface Condition (Crawl Space Only)		Intake Tubing Used?	
Intake Height Above Floor Level (ft.)		Intake Height Above Floor Level (ft.)		If slab, intake Depth If Crawl Space, intake height		Distance to nearest Roadway	
Noticeable Odor?		Noticeable Odor?		Noticeable Odor?		Noticeable Odor?	
PID Reading (ppb)		PID Reading (ppb)		PID Reading (ppb)		PID Reading (ppb)	
Duplicate Sample?		Duplicate Sample?		Duplicate Sample?		Duplicate Sample?	

Comments:

Sampler Signature:

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MONITORING WELL DEVELOPMENT LOG

Well I.D.:	**EA Personnel:**	**Client:** NYSDEC
Location:	**Well Condition:**	**Weather:**
Sounding Method:	**Gauge Date:** **Gauge Time:**	**Measurement Ref:**
Stick Up/Down (ft):	**PID Headspace Reading:**	**Well Diameter (in):**

Purge Date:	**Purge Time:**
Purge Method:	**Field Technician:**

Well Volume

A. Well Depth (ft):	**D. Well Volume (ft):**	**Depth/Height of Top of PVC:**
B. Depth to Water (ft):	**E. Well Volume (gal) C*D):**	**Pump Type:**
C. Liquid Depth (ft) (A-B):	**F. Three Well Volumes (gal) (E3):**	**Pump Intake Depth:**

Water Quality Parameters

Time (hrs)	pH (pH units)	Conductivity (mS/cm)	Turbidity (ntu)	DO (mg/L)	Temperature (^{o}C)	ORP (mV)	DTW (ft btoc)	Rate (Lpm)	Volume (liters)

Total Quantity of Water Removed (gal): ______________ **Personnel:** ______________

COMMENTS AND OBSERVATIONS: ______________

OSR – 3

NEW YORK STATE DEPARTMENT OF HEALTH
INDOOR AIR QUALITY QUESTIONNAIRE AND BUILDING INVENTORY
CENTER FOR ENVIRONMENTAL HEALTH

This form must be completed for each residence involved in indoor air testing.

Preparer's Name ___________________________________ Date/Time Prepared ______________

Preparer's Affiliation _______________________________ Phone No.______________________

Purpose of Investigation____

1. OCCUPANT:

Interviewed: Y / N

Last Name: ________________________ First Name: ________________________

Address: ____

County: ________________

Home Phone: ___________________ Office Phone: ___________________

Number of Occupants/persons at this location _______ Age of Occupants ______________________

2. OWNER OR LANDLORD: (Check if same as occupant ___)

Interviewed: Y / N

Last Name: ________________________ First Name: ________________________

Address: ____

County: ________________

Home Phone: ___________________ Office Phone: ___________________

3. BUILDING CHARACTERISTICS

Type of Building: (Circle appropriate response)

Residential
Industrial
School
Church
Commercial/Multi-use
Other: ________________

If the property is residential, type? (Circle appropriate response)

Ranch	2-Family	3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouses/Condos
Modular	Log Home	Other:_______________

If multiple units, how many? ________

If the property is commercial, type?

Business Type(s) _____________________________________

Does it include residences (i.e., multi-use)? Y / N If yes, how many? ______

Other characteristics:

Number of floors______ Building age______

Is the building insulated? Y / N How air tight? Tight / Average / Not Tight

4. AIRFLOW

Use air current tubes or tracer smoke to evaluate airflow patterns and qualitatively describe:

Airflow between floors

____

____

____

Airflow near source

____

____

____

Outdoor air infiltration

____

____

____

Infiltration into air ducts

____

____

____

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS (Circle all that apply)

a. Above grade construction:	wood frame	concrete	stone	brick
b. Basement type:	full	crawlspace	slab	other ________
c. Basement floor:	concrete	dirt	stone	other ________
d. Basement floor:	uncovered	covered	covered with _______________	
e. Concrete floor:	unsealed	sealed	sealed with ________________	
f. Foundation walls:	poured	block	stone	other ________
g. Foundation walls:	unsealed	sealed	sealed with ________________	
h. The basement is:	wet	damp	dry	moldy
i. The basement is:	finished	unfinished	partially finished	
j. Sump present?	Y / N			
k. Water in sump?	Y / N / not applicable			

Basement/Lowest level depth below grade: ________(feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

____

____

6. HEATING, VENTING and AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation
Space Heaters
Electric baseboard
Heat pump
Stream radiation
Wood stove
Hot water baseboard
Radiant floor
Outdoor wood boiler
Other ___________

The primary type of fuel used is:

Natural Gas
Electric
Wood
Fuel Oil
Propane
Coal
Kerosene
Solar

Domestic hot water tank fueled by: ____________________________

Boiler/furnace located in:	Basement	Outdoors	Main Floor	Other___________
Air conditioning:	Central Air	Window units	Open Windows	None

Are there air distribution ducts present? Y / N

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

____

____

____

____

7. OCCUPANCY

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

Level	**General Use of Each Floor (e.g., familyroom, bedroom, laundry, workshop, storage)**
Basement	____
1st Floor	____
2nd Floor	____
3rd Floor	____
4th Floor	____

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage?		Y / N
b. Does the garage have a separate heating unit?		Y / N / NA
c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, atv, car)		Y / N / NA Please specify___________________
d. Has the building ever had a fire?		Y / N When?__________________
e. Is a kerosene or unvented gas space heater present?		Y / N Where? _________________
f. Is there a workshop or hobby/craft area?	Y / N	Where & Type? _________________
g. Is there smoking in the building?	Y / N	How frequently? ________________
h. Have cleaning products been used recently?	Y / N	When & Type? _________________
i. Have cosmetic products been used recently?	Y / N	When & Type? _________________

j. Has painting/staining been done in the last 6 months? Y / N Where & When? _______________

k. Is there new carpet, drapes or other textiles? Y / N Where & When? _______________

l. Have air fresheners been used recently? Y / N When & Type? ________________

m. Is there a kitchen exhaust fan? Y / N If yes, where vented?____________

n. Is there a bathroom exhaust fan? Y / N If yes, where vented?____________

o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N

p. Has there been a pesticide application? Y / N When & Type?_________________

Are there odors in the building? Y / N
If yes, please describe: ____

Do any of the building occupants use solvents at work? Y / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist

If yes, what types of solvents are used? ____

If yes, are their clothes washed at work? Y / N

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly)
Yes, use dry-cleaning infrequently (monthly or less)
Yes, work at a dry-cleaning service
No
Unknown

Is there a radon mitigation system for the building/structure? Y / N Date of Installation: ____________
Is the system active or passive? Active/Passive

9. WATER AND SEWAGE

Water Supply: Public Water Drilled Well Driven Well Dug Well Other: _______

Sewage Disposal: Public Sewer Septic Tank Leach Field Dry Well Other: _______

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended: _____________________________________

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided and explained to residents? Y / N

11. FLOOR PLANS

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

Basement:

First Floor:

12. OUTDOOR PLOT

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

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

13. PRODUCT INVENTORY FORM

Make & Model of field instrument used: ______________________________________

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (units)	Photo ** Y / N

* Describe the condition of the product containers as **Unopened (UO), Used (U),** or **Deteriorated (D)**
** Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.

WELL PURGING AND SAMPLING RECORD

Site Name/Location	Project No:	Page of
Well ID	Date	Time
Well Site Description		
Weather/Temp		
Field Technician		

WELL CONSTRUCTION DATA

TOC Elevation (ft amsl)	Screened Interval (ft bgs)
Well Diameter (in.)	Nominal Borehole Diameter (in.)

FIELD MEASUREMENTS

Well Depth (gauge after sampling) (ft)	Gallons per foot of depth
Depth to product (ft)	Static water level (ft)
Product column height (ft)	Water column height (ft)
Product volume (Gallons)	Water volume (Gallons)

PURGE INFORMATION

Pump Type / ID	Water Quality Meter Type / ID	
Pump Intake Depth (ft)	Flow-Thru Cell Volume (L)	
Purge Start Time	Appearance/Odor (Start)	
Purge End Time	Appearance/Odor (End)	
Average Purge Rate (mL/min)	Total Drawdown (ft)	
Well Went Dry (Y/N)	Stop Time	Volume removed (L)
Recovery Time	Recovery Rate (mL/min)	Restart Purge Time
Total Volume Removed (L)	Total Pump Time (min)	

Date	Time	Purge Rate (mL/min)	Volume Removed (LPM)	pH (+/-0.1)	Cond. (µS/cm) (+- 3%)	Temp. (°C) (+- 3%)	ORP (mV) (+/- 10)	Turbidity (NTU) +/-10% or <5 NTU	DO (mg/L) +/-10% or <5 mg/L	Depth to Water (ft below TOC)

COMMENTS ____

____

SAMPLE COLLECTION

Sample Date	Sample Time
Sample ID	
QA/QC Collected / ID	Sample Appearance/Odor
Analyses	
Sampler	Signature

SEDIMENT SAMPLING LOG

Client Name and Project Name

Location/Boring Name

Sheet

of

1 Geologist Name/Signature

5 Project Number

8 Start - Stop (Date/Tme)

2 Subcontractor/Equipment Operator

6 Latitude/Northing/Grid

3 Operator Name *(Licence # If Required)*

7 Longitude/Easting/Grid

9 Sed Surface Elevation *ft*

10 Coordinate System H V

11 Depth of Water (start) *ft*

12 Depth of Water (end) *ft*

13 Sunny/Cloudy/Rain

14 Temperature (start/high) *F*

15 Wind Direction

16 Total Boring Depth *ft*

17 Recovery Depth ft *%*

18 Location Notes

4 Sampling Equipment and Methodology (Check One)

☐ Rotosonic: ____ -ft barrel ____ -in diameter ________ -ft spoon/sample

☐ Core: ____ -ft barrel ____ -in diameter ________ -VPM Manual/Vibracore/Other

☐ Grab Sample: -ft x -ft x -ft Box/Ponar/Van Veen/Other

☐ Other:

☐ Sample Collection Method:

Interval *(Depth)*	**Recovery** *(ft & %)*	**Description of Materials** Munsell Color; Moisture; Density; Consistency (Other Remarks)	**Sample ID** **Sample Interval**	**USCS** *Code*

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EA Science and Technology

SOIL BORING LOG

Coordinates: Northing ________ Easting: ________
Surface Elevation:
Casing Below Surface: ________
Reference Elevation: ________
Reference Description: ________

Job. No.	**Client:** NYSDEC **Project:**	**Location:**
Drilling Method:		**Soil Boring Number:**
Sampling Method:		**Sheet** 1 **of**

Drilling	
Start	**Finish**
DATE	DATE
TIME	TIME

Water Level:				
Time:				
Date:				

Surface Conditions:
Weather:
Temperature:

Blow Counts (140-lb)	**Ft. Driven/ Ft. Record**	**Boring Diagram**	**PID (ppm)**	**Depth in Feet**	**USCS Log**	
				0		
				1		
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		
				18		
				19		
				20		
				21		
				22		
				23		
				24		
				25		
				26		
				27		
				28		
				29		

Monitoring Well Construction Information

Monitoring Well Diameter: ________ in
Bottom of Monitoring Well: ________ ft bgs
Stick Up or Flush Mount: ________
Screen Interval: ________ To ________ ft bgs
Riser Interval: ________ To ________ ft bgs
Sand Pack Interval: ________ To ________ ft bgs
Bentonite Seal: ________ To ________ ft bgs
Grout Interval: ________ To ________ ft bgs

Soil Vapor Point Installation Information

Depth of Soil Vapor Point: ________ ft
Bottom of Tubing: ________ ft
Top of Sand Pack: ________ ft
Top of Bentonite Seal: ________ ft

Logged by: ________ Date: ________
Drilling Contractor: ________ Driller: ________

EA Engineering, P.C. and Its Affiliate EA Science and Technology

SOIL VAPOR SAMPLING LOG

Project #:

Project Name:

Location:

Project Manager:

Sample Location Information:

Site ID Number:				Sampler(s):	
PID Meter Used (Model, Serial #) :				Soil Vapor I.D. No.:	

SUMMA Canister Record:

SOIL VAPOR POINT		DUPLICATE SAMPLE (IF COLLECTED)	
Flow Regulator No.:		Flow Regulator No.:	
Canister Serial No.:		Canister Serial No.:	
Start Date/Time:		Start Date/Time:	
Start Pressure: (inches Hg)		Start Pressure: (inches Hg)	
Stop Date/Time:		Stop Date/Time:	
Stop Pressure: (inches Hg)		Stop Pressure: (inches Hg)	
Sample ID:		Sample ID:	

Other Sampling Information:

Helium percentage achieved in enclosure for Tracer Gas Test:		Depth to sample point:	
Tracer Gas test result (% of Helium):		Nearest Groundwater Elevation:	
Noticeable Odor?		Additional info:	
Purge Volume PID Reading (ppb)			
Duplicate Sample?			
Outdoor Ambient Temperature:			
Wind Direction:			

Comments:

Sampler Signature:

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EA Science and Technology

SURFACE SOIL SAMPLING LOG

Coordinates: Northing: ____________ Easting: ____________

Surface Elevation: ____________

Reference Elevation: ____________

Reference Description: ____________

Job. No.	**Client:** NYSDEC **Project:**	**Location**
Sampling Location Description:		**Sample Location ID:**
		Sheet 1 of 1
		Sampling Date/Time

Sample Method:	**Start**	**Finish**
	DATE TIME	DATE TIME

Sample Interval (in.)	**PID (ppm)**	**TCL VOCs**	**TCL SVOCs**	**TCL Metals**	**TCL PCBs/ Pesticides**	**USCS Log**	**Surface Conditions:** **Weather:** **Temperature:**

Logged by: ____________ **Date:** ____________

Sample Interval: ____________ **Time:** ____________

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EA Science and Technology

SURFACE WATER SAMPLING LOG

Job. No.	**Client:** NYSDEC **Project:**	**Location**
Sampling Location Description:		**Sample Location ID:**
		Sheet 1 of 1
Sample Method:		
Depth of Water Body:		**Sampling Date/Time**
Width of Water Body:	**Start**	**Finish**
Water Body Location	DATE	DATE
	TIME	TIME

Coordinates: Northing: Easting:
Surface Water Elevation:
Reference Elevation:
Reference Description:

Surface Conditions:
Weather:

	Water Quality Parameters							
	Time (hrs)	**pH** (pH units)	**Cond.** (mS/cm)	**Turb.** (ntu)	**DO** (mg/L)	**Temp** (˚C)	**ORP** (mV)	**Description of Surface Water**

Total Quantity of Water Removed (gal):
Samplers:
Sampling Date:

Sampling Time:
Split Sample With:
Sample Type:

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TEST PIT LOG

Coordinates: Northing: Easting:
Surface Elevation:
Reference Elevation:
Reference Description:

Job. No.	**Client:** NYSDEC **Project:**	**Location**
Sampling Location Description:		**Sample Location ID:**
		Sheet 1 of
Sample Method:		
Depth of Test Pit:		**Sampling Date/Time**
Depth to Bedrock (ft bgs):	**Start**	**Finish**
Groundwater Encountered (ft bgs):	DATE	DATE
Disposition of Test Pit:	TIME	TIME

Surface Conditions:
Weather:

Depth Interval (ft bgs)	PID (ppm)	Analysis						USCS Log	Description of Material
		TCL VOCs	TCL SVOCs	TCL Metals	TCL PCBs/ Pesticides	Other	Other		

Logged by: ______________________ **Date:** ______________

Sample Interval: ______________________ **Time:** ______________

Appendix B

Health and Safety Plan

Health and Safety Plan Addendum
Zip Zip Mini Market Site (B00075)
Syracuse, New York

Prepared for

New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
269 W. Jefferson Street
Syracuse, New York 13202
315-431-4610

Revisions to Health and Safety Plan Addendum:

Revision No.	Date Submitted	Summary of Revision	NYSDEC Approval Date
00	May 2023	Initial HASP Addendum Submittal	

Health and Safety Plan Addendum
Zip Zip Mini Market Site (B00075)
Syracuse, New York

Prepared for

New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233

NEW YORK STATE | Department of Environmental Conservation

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
269 W. Jefferson Street
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315-431-4610

Final To Be Signed

Donald F. Conan, P.E., Program Manager — Date
EA Engineering, P.C.

Final To Be Signed

Emily Cummings, Project Manager — Date
EA Science and Technology

Revision 00
May 2023
EA Project No. 16025.32

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LIST OF APPENDIXES

LIST OF ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	Microgram(s) per cubic meter
bgs	Below ground surface
CFR	Code of Federal Regulations
CHMM	Certified Hazardous Materials Manager
CIH	Certified Industrial Hygienist
CSP	Certified Safety Professional
EA	EA Engineering, P.C. and its affiliate EA Science and Technology
ft	Foot (feet)
G.I.T.	Geologist-in-Training
HASP	Health and Safety Plan
IDW	Investigation-derived waste
No.	Number
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OSHA	Occupational Safety and Health Administration
P.E.	Professional Engineer
P.G.	Professional Geologist
PM	Particulate matter
PPE	Personal protective equipment
Ppm	Parts per million
SSHO	Site Safety and Health Officer
STS	Safety Trained Supervisor
SVOC	Semivolatile organic compound
VOC	Volatile organic compound

1. INTRODUCTION

1.1 GENERAL

A Generic Health and Safety Plan (HASP) (EA Engineering, P.C. and its affiliate EA Science and Technology [EA] 2020a) was developed for field activities performed under the New York State Department of Environmental Conservation (NYSDEC) Standby Contract Number (No.) D009806. This HASP Addendum is to supplement the Generic HASP with site-specific information to protect the health and safety of personnel while performing field investigation activities to complete the pre-design investigation and pilot study for the Zip Zip Mini Market Site (NYSDEC Site No. B00075) (Site), in Syracuse, New York (Figure 1).

This HASP Addendum describes the safety organization, procedures, and protective equipment that have been established based on an analysis of potential physical, chemical, and biological hazards. Specific hazard control methodologies have been evaluated and selected to minimize the potential for accidents or injuries to occur. One copy of the Generic HASP (EA 2020a) and this HASP Addendum will be maintained for use during the scheduled field investigation activities. The copies will be made available for site use and employee review at all times.

This HASP Addendum addresses regulations and guidance practices set forth in the Occupational Safety and Health Administration (OSHA) Standards for Construction Industry, 29 Code of Federal Regulations (CFR) 1926, including 29 CFR 1926.65, Hazardous Waste Operations and Emergency Response (HAZWOPER) and 29 CFR 1926.59, Hazardous Communications.

The following are provided as appendixes:

- **Appendix A:** Worker Training and Physical Examination Record
- **Appendix B:** Health and Safety Plan Addendum Review Record
- **Appendix C:** Site Entry and Exit Log
- **Appendix D:** Accident/Loss Report
- **Appendix E:** Emergency Telephone Numbers and Hospital Directions
- **Appendix F:** Emergency Equipment Available On-site
- **Appendix G:** Personal Protective Equipment Activity Record
- **Appendix H:** Safety Data Sheets
- **Appendix I:** Coronavirus Disease 2019 Protocol.

Note: This site-specific HASP Addendum should be left open to display Appendix E (Emergency Telephone Numbers and Hospital Directions) and made available to all site personnel in a conspicuous location for the duration of field investigation activities in the event of an emergency.

1.2 SITE DESCRIPTION AND BACKGROUND

The Site is a 1.14-acre parcel along Erie Boulevard East in the city of Syracuse. It is located in an urban area is currently zoned for commercial use. Surrounding parcels are zoned for commercial, residential, and industrial use. Previously, the site contained a gasoline service station and auto repair shop from approximately 1980 to 1997, when the service station was destroyed by a severe fire. Interim remedials measures were conducted in 2006 and 2008 to remove underground storage tanks and contaminated soil. The Site is currently vacant with one building partially located on-site. The building is owned by the adjoining property owner and is utilized as a plumbing supply warehouse. The Site is relatively flat and used as a parking area for surrounding businesses.

Results of the remedial investigation indicate that site contaminants of concern are volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) in groundwater and soil. Primary contaminants are methyl tert-butyl ether, benzene, ethylbenzene, and xylenes associated with operation of the former service station. Contaminants of concern in soil are benzo[a]anthracene, benzo[a]pyrene, and benzo[b]fluoranthene.

1.3 POLICY STATEMENT

EA takes every reasonable step to provide a safe and healthy work environment, and to eliminate or control hazards in order to minimize the possibility of injuries, illnesses, or accidents to site personnel. EA and EA subcontractor employees will be familiar with this HASP Addendum for the project activities they are involved in. Prior to entering the Site, the HASP Addendum will be reviewed and an agreement to comply with the requirements will be signed by EA personnel, subcontractors, and visitors (Appendix B).

Operational changes that could affect the health and safety of site personnel, the community, or the environment will not be made without approval from the Project Manager and the Program Health and Safety Officer. This document will be periodically reviewed to ensure it is current and technically correct. Any changes in site conditions and/or the Scope of Work will require a review and modification to the HASP Addendum. Such changes will be documented in the form of a revision to this Addendum.

2. KEY PERSONNEL

The following table contains information on key project personnel.

Title	Name	Contact Information
NYSDEC Project Manager	Michael Belveg	P: 315-426-7446
Program Health and Safety Officer	Rob Marcase, CIH, CSP, CHMM	P: 410-329-5192
Program Manager	Donald Conan. P.G., P.E.	M: 315-877-7403
Quality Assurance/Quality Control Officer	Frank Barranco. P.E., P.G.	P: 410-584-7000
Project Manager	Emily Cummings	P: 315-565-6553 M: 860-309-3837
Site Manager/SSHO	Edward Ashton, P.G., STS	P: 315-565-6560 M: 315-551-1161
Project Engineer	Thomas Robinson	P: 315-565-6559 M: 207-318-8414
Project Geologist	Patrick Gannon, G.I.T.	P: 916-604-4366 M: 845-238-8203

Notes:
CHMM = Certified Hazardous Materials Manager
CIH = Certified Industrial Hygienist
CSP = Certified Safety Professional
G.I.T. = Geologist-in-Training
P.E. = Professional Engineer
P.G. = Professional Geologist
SSHO = Site Safety and Health Officer
STS = Safety Trained Supervisor

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3. SCOPE OF WORK

This HASP Addendum was developed to designate and define site-specific health and safety protocols applicable to project activities to be implemented and followed during field activities and consulting work at the Site. The Scope of Work covered by this HASP Addendum includes the following:

- Ground-penetrating radar survey
- Soil borings with subsurface soil sampling
- Monitoring well installation and development
- Groundwater gauging and sampling
- Soil vapor point installation and sampling
- Hydraulic Conductivity (Slug) Testing
- Investigation-derived waste storage and disposal.

Each of these activities is summarized below and additional detail for each activity is provided in the Letter Work Plan (EA 2023).

3.1 GROUND PENETRATING RADAR SURVEY

EA will conduct a survey using ground-penetrating radar technology across the site to identify and/or locate utilities that may present a hazard during soil boring installation and soil sampling activities.

3.2 MONITORING WELL INSTALLATION AND DEVELOPMENT

Dig Safely New York will be called to mark out site utilities. Before drilling at each location, the subcontractor will be required to soft dig each location to a depth of 5 feet (ft) below ground surface (bgs). After the utility clearance has been completed, the overburden will be drilled and continuously sampled with a truck mounted drilling unit utilizing hollow stem augers and continuous split-spoon sampling techniques following ASTM International D1586-11 protocols for soil sampling and the monitoring wells (eight total) will be installed to the desired depth. Personnel will develop newly installed monitoring wells.

3.3 GROUNDWATER GAUGING AND SAMPLING

Groundwater samples will be collected from the existing network of monitoring wells and analyzed according to the scope presented in the Letter Work Plan (EA 2023) to identify current conditions of the groundwater plume. It is not anticipated that the field activities will pose a risk to subsurface utilities or generate nuisance odors or dust.

3.4 SOIL VAPOR POINT INSTALLATION AND SAMPLING

EA will install a total of two soil vapor monitoring points at the Site as described in the Letter Work Plan (EA 2023). Each soil vapor monitoring point will be installed using the same drilling methods as described in Section 3.2 to 2 ft above the groundwater table. Soil vapor samples will be collected to characterize soil vapor contamination within the vadose zone. Subsequent to the sampling event, sample tubing will be removed and the soil vapor monitoring point will be backfilled with bentonite. Soil vapor monitoring points installed in paved or concrete areas will be backfilled and refinished at the ground surface with concrete or cold patch.

3.5 WASTE STORAGE AND DISPOSAL

EA is responsible for the proper storage, handling, and disposal of investigation-derived waste including personal protective equipment (PPE); solids and liquids generated groundwater sampling in accordance with EA's Generic Field Activities Plan (EA 2020b). All downhole sampling equipment will be decontaminated between each well. Decontamination fluids and monitoring well purge water will be collected and containerized for disposal by a waste-disposal contractor. Associated investigation-derived waste disposal will be conducted by a NYSDEC call-out contractor.

Accordingly, handling and disposal will be as follows:

- Liquids generated from contaminated equipment decontamination that exhibit visual staining, sheen, or discernable odors will be collected in drums or other containers at the point of generation. They will be stored in the staging area. A licensed waste subcontractor will remove the drums and dispose at an off-site location.

- Liquid generated during well purging or a decontamination activity that does not exhibit visible staining, sheen, or discernable odors will be containerized and staged on-site until a NYSDEC call-out contractor removes the drums and disposes them at an off-site location.

- Used protective clothing and equipment that is suspected to be contaminated with hazardous waste will be placed in plastic bags, packed in 55-gallon ring-top drums, and transported to the drum staging area.

- Non-contaminated trash and debris will be placed in trash bags and disposed of at an off-site location.

4. POTENTIAL HAZARD ANALYSIS

Based on the field activities detailed in Section 3, the following potential hazard conditions may be anticipated. Further details regarding each hazard are presented in Section 3 of the Generic HASP.

- Personnel may be injured during physical lifting and handling of equipment, construction materials, or containers. Additionally, personnel may encounter slip, trip, and fall hazards associated with sampling activities. Precautionary measures should be taken in accordance with the Generic HASP (EA 2020a) and this HASP Addendum.

- Field operations conducted during the summer months can impose heat stress on field personnel conducting strenuous activities during unseasonably hot weather days. Because wearing PPE can increase the risk of developing heat stress, workers must be capable of recognizing the signs and symptoms of heat-related illnesses and be able to recognize these signs and symptoms in both themselves and their co-workers.

- The use of mechanical and construction equipment such as Geoprobes®, drill rigs, front loaders, dump trucks, backhoes, excavators, and bobcats can create a potential for crushing and pinching hazards due to movement and positioning of the equipment. In addition, the ambient noise levels around heavy equipment machinery can cause disorientation and reduced awareness levels. Hard hats and steel toe boots are required when working around this type of equipment.

- Work around large equipment and traffic often creates excessive noise. Noise can cause workers to be startled, annoyed, or distracted; can cause physical damage to the ear, pain, and temporary and/or permanent hearing loss; and can interfere with communication. If workers are subjected to noise exceeding an 8-hour time-weighted average sound level of 85 decibels, hearing protection will be selected with an appropriate noise reduction rating to comply with 29 CFR 1910.95 and to reduce noise below levels of concern.

- Entry into a confined space in support of this project is not anticipated and is forbidden.

- Field activities intended to define potential sources of environmental contamination often require employees to be in direct proximity or contact with hazardous substances. Employees may be exposed through inhalation of toxic dusts, vapors, or gases. Normal dust particulates from surficial soil may have absorbed toxic solvents, petroleum compounds, or toxic metal salts or metal particulates. The proposed work is not anticipated to generate nuisance odors or dust. Toxic materials contained in dusts or particulates can be ingested if eating, smoking, drinking, and gum chewing prior to personnel washing their hands and face or removing contaminated work clothing and PPE. Some chemicals may be absorbed directly through the skin. PPE, properly designed for the chemicals of concern, will always be provided and worn when a potential for skin contact is present.

- Biological Hazards—Potential hazards may be present at the Site due to bites from stray domestic and wild animals (to include rodents), spiders, bees, and other venomous anthropods. Potential hazards may also be present at the Site in the form of poisonous plant life, which can result in skin rashes or abrasions. In the case of an animal or insect bite that can be serious or fatal, workers must seek immediate medical attention and report the incident to the SSHO prior to leaving the Site. An employee known to be allergic or sensitive to poisonous insects should alert the Site Manager and SSHO.

- Subsurface utilities – The potential of encountering subsurface utilities exist when performing intrusive work (i.e., excavation or drilling). Subcontractors will notify Dig Safely New York prior to field activities so agency can mark out utilities in area/property and subcontractor will perform hand clearing to a depth of 5 ft bgs at each intrusive location, at a minimum.

    - If any utilities exist at the intrusive location, then the location will be moved and hand cleared to 5 ft bgs.

    - Additional resources may be utilized to clear location (i.e., geophysical survey), if deemed necessary.

- Subcontractors will also be pay attention to any potential overhead utilities and make sure drilling equipment is located the appropriate distance away from utilities to prevent electrical current arcing.

- All subcontractors will be required to develop a comprehensive safety plan and implement it at the site. Safety plan should include all subcontractor's safety procedures and protocols with all associated supporting documents (i.e., safety forms, Activity Hazard Analysis forms, inspection forms, etc.). The safety plan should also be present at the site for EA's field representative and/or SSHO review.

- Subcontractors will perform various activities at the site and will be required to hold specific qualifications/certification, at a minimum. See list below:

    - Drilling and well installations

        - 40-hour OSHA HAZWOPER and 8-hour Annual OSHA Refresher training.

        - Driller is qualified to performed work (i.e, competent person form signed off by supervisor)

        - Current on cardiopulmonary resuscitation/first aid.

    - Geophysical and Land Surveyor

    - Field personnel is qualified to performed work (i.e., competent person form signed off by supervisor)
    - New York State licensed land surveyor.
  - Investigation-derived waste (IDW) removal, transportation, and disposal from site.
    - Current on all federal, state, and local licenses and permits.
  - Laboratory services
    - Hold current New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program certification.
- The potential chemicals of concern present at the site include, but are not limited to, VOCs and SVOCs.
- Safety data sheets for chemicals that may be used on-site are provided in Appendix H.

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5. GENERAL SAFETY PRACTICES

5.1 SAFE WORK PRACTICES

Safe work practices that will be followed by site workers include, but are not limited to, the following rules:

- Adherence to the Coronavirus Disease 1019 Crisis Responses and Working Protocol (Appendix I).
- Working before or after daylight hours without special permission is prohibited.
- Do not enter restricted or posted areas without permission from the SSHO.
- Smoking on-site is prohibited.
- Possessing, using, purchasing, distributing, or having controlled substances in their system throughout the day or during meal breaks is prohibited.
- Consuming or possessing alcoholic beverages is prohibited.
- Good housekeeping; employees will be instructed about housekeeping throughout field activities.
- Sitting or kneeling in areas of obvious contamination is prohibited.
- Avoid overgrown vegetation and tall grass areas.

5.2 DAILY STARTUP AND SHUTDOWN PROCEDURES

The following protocols will be followed daily prior to start of work activities:

- The SSHO will review site conditions to determine if modification of work and safety plans is needed.
- Personnel will be briefed and updated on new safety procedures as appropriate.
- Safety equipment will be checked for proper function.
- The SSHO will ensure that the first aid kit is adequately stocked and readily available.
- On-site equipment and supplies will be locked and secure.

5.3 TRAFFIC SAFETY AND PEDESTRIAN PROTECTION MEASURES

Work is expected to occur in close proximity to Erie Boulevard East. Traffic cones and caution tape will be used to establish a work zone.

The following protocols will be followed to protect the public while field activities are occurring:

- Cones and caution tape will be used around open boreholes/well vaults and adjacent work areas to prevent pedestrians from entering the work area.

- Drilling and sampling activities will avoid blocking pedestrian walkways, if a walkway is partially blocked due to sampling activities an alternate pathway will be provided.

- Well sampling activities will avoid blocking pedestrian walkways, if a walkway is partially blocked due to sampling activities an alternate pathway will be provided.

- When mobilizing a drill to the Site, an individual that is not operating the drill rig will be directing pedestrians.

6. PERSONAL PROTECTIVE EQUIPMENT

Based upon currently available information, it is anticipated that Level D PPE will be required for currently anticipated conditions and activities. The PPE components for use during this project are detailed in the Generic HASP (EA 2020a). The components of Level D PPE are summarized below. Level D will be worn for initial entry on-site and for all activities and will consist of the following:

- Coveralls or appropriate work clothing.
    - Insulated clothing, hats, etc. must be worn when temperatures or wind chill fall below 40 degrees Fahrenheit.
- High visibility clothing (e.g., clothing or vest with retroreflective material).
- Steel toe, steel shank safety boots/shoes that comply with American National Standards Institute Z41-1991.
- Chemical resistant gloves (nitrile/neoprene) when contact with potentially contaminated soil or water is expected. Hand protection needs to comply with to comply with OSHA 1910.138 standard.
- Safety glasses with side shields to comply with OSHA 1926.102 standard.
- Hearing protectors (during operations producing excessive noise) to comply with OSHA 1926.101 standard.
- Hard hats (when overhead hazards are present or as required by the SSHO) to comply with OSHA 29 CFR 1910.135 standard.

6.1 UPGRADE OR DOWNGRADE PERSONAL PROTECTIVE EQUIPMENT LEVEL

Procedures and levels for upgrades or downgrades to the PPE level required at the Site are outlined in the Generic HASP (EA 2020a). Changes in PPE levels must be documented in the PPE Activity Report provided in Attachment G of this HASP Addendum.

If, at any time, the sustained level of total organic vapors in the worker breathing zone exceeds 5 parts per million (ppm) above background (determined by photoionization detector measurements), site workers will evacuate the area and the condition will be brought to the attention of the SSHO. Efforts will be undertaken to mitigate the source of the vapors. Once the sustained level of total organic vapors decreases to below 5 ppm above background, site workers will be allowed to continue activities at the direction of the SSHO. If dust levels exceed the OSHA (EA 2020a) permissible exposure limit; dust masks will be worn by all on-site personnel until dust suppression using water methods reduce the levels.

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7. SITE CONTROL AND SECURITY

Only authorized personnel will be permitted to conduct field activities. Authorized personnel include those who have completed hazardous waste operations initial training, as defined under OSHA 29 CFR 1910.120/29 CFR 1926.65, have completed their training or refresher training within the past 12 months, and have been certified by a physician as fit for hazardous waste operations. A list of staff and training is provided in Attachment A.

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8. SITE MONITORING

8.1 WORK AREA MONITORING

Specific compounds of concern for the Zip Zip Mini Market Site include VOCs and SVOCs. Permissible exposure limits applicable for site related contaminants are presented in Table 1 of the Generic HASP (EA 2020a). For intrusive work (i.e., during installation of soil borings), the work area will be monitored continuously with a photoionization detector and combustible gas indicator. Action levels and response actions are defined in Section 6.1 of this HASP Addendum.

8.2 COMMUNITY AIR MONITORING PLAN

Community air monitoring activities will consist of a combination of continuous and periodic monitoring, which will be performed dependent upon the type of activity conducted at the site, as discussed in the following section. VOC monitoring will be performed using a MiniRAE 3000 or equivalent, which is capable of calculating instantaneous concentrations, 15-minute time-weighted averages, and an average of the previous running time period. These levels will be compared to the levels specified in Section 8.3.

8.2.1 Continuous Air Monitoring

Continuous monitoring for VOCs and particulates will be required for ground intrusive activities including soil boring, soil vapor point, and well installation (e.g., boring installation, construction, development, and completion) and management of IDW. Monitoring will take place at the perimeter of the exclusion zone and should include upwind and downwind concentrations at the start of each workday and as-needed thereafter (i.e., wind direction changes, change in work location, modification of exclusion zone, etc.). Weather conditions, including prevailing wind direction, will be observed and recorded for each day of activities.

Particulate concentrations will be monitored continuously at the upwind and downwind perimeters of the work area at temporary particulate monitoring stations. Locations will be dependent on prevailing winds. The particulate monitoring will be performed using a Thermo MIE pDR-1000 DataRam or equivalent. The Thermo MIE pDR-1000 DataRam is real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (particulate matter [PM]-10) and capable of integrating over a period of 15 minutes for comparison to the airborne particulate action level. The Thermo MIE pDR is equipped with an audible alarm to indicate exceedance of the action level. In addition to using the Thermo MIE pDR-1000 DataRam, fugitive dust migration will be visually assessed during all work activities. If particulate concentrations are recorded at higher or equivalent concentrations at the upwind station during investigation activities then continuous air monitoring will be discontinued, as approved by NYSDEC representative.

8.2.2 Periodic Air Monitoring

Periodic monitoring for VOCs will be required during non-intrusive activities. Non-intrusive activities are anticipated to include the collection of groundwater and soil vapor samples, IDW management, and slug testing. Periodic monitoring during sample collection and slug testing will consist of taking a reading as follows– upon arrival at a sample location, opening a well cap, during IDW management, and prior to leaving a sample location.

8.3 ACTION LEVELS AND RESPONSE

This subsection identifies the action levels and corresponding responses for concentrations of VOCs and particulates detected during the field activities.

8.3.1 Volatile Organic Compounds

VOCs and SVOCs were identified in soil and groundwater. VOC action levels are as follows:

- If ambient air concentrations of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 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 conditions (upwind concentrations), work activities will resume with continued monitoring.

- If the total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist in excess of 5 ppm over background but less than 25 ppm, work activities will be stopped, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities will resume provided that the total organic vapor level 200 ft downwind of the work zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less (but in no case less than 20 ft), is below 5 ppm over background for the 15-minute average.

- If the total organic vapor level is above 25 ppm at the perimeter of the work area, work activities will be shut down.

All 15-minute readings will be recorded and be available for NYSDEC and NYSDOH personnel to review. Instantaneous readings, if any, used for decision purposes will also be recorded.

8.3.2 Particulates

If the downwind PM-10 particulate level is 100 micrograms per cubic meter ($\mu g/m^3$) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques will be employed. Work will continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 $\mu g/m^3$ above the upwind level and provided that no visible dust is migrating from the work area.

If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 $\mu g/m^3$ above the upwind level, work will be stopped, and a re-evaluation of activities initiated. Work will 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.

Similar to the VOC readings, all particulate readings will be recorded and be available for NYSDEC and NYSDOH personnel to review.

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9. REFERENCES

EA Engineering, P.C. and Its Affiliate EA Science and Technology. 2020a. *Generic HASP for Work Assignments under NYSDEC Contract No. D009806*. Revision 01. April.

——. 2020b. *Generic Field Activities Plan for Work Assignments under NYSDEC Contract D009806. Rev 01.* March

——. 2023. *Pre-Design Investigation Letter Work Plan.* May.

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Appendix A

Worker Training and
Physical Examination Record

Worker Training and Physical Examination Record

SITE: Zip Zip Mini Market, Syracuse, NY

Name	**OSHA 40-hour Hazardous Waste Operations Training**		**OSHA Hazardous Waste Supervisor Training**	**CPR (date of expiration)**	**First Aid (date of expiration)**	**Date of Last Physical Examination**
	Initial	**Annual**				
EA PERSONNEL						
Emily Cummings	1/15/2014	12/14/22	—	1/4/2024	1/2/2024	9/8/2022
Thomas Robinson	10/17/2022	—	12/27/2022	1/3/2023	1/3/2023	9/20/2022
Edward Ashton	4/10/1992	10/20/2022	11/01/2002	5/17/2023	5/17/2023	10/3/2022
Patrick Gannon	9/11/2020	12/14/2022	4/5/2021	12/11/2024	12/11/2024	9/22/2022
SUBCONTRACTOR OR ADDITIONAL PERSONNEL						
To be determined	—	—	—	—	—	—

Prior to performing work at the site, this Health and Safety Plan Addendum must be reviewed and an agreement to comply with the requirements must be signed by all personnel, including contractors, subcontractors, and visitors. Contractors and subcontractors are ultimately responsible for ensuring that their own personnel are adequately protected. In signing this agreement, the contractors and subcontractors acknowledge their responsibility for the implementation of the Health and Safety Plan Addendum requirements. All personnel onsite shall be informed of the site emergency response procedures and any potential safety or health hazards of the operations.

Note:
CPR = Cardiopulmonary resuscitation
EA = EA Engineering, P.C. and Its Affiliate EA Science and Technology
OSHA = Occupational Safety and Health Administration

Appendix B

Health and Safety Plan Addendum Review Record

HEALTH AND SAFETY PLAN ADDENDUM REVIEW RECORD

I have read the Health and Safety Plan Addendum for this site and have been briefed on the nature, level, and degree of exposure likely as a result of participation in this project. I agree to conform to all the requirements of this Plan.

SITE: Zip Zip Mini Market, Syracuse, New York

Name	Signature	Affiliation	Date

Appendix C

Site Entry and Exit Log

SITE ENTRY AND EXIT LOG

SITE: Zip Zip Mini Market, Syracuse, New York

Name	Date	Time of Entry	Time of Exit	Initials

Appendix D

Accident/Loss Report

ACCIDENT/LOSS REPORT

This report must be completed by the injured employee or supervisor and faxed to EA corporate headquarters within 24 hours of any accident. **Fax number: (410) 771-1780.**

Note: Whenever an employee is sent for medical treatment for a work related injury or illness, **page 4 of this report** must accompany that individual to ensure that all invoices, bills, and correspondence are sent to Human Resources for a timely response.

A. DEMOGRAPHIC INFORMATION		
Name of injured employee:		
Home address:		
Home telephone:		
Date of birth:	Age:	Sex: M F
Marital status:	Name of spouse (if applicable):	
Social security number:		Date of hire:
Number of dependents:		
Employee job title:	Department regularly employed:	
Was employee injured on the job: yes or no		
Primary language of employee:		

B. ACCIDENT/INCIDENT INFORMATION	
Date of accident:	Time of accident:
Reported to whom:	Name of supervisor:
Exact location where accident occurred (include street, city, state, and county):	
Explain what happened (include what the employee was doing at the time of the accident and how it occurred):	
Describe the injury and the specific part of the body affected (i.e., laceration, right hand, third finger):	
Object or substance that directly injured the employee:	
Number of days and hours employee usually works per week:	
Is the employee expected to lose at least one full day of work?	
Does the employee have a previous claim? yes or no	If yes, status? open or closed
Was the employee assigned to restricted duty? yes or no	If yes, describe:

ACCIDENT/LOSS REPORT

C. ACCIDENT INVESTIGATION INFORMATION

Was safety equipment provided? yes or no If yes, was it used? yes or no

Was an unsafe act being formed? yes or no If yes, describe:

Was a machine part involved? yes or no If yes, in what way?

Was the machine part defective? yes or no If yes, in what way?

Was a third party responsible for the accident/incident: yes or no If yes, list name, address, and telephone number.

Was the accident/incident witnessed? yes or no If yes, list name, address, and telephone number.

D. PROVIDER INFORMATION

Was first aid given onsite? yes or no

If yes, what type of medical treatment given?

Physician information (if medical attention was administered):
Name:
Address (include city, state, and zip):

Telephone:

Hospital address (include name, address, city, state, zip code, and telephone number):

Was the employee hospitalized? yes or no If yes, on what date?

Was the employee treated as an outpatient, receive emergency treatment or ambulance service? yes or no

Please attach the physician's written return to work slip.

Note: A physician's return to work slip is required prior to allowing the worker to return to work.

E. AUTOMOBILE ACCIDENT INFORMATION (complete if applicable)

Authority contacted and report number:

EA employee's vehicle year, make, and model:

V.I.N. Plate/tag number:

Owner's name and address:

Driver's name and address:

Relationship to insured?

Driver's license number?

ACCIDENT/LOSS REPORT

E. AUTOMOBILE ACCIDENT INFORMATION (continued)
Describe damage to ***your*** property:
Describe damage to ***other*** vehicle or property:
Other driver's name, address, and telephone:
Other driver's insurance company (include name, address and telephone number):
Location of other vehicle?
Name, address, and telephone of other injured parties:
Witness (include name, address, and telephone number):
Witness's statement:
Witness (include name, address, and telephone number):
Witness's statement:

F. ACKNOWLEDGEMENT

Name of supervisor:	
Date of this report:	
Report prepared by:	
I have read this report and the contents as to how the accident/loss occurred are accurate to the best of my knowledge. Signature (injured employee):	Date:

ACCIDENT/LOSS REPORT

I am seeking medical treatment for a work related injury/illness.
Please forward all bills/invoices/correspondence to:

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle
Suite 400
Hunt Valley, Maryland 21031

Attention: Michele Bailey

Human Resources

(410) 584-7000

Appendix E

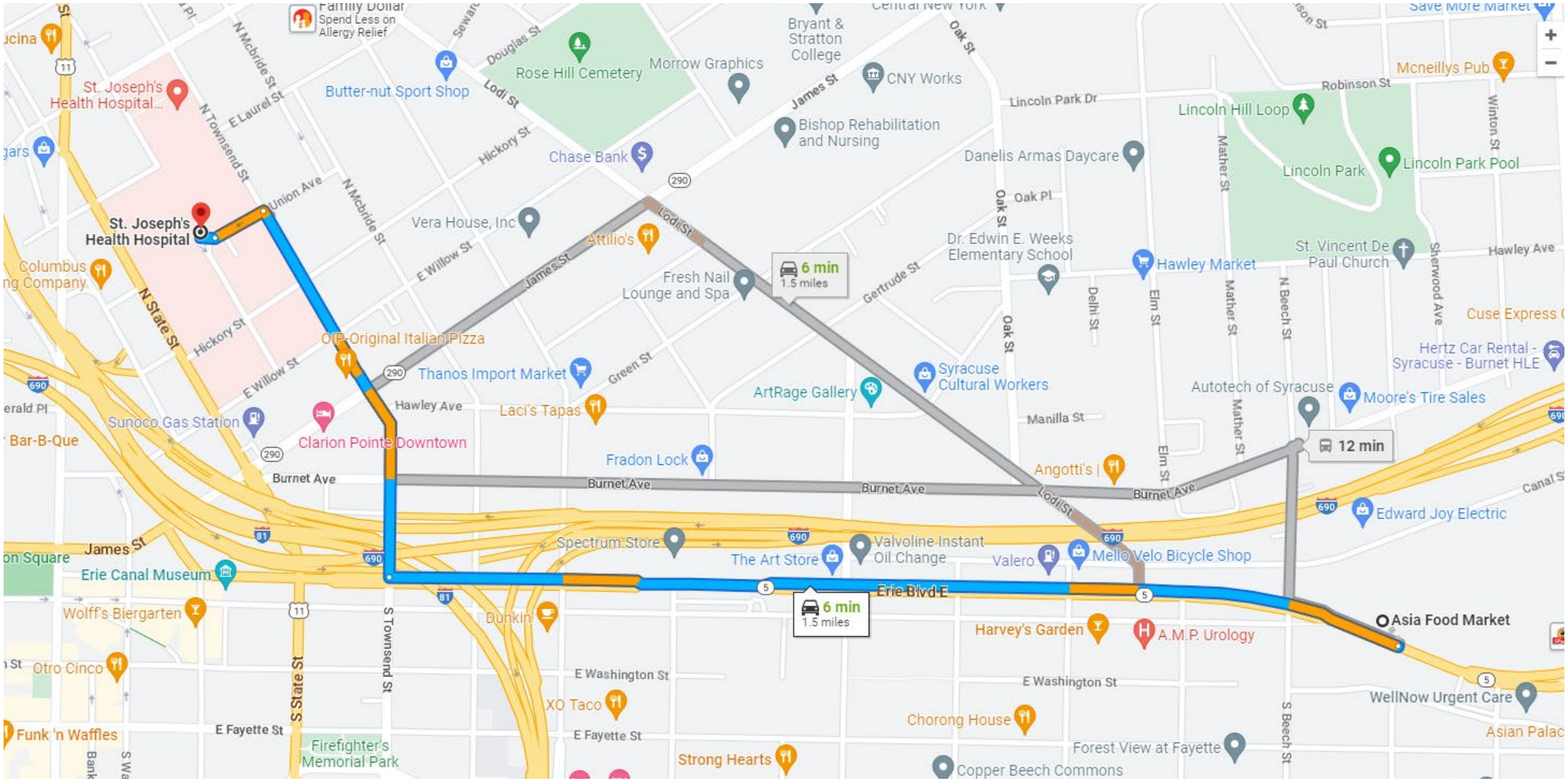
Emergency Telephone Numbers and Hospital Directions

EMERGENCY TELEPHONE NUMBERS AND HOSPITAL DIRECTIONS

Emergency Telephone Numbers

SITE: Zip Zip Mini Market, Syracuse, New York	
Police	9-1-1
Fire	9-1-1
Ambulance	9-1-1
Hospital: St. Joseph's Health Hospital	(315) 448-5111
Poison Control	(800) 222-1222
Program Safety and Health Officer: ***Robert Marcase, CIH, CSP, CHMM***	(410) 329-5192
Program Manager: ***Donald Conan, P.E., P.G.***	(315) 877-7403 Cell
EA Project Manager ***Emily Cummings***	(315) 565-6553 Office (860) 309-3837 Cell
In case of spill, contact ***James Hayward, P.E.***	(315) 565-6555 Office
EA Medical Services (Physician) ***All One Health Services***	(800) 229-3674
Site Manager/Site Health and Safety Officer: ***Edward Ashton***	(315) 565-6560 Office (315) 551-1161 Cell
Site Geologist: ***Patrick Gannon***	(916) 604-4366 Office (845) 238-8203 Cell
Site Engineer ***Thomas Robinson***	(315) 565-6559 Office (207) 318-8414 Cell
In case of accident or exposure incident, contact Corporate Health and Safety Officer ***Robert Marcase, CIH, CSP, CHMM***	(410) 329-5192

Hospital Directions



1. Head northwest on Erie Blvd East toward E Water Street
2. Turn right on N. Townsend Street
3. Turn left onto Union Ave
4. Slight right onto Prospect Ave

Appendix F

Emergency Equipment Available On-site

EMERGENCY EQUIPMENT AVAILABLE ONSITE

Type of Equipment	Location
Communications Equipment	
Mobile Telephone	On Person
Medical Support Equipment	
First Aid Kits	In EA vehicle
Eye Wash Station	In EA vehicle
Firefighting Equipment	
Fire Extinguishers	In EA vehicle

Appendix G

Personal Protective Equipment Activity Record

PERSONAL PROTECTIVE EQUIPMENT ACTIVITY RECORD

SITE: Zip Zip Mini Market, Syracuse, New York

Weather Condition:

Onsite Hours: From
To

Changes in Personal Protective Equipment Levels[a]	Work Operations	Reasons for Change

Site Health and Safety Plan Violations	Corrective Action Specified	Corrective Action Taken (yes/no)

Observations and Comments:

Completed by:

____

Site Health and Safety Officer Date

(a) Only the Site Health and Safety Officer may change personal protective equipment levels, using only criteria specified in the Health and Safety Plan Addendum.

Appendix H

Safety Data Sheets

SAFETY DATA SHEET
BENTONITE

1 IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND COMPANY/UNDERTAKING

PRODUCT NAME	BENTONITE
APPLICATION	Viscosifier.
SUPPLIER	M-I Drilling Fluids UK Ltd, Pocra Quay, Footdee, Aberdeen. AB11 5DQ T -44 (0)1224-584336 F -44 (0)1224-576119
EMERGENCY TELEPHONE	+44(0)208 762 8322

2 COMPOSITION/INFORMATION ON INGREDIENTS

Name	EC No.	CAS-No.	Content	Classification
BENTONITE	215-108-5	1302-78-9	80 - 95%	-
QUARTZ, CRYSTALLINE SILICA	238-878-4	14808-60-7	2 -15%	Xn;R20.

The Full Text for all R-Phrases are Displayed in Section 16

COMPOSITION COMMENTS

This material is a naturally occurring mineral. The Data Shown is in accordance with the latest EC Directives. This product contains a small quantity of quartz, crystalline silica. Prolonged and repeated exposure to concentrations of crystalline silica exceeding the maximum exposure limit may lead to chronic lung disease such as silicosis.

3 HAZARDS IDENTIFICATION

Not regarded as a health or environmental hazard under current legislation.

HUMAN HEALTH

This product contains a small quantity of quartz. IARC Monographs, Vol.68, 1997, concludes that there is sufficient evidence that inhaled crystalline silica in the form of quartz or crystobalite from occupational sources causes cancer in humans. IARC classification Group 1.

4 FIRST-AID MEASURES

INHALATION

Move the exposed person to fresh air at once. Get medical attention if any discomfort continues.

INGESTION

First aid is not normally required. Rinse mouth thoroughly. Drink plenty of water.

SKIN CONTACT

Wash skin thoroughly with soap and water. Remove contaminated clothing. Get medical attention if any discomfort continues.

EYE CONTACT

Promptly wash eyes with plenty of water while lifting the eye lids. Continue to rinse for at least 15 minutes. Get medical attention if any discomfort continues.

5 FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA

The product is non-combustible. Use fire-extinguishing media appropriate for surrounding materials.

UNUSUAL FIRE & EXPLOSION HAZARDS

No unusual fire or explosion hazards noted.

PROTECTIVE MEASURES IN FIRE

Self contained breathing apparatus and full protective clothing must be worn in case of fire.

6 ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS

Wear protective clothing as described in Section 8 of this safety data sheet.

ENVIRONMENTAL PRECAUTIONS

Do not allow to enter drains, sewers or watercourses.

SPILL CLEAN UP METHODS

Shovel into dry containers. Cover and move the containers. Flush the area with water. May be slippery when wet.

7 HANDLING AND STORAGE

USAGE PRECAUTIONS

Avoid handling which leads to dust formation. Provide good ventilation. Mechanical ventilation or local exhaust ventilation may be required .

STORAGE PRECAUTIONS

Store at moderate temperatures in dry, well ventilated area.

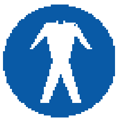
8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	Std	LT - ppm	LT - mg/m3	ST - ppm	ST - mg/m3
QUARTZ, CRYSTALLINE SILICA	WEL		0.3 mg/m3 resp. dust		
BENTONITE			4 mg/m3 resp. dust		

INGREDIENT COMMENTS

WEL = Workplace Exposure Limits * OSHA PELs for Mineral Dusts containing crystalline silica are 10 mg/m3 / (%SiO2+2) for quartz and 1/2 the calculated quartz value for cristobalite and tridymite. NUI = Nuisance Dust. WEL TWA 4mg/m3 respirable dust, 10mg/m3 total dust.

PROTECTIVE EQUIPMENT



ENGINEERING MEASURES

Provide adequate general and local exhaust ventilation.

RESPIRATORY EQUIPMENT

Respiratory protection must be used if air contamination exceeds acceptable level. Dust filter P3 (for especially fine dust/powder).

HAND PROTECTION

No specific hand protection noted, but gloves may still be advisable. For prolonged or repeated skin contact use suitable protective gloves . Rubber or plastic.

EYE PROTECTION

Wear dust resistant safety goggles where there is danger of eye contact.

OTHER PROTECTION

Wear appropriate clothing to prevent repeated or prolonged skin contact. Provide eyewash station.

9 PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE	Powder, dust		
COLOUR	Cream to Grey		
ODOUR	Odourless		
SOLUBILITY	Insoluble in water		
RELATIVE DENSITY	2.3 - 2.6 20	BULK DENSITY	769 - 833 kg/m3
pH-VALUE, CONC. SOLUTION	9 - 10		

10 STABILITY AND REACTIVITY

STABILITY

Stable under normal temperature conditions.

CONDITIONS TO AVOID

Avoid wet and humid conditions.

MATERIALS TO AVOID

No incompatible materials noted.

HAZARDOUS DECOMPOSITION PRODUCTS

No specific hazardous decomposition products noted.

11 TOXICOLOGICAL INFORMATION

INHALATION

Dust may irritate respiratory system or lungs. Harmful: danger of serious damage to health by prolonged exposure through inhalation.

INGESTION

May cause discomfort if swallowed.

SKIN CONTACT

Powder may irritate skin.

EYE CONTACT

Particles in the eyes may cause irritation and smarting.

HEALTH WARNINGS

This product contains small quantities of quartz. Prolonged inhalation of high concentrations may damage respiratory system. Because of quantity and composition, the health hazard is small.

12 ECOLOGICAL INFORMATION

ECOTOXICITY

Not regarded as dangerous for the environment. Contact M-I Swaco's QHSE Department for ecological information.

13 DISPOSAL CONSIDERATIONS

DISPOSAL METHODS

Recover and reclaim or recycle, if practical. Dispose of waste and residues in accordance with local authority requirements.

14 TRANSPORT INFORMATION

GENERAL	The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

15 REGULATORY INFORMATION

RISK PHRASES

NC	Not classified.

SAFETY PHRASES

NC	Not classified.

UK REGULATORY REFERENCES

The Control of Substances Hazardous to Health Regulations 1988. Chemicals (Hazard Information & Packaging) Regulations. IARC Monographs, Vol.68, 1997.

EU DIRECTIVES

Dangerous Substance Directive 67/548/EEC. Dangerous Preparations Directive 1999/45/EEC.

GUIDANCE NOTES

Workplace Exposure Limits EH40.

16 OTHER INFORMATION

GENERAL INFORMATION

HMIS Health - 1 HMIS Flammability - 1 HMIS Physical Hazard - 0 E - Safety glasses, Gloves, Dust Respirator

INFORMATION SOURCES

Material Safety Data Sheet, Misc. manufacturers. Transport of Dangerous Goods, Model Regulations, Tenth Revised Edition, United Nations.

REVISION COMMENTS

The following sections have been revised: 5, 6, 7, 8, 13, 14, 15 and 16. Revised by Bill Cameron

ISSUED BY

Sam Hoskin

REVISION DATE	23-09-05
REV. NO./REPL. SDS GENERATED	2
SDS NO.	10609

RISK PHRASES IN FULL

R20	Harmful by inhalation.

SAFETY DATA SHEET

SDS ID NO.:	0290MAR019
Revision Date:	06/01/2016

1. IDENTIFICATION

Product Name:	Marathon Petroleum No. 2 Ultra Low Sulfur Diesel
Synonym:	#2 Diesel; No. 2 Ultra Low Sulfur Diesel 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Motor Vehicle Use, Undyed; No. 2 Diesel, Motor Vehicle Use, Undyed, with Polar Plus; ULSD No. 2 Diesel 15 ppm Sulfur Max; ULSD No. 2 Diesel 15 ppm Sulfur Max with Polar Plus; No. 2 MV 15 Diesel; No. 2 MV 15 Diesel with Polar Plus; No. 2 Ultra Low Sulfur Diesel Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed, with Polar Plus; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max, with Polar Plus; No. 2 MV 15 Diesel Dyed; #2 MV 15 CFI Diesel; #2 MV 15 CFI Diesel Dyed; No. 2 Low Sulfur Diesel (TxLED); No. 2 MV 15 Diesel Dyed, with Polar Plus; No. 2 NRLM 15 Diesel Dyed; No.2 NRLM Diesel Dyed; No. 2 MV 500 ppm TxLED; No.2 Low Emission Low Sulfur Diesel; No. 2 Low Sulfur Diesel (TxLED) 500 ppm Sulfur Max; No. 2 Heating Oil 5000 NMA Unmarked; NEMA No. 2 Heating Oil; Heating Oil, No. 2 Low Sulfur 5000 ppm; No. 2 Ultra Low Sulfur Diesel Dyed with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel Dyed with <6% Renewable Diesel Fuel; No. 2 Diesel Dyed with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; No. 2 Ultra Low Sulfur Diesel with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel with <6% Renewable Diesel Fuel; No. 2 Diesel with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; Garyville Export Diesel; Export Diesel, Garyville; Diesel Fuel, Export Garyville; #2 Motor Vehicle ULSD 15 ppm with 0-5% Renewable Diesel; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R100; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R99; No. 2 Heating Oil 2000 ppm Sulfur Max, Clear (Undyed) Unmarked;Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Clear (Undyed) Unmarked; ULS Heating Oil 15 ppm Clear (Undyed) Unmarked; ULS HO 15 ppm CLR; Ultra-Low Sulfur Heating Oil (<= 15ppm, Undyed); No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Unmarked; No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Marked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Unmarked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Marked;15 ppm Sulfur Heating Oil Grade 67; 15 PPM Heating Oil; 15 PPM Dyed Heating Oil; 0291MAR019; 0306MAR019; 0308MAR019; 0334MAR019; 0335MAR019; 0336MAR019; 0337MAR019; 0340MAR019;
Chemical Family:	Complex Hydrocarbon Substance
Recommended Use:	Fuel.
Restrictions on Use:	All others.

Manufacturer, Importer, or Responsible Party Name and Address:

MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information:	1-419-421-3070
Emergency Telephone:	1-877-627-5463

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 3
Acute toxicity - Inhalation (Dusts/Mists)	Category 4
Skin corrosion/irritation	Category 2
Carcinogenicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Specific target organ toxicity (repeated exposure)	Category 2
Aspiration toxicity	Category 1
Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 2

Hazards Not Otherwise Classified (HNOC)
Static accumulating flammable liquid

Label elements

EMERGENCY OVERVIEW

Danger

FLAMMABLE LIQUID AND VAPOR
May accumulate electrostatic charge and ignite or explode
May be fatal if swallowed and enters airways
Harmful if inhaled
Causes skin irritation
May cause respiratory irritation
May cause drowsiness or dizziness
Suspected of causing cancer
May cause damage to organs (thymus, liver, bone marrow) through prolonged or repeated exposure
Toxic to aquatic life with long lasting effects

Appearance Yellow to Red Liquid **Physical State** Liquid **Odor** Hydrocarbon

Precautionary Statements - Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use only non-sparking tools.
Use explosion-proof electrical/ventilating/lighting/equipment
Take precautionary measures against static discharge
Do not breathe mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection

Wash hands and any possibly exposed skin thoroughly after handling
Avoid release to the environment

Precautionary Statements - Response
IF exposed or concerned: Get medical attention
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
If skin irritation occurs: Get medical attention
Wash contaminated clothing before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor if you feel unwell
IF SWALLOWED: Immediately call a POISON CENTER or doctor
Do NOT induce vomiting
In case of fire: Use water spray, fog or regular foam for extinction
Collect spillage

Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed
Keep cool
Store locked up

Precautionary Statements - Disposal
Dispose of contents/container at an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

No. 2 Ultra Low Sulfur Diesel is a complex mixture of paraffins, cycloparaffins, olefins and aromatic hydrocarbon chain lengths predominantly in the range of eleven to twenty carbons. May contain up to 5% Renewable Diesel. May contain small amounts of dye and other additives (<0.15%) which are not considered hazardous at the concentration(s) used. May contain a trace amount of benzene (<0.01%). Contains a trace amount of sulfur (<0.0015%)

Composition Information:

Name	CAS Number	% Concentration
No. 2 Diesel Fuel	68476-34-6	50-100
Kerosine, Petroleum	8008-20-6	0-50
Alkanes, C10-C20 branched and linear	928771-01-1	0-5
Naphthalene	91-20-3	0.3-2.6

All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

4. FIRST AID MEASURES

First Aid Measures

General Advice: In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation: Remove to fresh air. If not breathing, institute rescue breathing. If breathing is difficult, ensure airway is clear, give oxygen and continue to monitor. If heart has stopped, immediately begin cardiopulmonary resuscitation (CPR). Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Skin Contact: Immediately wash exposed skin with plenty of soap and water while removing contaminated clothing and shoes. May be absorbed through the skin in harmful amounts. Get medical attention if irritation persists. Any injection injury from high pressure equipment should be evaluated immediately by a physician as potentially serious (See NOTES TO PHYSICIAN).

Place contaminated clothing in closed container until cleaned or discarded. If clothing is to be laundered, inform the person performing the operation of contaminant's hazardous properties. Destroy contaminated, non-chemical resistant footwear.

Eye Contact:	Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention if irritation persists.
Ingestion:	Do not induce vomiting because of danger of aspirating liquid into lungs, causing serious damage and chemical pneumonitis. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects:	Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause adverse effects to the thymus, liver, and bone marrow.

Indication of any immediate medical attention and special treatment needed

Notes To Physician:	INHALATION: This material (or a component) sensitizes the myocardium to the effects of sympathomimetic amines. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in individuals exposed to this material. Administration of sympathomimetic drugs should be avoided. SKIN: Leaks or accidents involving high-pressure equipment may inject a stream of material through the skin and initially produce an injury that may not appear serious. Only a small puncture wound may appear on the skin surface but, without proper treatment and depending on the nature, original pressure, volume, and location of the injected material, can compromise blood supply to an affected body part. Prompt surgical debridement of the wound may be necessary to prevent irreversible loss of function and/or the affected body part. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES. INGESTION: This material represents a significant aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media
For small fires, Class B fire extinguishing media such as CO2, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media
Do not use straight water streams to avoid spreading fire.

Specific hazards arising from the chemical
This product has been determined to be a flammable liquid per the OSHA Hazard Communication Standard and should be handled accordingly. May accumulate electrostatic charge and ignite or explode. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant from material handling. Flashback can occur along vapor trail. For additional fire related information, see NFPA 30 or the Emergency Response Guidebook 128.

Hazardous combustion products
Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data
Sensitivity to Mechanical Impact No.

Sensitivity to Static Discharge Yes.

Special protective equipment and precautions for firefighters
Firefighters should wear full protective clothing and positive-pressure self-contained breathing apparatus (SCBA) with a full face-piece, as appropriate. Avoid using straight water streams. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Avoid excessive water spray application. Keep surrounding area cool with water spray from a distance and prevent further ignition of combustible material. Keep run-off water out of sewers and water sources.

Additional firefighting tactics
FIRES INVOLVING TANKS OR CAR/TRAILER LOADS: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after the fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles: if this is impossible, withdraw from area and let fire burn.

EVACUATION: Consider initial downwind evacuation for at least 1000 feet. If tank, rail car or tank truck is involved in a fire, ISOLATE for 5280 feet (1 mile) in all directions; also, consider initial evacuation of 5280 feet (1 mile) in all directions.

NFPA	Health 1	Flammability 2	Instability 0	Special Hazard -

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources. All contaminated surfaces will be slippery.
Protective equipment:	Use personal protection measures as recommended in Section 8.
Emergency procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.
Environmental precautions:	Avoid release to the environment. Avoid subsoil penetration.
Methods and materials for containment:	Contain liquid with sand or soil. Prevent spilled material from entering storm drains, sewers, and open waterways.
Methods and materials for cleaning up:	Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers. When recovering free liquids ensure all equipment is grounded and bonded. Use only non-sparking tools.

7. HANDLING AND STORAGE

Safe Handling Precautions:	NEVER SIPHON THIS PRODUCT BY MOUTH. Use appropriate grounding and bonding practices. Static accumulating flammable liquid. Bonding and grounding may be insufficient to eliminate the hazard from static electricity. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Vapors may travel along the ground or be moved by ventilation. Flashback may occur along vapor trails. No smoking. Use only non-sparking tools. Avoid breathing fumes, gas, or vapors. Use only with adequate ventilation. Avoid repeated and prolonged skin contact. Use personal protection measures as recommended in Section 8. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements. Hydrocarbons are basically non-conductors of electricity and can become electrostatically charged during mixing, filtering, pumping at high flow rates or loading and transfer operations. If this charge reaches a sufficiently high level, sparks can form that may ignite the vapors of flammable liquids. Sudden release of hot organic chemical vapors or mists

from process equipment operating under elevated temperature and pressure, or sudden ingress of air into vacuum equipment may result in ignition of vapors or mists without the presence of obvious ignition sources. Nozzle spouts must be kept in contact with the containers or tank during the entire filling operation.

Portable containers should never be filled while in or on a motor vehicle or marine craft. Containers should be placed on the ground. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only approved containers.

A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling.

Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

High-pressure injection of any material through the skin is a serious medical emergency even though the small entrance wound at the injection site may not initially appear serious. These injection injuries can occur from high-pressure equipment such as paint spray or grease or guns, fuel injectors, or pinhole leaks in hoses or hydraulic lines and should all be considered serious. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES (See First Aid Section 4).

Storage Conditions: Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Do not store near an open flame, heat or other sources of ignition.

Incompatible Materials Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELS:	OSHA - Vacated PELs	NIOSH IDLH
No. 2 Diesel Fuel 68476-34-6	100 mg/m³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Kerosine, Petroleum 8008-20-6	200 mg/m³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	10 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm TWA: 50 mg/m³	10 ppm TWA 50 mg/m³ TWA 15 ppm STEL 75 mg/m³ STEL	250 ppm

Notes: The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures: Local or general exhaust required in an enclosed area or with inadequate ventilation. Use mechanical ventilation equipment that is explosion-proof.

Personal protective equipment

Eye protection:	Use goggles or face-shield if the potential for splashing exists.
Skin and body protection:	Wear neoprene, nitrile or PVA gloves to prevent skin contact. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times.
Respiratory protection:	Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.
Hygiene measures:	Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State	Liquid
Appearance	Yellow to Red Liquid
Color	Yellow to Red
Odor	Hydrocarbon
Odor Threshold	No data available.

Property	**Values (Method)**
Melting Point / Freezing Point	No data available.
Initial Boiling Point / Boiling Range	154-366 °C / 310-691 °F (ASTM D86)
Flash Point	58-76 °C / 136-168 °F (ASTM D93)
Evaporation Rate	No data available.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	
Upper Flammability Limit:	No data available.
Lower Flammability Limit:	No data available.
Explosion limits:	No data available.
Vapor Pressure	No data available.
Vapor Density	No data available.
Specific Gravity / Relative Density	0.82-0.86 (ASTM D4052)
Water Solubility	No data available.
Solubility in other solvents	No data available.
Partition Coefficient	No data available.
Decomposition temperature	No data available.
pH:	Not applicable
Autoignition Temperature	No data available.
Kinematic Viscosity	1.90-3.32 cSt @ 40°C (ASTM D445)
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	No data available.
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

Reactivity	The product is non-reactive under normal conditions.
Chemical stability	The material is stable at 70°F, 760 mmHg pressure.

Possibility of hazardous reactions	None under normal processing.
Hazardous polymerization	Will not occur.
Conditions to avoid	Excessive heat, sources of ignition, open flame.
Incompatible Materials	Strong oxidizing agents.
Hazardous decomposition products	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	Harmful if inhaled. May cause irritation of respiratory tract. May cause drowsiness or dizziness. Breathing high concentrations of this material in a confined space or by intentional abuse can cause irregular heartbeats which can cause death.
Eye contact	Exposure to vapor or contact with liquid may cause mild eye irritation, including tearing, stinging, and redness.
Skin contact	Causes skin irritation. Effects may become more serious with repeated or prolonged contact. May be absorbed through the skin in harmful amounts.
Ingestion	May be fatal if swallowed or vomited and enters airways. May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
No. 2 Diesel Fuel 68476-34-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	>1 - <5 mg/L (Rat) 4 h
Kerosine, Petroleum 8008-20-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.28 mg/L (Rat) 4 h
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	>1 - <5 mg/l (Rat) 4 h
Naphthalene 91-20-3	490 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 340 mg/m^3 (Rat) 1 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

MIDDLE DISTILLATES, PETROLEUM: Long-term repeated (lifetime) skin exposure to similar materials has been reported to result in an increase in skin tumors in laboratory rodents. The relevance of these findings to humans is not clear at this time. Altered mental state, drowsiness, peripheral motor neuropathy, irreversible brain damage (so-called Petrol Sniffer's Encephalopathy), delirium, seizures, and sudden death have been reported from repeated overexposure to some hydrocarbon solvents, naphthas, and gasoline.

MIDDLE DISTILLATES WITH CRACKED STOCKS: Light cracked distillates have been shown to be carcinogenic in animal tests and have tested positive with in vitro genotoxicity tests. Repeated dermal exposures to high concentrations in test animals resulted in reduced litter size and litter weight, and increased fetal resorptions at maternally toxic doses. Dermal exposure to high concentrations resulted in severe skin irritation with weight loss and some mortality. Inhalation exposure to high concentrations resulted in respiratory tract irritation, lung changes/infiltration/accumulation, and reduction in lung function.

ISOPARAFFINS: Studies in laboratory animals have shown that long-term exposure to similar materials (isoparaffins) can cause kidney damage and kidney cancer in male laboratory rats. However, in-depth research indicates that these findings are unique to the male rat, and that these effects are not relevant to humans.

NAPHTHALENE: Severe jaundice, neurotoxicity (kernicterus) and fatalities have been reported in young children and infants as a result of hemolytic anemia from overexposure to naphthalene. Persons with glucose 6-phosphate dehydrogenase (G6PD) deficiency are more prone to the hemolytic effects of naphthalene. Adverse effects on the kidney have been reported in persons overexposed to naphthalene but these effects are believed to be a consequence of hemolytic anemia, and not a direct effect. Hemolytic anemia has been observed in laboratory animals exposed to naphthalene. Laboratory rodents exposed to naphthalene vapor for 2 years (lifetime studies) developed non-neoplastic and neoplastic tumors and inflammatory lesions of the nasal and respiratory tract. Cataracts and other adverse effects on the eye have been observed in laboratory animals exposed to high levels of naphthalene. Findings from a large number of bacterial and mammalian cell mutation assays have been negative. A few studies have shown chromosomal effects (elevated levels of Sister Chromatid Exchange or chromosomal aberrations) in vitro. Naphthalene has been classified as Possibly Carcinogenic to Humans (2B) by IARC, based on findings from studies in laboratory animals.

DIESEL EXHAUST: The combustion of diesel fuels produces gases including carbon monoxide, carbon dioxide, oxides of nitrogen and/or sulfur, and hydrocarbons that can be irritating and hazardous with overexposure. Long-term occupational overexposure to diesel exhaust and diesel exhaust particulate matter has been associated with an increased risk of respiratory disease, including lung cancer, and is characterized as a “known human carcinogen” by the International Agency for Research on Cancer (IARC), as “a reasonably anticipated human carcinogen” by the National Toxicology Program, and as “likely to be carcinogenic to humans” by the EPA, based upon animal and occupational exposure studies. However, uncertainty exists with these classifications because of deficiencies in the supporting occupational exposure/epidemiology studies, including reliable exposure estimates. Lifetime animal inhalation studies with pulmonary overloading exposure concentrations of diesel exhaust emissions have produced tumors and other adverse health effects. However, in more recent long-term animal inhalation studies of diesel exhaust emissions, no increase in tumor incidence and in fact a substantial reduction in adverse health effects along with significant reductions in the levels of hazardous material emissions were observed and are associated with fuel composition alterations coupled with new technology diesel engines.

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause damage to organs.

Sensitization Not expected to be a skin or respiratory sensitizer.

Mutagenic effects None known.

Carcinogenicity Suspected of causing cancer.

Cancer designations are listed in the table below

Name	ACGIH (Class)	IARC (Class)	NTP	OSHA
No. 2 Diesel Fuel 68476-34-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Kerosine, Petroleum 8008-20-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Alkanes, C10-C20 branched and linear 928771-01-1	Not Listed	Not Listed	Not Listed	Not Listed
Naphthalene	Confirmed animal	Possible human carcinogen	Reasonably anticipated to	Not Listed

91-20-3	carcinogen (A3)	(2B)	be a human carcinogen	

Reproductive toxicity None known.

Specific Target Organ Toxicity (STOT) - single exposure Respiratory system. Central nervous system.

Specific Target Organ Toxicity (STOT) - repeated exposure Thymus. Liver. Bone marrow.

Aspiration hazard May be fatal if swallowed or vomited and enters airways.

12. ECOLOGICAL INFORMATION

Ecotoxicity This product should be considered toxic to aquatic organisms, with the potential to cause long lasting adverse effects in the aquatic environment.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
No. 2 Diesel Fuel 68476-34-6	-	96-hr LC50 = 35 mg/l Fathead minnow (flow-through)	-	48-hr EL50 = 6.4 mg/l Daphnia magna
Kerosine, Petroleum 8008-20-6	72-hr EL50 = 5.0-11 mg/l Algae	96-hr LL50 = 18-25 mg/l Fish	-	48-hr EL50 = 1.4-21 mg/l Invertebrates
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	-	96-hr LC50 = 0.91-2.82 mg/l Rainbow trout (static) 96-hr LC50 = 1.99 mg/l Fathead minnow (static)	-	48-hr LC50 = 1.6 mg/l Daphnia magna

Persistence and degradability Expected to be inherently biodegradable.

Bioaccumulation Has the potential to bioaccumulate.

Mobility in soil May partition into air, soil and water.

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues
This material may be a flammable liquid waste.

Safe Handling of Wastes
Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required. Use appropriate grounding and bonding practices. Use only non-sparking tools. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking.

Disposal of Wastes / Methods of Disposal
The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal
Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name:	Fuel Oil, No. 2
UN/Identification No:	NA 1993
Transport Hazard Class(es):	3
Packing Group:	III

TDG (Canada):

UN Proper Shipping Name:	Diesel Fuel
UN/Identification No:	UN 1202
Transport Hazard Class(es):	3
Packing Group:	III

15. REGULATORY INFORMATION

US Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b):	This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product does not contain any component(s) included on EPA's Extremely Hazardous Substance (EHS) List.

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
No. 2 Diesel Fuel	NA
Kerosine, Petroleum	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	NA

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	Hazardous Substances RQs
No. 2 Diesel Fuel	NA
Kerosine, Petroleum	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	100 lb final RQ 45.4 kg final RQ

SARA: The following EPA hazard categories apply to this product:

Acute Health Hazard
Fire Hazard
Chronic Health Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
No. 2 Diesel Fuel	None
Kerosine, Petroleum	None
Alkanes, C10-C20 branched and linear	None
Naphthalene	0.1 % de minimis concentration

State and Community Right-To-Know Regulations:
The following component(s) of this material are identified on the regulatory lists below:

No. 2 Diesel Fuel

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 2444
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 2444 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Kerosine, Petroleum

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1091
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 1091 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Alkanes, C10-C20 branched and linear

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Naphthalene

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Carcinogen, initial date 4/19/02

New Jersey Right-To-Know:	SN 1322 SN 3758
Pennsylvania Right-To-Know:	Environmental hazard Present (particulate)
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen
New Jersey - Environmental Hazardous Substances List:	SN 1322 TPQ: 500 lb (Reportable at the de minimis quantity of >0.1%)
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	100 lb RQ (air); 1 lb RQ (land/water)

Canada DSL/NDSL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
No. 2 Diesel Fuel	B3,D2A,D2B	0.1%
Kerosine, Petroleum	B3,D2B	1%
Alkanes, C10-C20 branched and linear	B3,D2A,D2B	0.1%
Naphthalene	B4,D2A	0.1%

Note: Not applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Revision Date: 06/01/2016

Revision Note:

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

SAFETY DATA SHEET

SDS ID NO.: 0130MAR019
Revision Date: 05/14/2015

1. IDENTIFICATION

Product Name: Marathon Petroleum Regular Unleaded Gasoline With Ethanol

Synonym: Regular Unleaded Gasoline With Alcohol
Chemical Family: Complex Hydrocarbon Substance

Recommended Use: Fuel.
Use Restrictions: All others.

Supplier Name and Address:
MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information: 1-419-421-3070

Emergency Telephone: 1-877-627-5463

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status
This chemical is considered hazardous according to the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 1
Skin corrosion/irritation	Category 2
Germ cell mutagenicity	Category 1B
Carcinogenicity	Category 1B
Reproductive toxicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Aspiration toxicity	Category 1
Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 2

Hazards Not Otherwise Classified (HNOC)
Static accumulating flammable liquid

Label elements

EMERGENCY OVERVIEW

Danger

EXTREMELY FLAMMABLE LIQUID AND VAPOR
May accumulate electrostatic charge and ignite or explode

May be fatal if swallowed and enters airways
Causes skin irritation
May cause respiratory irritation
May cause drowsiness or dizziness
May cause genetic defects
May cause cancer
Suspected of damaging fertility or the unborn child
Toxic to aquatic life with long lasting effects

Appearance Clear or Colored Liquid **Physical State** Liquid **Odor** Strong Hydrocarbon

Precautionary Statements - Prevention
Keep away from heat/sparks/open flames/hot surfaces. — No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use explosion-proof electrical/ventilating/lighting/equipment
Use only non-sparking tools
Take precautionary measures against static discharge
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Wear protective gloves/protective clothing/eye protection/face protection
Do not eat, drink or smoke when using this product
Do not breathe mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wash hands thoroughly after handling
Avoid release to the environment

Precautionary Statements - Response
IF exposed or concerned: Get medical attention
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
If skin irritation occurs: Get medical attention
Wash contaminated clothing before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor if you feel unwell
IF SWALLOWED: Immediately call a POISON CENTER or doctor
Do NOT induce vomiting
In case of fire: Use water spray, fog or regular foam for extinction
Collect spillage

Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed
Keep cool
Store locked up

Precautionary Statements - Disposal
Dispose of contents/container at an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

Gasoline is a complex combination of hydrocarbons consisting of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons having molecular chains ranging in length from four to ten carbons. May contain small amounts of dye and other additives (>0.02%) which are not considered hazardous at the concentrations used.

Composition Information:

Name	CAS Number	Weight %
Gasoline	86290-81-5	100
Toluene	108-88-3	0.9-13.5
Ethyl Alcohol	64-17-5	5.7-10
Xylene (mixed isomers)	1330-20-7	1.8-9
1,2,4 Trimethylbenzene	95-63-6	0.9-4.5
Benzene	71-43-2	0.45-3.2
n-Hexane	110-54-3	0-2.7
Ethylbenzene	100-41-4	0.45-1.8
Naphthalene	91-20-3	0.1-0.5

4. FIRST AID MEASURES

First Aid Measures

General advice In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation: Remove to fresh air. If not breathing, institute rescue breathing. If breathing is difficult, ensure airway is clear, give oxygen and continue to monitor. If heart has stopped, immediately begin cardiopulmonary resuscitation (CPR). Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Skin Contact: Immediately wash exposed skin with plenty of soap and water while removing contaminated clothing and shoes. May be absorbed through the skin in harmful amounts. Get medical attention if irritation persists. Any injection injury from high pressure equipment should be evaluated immediately by a physician as potentially serious (See NOTES TO PHYSICIAN).

Place contaminated clothing in closed container until cleaned or discarded. If clothing is to be laundered, inform the person performing the operation of contaminant's hazardous properties. Destroy contaminated, non-chemical resistant footwear.

Eye Contact: Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention if irritation persists.

Ingestion: Do not induce vomiting because of danger of aspirating liquid into lungs, causing serious damage and chemical pneumonitis. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects: Acute: Headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue.
Delayed: Dry skin and possible irritation with repeated or prolonged exposure.

Indication of any immediate medical attention and special treatment needed

NOTES TO PHYSICIAN:	INHALATION: This material (or a component) sensitizes the myocardium to the effects of sympathomimetic amines. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in individuals exposed to this material. Administration of sympathomimetic drugs should be avoided. SKIN: Leaks or accidents involving high-pressure equipment may inject a stream of material through the skin and initially produce an injury that may not appear serious. Only a small puncture wound may appear on the skin surface but, without proper treatment and depending on the nature, original pressure, volume, and location of the injected material, can compromise blood supply to an affected body part. Prompt surgical debridement of the wound may be necessary to prevent irreversible loss of function and/or the affected body part. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES. INGESTION: This material represents a significant aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media
For small fires, Class B fire extinguishing media such as CO2, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media
Do not use straight water streams to avoid spreading fire.

Specific hazards arising from the chemical
This product has been determined to be an extremely flammable liquid per the OSHA Hazard Communication Standard and should be handled accordingly. May accumulate electrostatic charge and ignite or explode. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant from material handling. Flashback can occur along vapor trail. For additional fire related information, see NFPA 30 or the North American Emergency Response Guide 128.

Hazardous combustion products
Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data

Sensitivity to Mechanical Impact	No.
Sensitivity to Static Discharge	Yes.

Special protective equipment and precautions for firefighters
Firefighters should wear full protective clothing and positive-pressure self-contained breathing apparatus (SCBA) with a full face-piece, as appropriate. Avoid using straight water streams. Water may be ineffective in extinguishing low flash point fires, but can be used to cool exposed surfaces. Avoid excessive water spray application. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Keep run-off water out of sewers and water sources.

NFPA:	Health 1	Flammability 3	Instability 0	Special Hazards -

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources.
Protective Equipment:	Use personal protection measures as recommended in Section 8.
Emergency Procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.

Environmental precautions:	Ethanol in gasoline phase seperates in contact with water. Monitor downstream for dissolved ethanol or other appropriate indicators. Avoid release to the environment. Avoid subsoil penetration.
Methods and materials for containment:	Contain liquid with sand or soil.
Methods and materials for cleaning up:	Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers. When recovering free liquids ensure all equipment is grounded and bonded. Use only non-sparking tools.

7. HANDLING AND STORAGE

Safe Handling Precautions:

NEVER SIPHON THIS PRODUCT BY MOUTH. Use appropriate grounding and bonding practices. Static accumulating flammable liquid. Bonding and grounding may be insufficient to eliminate the hazard from static electricity. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking. Avoid repeated and prolonged skin contact. Use personal protection measures as recommended in Section 8. Use only non-sparking tools. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements.

Hydrocarbons are basically non-conductors of electricity and can become electrostatically charged during mixing, filtering, pumping at high flow rates or loading and transfer operations. If this charge reaches a sufficiently high level, sparks can form that may ignite the vapors of flammable liquids. Sudden release of hot organic chemical vapors or mists from process equipment operating under elevated temperature and pressure, or sudden ingress of air into vacuum equipment may result in ignition of vapors or mists without the presence of obvious ignition sources. Nozzle spouts must be kept in contact with the containers or tank during the entire filling operation.

Portable containers should never be filled while in or on a motor vehicle or marine craft. Containers should be placed on the ground. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only approved containers.

A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling.

Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

High-pressure injection of any material through the skin is a serious medical emergency even though the small entrance wound at the injection site may not initially appear serious. These injection injuries can occur from high-pressure equipment such as paint spray or grease or guns, fuel injectors, or pinhole leaks in hoses or hydraulic lines and should all be considered serious. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES (See First Aid Section 4).

Storage Conditions:	Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area.
Incompatible materials	Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELS:	OSHA - Vacated PELs	NIOSH IDLH
Gasoline 86290-81-5	300 ppm TWA 500 ppm STEL	-	300 ppm TWA 900 mg/m³ TWA 500 ppm STEL 1500 mg/m³ STEL	-
Toluene 108-88-3	20 ppm TWA	TWA: 200 ppm Ceiling: 300 ppm	100 ppm TWA 375 mg/m³ TWA 150 ppm STEL 560 mg/m³ STEL	500 ppm
Ethyl Alcohol 64-17-5	1000 ppm STEL	TWA: 1000 ppm TWA: 1900 mg/m³	1000 ppm TWA 1900 mg/m³ TWA	3300 ppm
Xylene (mixed isomers) 1330-20-7	100 ppm TWA 150 ppm STEL	TWA: 100 ppm TWA: 435 mg/m³	100 ppm TWA 435 mg/m³ TWA 150 ppm STEL 655 mg/m³ STEL	900 ppm
1,2,4 Trimethylbenzene 95-63-6	25 ppm TWA	-	25 ppm TWA 125 mg/m³ TWA	-
Benzene 71-43-2	0.5 ppm TWA 2.5 ppm STEL Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm (applies to industry segments exempt from the benzene standard at 29 CFR 1910.1028) TWA: 1 ppm STEL: 5 ppm (see 29 CFR 1910.1028)	25 ppm Ceiling 1 ppm TWA 5 ppm STEL	500 ppm
n-Hexane 110-54-3	50 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 500 ppm TWA: 1800 mg/m³	50 ppm TWA 180 mg/m³ TWA	1100 ppm
Ethylbenzene 100-41-4	20 ppm TWA	TWA: 100 ppm TWA: 435 mg/m³	100 ppm TWA 435 mg/m³ TWA 125 ppm STEL 545 mg/m³ STEL	800 ppm
Naphthalene 91-20-3	10 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm TWA: 50 mg/m³	10 ppm TWA 50 mg/m³ TWA 15 ppm STEL 75 mg/m³ STEL	250 ppm

Notes: The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures: Local or general exhaust required in an enclosed area or when there is inadequate ventilation. Use mechanical ventilation equipment that is explosion-proof.

Personal protective equipment

Eye protection: Use goggles or face-shield if the potential for splashing exists.

Skin and body protection: Use nitrile rubber, viton or PVA gloves for repeated or prolonged skin exposure. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times.

Respiratory protection: Approved organic vapor chemical cartridge or supplied air respirators should be worn for exposures to any components exceeding the established exposure limits. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.

Hygiene measures:	Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State	Liquid
Appearance	Clear or Colored Liquid
Color	Clear or Colored
Odor	Strong Hydrocarbon
Odor Threshold	No available data.

Property	**Values (Method)**
Melting Point / Freezing Point	No available data.
Initial Boiling Point / Boiling Range	32-225 °C / 90-437 °F
Flash Point	-45.5 °C / -50 °F
Evaporation Rate	No available data.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%)	
Upper Flammability Limit:	7.6
Lower Flammability Limit:	1.4
Vapor Pressure	403-776 mm Hg@ 100°F
Vapor Density	3-4
Specific Gravity / Relative Density	0.70-0.77
Water Solubility	Negligible
Solubility in other solvents	No available data.
Partition Coefficient	2.13-4.5
Decomposition temperature:	No available data.
pH:	Not applicable
Autoignition Temperature	C.A. 257 °C / 495 °F
Kinematic Viscosity	No available data.
Dynamic Viscosity	No available data.
Explosive Properties	No available data.
Softening Point	No available data.
VOC Content (%)	100%
Density	5.9-6.3 lbs/gal
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

Reactivity	The product is non-reactive under normal conditions.
Chemical stability	The material is stable at 70°F, 760 mmHg pressure.
Possibility of hazardous reactions	None under normal processing.
Hazardous polymerization	Will not occur.
Conditions to avoid	Excessive heat, sources of ignition, open flame.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	Irritating to the respiratory system. May cause drowsiness or dizziness. Breathing high concentrations of this material in a confined space or by intentional abuse can cause irregular heartbeats which can cause death.
Eye contact	Causes mild eye irritation.
Skin contact	Causes skin irritation. Effects may become more serious with repeated or prolonged contact. May be absorbed through the skin in harmful amounts.
Ingestion	May be fatal if swallowed or vomited and enters airways. May cause irritation of the mouth, throat and gastrointestinal tract.

Acute Toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
Gasoline 86290-81-5	14000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.2 mg/L (Rat) 4 h
Toluene 108-88-3	> 2000 mg/kg (Rat)	8390 mg/kg (Rabbit)	12.5 mg/L (Rat) 4 h
Ethyl Alcohol 64-17-5	> 5000 mg/kg (Rat)	-	124.7 mg/L (Rat) 4 h
Xylene (mixed isomers) 1330-20-7	> 2000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.04 mg/L (Rat) 4 h
1,2,4 Trimethylbenzene 95-63-6	3280 mg/kg (Rat)	> 3160 mg/kg (Rabbit)	18,000 mg/m^3 (Rat) 4 h
Benzene 71-43-2	> 2000 mg/kg (Rat)	> 5000 mg/kg (Rabbit)	> 20 mg/l (Rat) 4 h
n-Hexane 110-54-3	15000 mg/kg (Rat)	3000 mg/kg (Rabbit)	48000 ppm (Rat) 4 h
Ethylbenzene 100-41-4	> 2000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	17.2 mg/L (Rat) 4 h
Naphthalene 91-20-3	490 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 340 mg/m^3 (Rat) 1 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

BENZENE: Studies of workers exposed to benzene show clear evidence that overexposure can cause cancer and other diseases of the blood forming organs including Acute Myelogenous Leukemia (AML), and Aplastic Anemia (AA), an often fatal disease. Some studies suggest overexposure to benzene may also be associated with Myelodysplastic Syndrome (MDS). Findings from a case control study of workers exposed to benzene was reported during the 2009 Benzene Symposium in Munich included an increase in Acute Myeloid Leukemias and Non-Hodgkins Lymphoid Neoplasms (NHLN) of the subtype follicular lymphoma (FL) in some occupational categories. Some studies of workers exposed to benzene have shown an association with increased rates of chromosome aberrations in circulating lymphocytes. One study of women workers exposed to benzene suggested a weak association with irregular menstruation. However, other studies of workers exposed to benzene have not demonstrated clear evidence of an effect on fertility or reproductive outcome in humans. Benzene can cross the placenta and affect the developing fetus. Cases of AA have been reported in the offspring of persons severely overexposed to benzene. Studies in laboratory animals indicate that prolonged, repeated exposure to high levels of benzene vapor can cause bone marrow suppression and cancer in multiple organ systems. Studies in laboratory animals show evidence of adverse effects on male reproductive organs following high levels of exposure but no significant effects on reproduction have been observed. Embryotoxicity has been reported in studies of laboratory animals but effects were limited to reduced fetal weight and minor skeletal variations. Benzene has been classified as a proven human carcinogen by OSHA and a Group 1 (Carcinogenic to Humans) material by IARC. The current proposed IARC classification for benzene is summarized as follows: Sufficient evidence for Acute Myeloid Leukemia; limited evidence for Acute Lymphatic Leukemia, Chronic Lymphatic Leukemia, Non-Hodgkin Lymphoma, and Multiple Myeloma.

NAPHTHAS: In a large epidemiological study on over 15,000 employees at several petroleum refineries and amongst residents located near these refineries, no increased risk of kidney cancer was observed in association with gasoline exposures (a similar material). In a similar study, no increased risk of kidney cancer was observed among petroleum refinery workers, but there was a slight trend in the incidence of kidney cancers among service station employees, especially after a 30-year latency period. Altered mental state, drowsiness, peripheral motor neuropathy, irreversible brain damage (so-called Petrol Sniffer's Encephalopathy), delirium, seizures, and sudden death have been reported from repeated overexposure to some hydrocarbon solvents, naphthas, and gasoline.

ISOPARAFFINS: Studies in laboratory animals have shown that long-term exposure to similar materials (isoparaffins) can cause kidney damage and kidney cancer in male laboratory rats. However, in-depth research indicates that these findings are unique to the male rat, and that these effects are not relevant to humans.

TOLUENE: Case studies of persons abusing toluene suggest isolated incidences of adverse effects on the fetus including birth defects. Abuse of toluene at high concentrations (e.g., glue sniffing and solvent abuse) has been associated with adverse effects on the liver, kidney and nervous system, and can cause CNS depression, cardiac arrhythmias, and death. Studies of workers indicate longterm exposure may be related to impaired color vision and hearing. Some studies of workers suggest longterm exposure may be related to neurobehavioral and cognitive changes. Some of these effects have been observed in laboratory animals following repeated exposure to high levels of toluene. Several studies of workers suggest longterm exposure may be related to small increases in spontaneous abortions and changes in some gonadotropic hormones. However, the weight of evidence does not indicate toluene is a reproductive hazard to humans. Studies in laboratory animals indicate some changes in reproductive organs following high levels of exposure, but no significant effects on mating performance or reproduction were observed. Case studies of persons abusing toluene suggest isolated incidences of adverse effects on the fetus including birth defects. Findings in laboratory animals have been largely negative. Positive findings include small increases in minor skeletal and visceral malformations and developmental delays following very high levels of maternal exposure. Studies of workers indicate long-term exposure may be related to effects on the liver, kidney and blood, but these appear to be limited to changes in serum enzymes and decreased leukocyte counts. Adverse effects on the liver, kidney, thymus and nervous system were observed in animal studies following very high levels of exposure. The relevance of these findings to humans is not clear at this time.

ETHYLBENZENE: Findings from a 2-year inhalation study in rodents conducted by NTP were as follows: Effects were observed only at the highest exposure level (750 ppm). At this level the incidence of renal tumors was elevated in male rats (tubular carcinomas) and female rats (tubular adenomas). The incidence of tumors was also elevated in male mice (alveolar and bronchiolar carcinomas) and female mice (hepatocellular carcinomas). IARC has classified ethyl benzene as "possibly carcinogenic to humans" (Group 2B). Studies in laboratory animals indicate some evidence of post-implantation deaths following high levels of maternal exposure. The relevance of these findings to humans is not clear at this time. Studies in laboratory animals indicate limited evidence of renal malformations, resorptions, and developmental delays following high levels of maternal exposure with evidence of maternal toxicity. The relevance of these findings to humans is not clear at this time. Studies in laboratory animals have demonstrated evidence of ototoxicity (hearing loss) following exposure levels as low as 300 ppm for 5 days. Studies in laboratory animals indicate some evidence of adverse effects on the liver, kidney, thyroid, and pituitary gland.

XYLENES, ALL ISOMERS: Overexposure to xylene may cause upper respiratory tract irritation, headache, cyanosis, blood serum changes, nervous system damage and narcosis. Effects may be increased by the use of alcoholic beverages. Evidence of liver and kidney impairment were reported in workers recovering from a gross overexposure. Effects from Prolonged or Repeated Exposure: Impaired neurological function was reported in workers exposed to solvents including xylene. Studies in laboratory animals have shown evidence of impaired hearing following high levels of exposure. Studies in laboratory animals suggest some changes in reproductive organs following high levels of exposure but no significant effects on reproduction were observed. Studies in laboratory animals indicate skeletal and visceral malformations, developmental delays, and increased fetal resorptions following extremely high levels of maternal exposure with evidence of maternal toxicity. The relevance of these observations to humans is not clear at this time. Adverse effects on the liver, kidney, bone marrow (changes in blood cell parameters) were observed in laboratory animals following high levels of exposure. The relevance of these observations to humans is not clear at this time.

C9 AROMATIC HYDROCARBONS: A developmental inhalation study was conducted in laboratory mice. Increased implantation losses, reduced fetal weights, delayed ossification and an increased incidence of cleft palate were observed at the highest exposure level (1,500 ppm). This exposure level was extremely toxic to pregnant female mice (44% mortality). Reduced fetal body weights were also observed at 500 ppm. A multi-generation reproduction inhalation study was conducted in laboratory rats. Reductions in pup weights, pup weight gain, litter size, and pup survival were observed at 1,500 ppm, an exposure level at which significant maternal toxicity was observed. Reduced pup weight gain was also observed at 500 ppm.

NAPHTHALENE: Severe jaundice, neurotoxicity (kernicterus) and fatalities have been reported in young children and infants as a result of hemolytic anemia from overexposure to naphthalene. Persons with glucose 6-phosphate dehydrogenase (G6PD) deficiency are more prone to the hemolytic effects of naphthalene. Adverse effects on the kidney have been reported in persons overexposed to naphthalene but these effects are believed to be a consequence of hemolytic anemia, and not a direct effect. Hemolytic anemia has been observed in laboratory animals exposed to naphthalene. Laboratory rodents exposed to naphthalene vapor for 2 years (lifetime studies) developed non-neoplastic and neoplastic tumors and inflammatory lesions of the nasal and respiratory tract. Cataracts and other adverse effects on the eye have been observed in laboratory animals exposed to high levels of naphthalene. Findings from a large number of bacterial and mammalian cell mutation assays have been negative. A few studies have shown chromosomal effects (elevated levels of Sister Chromatid Exchange or chromosomal aberrations) in vitro. Naphthalene has been classified as Possibly Carcinogenic to Humans (2B) by IARC, based on findings from studies in laboratory animals.

N-HEXANE: Long-term or repeated exposure to n-hexane can cause peripheral nerve damage. Initial symptoms are numbness of the fingers and toes. Also, motor weakness can occur in the digits, but may also involve muscles of the arms, thighs and forearms. The onset of these symptoms may be delayed for several months to a year after the beginning of exposure. Testicular atrophy and partial to full loss of the germ cell line were observed in sub-chronic high-dose inhalation studies of laboratory rodents. These effects appeared irreversible. Rodent reproduction studies have shown evidence of reduced fetal weight but no frank malformations.

PENTANES: Studies of pentane isomers in laboratory animals indicate exposure to extremely high levels (roughly 10 vol.%) may induce cardiac arrhythmias (irregular heartbeats) which may be serious or fatal.

ETHANOL: Repeated ingestion of ethanol can result in alcohol abuse, causing behavioral changes, memory loss, impaired judgement, decreased appetite, irregular heartbeats, and decreased fertility. Prolonged and repeated ingestion of ethanol has also been associated with cancers of the mouth, pharynx, esophagus and liver. Ethanol ingestion by pregnant women can cause miscarriage, low birth weight, premature birth and fetal alcohol syndrome. In males, acute and chronic alcohol ingestion may affect gonadal hormone levels. It may also affect the liver, kidney, brain, blood and cardiovascular system.

CARBON MONOXIDE: is a chemical asphyxiant with no warning properties (such as odor). At 400-500 ppm for 1 hour headache and dyspnea may occur. If activity is increased, symptoms of overexposure may include nausea, irritability, increased respiration, tinnitus, sweating, chest pain, confusion, impaired judgement, dizziness, weakness, drowsiness, ataxia, irregular heart beat, cyanosis and pallor. Levels in excess of 1000 ppm can result in collapse, loss of conciousness, respiratory failure and death. Extremely high concentrations (12,800 ppm) can cause immediate unconsciousness and death in 1-3 minutes. Repeated anoxia can lead to central nervous system damage and peripheral neuropathy, with loss of sensation in the fingers, amnesia, and mental deterioration and possible congestive heart failure. Damage may also occur to the fetus, lung, liver, kidney, spleen, cardiovascular system and other organs.

COMBUSTION ENGINE EXHAUST: Chronic inhalation studies of gasoline engine exhaust in mice, rats and hamsters did not produce any carcinogenic effects. Condensates/extracts of gasoline engine exhaust produced an increase in tumors compared to controls when testing by skin painting, subcutaneous injection, intratracheal instillation or implantation into the lungs.

Adverse effects related to the physical, chemical and toxicological characteristics

Signs & Symptoms Nausea, vomiting, signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue.

Sensitization Not expected to be a skin or respiratory sensitizer.

Mutagenic effects May cause genetic defects.

Carcinogenicity Cancer designations are listed in the table below.

Name	ACGIH (Class)	IARC (Class)	NTP	OSHA
Gasoline 86290-81-5	Confirmed animal carcinogen (A3)	Possibly Carcinogenic (2B)	Not Listed	Not Listed
Toluene 108-88-3	Not Classifiable (A4)	Not Classifiable (3)	Not Listed	Not Listed
Ethyl Alcohol 64-17-5	Confirmed animal carcinogen (A3)	Carcinogenic (1) Alcoholic Beverages	Known to be human carcinogen - Alcoholic Beverage Consumption	Not Listed
Xylene (mixed isomers) 1330-20-7	Not Classifiable (A4)	Not Classifiable (3)	Not Listed	Not Listed
1,2,4 Trimethylbenzene 95-63-6	Not Listed	Not Listed	Not Listed	Not Listed

Benzene 71-43-2	Confirmed human carcinogen (A1)	Carcinogenic to humans (1)	Known to be human carcinogen	Known carcinogen
n-Hexane 110-54-3	Not Listed	Not Listed	Not Listed	Not Listed
Ethylbenzene 100-41-4	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Not Listed	Not Listed
Naphthalene 91-20-3	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not Listed

Reproductive toxicity	Suspected of damaging fertility or the unborn child.
Specific Target Organ Toxicity (STOT) - single exposure	Respiratory system. Central nervous system.
Specific Target Organ Toxicity (STOT) - repeated exposure	Not classified.
Aspiration hazard	May be fatal if swallowed or vomited and enters airways.

12. ECOLOGICAL INFORMATION

Ecotoxicity

This product should be considered toxic to aquatic organisms, with the potential to cause long lasting adverse effects in the aquatic environment.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
Gasoline 86290-81-5	72-hr EC50 = 56 mg/l Algae	96-hr LC50 = 11 mg/l Rainbow trout (static)	-	48-hr LC50 = 7.6 mg/l Daphnia magna
Toluene 108-88-3	72-hr EC50 = 12.5 mg/l Algae	96-hr LC50 <= 10 mg/l Rainbow trout	-	48-hr EC50 = 5.46-9.83 mg/l Daphnia magna 48-hr EC50 = 11.5 mg/l Daphnia magna (Static)
Ethyl Alcohol 64-17-5	-	96-hr LC50 >1,000 mg/l Rainbow Trout (static) 96-hr LC50 >100 mg/l Fathead minnow (static)	-	48-hr LC50 >1,000 mg/l Daphnia magna
Xylene (mixed isomers) 1330-20-7	72-hr EC50 = 11 mg/l Algae	96-hr LC50 = 8 mg/l Rainbow trout	-	48-hr LC50 = 3.82 mg/l Daphnia magna
1,2,4 Trimethylbenzene 95-63-6	-	96-hr LC50 = 7.19-8.28 mg/l Fathead minnow (flow-through)	-	48-hr EC50 = 6.14 mg/L Daphnia magna
Benzene 71-43-2	72-hr EC50 = 29 mg/l Algae	96-hr LC50 = 5.3 mg/l Rainbow trout (flow-through)	-	48-hr EC50 = 8.76-15.6 mg/l Daphnia magna (Static)
n-Hexane 110-54-3	-	96-hr LC50 = 2.5 mg/l Fathead minnow	-	-
Ethylbenzene 100-41-4	72-hr EC50 = 1.7-7.6 mg/l Algae	96-hr LC50 = 4 mg/L Rainbow trout	-	48-hr EC50 = 1-4 mg/L Daphnia magna
Naphthalene 91-20-3	-	96-hr LC50 = 0.91-2.82 mg/l Rainbow trout (static) 96-hr LC50 = 1.99 mg/l Fathead minnow (static)	-	48-hr LC50 = 1.6 mg/l Daphnia magna

Persistence and degradability	Expected to be inherently biodegradable. The presence of ethanol in this product may impede the biodegradation of benzene, toluene, ethylbenzene and xylene in groundwater, resulting in elongated plumes of these constituents.
Bioaccummulation	Has the potential to bioaccumulate.
Mobility in soil	May partition into air, soil and water.
Other adverse effects	No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues
This material may be a flammable liquid waste.

Safe Handling of Wastes
Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required. Use appropriate grounding and bonding practices. Use only non-sparking tools. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking.

Disposal of Wastes / Methods of Disposal
The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal
Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper shipping name:	Gasoline
UN/Identification No:	UN 1203
Transport Hazard Class(es):	3
Packing group:	II

TDG (Canada):

UN Proper shipping name:	Gasoline
UN/Identification No:	UN 1203
Transport Hazard Class(es):	3
Packing group:	II

15. REGULATORY INFORMATION

US Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b):	This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product does not contain any component(s) included on EPA's Extremely Hazardous Substance (EHS) List.

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
Gasoline	NA
Toluene	NA
Ethyl Alcohol	NA
Xylene (mixed isomers)	NA
1,2,4 Trimethylbenzene	NA
Benzene	NA
n-Hexane	NA
Ethylbenzene	NA
Naphthalene	NA

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	CERCLA/SARA - Hazardous Substances and their Reportable Quantities
Gasoline	NA
Toluene	1000 lb final RQ 454 kg final RQ
Ethyl Alcohol	NA
Xylene (mixed isomers)	100 lb final RQ 45.4 kg final RQ
1,2,4 Trimethylbenzene	NA
Benzene	10 lb final RQ 4.54 kg final RQ
n-Hexane	5000 lb final RQ 2270 kg final RQ
Ethylbenzene	1000 lb final RQ 454 kg final RQ
Naphthalene	100 lb final RQ 45.4 kg final RQ

SARA: The following EPA hazard categories apply to this product:

Acute Health Hazard
Chronic Health Hazard
Fire Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
Gasoline	None
Toluene	1.0 % de minimis concentration
Ethyl Alcohol	None
Xylene (mixed isomers)	1.0 % de minimis concentration
1,2,4 Trimethylbenzene	None
Benzene	0.1 % de minimis concentration
n-Hexane	1.0 % de minimis concentration
Ethylbenzene	0.1 % de minimis concentration
Naphthalene	0.1 % de minimis concentration

State and Community Right-To-Know Regulations:
The following component(s) of this material are identified on the regulatory lists below:

Gasoline

Louisiana Right-To-Know:	Not Listed.
California Proposition 65:	Not Listed.
New Jersey Right-To-Know:	SN 0957
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed.
Rhode Island Right-To-Know:	Not Listed.
Michigan Critical Materials Register List:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed.
California - Regulated Carcinogens:	Not Listed.
Pennsylvania RTK - Special Hazardous Substances:	Not Listed.
New Jersey - Special Hazardous Substances:	Carcinogen; Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 0957 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants	Present

New York - Reporting of Releases Part 597 - List of Hazardous Substances: Not Listed.

Toluene
Louisiana Right-To-Know: Not Listed.
California Proposition 65: Developmental toxicity, initial date 1/1/91
Female reproductive toxicity, initial date 8/7/09
New Jersey Right-To-Know: SN 1866
Pennsylvania Right-To-Know: Environmental hazard
Massachusetts Right-To Know: Present
Florida Substance List: Not Listed.
Rhode Island Right-To-Know: Toxic (skin); Flammable (skin)
Michigan Critical Materials Register List: 100 lb Annual usage threshold
Massachusetts Extraordinarily Hazardous Substances: Not Listed.
California - Regulated Carcinogens: Not Listed.
Pennsylvania RTK - Special Hazardous Substances: Not Listed.
New Jersey - Special Hazardous Substances: Flammable - third degree; Teratogen
New Jersey - Environmental Hazardous Substances List: SN 1866 TPQ: 500 lb
Illinois - Toxic Air Contaminants Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances: 1000 lb RQ (air); 1 lb RQ (land/water)

Ethyl Alcohol
Louisiana Right-To-Know: Not Listed.
California Proposition 65: Carcinogen, initial date 4/29/11 (in alcoholic beverages)
Carcinogen, initial date 7/1/88 (when associated with alcohol abuse)
Developmental toxicity, initial date 10/1/87 (in alcoholic beverages)
New Jersey Right-To-Know: SN 0844
Pennsylvania Right-To-Know: Present
Massachusetts Right-To Know: Teratogen
Florida Substance List: Not Listed.
Rhode Island Right-To-Know: Toxic; Flammable
Michigan Critical Materials Register List: Not Listed.
Massachusetts Extraordinarily Hazardous Substances: Not Listed.
California - Regulated Carcinogens: Not Listed.
Pennsylvania RTK - Special Hazardous Substances: Not Listed.
New Jersey - Special Hazardous Substances: Carcinogen; Flammable - third degree; Mutagen; Teratogen
New Jersey - Environmental Hazardous Substances List: Not Listed.
Illinois - Toxic Air Contaminants Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances: Not Listed.

Xylene (mixed isomers)
Louisiana Right-To-Know: Not Listed.
California Proposition 65: Not Listed.
New Jersey Right-To-Know: SN 2014
Pennsylvania Right-To-Know: Environmental hazard
Massachusetts Right-To Know: Present
Florida Substance List: Not Listed.
Rhode Island Right-To-Know: Toxic (skin); Flammable (skin)
Michigan Critical Materials Register List: 100 lb Annual usage threshold all isomers
Massachusetts Extraordinarily Hazardous Substances: Not Listed.
California - Regulated Carcinogens: Not Listed.
Pennsylvania RTK - Special Hazardous Substances: Not Listed.
New Jersey - Special Hazardous Substances: Flammable - third degree
New Jersey - Environmental Hazardous Substances List: SN 2014 TPQ: 500 lb

Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)

1,2,4 Trimethylbenzene

Louisiana Right-To-Know:	Not Listed.
California Proposition 65:	Not Listed.
New Jersey Right-To-Know:	SN 1929
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic
Michigan Critical Materials Register List:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed.
California - Regulated Carcinogens:	Not Listed.
Pennsylvania RTK - Special Hazardous Substances:	Not Listed.
New Jersey - Special Hazardous Substances:	Not Listed.
New Jersey - Environmental Hazardous Substances List:	Not Listed.
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed.

Benzene

Louisiana Right-To-Know:	Not Listed.
California Proposition 65:	Carcinogen, initial date 2/27/87 Developmental toxicity, initial date 12/26/97 Male reproductive toxicity, initial date 12/26/97
New Jersey Right-To-Know:	SN 0197
Pennsylvania Right-To-Know:	Environmental hazard; Special hazardous substance
Massachusetts Right-To Know:	Carcinogen; Extraordinarily hazardous
Florida Substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic (skin); Flammable (skin); Carcinogen (skin)
Michigan Critical Materials Register List:	100 lb Annual usage threshold
Massachusetts Extraordinarily Hazardous Substances:	Carcinogen; Extraordinarily hazardous
California - Regulated Carcinogens:	Not Listed.
Pennsylvania RTK - Special Hazardous Substances:	Present
New Jersey - Special Hazardous Substances:	Carcinogen; Flammable - third degree; Mutagen
New Jersey - Environmental Hazardous Substances List:	SN 0197 TPQ: 500 lb
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	10 lb RQ (air); 1 lb RQ (land/water)

n-Hexane

Louisiana Right-To-Know:	Not Listed.
California Proposition 65:	Not Listed.
New Jersey Right-To-Know:	SN 1340
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed.
California - Regulated Carcinogens:	Not Listed.
Pennsylvania RTK - Special Hazardous Substances:	Not Listed.
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 1340 TPQ: 500 lb
Illinois - Toxic Air Contaminants	Present

New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1 lb RQ (air); 1 lb RQ (land/water)
Ethylbenzene	
Louisiana Right-To-Know:	Not Listed.
California Proposition 65:	Carcinogen, initial date 6/11/04
New Jersey Right-To-Know:	SN 0851
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed.
California - Regulated Carcinogens:	Not Listed.
Pennsylvania RTK - Special Hazardous Substances:	Not Listed.
New Jersey - Special Hazardous Substances:	Carcinogen; flammable - Third degree
New Jersey - Environmental Hazardous Substances List:	SN 0851 TPQ: 500 lb
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)
Naphthalene	
Louisiana Right-To-Know:	Not Listed.
California Proposition 65:	Carcinogen, initial date 4/19/02
New Jersey Right-To-Know:	SN 1322 SN 3758
Pennsylvania Right-To-Know:	Environmental hazard Present (particulate)
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed.
California - Regulated Carcinogens:	Not Listed.
Pennsylvania RTK - Special Hazardous Substances:	Not Listed.
New Jersey - Special Hazardous Substances:	Carcinogen
New Jersey - Environmental Hazardous Substances List:	SN 1322 TPQ: 500 lb (Reportable at the de minimis quantity of >0.1%)
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	100 lb RQ (air); 1 lb RQ (land/water)

Canada DSL/NDSL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: "This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations."

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
Gasoline	B2,D2A,D2B	0.1%
Toluene	B2,D2A,D2B	0.1%
Ethyl Alcohol	B2,D2B	0.1%
Xylene (mixed isomers)	B2,D2A,D2B	m-, o-isomers 1.0%; p-isomer 0.1%
1,2,4 Trimethylbenzene	B3	1
Benzene	B2,D2A,D2B	0.1%
n-Hexane	B2,D2A,D2B	1%
Ethylbenzene	B2,D2A,D2B	0.1%
Naphthalene	B4,D2A	0.1%

NOTE: Not Applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety
Revision Date: 05/14/2015

Revision Note:

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Fisher Scientific
Part of Thermo Fisher Scientific

SAFETY DATA SHEET

Creation Date 24-Aug-2009 **Revision Date** 10-Jan-2017 **Revision Number** 3

1. Identification

Product Name **Hydrochloric Acid**

Cat No. : **A144-212; A144-212LC; A144-500; A144-500LB; A144-500LC; A144-612GAL; A144C-212; A144C-212EA; A144P-19; A144P-20; A144S-212; A144S-212EA; A144S-500; A144SI-212**

Synonyms Muriatic acid

Recommended Use Laboratory chemicals.

Uses advised against No Information available

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Supplier
Fisher Scientific UK
Bishop Meadow Rd
Loughborough, Leicestershire, LE11 5RG Great Britain
Tel: 01509 231166

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Corrosive to metals	Category 1
Skin Corrosion/irritation	Category 1 B
Serious Eye Damage/Eye Irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	

Label Elements

Signal Word
Danger

Hazard Statements
May be corrosive to metals
Causes severe skin burns and eye damage
May cause respiratory irritation

Precautionary Statements
Prevention
Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Keep only in original container
Response
Immediately call a POISON CENTER or doctor/physician
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Ingestion
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting
Spills
Absorb spillage to prevent material damage
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Store in corrosive resistant polypropylene container with a resistant inliner
Store in a dry place
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
None identified

3. Composition / information on ingredients

Component	CAS-No	Weight %
Water	7732-18-5	62-65
Hydrochloric acid	7647-01-0	35-38

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.
Inhalation	Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.

Ingestion	Do not induce vomiting. Call a physician or Poison Control Center immediately.
Most important symptoms/effects	Causes burns by all exposure routes. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Substance is nonflammable; use agent most appropriate to extinguish surrounding fire.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Corrosive Material. Causes burns by all exposure routes. Thermal decomposition can lead to release of irritating gases and vapors.

Hazardous Combustion Products
Hydrogen chloride gas
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
3	0	0	N/A

6. Accidental release measures

Personal Precautions	Use personal protective equipment. Ensure adequate ventilation. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Do not get in eyes, on skin, or on clothing.
Environmental Precautions	Should not be released into the environment. See Section 12 for additional ecological information.
Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling	Wear personal protective equipment. Do not breathe vapors or spray mist. Do not get in eyes, on skin, or on clothing. Do not ingest.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place. Corrosives area.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Hydrochloric acid	Ceiling: 2 ppm	Ceiling: 5 ppm Ceiling: 7 mg/m³ (Vacated) Ceiling: 5 ppm (Vacated) Ceiling: 7 mg/m³	IDLH: 50 ppm Ceiling: 5 ppm Ceiling: 7 mg/m³

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Hydrochloric acid	Ceiling: 5 ppm Ceiling: 7.5 mg/m³	Ceiling: 5 ppm Ceiling: 7 mg/m³	CEV: 2 ppm

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	pungent
Odor Threshold	No information available
pH	< 1
Melting Point/Range	-35 °C / -31 °F
Boiling Point/Range	57 °C / 135 °F @ 760 mmHg
Flash Point	No information available
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	125 mbar @ 20 °C
Vapor Density	1.27
Specific Gravity	1.18
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	1.8 mPa.s @ 15°C
Molecular Formula	HCl.H2O
Molecular Weight	36.46

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under normal conditions.
Conditions to Avoid	Incompatible products. Excess heat.
Incompatible Materials	Metals, Strong oxidizing agents, Bases, sodium hypochlorite, Amines, Fluorine, Cyanides, Alkaline
Hazardous Decomposition Products	Hydrogen chloride gas
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	Contact with metals may evolve flammable hydrogen gas.

11. Toxicological information

Acute Toxicity

Product Information

Oral LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Dermal LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Vapor LC50	Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Water	-	Not listed	Not listed
Hydrochloric acid	238 - 277 mg/kg (Rat)	> 5010 mg/kg (Rabbit)	1.68 mg/L (Rat) 1 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	Causes burns by all exposure routes
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed
Hydrochloric acid	7647-01-0	Not listed	Not listed	Not listed	Not listed	Not listed

IARC: (International Agency for Research on Cancer)

IARC: (International Agency for Research on Cancer)
Group 1 - Carcinogenic to Humans
Group 2A - Probably Carcinogenic to Humans
Group 2B - Possibly Carcinogenic to Humans

Mutagenic Effects	No information available
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	Respiratory system
STOT - repeated exposure	None known
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains. Large amounts will affect pH and harm aquatic organisms.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Hydrochloric acid	-	282 mg/L LC50 96 h Gambusia affinis mg/L LC50 48 h Leucscus idus	-	56mg/L EC50 72h Daphnia

Persistence and Degradability	Persistence is unlikely based on information available.
Bioaccumulation/ Accumulation	No information available.
Mobility	Will likely be mobile in the environment due to its water solubility.

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No	UN1789
Proper Shipping Name	HYDROCHLORIC ACID
Hazard Class	8
Packing Group	II

TDG

UN-No	UN1789
Proper Shipping Name	HYDROCHLORIC ACID
Hazard Class	8
Packing Group	II

IATA

UN-No	UN1789
Proper Shipping Name	Hydrochloric acid
Hazard Class	8
Packing Group	II

IMDG/IMO

UN-No	UN1789
Proper Shipping Name	Hydrochloric acid
Hazard Class	8
Packing Group	II

15. Regulatory information

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Water	X	X	-	231-791-2	-		X	-	X	X	X
Hydrochloric acid	X	X	-	231-595-7	-		X	X	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.

S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Hydrochloric acid	7647-01-0	35-38	1.0

SARA 311/312 Hazard Categories

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Hydrochloric acid	X	5000 lb	-	-

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Hydrochloric acid	X		-

OSHA Occupational Safety and Health Administration
Not applicable

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Hydrochloric acid	-	TQ: 5000 lb

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Hydrochloric acid	5000 lb	5000 lb

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Water	-	-	X	-	-
Hydrochloric acid	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security

This product contains the following DHS chemicals:

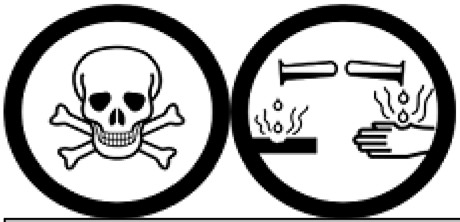
Component	DHS Chemical Facility Anti-Terrorism Standard
Hydrochloric acid	0 lb STQ (anhydrous); 11250 lb STQ (37% concentration or greater)

Other International Regulations

Mexico - Grade No information available

Canada
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR

WHMIS Hazard Class
D1A Very toxic materials
E Corrosive material



16. Other information

Prepared By
Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

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Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

SAFETY DATA SHEET

Isopropyl Alcohol (Isopropanol)

Section 1. Identification

GHS product identifier : Isopropyl Alcohol (Isopropanol)

Chemical name : Isopropyl alcohol

Other means of identification : propan-2-ol; 2-Propanol; isopropanol; isopropyl alcohol

Product use : Synthetic/Analytical chemistry.

Synonym : propan-2-ol; 2-Propanol; isopropanol; isopropyl alcohol

SDS # : 001105

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation) : 1-866-734-3438

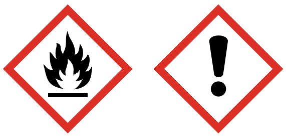
Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE LIQUIDS - Category 2
SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 2
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Narcotic effects) - Category 3

GHS label elements

Hazard pictograms :



Signal word : Danger

Hazard statements : Highly flammable liquid and vapor.
May form explosive mixtures with air.
Causes serious eye irritation.
May cause drowsiness and dizziness.

Precautionary statements

General : Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

Prevention : Wear protective gloves. Wear eye or face protection. Keep away from heat, sparks, open flames and hot surfaces. - No smoking. Use explosion-proof electrical, ventilating, lighting and all material-handling equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Keep container tightly closed. Use only outdoors or in a well-ventilated area. Avoid breathing vapor. Wash hands thoroughly after handling. Use and store only outdoors or in a well ventilated place.

Section 2. Hazards identification

Response : IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or physician if you feel unwell. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical attention.

Storage : Store locked up. Store in a well-ventilated place. Keep cool.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : Isopropyl alcohol

Other means of identification : propan-2-ol; 2-Propanol; isopropanol; isopropyl alcohol

CAS number/other identifiers

CAS number : 67-63-0

Product code : 001105

Ingredient name	%	CAS number
propan-2-ol	100	67-63-0

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If necessary, call a poison center or physician. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. If necessary, call a poison center or physician. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention

Section 4. First aid measures

immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Causes serious eye irritation.

Inhalation : Can cause central nervous system (CNS) depression. May cause drowsiness and dizziness.

Skin contact : No known significant effects or critical hazards.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : Can cause central nervous system (CNS) depression. Irritating to mouth, throat and stomach.

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:
pain or irritation
watering
redness

Inhalation : Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use dry chemical, CO_2, water spray (fog) or foam.

Unsuitable extinguishing media : Do not use water jet.

Specific hazards arising from the chemical : Highly flammable liquid and vapor. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. The vapor/gas is heavier than air and will spread along the ground. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard.

Section 5. Fire-fighting measures

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapor or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Dilute with water and mop up if water-soluble. Alternatively, or if water-insoluble, absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.

Large spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see Section 13). Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Do not ingest. Avoid contact with eyes, skin and clothing. Avoid breathing vapor or mist. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Take precautionary measures against electrostatic discharges. Empty containers retain product residue and can be hazardous. Do not reuse container.

Section 7. Handling and storage

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
propan-2-ol	**ACGIH TLV (United States, 3/2012).** TWA: 200 ppm 8 hours. STEL: 400 ppm 15 minutes. **OSHA PEL 1989 (United States, 3/1989).** TWA: 400 ppm 8 hours. TWA: 980 mg/m³ 8 hours. STEL: 500 ppm 15 minutes. STEL: 1225 mg/m³ 15 minutes. **NIOSH REL (United States, 1/2013).** TWA: 400 ppm 10 hours. TWA: 980 mg/m³ 10 hours. STEL: 500 ppm 15 minutes. STEL: 1225 mg/m³ 15 minutes. **OSHA PEL (United States, 6/2010).** TWA: 400 ppm 8 hours. TWA: 980 mg/m³ 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Section 8. Exposure controls/personal protection

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Liquid. [COLORLESS LIQUID WITH THE ODOR OF RUBBING ALCOHOL]

Color : Colorless.

Molecular weight : 60.11 g/mole

Molecular formula : C3-H8-O

Boiling/condensation point : 83°C (181.4°F)

Melting/freezing point : -90°C (-130°F)

Critical temperature : Not available.

Odor : Alcohol-like.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: 11.7°C (53.1°F)

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : 1.7 (butyl acetate = 1)

Flammability (solid, gas) : Not available.

Lower and upper explosive (flammable) limits : Lower: 2%
Upper: 12%

Vapor pressure : 4.4 kPa (33.002681467 mm Hg) [room temperature]

Vapor density : 2.1 (Air = 1)

Specific Volume (ft ^{3}/lb) : 1.2739

Gas Density (lb/ft ^{3}) : 0.785

Relative density : 0.79

Section 9. Physical and chemical properties

Solubility	: Not available.
Solubility in water	: Not available.
Partition coefficient: n-octanol/water	: 0.05
Auto-ignition temperature	: 456°C (852.8°F)
Decomposition temperature	: Not available.
SADT	: Not available.
Viscosity	: Not available.

Section 10. Stability and reactivity

Reactivity	: No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	: The product is stable.
Possibility of hazardous reactions	: Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to avoid	: Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition. Do not allow vapor to accumulate in low or confined areas.
Incompatibility with various substances	: Highly reactive or incompatible with the following materials: acids and moisture.
Hazardous decomposition products	: Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Hazardous polymerization	: Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
propan-2-ol	LC50 Inhalation Gas. LD50 Dermal LD50 Oral	Rat Rabbit Rat	45248 ppm 12800 mg/kg 5000 mg/kg	1 hours - -

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
propan-2-ol	Eyes - Moderate irritant	Rabbit	-	24 hours 100 milligrams	-
	Eyes - Moderate irritant	Rabbit	-	10 milligrams	-
	Eyes - Severe irritant	Rabbit	-	100 milligrams	-
	Skin - Mild irritant	Rabbit	-	500 milligrams	-

Sensitization

Not available.

Section 11. Toxicological information

Mutagenicity

Not available.

Carcinogenicity

Not available.

Classification

Product/ingredient name	OSHA	IARC	NTP
propan-2-ol	-	3	-

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Name	Category	Route of exposure	Target organs
propan-2-ol	Category 3	Not applicable.	Narcotic effects

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Causes serious eye irritation.

Inhalation : Can cause central nervous system (CNS) depression. May cause drowsiness and dizziness.

Skin contact : No known significant effects or critical hazards.

Ingestion : Can cause central nervous system (CNS) depression. Irritating to mouth, throat and stomach.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:
pain or irritation
watering
redness

Inhalation : Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Section 11. Toxicological information

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
propan-2-ol	Acute LC50 1400000 to 1950000 µg/l Marine water	Crustaceans - Crangon crangon	48 hours
	Acute LC50 4200 mg/l Fresh water	Fish - Rasbora heteromorpha	96 hours

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
propan-2-ol	0.05	-	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Vapor from product residues may create a highly flammable or explosive atmosphere inside the container. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1219	UN1219	UN1219	UN1219	UN1219
UN proper shipping name	ISOPROPANOL OR ISOPROPYL ALCOHOL	ISOPROPANOL; OR ISOPROPYL ALCOHOL	ISOPROPANOL OR ISOPROPYL ALCOHOL	ISOPROPANOL (ISOPROPYL ALCOHOL)	ISOPROPANOL
Transport hazard class(es)	3 	3 	3 	3 	3 
Packing group	II	II	II	II	II
Environment	No.	No.	No.	No.	No.
Additional information	**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 5 L **Cargo aircraft** Quantity limitation: 60 L **Special provisions** IB2, T4, TP1	**Explosive Limit and Limited Quantity Index** 1 **Passenger Carrying Road or Rail Index** 5	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 5 L **Cargo Aircraft Only** Quantity limitation: 60 L **Limited Quantities - Passenger Aircraft** Quantity limitation: 1 L

“Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product.”

Special precautions for user : **Transport within user’s premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Fire hazard
Immediate (acute) health hazard

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
propan-2-ol	100	Yes.	No.	No.	Yes.	No.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	Isopropyl alcohol	67-63-0	100
Supplier notification	Isopropyl alcohol	67-63-0	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

Canada inventory : This material is listed or exempted.

International regulations

Section 15. Regulatory information

International lists : **Australia inventory (AICS)**: This material is listed or exempted.
China inventory (IECSC): This material is listed or exempted.
Japan inventory: This material is listed or exempted.
Korea inventory: This material is listed or exempted.
Malaysia Inventory (EHS Register): Not determined.
New Zealand Inventory of Chemicals (NZIoC): This material is listed or exempted.
Philippines inventory (PICCS): This material is listed or exempted.
Taiwan inventory (CSNN): Not determined.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

Canada

WHMIS (Canada) : Class B-2: Flammable liquid
Class D-2B: Material causing other toxic effects (Toxic).

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class B-2: Flammable liquid
Class D-2B: Material causing other toxic effects (Toxic).

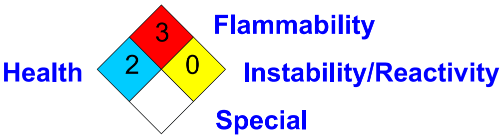
Hazardous Material Information System (U.S.A.)

Health	*	2
Flammability		3
Physical hazards		0

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)



Section 16. Other information

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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of printing : 5/20/2015.

Date of issue/Date of revision : 5/20/2015.

Date of previous issue : 10/28/2014.

Version : 0.02

Key to abbreviations :

ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United NationsACGIH – American Conference of Governmental Industrial Hygienists
AIHA – American Industrial Hygiene Association
CAS – Chemical Abstract Services
CEPA – Canadian Environmental Protection Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA)
CFR – United States Code of Federal Regulations
CPR – Controlled Products Regulations
DSL – Domestic Substances List
GWP – Global Warming Potential
IARC – International Agency for Research on Cancer
ICAO – International Civil Aviation Organisation
Inh – Inhalation
LC – Lethal concentration
LD – Lethal dosage
NDSL – Non-Domestic Substances List
NIOSH – National Institute for Occupational Safety and Health
TDG – Canadian Transportation of Dangerous Goods Act and Regulations
TLV – Threshold Limit Value
TSCA – Toxic Substances Control Act
WEEL – Workplace Environmental Exposure Level
WHMIS – Canadian Workplace Hazardous Material Information System

References : Not available.

◤ **Indicates information that has changed from previously issued version.**

Notice to reader

Section 16. Other information

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and GHS

Effective date: 05/12/2015 **Revision:** 05/12/2015

LIQUINOX

1 Identification of the Substance/mixture and of the Company/Undertaking

1.1 Product identifier

Trade name: LIQUINOX

Application of the substance / the preparation: Hand detergent.

1.2 Relevant identified uses of the substance or mixture and uses advised against:

No additional information available.

1.3 Details of the supplier of the Safety Data Sheet

Manufacturer/Supplier:

Alconox, Inc.
30 Glenn St., Suite 309
White Plains, NY 10603
Phone: 914-948-4040

Further information obtainable from: Product Safety Department.

1.4 Emergency telephone number:

ChemTel Inc.: (800)255-3924, +1 (813)248-0585

2 Hazards Identification

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No 1272/2008:

Classification according to Directive 67/548/EEC or Directive 1999/45/EC:

GHS07

Skin Irrit. 2, H315: Causes skin irritation.

Information concerning particular hazards for human and environment:

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to the latest editions of the EU-lists, and extended by company and literature data

2.2 Label elements

Labelling according to Regulation (EC) No 1272/2008:

The product is classified and labelled according to the CLP regulation.

Hazard pictograms:

GHS07

Signal word: Warning

Hazard-determining components of labelling:

Alkyl benzene sulfonic acid, sodium salt.

Hazard statements:

H315: Causes skin irritation.

Precautionary statements:

P332+P313: If skin irritation occurs: Get medical advice/attention.

P302+P352: IF ON SKIN: Wash with plenty of soap and water.

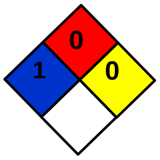
P501: Dispose of contents/container in accordance with local/regional/national/international regulations.

Other Hazard description:

WHMIS-classification and symbols:

D2B - Toxic material causing other toxic effects

NFPA ratings (scale 0 - 4)



Health = 1
Fire = 0
Reactivity = 0

HMIS-ratings (scale 0 - 4)

HEALTH	1	🟦
FIRE	0	🟥
REACTIVITY	0	🟨

Health = 1
Fire = 0
Reactivity = 0

2.3 Other hazards

Results of PBT and vPvB assessment

PBT: Not applicable.
vPvB: Not applicable.

3 Composition/Information on Ingredients

3.2 Chemical characterization: Mixture

Description: Hazardous ingredients of mixture listed below.

Identifying Nos.	Description	Wt. %
CAS: 68081-81-2	Alkyl benzene sulfonic acid, sodium salt	10 - 25%
CAS: 1300-72-7 EINECS: 215-090-9	Sodium xylene sulphonate	2.5 - 10%
CAS: 84133-50-6	Alcohol Ethoxylate	2.5 - 10%
CAS: 68603-42-9 EINECS: 271-657-0	Coconut diethanolamide	2.5 - 10%
CAS: 17572-97-3 EINECS: 241-543-5	Ethylenediaminetetraacetic acid, tripotassium salt	2.5 - 10%

Additional information: For the wording of the listed risk phrases refer to section 16.

4 First Aid Measures

4.1 Description of first aid measures

General information:

Take affected persons out into the fresh air.

After inhalation:

Supply fresh air; consult doctor in case of complaints.

After skin contact:

Immediately wash with water and soap and rinse thoroughly for 30 minutes. If skin irritation continues, consult a doctor.

After eye contact:

Remove contact lenses if worn.

Rinse opened eye for at least 30 minutes under running water, lifting upper and lower lids occasionally. Immediately consult a doctor.

After swallowing:

Do not induce vomiting; call for medical help immediately. Rinse out mouth and then drink plenty of water.

A person vomiting while laying on their back should be turned onto their side.

4.2 Most important symptoms and effects, both acute and delayed:

Irritating, all routes of exposure.

4.3 Indication of any immediate medical attention and special treatment needed:

No additional information available.

5 Firefighting Measures

5.1 Extinguishing media:

Suitable extinguishing agents:

CO2, powder or water spray. Fight larger fires with water spray or alcohol resistant foam.

5.2 Special hazards arising from the substance or mixture:

No additional information available.

5.3 Advice for firefighters:

Protective equipment:

Wear self-contained respiratory protective device.

Wear fully protective suit.

6 Accidental Release Measures

6.1 Personal precautions, protective equipment and emergency procedures:

Ensure adequate ventilation.

Particular danger of slipping on leaked/spilled product.

6.2 Environmental precautions:

Dilute with plenty of water.

Do not allow to enter sewers/ surface or ground water.

6.3 Methods and material for containment and cleaning up:

Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).

Clean the affected area carefully; suitable cleaners are: Warm water

Dispose contaminated material as waste according to item 13. Ensure adequate ventilation.

6.4 Reference to other sections:

See Section 7 for information on safe handling.

See Section 8 for information on personal protection equipment.

See Section 13 for disposal information

7 Handling and Storage

7.1 Precautions for safe handling:

No special precautions are necessary if used correctly.

Information about fire - and explosion protection:

No special measures required.

7.2 Conditions for safe storage, including any incompatibilities:

Storage:

Requirements to be met by storerooms and receptacles: No special requirements.

Information about storage in one common storage facility: No special requirements.

Further information about storage conditions: None

7.3 Specific end use(s): No additional information available.

8 Exposure Controls/Personal Protection

8.1 Control parameters

Ingredients with limit values that require monitoring at the workplace:

The product does not contain any relevant quantities of materials with critical values that have to be monitored at the workplace.

Additional information: The lists valid during the making were used as basis.

8.2 Exposure controls:

Personal protective equipment:

General protective and hygienic measures:

Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Avoid contact with the eyes and skin.

Respiratory protection:

Not required under normal conditions of use.

Protection of hands:

Protective gloves

The glove material has to be impermeable and resistant to the product. Selection of the glove material should be based on the penetration time, rates of diffusion and the degradation of the glove material.

Material of gloves:

The selection of a suitable gloves does not only depend on the material, but also on the quality, and varies from manufacturer to manufacturer.

Penetration time of glove material:

The exact break through time has to be determined by the manufacturer of the protective gloves. DO NOT exceed the breakthrough time set by the Manufacturer.

For long term contact, gloves made of the following materials are considered suitable:

Butyl rubber, BR
Nitrile rubber, NBR
Natural rubber (NR)
Neoprene gloves

Eye protection:

Safety glasses
Goggles recommended during refilling.

Body protection: Protective work clothing

9 Physical and Chemical Properties

9.1 Information on basic physical and chemical properties:

General Information:	
Appearance:	
Form:	Liquid
Color:	Light Yellow
Odor:	Odorless
Odor threshold:	Not determined.
pH-value:	8.5
Change in condition:	
Melting point/Melting range:	Not determined.
Boiling point/Boiling range:	100°C
Flash point:	Not applicable.
Flammability (solid, gaseous):	Not applicable.
Ignition temperature:	Not applicable.
Decomposition temperature:	Not determined.
Self-igniting:	Product is not selfigniting.
Danger of explosion:	Product does not present an explosion hazard.
Explosion limits:	
Lower:	Not determined.
Upper:	Not determined.
Vapor pressure at 20°C:	23 hPa
Density:	1.08 g/cm^3
Relative density:	Not determined.
Vapor density:	Not determined.
Evaporation rate:	Not determined.
Solubility in / Miscibility with water:	Fully miscible.
Segregation coefficient (n-octanol/water):	Not determined.
Viscosity:	
Dynamic:	Not determined.
Kinematic:	Not determined.
Solvent content:	
Organic solvents:	Not determined.
Solids content:	Not determined.
9.2 Other information:	No additional information available.

10 Stability and Reactivity

10.1 Reactivity:

10.2 Chemical stability:

Thermal decomposition / conditions to be avoided:

No decomposition if used according to specifications.

10.3 Possibility of hazardous reactions:

Reacts with strong oxidizing agents. Reacts with strong acids.

10.4 Conditions to avoid:

No additional information available.

10.5 Incompatible materials:

No additional information available.

10.6 Hazardous decomposition products:
Carbon monoxide and carbon dioxide
Sulphur oxides (SOx)
Nitrogen oxides

11 Toxicological Information

11.1 Information on toxicological effects:

Toxicity data: Toxicity data is available for mixture:

Primary irritant effect:

On the skin: Irritating to skin and mucous membranes.

On the eye: Strong irritant with the danger of severe eye injury.

Sensitization: No sensitizing effects known.

Additional toxicological information:

The product shows the following dangers according to the calculation method of the General EU Classification Guidelines for Preparations as issued in the latest version: Irritant

12 Ecological Information

12.1 Toxicity:

Aquatic toxicity: No additional information available.

12.2 Persistence and degradability: Biodegradable.

12.3 Bioaccumulative potential: Does not accumulate in organisms.

12.4 Mobility in soil: No additional information available.

Additional ecological information:

General notes:

Water hazard class 1 (German Regulation) (Self-assessment): slightly hazardous for water.
Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
Must not reach sewage water or drainage ditch undiluted or un-neutralized.

12.5 Results of PBT and vPvB assessment:

PBT: Not applicable.

vPvB: Not applicable.

12.6 Other adverse effects: No additional information available.

13 Disposal Considerations

13.1 Waste treatment methods:

Recommendation:

Smaller quantities can be disposed of with household waste.

Small amounts may be diluted with plenty of water and washed away. Dispose of bigger amounts in accordance with Local Authority requirements.

The surfactant used in this product complies with the biodegradability criteria as laid down in Regulation (EC) No. 648/2004 on detergents. Data to support this assertion are held at the disposal of the competent authorities of the Member States and will be made available to them, at their direct request or at the request of a detergent manufacturer.

Uncleaned packaging:

Recommendation: Disposal must be made according to official regulations.

Recommended cleansing agents: Water, together with cleansing agents, if necessary.

14 Transport Information

14.1 UN-Number:

DOT, ADR, ADN, IMDG, IATA:	Not Regulated

14.2 UN proper shipping name:

DOT, ADR, IMDG, IATA:	Not Regulated

14.3 Transport hazard class(es):	
DOT, ADR, IMDG, IATA:	
Class:	Not Regulated
Label:	-
14.4 Packing group:	
DOT, ADR, IMDG, IATA:	Not Regulated
14.5 Environmental hazards:	
Marine pollutant:	No
14.6 Special precautions for user:	Not applicable.

14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code: Not applicable.

UN "Model Regulation": Not Regulated

15 Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture:

United States (USA):

SARA:

Section 355 (extremely hazardous substances): None of the ingredient is listed.

Section 313 (Specific toxic chemical listings): None of the ingredient is listed.

TSCA (Toxic Substances Control Act): All ingredients are listed.

Proposition 65 (California):

Chemicals known to cause cancer: None of the ingredient is listed.

Chemicals known to cause reproductive toxicity for females: None of the ingredient is listed.

Chemicals known to cause reproductive toxicity for males: None of the ingredient is listed.

Chemicals known to cause developmental toxicity: None of the ingredient is listed.

Carcinogenic Categories:

EPA (Environmental Protection Agency): None of the ingredient is listed.

TLV (Threshold Limit Value established by ACGIH): None of the ingredient is listed.

NIOSH-Ca (National Institute for Occupational Safety and Health): None of the ingredient is listed.

OSHA-Ca (Occupational Safety & Health Administration): None of the ingredient is listed.

Canadá:

Canadian Domestic Substances List (DSL): All ingredients are listed.

Canadian Ingredient Disclosure list (limit 0.1%): None of the ingredient is listed.

Canadian Ingredient Disclosure list (limit 1%): None of the ingredient is listed.

15.2 Chemical safety assessment: A Chemical Safety Assessment has not been carried out.

16 Other Information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

Relevant phrases:

H315: Causes skin irritation.

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and GHS

Effective date: 05/12/2015 **Revision:** 05/12/2015

LIQUINOX

Abbreviations and Acronyms:

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road.
IMDG: International Maritime Code for Dangerous Goods.
DOT: US Department of Transportation.
IATA: International Air Transport Association.
GHS: Globally Harmonized System of Classification and Labelling of Chemicals.
ACGIH: American Conference of Governmental Industrial Hygienists.
NFPA: National Fire Protection Association (USA).
HMIS: Hazardous Materials Identification System (USA).
WHMIS: Workplace Hazardous Materials Information System (Canada).
VOC: Volatile Organic Compounds (USA, EU).
LC50: Lethal concentration, 50 percent.
LD50: Lethal dose, 50 percent.

SDS Created by:

Global Safety Management, Inc.
10006 Cross Creek Blvd
Tampa, FL, 33647
Tel: 1-844-GSM-INFO (1-844-476-4636)
Website: www.GSMSDS.com

Fisher Scientific

Part of Thermo Fisher Scientific

SAFETY DATA SHEET

Creation Date 12-Mar-2009 **Revision Date** 28-Nov-2016 **Revision Number** 5

1. Identification

Product Name **Nitric acid (65 - 70%)**

Cat No. : **A198C-212, A200-212, A200-212LC, A200-500, A200-500LC, A200-612GAL, A200C-212, A200S-212, A200S-212LC, A200S-500, A200SI-212, A467-1, A467-2, A467-250, A467-500, A483-212; S719721**

Synonyms Azotic acid; Engraver's acid; Aqua fortis

Recommended Use Laboratory chemicals.

Uses advised against No Information available

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Oxidizing liquids	Category 3
Corrosive to metals	Category 1
Skin Corrosion/irritation	Category 1 A
Serious Eye Damage/Eye Irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	

Label Elements

Signal Word
Danger

Hazard Statements
May intensify fire; oxidizer
May be corrosive to metals
Causes severe skin burns and eye damage
May cause respiratory irritation

Precautionary Statements
Prevention
Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep/Store away from clothing/ other combustible materials
Take any precaution to avoid mixing with combustibles
Keep only in original container
Response
Immediately call a POISON CENTER or doctor/physician
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Ingestion
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting
Fire
In case of fire: Use CO2, dry chemical, or foam for extinction
Spills
Absorb spillage to prevent material damage
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Store in corrosive resistant polypropylene container with a resistant inliner
Store in a dry place
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
None identified

3. Composition / information on ingredients

Component	CAS-No	Weight %
Nitric acid	7697-37-2	65 - 70
Water	7732-18-5	30 - 35

4. First-aid measures

General Advice	Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Remove and wash contaminated clothing before re-use. Call a physician immediately.
Inhalation	If breathing is difficult, give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Remove from exposure, lie down. Call a physician immediately.
Ingestion	Do not induce vomiting. Never give anything by mouth to an unconscious person. Clean mouth with water. Call a physician immediately.
Most important symptoms/effects	Causes burns by all exposure routes. Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation: Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	CO_2, dry chemical, dry sand, alcohol-resistant foam.
Unsuitable Extinguishing Media	No information available
Flash Point	Not applicable
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Oxidizing Properties	Oxidizer
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors. The product causes burns of eyes, skin and mucous membranes. Oxidizer: Contact with combustible/organic material may cause fire. May ignite combustibles (wood paper, oil, clothing, etc.).

Hazardous Combustion Products
Nitrogen oxides (NOx) Thermal decomposition can lead to release of irritating gases and vapors

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
4	0	0	OX

6. Accidental release measures

Personal Precautions	Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Ensure adequate ventilation. Use personal protective equipment.
Environmental Precautions	Should not be released into the environment. Do not flush into surface water or sanitary sewer system. See Section 12 for additional ecological information.
Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal. Sweep up and shovel into suitable containers for disposal.

7. Handling and storage

Handling Use only under a chemical fume hood. Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Do not ingest. Do not breathe vapors or spray mist. Keep away from clothing and other combustible materials.

Storage Keep containers tightly closed in a cool, well-ventilated place. Do not store near combustible materials.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Nitric acid	TWA: 2 ppm STEL: 4 ppm	(Vacated) TWA: 2 ppm (Vacated) TWA: 5 mg/m³ (Vacated) STEL: 4 ppm (Vacated) STEL: 10 mg/m³ TWA: 2 ppm TWA: 5 mg/m³	IDLH: 25 ppm TWA: 2 ppm TWA: 5 mg/m³ STEL: 4 ppm STEL: 10 mg/m³

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Nitric acid	TWA: 2 ppm TWA: 5.2 mg/m³ STEL: 4 ppm STEL: 10 mg/m³	TWA: 2 ppm TWA: 5 mg/m³ STEL: 4 ppm STEL: 10 mg/m³	TWA: 2 ppm STEL: 4 ppm

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location. Ensure adequate ventilation, especially in confined areas.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. Tightly fitting safety goggles. Face-shield.

Skin and body protection Long sleeved clothing.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Keep away from food, drink and animal feeding stuffs. When using, do not eat, drink or smoke. Contaminated work clothing should not be allowed out of the workplace. Provide regular cleaning of equipment, work area and clothing. Avoid contact with skin, eyes and clothing. For environmental protection remove and wash all contaminated protective equipment before re-use. Wear suitable gloves and eye/face protection.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Clear Colorless, Light yellow
Odor	Strong Acrid
Odor Threshold	No information available
pH	< 1.0 (0.1M)
Melting Point/Range	-41 °C / -41.8 °F
Boiling Point/Range	Not applicable
Flash Point	Not applicable

Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	0.94 kPa (20°C)
Vapor Density	No information available
Specific Gravity	1.40
Solubility	miscible
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	No information available
Molecular Formula	HNO3
Molecular Weight	63.02

10. Stability and reactivity

Reactive Hazard	Yes
Stability	Oxidizer: Contact with combustible/organic material may cause fire.
Conditions to Avoid	Incompatible products. Combustible material. Excess heat. Exposure to air or moisture over prolonged periods.
Incompatible Materials	Combustible material, Strong bases, Reducing agents, Metals, Powdered metals, Organic materials, Aldehydes, Alcohols, Cyanides, Ammonia, Strong reducing agents
Hazardous Decomposition Products	Nitrogen oxides (NOx), Thermal decomposition can lead to release of irritating gases and vapors
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Oral LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Dermal LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Vapor LC50	Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Nitric acid	Not listed	Not listed	LC50 = 2500 ppm. (Rat) 1h
Water	-	Not listed	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	Causes severe burns by all exposure routes
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Nitric acid	7697-37-2	Not listed	Not listed	Not listed	Not listed	Not listed
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	Respiratory system
STOT - repeated exposure	None known
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation: Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains. Large amounts will affect pH and harm aquatic organisms.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Nitric acid	Not listed	LC50: = 72 mg/L, 96h (Gambusia affinis)	Not listed	Not listed

Persistence and Degradability	Miscible with water Persistence is unlikely based on information available.
Bioaccumulation/ Accumulation	No information available.
Mobility	Will likely be mobile in the environment due to its water solubility.

Component	log Pow
Nitric acid	-2.3

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

TDG

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

IATA

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

IMDG/IMO

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

15. Regulatory information

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Nitric acid	X	X	-	231-714-2	-		X	X	X	X	X
Water	X	X	-	231-791-2	-		X	-	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Nitric acid	7697-37-2	65 - 70	1.0

SARA 311/312 Hazard Categories

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	Yes

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Nitric acid	X	1000 lb	-	-

Clean Air Act Not applicable

OSHA Occupational Safety and Health Administration

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Nitric acid	-	TQ: 500 lb

CERCLA
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive

Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Nitric acid	1000 lb	1000 lb

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Nitric acid	X	X	X	X	X
Water	-	-	X	-	-

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security
This product contains the following DHS chemicals:

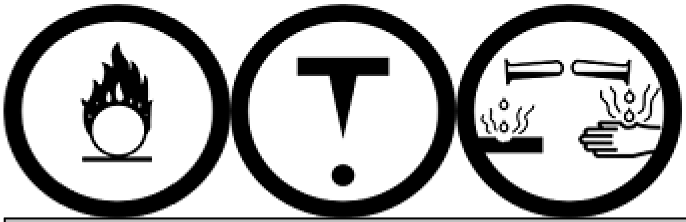
Component	DHS Chemical Facility Anti-Terrorism Standard
Nitric acid	2000 lb STQ

Other International Regulations

Mexico - Grade No information available

Canada
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR

WHMIS Hazard Class
C Oxidizing materials
E Corrosive material
D2B Toxic materials



16. Other information

Prepared By
Regulatory Affairs
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Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

SAFETY DATA SHEET

Section 1: IDENTIFICATION

1.1 PRODUCT IDENTIFIER

Product Name:

1. Sakrete Portland Cement
   Product Code: 65150087 (47lb)
2. Sakrete Type S Masonry Cement
   Product Code: 65150085

1.2 RECOMMENDED USE OF CHEMICAL AND RESTRICTIONS ON USE

Use: Various.

1.3 DETAILS OF THE SUPPLIER OF THE SAFETY DATA SHEET

Name/Address:

Oldcastle Architectural Inc.
900 Ashwood Parkway, Suite 600
30338 Atlanta, GA - USA

Telephone Number: 800-334-0784 Tech Service 8:00 to 5:00 Eastern, Mon.-Fri.

1.4 EMERGENCY TELEPHONE NUMBER

Emergency Telephone Number:

For Hazardous Materials [or Dangerous Goods] Incident
Spill, Leak, Fire, Exposure, or Accident
Call CHEMTREC Day or Night
1-800-424-9300 [USA] / +1 703-527-3887 [CAN]

Date of Preparation: January 31, 2018 **Version #:** 1.0

Section 2: HAZARD(S) IDENTIFICATION

2.1 CLASSIFICATION OF THE CHEMICAL

Hazard class

Acute toxicity 4 (Oral)
Skin irritation 2
Serious eye damage 1
Skin sensitization 1
Carcinogenicity 1A
Specific target organ toxicity - Single exposure 3
Specific target organ toxicity - Repeated exposure 1

2.2 LABEL ELEMENTS

Hazard Pictogram:

Signal Word: Danger

Hazard Statement: Harmful if swallowed. Causes skin irritation. Causes serious eye

	damage. May cause an allergic skin reaction. May cause cancer. May cause respiratory irritation. Causes damage to organs through prolonged or repeated exposure.
Prevention:	Do not eat, drink or smoke when using this product. Wash hands thoroughly after handling. Contaminated work clothing must not be allowed out of the workplace. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wear protective gloves/protective clothing/eye protection/face protection. Use only outdoors or in a well-ventilated area. Do not breathe dust.
Response:	If swallowed: Immediately call a poison center/doctor. Rinse mouth. 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 on skin: Wash with plenty of water. Take off contaminated clothing and wash it before reuse. If skin irritation or rash occurs: Get medical advice/attention. If exposed or concerned: Get medical advice/attention. If inhaled: Remove person to fresh air and keep comfortable for breathing. Call a poison center/doctor if you feel unwell.
Storage:	Store locked up. Store in a well-ventilated place. Keep container tightly closed.
Disposal:	Dispose of contents and container in accordance with all local, regional, national and international regulations.

2.3 ADDITIONAL INFORMATION

Hazards not otherwise classified:	Not applicable.

60.0 % of the mixture consists of ingredient(s) of unknown acute toxicity.

This product is a hazardous chemical as defined by NOM-018-STPS-2000.

Section 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1 MIXTURES

Ingredient	UN #	H / F/ R / *	CAS No	Wt. %
Portland cement	Not available.	1/0/0	65997-15-1	60 - 100
Ferric oxide	UN1376	1/0/0	1309-37-1	10 - 30
Silica, crystalline, quartz	Not available.	Not available.	14808-60-7	3 - 7
Calcium oxide	UN1910	3/0/1	1305-78-8	3 - 7
Gypsum	UN3077	Not available.	13397-24-5	3 - 7
Calcium carbonate	Not available.	1/0/0	1317-65-3	3 - 7
Magnesium oxide	UN1418	2/0/0	1309-48-4	3 - 7

The exact percentage (concentration) of chemicals has been withheld as a trade secret in accordance with paragraph (i) of §1910.1200.

* Per NOM-018-STPS-2000

SAFETY DATA SHEET

Section 4: FIRST- AID MEASURES

4.1 DESCRIPTION OF THE FIRST AID MEASURE

Eye:	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If easy to do, remove contact lenses, if worn. Get medical attention immediately.

Skin:	In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Call a physician if irritation develops and persists.
Inhalation:	If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical advice/attention if you feel unwell.
Ingestion:	If swallowed, do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical advice/attention.

4.2 MOST IMPORTANT SYMPTOMS AND EFFECTS, BOTH ACUTE AND DELAYED

Eye:	Causes serious eye damage. May cause burns in the presence of moisture. Symptoms may include discomfort or pain, excess blinking and tear production, with possible redness and swelling.
Skin:	Causes skin irritation. May cause burns in the presence of moisture. Skin contact during hydration may slowly develop sufficient heat that may cause severe burns possibly resulting in permanent injury. Do not allow product to harden around any body part or allow continuous, prolonged contact with skin. Handling can cause dry skin. May cause sensitization by skin contact.
Inhalation:	May cause respiratory tract irritation.
Ingestion:	Harmful if swallowed. May cause stomach distress, nausea or vomiting.

4.3 INDICATION OF ANY IMMEDIATE MEDICAL ATTENTION AND SPECIAL TREATMENTS NEEDED

Note to Physicians:	Symptoms may not appear immediately.
Specific Treatments:	In case of accident or if you feel unwell, seek medical advice immediately (show the label or SDS where possible).

Section 5: FIRE-FIGHTING MEASURES

5.1 EXTINGUISHING MEDIA

Suitable Extinguishing Media:	Treat for surrounding material.
Unsuitable Extinguishing Media:	Not available.

5.2 SPECIAL HAZARDS ARISING FROM THE CHEMICAL

Products of Combustion:	May include, and are not limited to: oxides of carbon.

5.3 SPECIAL PROTECTIVE EQUIPMENT AND PRECAUTIONS FOR FIRE FIGHTERS

Keep upwind of fire. Wear full fire fighting turn-out gear (full Bunker gear) and respiratory protection (SCBA).

Section 6: ACCIDENTAL RELEASE MEASURES

6.1 PERSONAL PRECAUTIONS, PROTECTIVE EQUIPMENT AND EMERGENCY PROCEDURES

Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected personnel.

6.2 METHODS AND MATERIALS FOR CONTAINMENT AND CLEANING - UP

Methods for Containment:	Contain spill, then place in a suitable container. Do not flush to sewer or allow to enter waterways. Use appropriate Personal Protective Equipment (PPE).
Methods for Cleaning-Up:	Vacuum or sweep material and place in a disposal container.

Section 7: HANDLING AND STORAGE

7.1 PRECAUTIONS FOR SAFE HANDLING

Handling:	Avoid contact with skin and eyes. Do not swallow. Good housekeeping is important to prevent accumulation of dust. Avoid generating and breathing dust. The use of compressed air for cleaning clothing, equipment, etc, is not recommended. Handle and open container with care. When using do not eat or drink. Wash hands before eating, drinking, or smoking. (See section 8)
General Hygiene Advice:	Launder contaminated clothing before reuse. Wash hands before eating, drinking, or smoking.

7.2 CONDITIONS FOR SAFE STORAGE, INCLUDING ANY INCOMPATIBILITIES

Storage:	Keep out of the reach of children. Store in dust-tight, dry, labeled containers. Keep containers closed when not in use. Avoid any dust buildup by frequent cleaning and suitable construction of the storage area. Do not store in an area equipped with emergency water sprinklers. (See section 10)

Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 CONTROL PARAMETERS

Exposure Guidelines

Occupational Exposure Limits		
Ingredient	**OSHA-PEL**	**ACGIH-TLV**
Portland cement	15 mg/m^3 (total); 5 mg/m^3 (resp)	1 mg/m^3 (no asbestos and <1% crystalline silica, respirable fraction)
Ferric oxide	10 mg/m^3	5 mg/m^3 (iron oxide fume; dust as Fe)
Silica, crystalline, quartz	((10 mg/m^3)/(%SiO$_2$+2) TWA (resp)) ((30 mg/m^3)/(%SiO$_2$+2) TWA (total)) ((250)/(%SiO$_2$+5) mppcf TWA (resp))	0.025 mg/m^3
Calcium oxide	5 mg/m^3	2 mg/m^3
Gypsum	15 mg/m^3 TWA (poussière totale) 5 mg/m^3 TWA (fraction respirable)	10 mg/m^3
Calcium carbonate	15 mg/m^3 (total); 5 mg/m^3 (resp)	10 mg/m^3
Magnesium oxide	15 mg/m^3	10 mg/m^3

8.2 EXPOSURE CONTROLS

Engineering Controls:	Use ventilation adequate to keep exposures (airborne levels of dust, fume, vapor, etc.) below recommended exposure limits.

8.3 INDIVIDUAL PROTECTIVE MEASSURES

Personal Protective Equipment:

Eye/Face Protection: Wear approved eye (properly fitted dust- or splash-proof chemical safety goggles) / face (face shield) protection.

Skin Protection:

Hand Protection: Wear suitable waterproof gloves.

Body Protection: Wear suitable waterproof protective clothing.

Respiratory Protection: A NIOSH approved dust mask or filtering facepiece is recommended in poorly ventilated areas or when permissible exposure limits may be exceeded. Respirators should be selected by and used under the direction of a trained health and safety professional following requirements found in OSHA's respirator standard (29 CFR 1910.134) and ANSI's standard for respiratory protection (Z88.2).

General Health and Safety Measures: Handle according to established industrial hygiene and safety practices. Do not eat, smoke or drink where material is handled, processed or stored. Wash hands carefully before eating or smoking.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1 INFORMATION ON BASIC PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Powder.
Color:	Not available.
Odor:	Not available.
Odor Threshold:	Not available.
Physical State:	Powder.
pH:	12 - 13
Melting Point/Freezing Point:	Not available.
Initial Boiling Point and Boiling Range:	Not available.
Flash Point:	Not available.
Evaporation Rate:	Not available.
Flammability:	Not Flammable.
Lower Flammability/Explosive Limit:	Not available.
Upper Flammability/Explosive Limit:	Not available.
Vapor Pressure:	Not available.
Vapor Density:	Not available.
Relative Density/Specific Gravity:	Not available.
Solubility:	Not available.
Partition coefficient: n-octanol/water:	Not available.

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Auto-ignition Temperature:	Not available.
Decomposition Temperature:	Not available.

Viscosity: Not available.

Percent Volatile, wt. %: Not available.

VOC content, wt. %: 0%, Not applicable; 0 wt, Not applicable.

Section 10: STABILITY AND REACTIVITY

10.1 REACTIVITY

No dangerous reaction known under conditions of normal use.

10.2 CHEMICAL STABILITY

Stable under normal storage conditions. Keep dry in storage.

10.3 POSSIBILITY OF HAZARDOUS REACTIONS

No dangerous reaction known under conditions of normal use.

10.4 CONDITIONS TO AVOID

Incompatible materials. Moisture.

10.5 INCOMPATIBLE MATERIALS

Wet cement is alkaline and incompatible with acid, ammonium salts and aluminum metal.

10.6 HAZARDOUS DECOMPOSITION PRODUCTS

May include, and are not limited to: oxides of carbon.

Section 11: TOXICOLOGICAL INFORMATION

11.1 INFORMATION ON TOXICOLOGICAL EFFECTS

Likely Routes of Exposure: Skin contact, skin absorption, eye contact, inhalation, and ingestion.

Symptoms related to physical/chemical/toxicological characteristics:

Eye: Causes serious eye damage. May cause burns in the presence of moisture. Symptoms may include discomfort or pain, excess blinking and tear production, with possible redness and swelling.

Skin: Causes skin irritation. May cause burns in the presence of moisture. Skin contact during hydration may slowly develop sufficient heat that may cause severe burns possibly resulting in permanent injury. Do not allow product to harden around any body part or allow continuous, prolonged contact with skin. Handling can cause dry skin. May cause sensitization by skin contact.

Ingestion: Harmful if swallowed. May cause stomach distress, nausea or vomiting.

Inhalation: May cause respiratory tract irritation.

Acute Toxicity:

Ingredient	IDLH	LC50	LD50
Portland cement	5000 mg/m^3	Not available.	Not available.
Ferric oxide	2500 mg Fe/m^3	Not available.	Oral >10000 mg/kg, rat
Silica, crystalline,	Ca [25 mg/m^3 (cristobalite, tridymite) 50 mg/m^3 (quartz, tripoli)]	Not available.	Oral 500 mg/kg, rat

quartz			
Calcium oxide	25 mg/m^3	Not available.	Oral 500 mg/kg, rat
Gypsum	Not available.	Not available.	Not available.

Calcium carbonate	Not available.	Not available.	Not available.
Magnesium oxide	750 mg/m^3	Not available.	Oral >5000 mg/kg, rat

Calculated overall Chemical Acute Toxicity Values		
LC50 (inhalation)	**LD50 (oral)**	**LD50 (dermal)**
Not available.	1603.8 mg/kg, rat	Not available.

Ingredient	**Chemical Listed as Carcinogen or Potential Carcinogen (NTP, IARC, OSHA, ACGIH, CP65)***
Portland cement	G-A4
Ferric oxide	G-A4, I-3
Silica, crystalline, quartz	G-A2, I-1, N-1, CP65
Calcium oxide	Not listed.
Gypsum	Not listed.
Calcium carbonate	Not listed.
Magnesium oxide	G-A4

11.2 DELAYED, IMMEDIATE, AND CHRONIC EFFECTS OF SHORT- AND LONG-TERM EXPOSURE

Skin Corrosion/Irritation: Causes skin irritation. May cause burns in the presence of moisture.

Serious Eye Damage/Irritation: Causes serious eye damage. May cause burns in the presence of moisture.

Respiratory Sensitization: Based on available data, the classification criteria are not met.

Skin Sensitization: May cause an allergic skin reaction.

STOT-Single Exposure: May cause respiratory irritation.

Chronic Health Effects: Respirable crystalline silica in the form of quartz or cristobalite from occupational sources is listed by the International Agency for Research on Cancer (IARC) and National Toxicology Program (NTP) as a lung carcinogen. Prolonged exposure to respirable crystalline silica has been known to cause silicosis, a lung disease, which may be disabling. While there may be a factor of individual susceptibility to a given exposure to respirable silica dust, the risk of contracting silicosis and the severity of the disease is clearly related to the amount of dust exposure and the length of time (usually years) of exposure.

Carcinogenicity: May cause cancer.

Germ Cell Mutagenicity: This product is not classified as a mutagen.

Reproductive Toxicity:

Developmental: Based on available data, the classification criteria are not met.

Fertility: Based on available data, the classification criteria are not met.

STOT-Repeated Exposure: Causes damage to organs through prolonged or repeated exposure.

Aspiration Hazard:	Based on available data, the classification criteria are not met.
Toxicologically Synergistic Materials:	Not available.

Other Information:	Not available.

Section 12: ECOLOGICAL INFORMATION

12.1 ECOTOXICITY

Acute/Chronic Toxicity:	No ecological consideration when used according to directions. Normal dilution of this product to drains, sewers, septic systems and treatment plants is not considered environmentally harmful.

12.2 PERSISTENCE AND DEGRADABILITY

Not available.

12.3 BIOACCUMULATIVE POTENTIAL

Bioaccumulation:	Not available.

12.4 MOBILITY IN SOIL

Not available.

12.5 OTHER ADVERSE EFFECTS

Not available.

Section 13: DISPOSAL CONSIDERATIONS

13.1 WASTE TREATMENT METHODS

Disposal Method:	This material must be disposed of in accordance with all local, state, provincial, and federal regulations.
Other disposal recommendations:	Not available.

Section 14: TRANSPORT INFORMATION

14.1 UN NUMBER

DOT	TDG	NOM-004-SCT2-1994
Not regulated.	Not regulated.	Not regulated.

14.2 UN PROPER SHIPPING NAME

DOT	TDG	NOM-004-SCT2-1994
Not applicable.	Not applicable.	Not applicable.

14.3 TRANSPORT HAZARD CLASS (ES)

DOT	TDG	NOM-004-SCT2-1994
Not applicable.	Not applicable.	Not applicable.

14.4 PACKING GROUP

DOT	TDG	NOM-004-SCT2-1994
Not applicable.	Not applicable.	Not applicable.

14.5 ENVIRONMENTAL HAZARDS

Not available.

14.6 TRANSPORT IN BULK ACCORDING TO ANNEX II OF MARPOL 73/78 AND THE IBC CODE

Not available.

14.7 SPECIAL PRECAUTIONS FOR USER

Do not handle until all safety precautions have been read and understood.

Section 15: REGULATORY INFORMATION

15.1 SAFETY, HEALTH AND ENVIRONMENTAL REGULATIONS/ LEGISLATIONS SPECIFIC FOR THE CHEMICAL

US: MSDS prepared pursuant to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012

Mexico: MSDS prepared pursuant to NOM-018-STPS-2000.

SARA Title III

Ingredient	Section 302 (EHS) TPQ (lbs.)	Section 304 EHS RQ (lbs.)	CERCLA RQ (lbs.)	Section 313
Portland cement	Not listed.	Not listed.	Not listed.	Not listed.
Ferric oxide	Not listed.	Not listed.	Not listed.	Not listed.
Silica, crystalline, quartz	Not listed.	Not listed.	Not listed.	Not listed.
Calcium oxide	Not listed.	Not listed.	Not listed.	Not listed.
Gypsum	Not listed.	Not listed.	Not listed.	Not listed.
Calcium carbonate	Not listed.	Not listed.	Not listed.	Not listed.
Magnesium oxide	Not listed.	Not listed.	Not listed.	Not listed.

State Regulations

California Proposition 65:

This product contains Crystalline Silica, Quartz and may also contain other chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

Global Inventories

Ingredient	USA TSCA
Portland cement	Yes.
Ferric oxide	Yes.
Silica, crystalline, quartz	Yes.
Calcium oxide	Yes.
Gypsum	No.
Calcium carbonate	Yes.
Magnesium oxide	Yes.

NFPA - National Fire Protection Association:

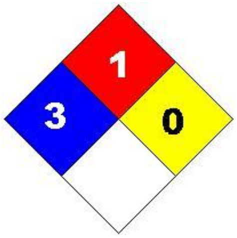
Health:	3
Fire:	1
Reactivity:	0

SAFETY DATA SHEET

HMIS - Hazardous Materials Identification System	
Health:	3*
Fire:	1
Reactivity:	0

Hazard Rating: 0 = minimal, 1 = slight, 2 = moderate, 3 = severe, 4 = extreme

Mexico Classification:



Blue = Health Red = Flammability Yellow = Reactivity White = Special

Hazard Rating: 0 = minimal, 1 = slight, 2 = moderate, 3 = severe, 4 = extreme

SOURCE AGENCY CARCINOGEN CLASSIFICATIONS:

CP65	**California Proposition 65**
OSHA (O)	**Occupational Safety and Health Administration.**
ACGIH (G)	**American Conference of Governmental Industrial Hygienists.** A1 - Confirmed human carcinogen. A2 - Suspected human carcinogen. A3 - Animal carcinogen. A4 - Not classifiable as a human carcinogen. A5 - Not suspected as a human carcinogen.
IARC (I)	**International Agency for Research on Cancer.** 1 - The agent (mixture) is carcinogenic to humans. 2A - The agent (mixture) is probably carcinogenic to humans; there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals. 2B - The agent (mixture) is possibly carcinogenic to humans; there is limited evidence of carcinogenicity in humans in the absence of sufficient evidence of carcinogenicity in experimental animals. 3 - The agent (mixture, exposure circumstance) is not classifiable as to its carcinogenicity to humans. 4 - The agent (mixture, exposure circumstance) is probably not carcinogenic to humans.
NTP (N)	**National Toxicology Program.** 1 - Known to be carcinogens. 2 - Reasonably anticipated to be carcinogens.

Section 16: OTHER INFORMATION

Date of Preparation:	February 1, 2013
Version:	1.0
Revision Date:	January 31, 2018

Disclaimer: We believe the statements, technical information and recommendations contained herein are reliable, but they are given without warranty or guarantee of any kind. The information contained in this document applies to this specific material as supplied. It may not be valid for this material if it is used in combination with any other materials. It is the user’s responsibility to satisfy oneself as to the suitability and completeness of this information for the user’s own particular use.

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Prepared for:	Oldcastle Architectural Inc.

SAFETY DATA SHEET

End of Safety Data Sheet

SAFETY DATA SHEET (SDS): NATURAL SAND

SECTION I –IDENTIFICATION

PRODUCT IDENTIFIER	TRADE NAME	OTHER SYNONYMS
Natural Sand	Sand	Construction Aggregate

RECOMMENDED USE AND RESTRICTION ON USE
Used for construction purposes
This product is not intended or designed for and should not be used as an abrasive blasting medium or for foundry applications.

MANUFACTURER/SUPPLIER INFORMATION
Martin Marietta Materials
4123 Parklake Ave
Raleigh, North Carolina 27612
Phone: 919-781-4550

For additional health, safety or regulatory information and other emergency situations, call 919-781-4550

SECTION II – HAZARD(S) IDENTIFICATION

HAZARD CLASSIFICATION:
Category 1A Carcinogen
Category 1 Specific Target Organ Toxicity (STOT) following repeated exposures
Category 2B Eye Irritant

SIGNAL WORD: DANGER

HAZARD STATEMENTS:
May cause cancer by inhalation.
Causes damage to lungs, kidneys and autoimmune system through prolonged or repeated exposure by inhalation.
Causes eye irritation.

PRECAUTIONARY STATEMENTS
Do not handle until the safety information presented in this SDS has been read and understood.
Do not breathe dusts or mists. Do not eat, drink or smoke while manually handling this product.
If swallowed: If gastrointestinal discomfort occurs and if person is conscious, give a large quantity of water and induce vomiting; however, never attempt to make an unconscious person drink or vomit.
If on skin: Rinse skin with soap and water.
If inhaled excessively: Remove person to fresh air and keep comfortable for breathing.
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do, and continue rinsing.
If exposed, concerned, unwell or irritation of the eyes, skin, mouth or throat/nasal passage persist or occur later: Get medical attention.
Wear eye protection and respiratory protection following this SDS, NIOSH guidelines and other applicable regulations.
Avoid creating dust when handling, using or storing. Use with adequate ventilation to keep exposure below recommended exposure limits.

Dispose of product in accordance with local, regional, national or international regulations.

Please refer to Section XI for details of specific health effects of the components.

SECTION III – COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENT(S) CHEMICAL NAME	CAS REGISTRY NO	% by weight (approx)
Natural Sand	None	100
Silicon Dioxide, SiO_2 (1)	7631-86-9	>1

(1): The composition of SiO_2 may be up to 100% crystalline silica, content of this material varies naturally

SECTION IV – FIRST-AID MEASURES

INHALATION: If excessive inhalation occurs, remove to fresh air. Dust in throat and nasal passages should clear spontaneously. Contact a physician if irritation persists or develops later.

EYES: Immediately flush eye(s) with plenty of clean water for at least 15 minutes, while holding the eyelid(s) open. Occasionally lift the eyelid(s) to ensure thorough rinsing. Remove contact lenses, if present and easy to do, and continue rinsing. Beyond flushing, do not attempt to remove material from the eye(s). Contact a physician if irritation persists or develops later.

SKIN: Rinse skin with soap and water after manually handling and wash contaminated clothing if there is potential for direct skin contact. Contact a physician if irritation persists or develops later.

INGESTION: If gastrointestinal discomfort occurs and if person is conscious, give a large quantity of water and induce vomiting; however, never attempt to make an unconscious person drink or vomit. Get medical attention.

SIGNS AND SYMPTOMS OF EXPOSURE: There are generally no signs or symptoms of exposure to respirable crystalline silica. Often, chronic silicosis has no symptoms. The symptoms of chronic silicosis, if present, are shortness of breath, wheezing, cough and sputum production. The symptoms of acute silicosis which can occur with exposures to very high concentrations of respirable crystalline silica over a very short time period, sometimes as short as 6 months, are the same as those associated with chronic silicosis; additionally, weight loss and fever may also occur. The symptoms of scleroderma, an autoimmune disease, include thickening and stiffness of the skin, particularly in the fingers, shortness of breath, difficulty swallowing and joint problems.

Direct skin and eye contact with dust may cause irritation by mechanical abrasion. Ingestion of large amounts may cause gastrointestinal irritation and blockage. Inhalation of dust may irritate nose, throat, mucous membranes and respiratory tract by mechanical abrasion. Coughing, sneezing, chest pain, shortness of breath, inflammation of mucous membrane, and flu-like fever may occur following exposures in excess of appropriate exposure limits. Repeated excessive exposure may cause pneumoconiosis, such as silicosis and other respiratory effects.

SECTION V – FIRE-FIGHTING MEASURES

EXTINGUISHING AGENT
Not flammable; use extinguishing media compatible with surrounding fire.

UNUSUAL FIRE AND EXPLOSION HAZARD
Contact with powerful oxidizing agents may cause fire and/or explosions (see Section X of this SDS).

SPECIAL FIRE FIGHTING PROCEDURES	HAZARDOUS COMBUSTION PRODUCTS
None known	None known

SECTION VI – ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Persons involved in cleaning should first follow the precautions defined in Section VII of the SDS. Spilled materials, where dust can be generated, may overexpose cleanup personnel to respirable crystalline silica-containing dust and other components that may pose inhalation hazards. Do not dry sweep spilled material. Collect the material using a method that does not produce dust such as a High-Efficiency Particulate Air (HEPA) vacuum or thoroughly wetting down the dust before cleaning up. Wear appropriate personal protective equipment as specified in Section VIII including appropriate respirators during and following clean up or whenever airborne dust is present to ensure worker exposures remain below occupational exposure limits (OELs - Refer to Section VIII).

Place the dust in a covered container appropriate for disposal. Dispose of the dust according to federal, state and local regulations.

This product is not subject to the reporting requirements of SARA Title III Section 313, and 40 CFR 372.

SECTION VII – HANDLING AND STORAGE

This product is not intended or designed for and should not be used as an abrasive blasting medium or for foundry applications. Follow protective controls set forth in Section VIII of this SDS when handling this product. Dust containing respirable crystalline silica may be generated during processing, handling and storage. Use good housekeeping procedures to prevent the accumulation of dust in the workplace.

Do not breathe dust. Avoid contact with skin and eyes. Do not store near food or beverages or smoking materials.
Do not stand on piles of materials; it may be unstable.

Use adequate ventilation and dust collection equipment and ensure that the dust collection system is adequate to reduce airborne dust levels to below the appropriate OELs. If the airborne dust levels are above the appropriate OELs, use respiratory protection during the establishment of engineering controls. Refer to Section VIII - Exposure Controls/Personal Protection for further information.

In accordance with OSHA’s Hazard Communication Standard (29 CFR 1910.1200, 1915.99, 1917.28, 1918.90, 1926.59, 1928.21), state, and/or local right-to-know laws and regulations, familiarize your employees with this SDS and the information contained herein. Warn your employees, your customers and other third parties (in case of resale or distribution to others) of the potential health risks associated with the use of this product and train them in the appropriate use of personal protective equipment and engineering controls, which will reduce their risks of exposure.

See also ASTM International standard practice E 1132-06, "Standard Practice for Health Requirements Relating to Occupational Exposure to Respirable Crystalline Silica."

For safe handling and use of this product for Hydraulic Fracturing, please see the OSHA/NIOSH Hazard Alert Worker Exposure to Silica during Hydraulic Fracturing DHHS (NIOSH) Publication No. 2012-166 (2012).
http://www.osha.gov/dts/hazardalerts/hydraulic_frac_hazard_alert.pdf

SECTION VIII – EXPOSURE CONTROLS/PERSONAL PROTECTION

Airborne OELs for Components of Natural Sand:

COMPONENT(S) CHEMICAL NAME	MSHA/OSHA PEL	ACGIH TLV-TWA	NIOSH REL
Silicon Dioxide, SiO_2 §	(R) 0.05 mg/m^3 (R) 0.025 mg/m^3 (AL)	(R) 0.025 mg/m^3 #	(R) 0.05 mg/m^3 #

§ The OSHA OELs for respirable crystalline silica are listed in the table. As of June 28, 2018, the MSHA standard for respirable crystalline silica has not been changed but may be revised in the future. The MSHA PEL for dust containing crystalline silica (quartz) is based on the silica content of the respirable dust sample and is calculated as: 10 mg/m^3/(% SiO_2 +2). The MSHA PEL for crystalline silica as tridymite and cristobalite is one-half the PEL for crystalline silica (quartz).
# The ACGIH and NIOSH limits are for crystalline silica (quartz), independent of the dust concentration. The ACGIH TLV for crystalline silica as cristobalite is equal to the TLV for crystalline silica as quartz. In 2005, ACGIH withdrew the TLV for crystalline silica as tridymite. The NIOSH REL for crystalline silica as cristobalite and tridymite is the same as for quartz. Refer to Section X for thermal stability information for crystalline silica (quartz).
AL: Action Level
(R): Respirable Fraction.

Airborne OELs for Inert/Nuisance Dust:

Standard	Respirable Dust	Total Dust
MSHA/OSHA PEL (as Inert or Nuisance Dust)	5 mg/m^3	15 mg/m^3
ACGIH TLV (as Particles Not Otherwise Specified)	3 mg/m^3	*10 mg/m^3
NIOSH REL (Particulates Not Otherwise Regulated)	-	-

Note: The limits for Inert Dust are provided as guidelines. Nuisance dust is limited to particulates not known to cause systemic injury or illness.
* The TLV provided is for inhalable particles not otherwise specified.

ENGINEERING CONTROLS
Ventilation: Use local exhaust, general ventilation or natural ventilation adequate to maintain exposures below appropriate exposure limits.

Other control measures: Respirable dust and crystalline silica levels should be monitored regularly. Dust and crystalline silica levels in excess of appropriate exposure limits should be reduced by implementing feasible engineering controls, including (but not limited to) dust suppression (wetting), ventilation, process enclosure and enclosed employee work stations.

EYE/FACE PROTECTION
Safety glasses with side shields should be worn as minimum protection. Dust goggles should be worn when excessively (visible) dusty conditions are present or are anticipated. If irritation persists, get medical attention immediately. There is potential for severe eye irritation if exposed to excessive concentrations of dust for those using contact lenses.

SKIN PROTECTION
Use appropriate protective gloves if manually handling the product.

RESPIRATORY PROTECTION
Respirator Recommendations:

For respirable crystalline silica levels that exceed or are likely to exceed appropriate exposure limits, a NIOSH-approved particulate filter respirator must be worn. Respirator use must comply with applicable MSHA or OSHA standards, which include provisions for a user training program, respirator repair and cleaning, respirator fit testing, and other requirements. For additional information contact NIOSH at 1-800-356-4674 or visit website: http://www.cdc.gov/niosh/npg (search for crystalline silica). See also ANSI standard Z88.2 (latest revision) "American National Standard for Respiratory Protection," 29 CFR 1910.134 and 1926.103, and 42 CFR 84.

NIOSH recommendations for respiratory protection include:
Up to 0.5 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100.
Up to 1.25 mg/m^3:
(APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate (100-series) filter.
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
Up to 2.5 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter.
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter

SECTION VIII – EXPOSURE CONTROLS/PERSONAL PROTECTION, CONTD.

NIOSH recommendations for respiratory protection include, continued:
Up to 25 mg/m^3:
(APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions (50 mg/m^3 for crystalline silica-quartz): A self-contained breathing apparatus (SCBA) that has a full-face piece and is operated in a pressure-demand or other positive-pressure mode or any supplied-air respirator that has a full-face piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus.

Escape from unknown or IDLH conditions: An air-purifying, full-face piece respirator with a high-efficiency particulate (100-series) filter or any appropriate escape-type, self-contained breathing apparatus.

If the workplace airborne crystalline silica concentration is unknown for a given task, conduct air monitoring to determine the appropriate level of respiratory protection to be worn. Consult with a certified industrial hygienist, your insurance risk manager or the OSHA Consultative Services group for detailed information. Ensure appropriate respirators are worn, as needed, during and following the task, including clean up or whenever airborne dust is present, to ensure worker exposures remain below OELs.

GENERAL HYGIENE CONSIDERATIONS
There are no known hazards associated with this material when used as recommended. Following the guidelines in this SDS are recognized as good industrial hygiene practices. Avoid breathing dust. Avoid skin and eye contact. Wash dust-exposed skin with soap and water before eating, drinking, smoking and using toilet facilities. Wash work clothes after each use.

SECTION IX— PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE Natural Sand is a mixture of angular or round multicolored particles.	ODOR AND ODOR THRESHOLD Odorless and not applicable
pH AND VISCOSITY Not applicable	MELTING POINT/FREEZING POINT Not applicable
BOILING POINT AND RANGE Not applicable	FLASH POINT AND FLAMMABILITY Not applicable
FLAMMABILITY/EXPLOSIVE LIMITS AND AUTOIGNITION TEMPERATURE Not applicable	EVAPORATION RATE AND DECOMPOSITION TEMPERATURE Not applicable
VAPOR PRESSURE AND VAPOR DENSITY IN AIR Not applicable	SPECIFIC GRAVITY. 2.55-2.8
SOLUBILITY IN WATER Negligible	PARTITION COEFFICIENT: N-OCTANOL/WATER Not applicable

SECTION X – STABILITY AND REACTIVITY

STABILITY Stable	CONDITIONS TO AVOID Contact with incompatible materials (see below).

THERMAL STABILITY
If crystalline silica (quartz) is heated to more than 870°C (1598°F), it can change to a form of crystalline silica known as tridymite, and if crystalline silica (quartz) is heated to more than 1470°C (2678°F), it can change to a form of crystalline silica known as cristobalite.

INCOMPATIBILITY (Materials to avoid)
Contact with powerful oxidizing agents such as fluorine, boron trifluoride, chlorine trifluoride, manganese trifluoride, and oxygen difluoride may cause fire and/or explosions.

SECTION X – STABILITY AND REACTIVITY, CONTD.

HAZARDOUS DECOMPOSITION PRODUCTS
Silica dissolves in hydrofluoric acid producing a corrosive gas - silicon tetrafluoride.

HAZARDOUS POLYMERIZATION
Not known to polymerize

SECTION XI – TOXICOLOGICAL INFORMATION

Health Effects: The information below represents an overview of health effects caused by overexposure to one or more components in natural sand.

Primary routes(s) of exposure: ■ Inhalation 🔄 Skin ■ Ingestion

EYE CONTACT: Direct contact with dust may cause irritation by mechanical abrasion. Conjunctivitis may occur.

SKIN CONTACT: Direct contact may cause irritation by mechanical abrasion.

SKIN ABSORPTION: Not expected to be a significant route of exposure.

INGESTION: Small amounts (a tablespoonful) swallowed during normal handling operations are not likely to cause injury. Ingestion of large amounts may cause gastrointestinal irritation and blockage.

INHALATION: Dust may irritate nose, throat, mucous membranes and respiratory tract by mechanical abrasion. Coughing, sneezing, chest pain, shortness of breath, inflammation of mucous membrane, and flu-like fever may occur following exposures in excess of appropriate exposure limits.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE
Inhaling respirable dust and/or crystalline silica may aggravate existing respiratory system disease(s) (e.g., bronchitis, emphysema, chronic obstructive pulmonary disease) and/or dysfunctions. Exposure to dust may aggravate existing skin and/or eye conditions. Smoking and obstructive/restrictive lung diseases may also exacerbate the effects of excessive exposure to this product.

This product is a mixture of components. The composition percentages are listed in Section III. Toxicological information for each component is listed below:

<u>Silicon Dioxide</u>: It is comprised of amorphous and crystalline forms of silica. In some batches, crystalline silica may represent up to 100% of silicon dioxide.

Exposure route: Eyes, respiratory system.

Target organs: Eyes, skin, respiratory system.

ACGIH, MSHA, and OSHA have determined that adverse effects are not likely to occur in the workplace provided exposure levels do not exceed the appropriate exposure limits. Lower exposure limits may be appropriate for some individuals including persons with pre-existing medical conditions as described under medical conditions aggravated by exposure.

A. <u>SILICOSIS</u>

The major concern is <u>silicosis</u> (lung disease), caused by the inhalation and retention of respirable crystalline silica dust. Silicosis leads to conditions such as lung fibrosis and reduced pulmonary function. The form and severity in which silicosis manifests itself, depends in part on the type and extent of exposure to silica dusts: chronic, accelerated and acute forms are recognized. In later stages the critical condition may become disabling and potentially fatal. Restrictive and/or obstructive changes in lung function may occur due to exposure. A risk associated with silicosis is development of pulmonary tuberculosis (silico-tuberculosis). Respiratory insufficiencies due to massive fibrosis and reduced pulmonary function, possibly with accompanying heart failure, are other potential causes of death due to silicosis.

SECTION XI – TOXICOLOGICAL INFORMATION, CONTD.

Chronic or Ordinary Silicosis is the most common form of silicosis and can occur after many years of exposure to levels above the OELs for airborne respirable crystalline silica dust. Not all individuals with silicosis will exhibit symptoms (signs) of the disease. Symptoms of silicosis may include (but are not limited to): Shortness of breath; difficulty breathing with or without exertion; coughing; diminished work capacity; diminished chest expansion; reduction of lung volume; heart enlargement and/or failure. It is further defined as either simple or complicated silicosis.

Simple Silicosis is characterized by lung lesions (shown as radiographic opacities) less than 1 centimeter in diameter, primarily in the upper lung zones. Often, simple silicosis is not associated with symptoms, detectable changes in lung function or disability. Simple silicosis may be progressive and may develop into complicated silicosis or progressive massive fibrosis (PMF).

Complicated Silicosis or PMF is characterized by lung lesions (shown as radiographic opacities) greater than 1 centimeter in diameter. Although there may be no symptoms associated with complicated silicosis or PMF, the symptoms, if present, are shortness of breath, wheezing, cough and sputum production. Complicated silicosis or PMF may be associated with decreased lung function and may be disabling. Advanced complicated silicosis or PMF may lead to death. Advanced complicated silicosis or PMF can result in heart disease (cor pumonale) secondary to the lung disease.

Accelerated Silicosis can occur with exposure to high concentrations of respirable crystalline silica over a relatively short period; the lung lesions can appear within five (5) years of the initial exposure. The progression can be rapid. Accelerated silicosis is similar to chronic or ordinary silicosis, except that the lung lesions appear earlier and the progression is more rapid.

Acute Silicosis can occur with exposures to very high concentrations of respirable crystalline silica over a very short time period, sometimes as short as a few months. The symptoms of acute silicosis include progressive shortness of breath, fever, cough and weight loss. Acute silicosis is a rapidly progressive, incurable lung disease and is typically fatal.

B. <u>CANCER</u>
IARC - The International Agency for Research on Cancer ("IARC") concluded that there is "*sufficient evidence* in humans for the carcinogenicity of crystalline silica in the form of quartz or cristobalite", there is "*sufficient evidence* in experimental animals for the carcinogenicity of quartz dust" and that there is "*limited evidence* in experimental animals for the carcinogenicity of tridymite dust and cristobalite dust." The overall IARC evaluation was that "crystalline silica inhaled in the form of quartz or cristobalite dust is *carcinogenic to humans* (*Group 1*)." The IARC evaluation noted that not all industrial circumstances studied evidenced carcinogenicity. The monograph also stated that "Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs." For further information on the IARC evaluation, see <u>IARC Monographs on the Evaluation of Carcinogenic Risks to Humans</u>, Volume 100C, "Silica Dust, Crystalline, in the Form of Quartz or Cristobalite" (2012).

NTP - In its Eleventh Annual Report on Carcinogens, concluded that respirable crystalline silica is known to be a human carcinogen, based on sufficient evidence of carcinogenicity from studies in humans indicating a causal relationship between exposure to respirable crystalline silica and increased lung cancer rates in workers exposed to crystalline silica dust.

OSHA - Crystalline silica is not on the OSHA carcinogen list.

CALIFORNIA PROPOSITION 65 - Crystalline silica in October 1996 was listed on the Safe Drinking Water and Toxic Enforcement ACT of 1986 as a chemical known to the state to cause cancer or reproductive toxicity.

There have been many articles published on the carcinogenicity of crystalline silica, which the reader should consult for additional information; the following are <u>examples</u> of recently published articles: (1) "Dose-Response Meta-Analysis of Silica and Lung Cancer", *Cancer Causes Control*, (20):925-33 (2009); (2) "Occupational Silica Exposure and Lung Cancer Risk: A Review of Epidemiological Studies 1996-2005', *Ann Oncol*, (17) 1039-50 (2006); (3) "Lung Cancer Among Industrial Sand Workers Exposed to Crystalline Silica", *Am J Epidemiol*, (153) 695-703 (2001); (4) "Crystalline Silica and The Risk of Lung Cancer in The Potteries", *Occup Environ Med*, (55) 779-785 (1998); (5) "Is Silicosis Required for Silica-Associated Lung Cancer?", *American Journal of Industrial Medicine*, (37) 252- 259 (2000); (6) " Silica, Silicosis, and Lung Cancer: A Risk Assessment", *American Journal of Industrial Medicine*, (38) 8-18 (2000); (7) "Silica, Silicosis, and Lung Cancer: A Response to a Recent Working Group Report", *Journal of Occupational and Environmental Medicine*, (42) 704-720 (2000).

SECTION XI – TOXICOLOGICAL INFORMATION, CONTD.

C. AUTOIMMUNE DISEASES

There is evidence that exposure to respirable crystalline silica (without silicosis) or that the disease silicosis may be associated with the increased incidence of several autoimmune disorders, -- scleroderma, systemic lupus erythematosus, rheumatoid arthritis and diseases affecting the kidneys. For a review of the subject, the following may be consulted: (1) “Antinuclear Antibody and Rheumatoid Factor in Silica-Exposed Workers”, *Arh Hig Rada Toksikol*, (60) 185-90 (2009); (2) "Occupational Exposure to Crystalline Silica and Autoimmune Disease", *Environmental Health Perspectives*, (107) Supplement 5, 793-802 (1999); (3) "Occupational Scleroderma", *Current Opinion in Rheumatology*, (11) 490-494 (1999); (4) “Connective Tissue Disease and Silicosis”, *Am J Ind Med*, (35), 375-381 (1999).

D. TUBERCULOSIS

Individuals with silicosis are at increased risk to develop pulmonary tuberculosis, if exposed to persons with tuberculosis. The following may be consulted for further information: (1) “Tuberculosis and Silicosis: Epidemiology, Diagnosis and Chemoprophylaxis”, *J Bras Pneumol*, (34) 959-66 (2008); (2) *Occupational Lung Disorders*, Third Edition, Chapter 12, entitled "Silicosis and Related Diseases", Parkes, W. Raymond (1994); (3) "Risk of Pulmonary Tuberculosis Relative to Silicosis and Exposure to Silica Dust in South African Gold Miners," *Occup Environ Med*, (55) 496-502 (1998); (4) “Occupational Risk Factors for Developing Tuberculosis”, *Am J Ind Med*, (30) 148-154 (1996).

E. KIDNEY DISEASE

There is evidence that exposure to respirable crystalline silica (without silicosis) or that the disease silicosis is associated with the increased incidence of kidney diseases, including end stage renal disease. For additional information on the subject, the following may be consulted: (1) “Mortality from Lung and Kidney Disease in a Cohort of North American Industrial Sand Workers: An Update”, *Ann Occup Hyg*, (49) 367-73 (2005); (2) "Kidney Disease and Silicosis", *Nephron*, (85) 14-19 (2000); (3) “End Stage Renal Disease Among Ceramic Workers Exposed to Silica”, *Occup Environ Med*, (56) 559-561 (1999); (4) “Kidney Disease and Arthritis in a Cohort Study of Workers Exposed to Silica”, *Epidemiology*, (12) 405-412 (2001).

F. NON-MALIGNANT RESPIRATORY DISEASES

NIOSH has cited the results of studies that report an association between dusts found in various mining operations and non-malignant respiratory disease, particularly among smokers, including bronchitis, emphysema, and small airways disease. *NIOSH Hazard Review – Health Effects of Occupational Exposure to Respirable Crystalline Silica*, published in April 2002, available from NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226, or at https://www.cdc.gov/niosh/docs/2002-129/default.html.

Respirable dust containing newly broken particles has been shown to be more hazardous to animals in laboratory tests than respirable dust containing older silica particles of similar size. Respirable silica particles which had aged for sixty days or more showed less lung injury in animals than equal exposures of respirable dust containing newly broken pieces of silica.

Acute Toxicity Estimates for Natural Sand – Not Available

SECTION XII – ECOLOGICAL INFORMATION

No data available for this product.

SECTION XIII – DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD

Collect and reuse clean materials. Dispose of waste materials only in accordance with applicable federal, state, and local laws and regulations.

The above information applies to Martin Marietta Materials product only as sold. The product may be contaminated during use and it is the responsibility of the user to assess the appropriate disposal method in that situation.

SECTION XIV – TRANSPORT INFORMATION

DOT HAZARD CLASSIFICATION
None

PLACARD REQUIRED
None

LABEL REQUIRED
Label as required by the OSHA Hazard Communication standard {29 CFR 1910.1200(f)}, and applicable state and local regulations.

SECTION XV – REGULATORY INFORMATION

OSHA: Crystalline Silica is not listed as a carcinogen.
SARA Title III: Section 311 and 312: Immediate health hazard and delayed health hazard.
TSCA.: Crystalline silica (quartz) appears on the EPA TSCA inventory under the CAS No. 14808-60-7.
RCRA: Crystalline silica (quartz) is not classified as a hazardous waste under the Resource Conservation and Recovery Act, or its regulations, 40 CFR §261 et seq.
CERCLA: Crystalline silica (quartz) is not classified as a hazardous substance under regulations of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 40 CFR §302.4
EPCRA (Emergency Planning and Community Right to Know Act): Crystalline silica (quartz) is not an extremely hazardous substance under regulations of the **Emergency Planning and Community Right to Know Act, 40 CFR Part 355, Appendices A and B** and is not a toxic chemical subject to the requirements of Section 313.
Clean Air Act: Crystalline silica (quartz) mined and processed by Martin Marietta Materials was not processed with or does not contain any Class I or Class II ozone depleting substances.
FDA: Silica is included in the list of substances that may be included in coatings used in food contact surfaces, 21 CFR §175.300(b)(3).(The FDA standard primarily applies to products containing silica used in the coatings of food contact surfaces).
California Proposition 65: Respirable crystalline silica (quartz) is classified as a substance known to the state of California to be a carcinogen.
Massachusetts Toxic Use Reduction Act: Respirable crystalline silica is considered toxic per the **Massachusetts Toxic Use Reduction Act when used in abrasive blasting and molding.**
Pennsylvania Worker and Community Right to Know Act: Quartz is considered hazardous for purposes of the Act, but it is not a special hazardous substance or an environmental hazardous substance.

SECTION XVI – OTHER INFORMATION

DEFINITIONS OF ACRONYMS/ABBREVIATIONS

ACGIH: American Conference of Governmental Industrial Hygienists
AL: Action Level
ANSI: American National Standards Institute
APF: Assigned Protection Factor
California REL: California Inhalation Reference Exposure Limit
CAS: Chemical Abstracts Service
CERCLA: Comprehensive Environmental Response, Compensation and Liability Act
CFR: US Code of Federal Regulations
DHHS: Department of Health and Human Services
EPA: Environmental Protection Agency
EPCRA: Emergency Planning and Community Right to Know Act
FDA: Food and Drug Administration
GHS: Globally Harmonized System
HEPA: High-Efficiency Particulate Air
IARC: International Agency for Research on Cancer
IDLH: Immediately Dangerous to Life and Health
MSHA: Mine Safety and Health Administration
NIOSH: National Institute for Occupational Safety and Health, US Department of Health and Human Services
NIOSH REL: NIOSH Recommended Exposure Limit
NTP: National Toxicology Program

SECTION XVI – OTHER INFORMATION, CONTD.

DEFINITIONS OF ACRONYMS/ABBREVIATIONS, CONTD.

OEL: Occupational Exposure Limit
OSHA: Occupational Safety and Health Administration, US Department of Labor
PEL: Permissible Exposure Limit
PMF: Progressive Massive Fibrosis
RCRA: Resource Conservation and Recovery Act
SARA Title III: Title III of the Superfund Amendments and Reauthorization Act, 1986
SDS: Safety Data Sheet
STOT: Specific Target Organ Toxicity
TLV: Threshold Limit Value
TSCA: Toxic Substance Control Act
TWA: Time-Weighted Average

User's Responsibility: The OSHA Hazard Communication Standard 29 CFR 1910.1200 requires that this SDS be made available to your employees who handle or may be exposed to this product. Educate and train your employees regarding applicable precautions. Instruct your employees to handle this product properly.

Disclaimer: The information contained in this document applies to this specific material as supplied and Martin Marietta Materials believes that the information contained in this SDS is accurate. The suggested precautions and recommendations are based on recognized good work practices and experience as of the date of publication. They are not necessarily all-inclusive or fully adequate in every circumstance as not all use circumstances can be anticipated. It may not be valid for this material if it is used in combination with other materials. It is the user's responsibility to satisfy oneself as to the suitability and completeness of this information for one's own particular use. Since the actual use of the product described herein is beyond our control, Martin Marietta Materials, assumes no liability arising out of the use of the product by others. Appropriate warnings and safe handling procedures should be provided to handlers and users. Also, the suggestions should not be confused with nor followed in violation of applicable laws, regulation, rules or insurance requirement. However, product must not be used in a manner which could result in harm.
An electronic version of this SDS is available at www.martinmarietta.com . More information on the effects of crystalline silica exposure may be obtained from OSHA (phone number: 1-800-321-OSHA; website: http://www.osha.gov) or from NIOSH (phone number: 1-800-35-NIOSH; website: http://www.cdc.gov/niosh).
DATE OF PREPARATION 6/2018 REPLACES 3/2015

Appendix I

Coronavirus Disease 2019 Crisis Response and Working Protocol

EA Engineering, P.C.
EA Science and Technology

269 West Jefferson Street
Syracuse, New York 13202
Telephone: 315-431-4610
www.eaest.com

March 23, 2020

MEMORANDUM

FROM: Donald Conan, PE, PG

TO: NYSDEC Program Staff

COPY: Peter Garger, CIH, CSP, EA Corporate Health and Safety Director

RE: COVID-19 Crisis Response and Working Protocol
NYSDEC Contracts D007624 and D009806

Based on the latest information available regarding the Coronavirus (COVID-19), all employees are advised of the following, effective immediately.

Maintain a Safe Workplace Through Practice of 'Social Distancing'

- Meetings are permissible, but it is recommended the spacing of individuals of at least 6 ft. Large in-person meetings (>12 persons) should be avoided.
- In general, focus on ways to reduce the amount of physical interaction between employees, and between consultants/contractors and employees.
- Please consider conducting any meetings, both client and internal, via Microsoft Teams or through a conference call.
- Increase use of email or telephone communication in lieu of face-to-face communication.
- Limit office visits from outside individuals as much as possible.

EA Teleworking Program

- Management is in the process of developing guidelines for possible telework scenarios.
- The Information Technology Department is testing our secured network infrastructure in order to handle a high demand of network traffic if events require an increase in remote work.

Non-Essential Business Travel

- All non-essential travel planned through 15 April 2020 is to be cancelled.
- All non-essential travel that has already been approved and has not been executed is to be cancelled.
- Non-essential travel includes conferences, trade shows and outside training. If you are unsure whether your travel is essential, please discuss it with your supervisor.
- Travel booked through Concur or Safe Harbors will require approval by your business unit director or corporate department manager.
- All international business travel is prohibited until further notice.

Essential Business Travel

- Essential business travel is defined as business critical, client-directed and project-related travel necessary to fulfill EA's contractual obligations.
- If you must travel, consider:
  - Any underlying health conditions you or your immediate family may have,
  - Where you will be traveling to, and
  - Is it feasible to drive to the location instead of flying or using mass transit?
- Limit the number of employees per vehicle to two (2).
- If you must travel (or are returning from business travel) and you feel you were at risk for being exposed to COVID-19, please discuss the situation with your supervisor and consider working from home for a period of time.

Personal Travel

- Personal travel is at the discretion of individual employees. We ask employees to volunteer information regarding prior or planned domestic travel and any plans for upcoming international travel. It is highly recommended that you avoid any travel to a country that is subject to a CDC designated Level 3 Travel Health Notice (currently the countries of China, Iran and all of Europe except for the United Kingdom) and South Korea
- Any employee that has traveled to a country that is subject to a CDC designated Level 3 Travel Health Notice is required to remain home for 14 days. Refer to https://www.cdc.gov/coronavirus/2019-ncov/travelers/index.htmlfor more information.

Performing Site Work

- Use typical engineering and administrative controls, safe work practices, and PPE to prevent worker exposure to the COVID-19 virus and site-specific contaminants:
  - nitrile gloves,
  - N95 dust mask (unless site contaminants dictate more stringent respirator), and
  - eye protection,

Field Cleaning/Disinfection General Guidance

- Disinfect surfaces and equipment via hypochlorite solution (i.e., chlorine bleach)
- Sanitizing/disinfecting all commonly touched surfaces such as doors, doorknobs and hardware, handrails, tabletops, windowsills, light switches, toilets, sinks, etc.
- Daily safety tailgates meetings will continue to be held in the warehouse but will be limited to no more than 10 people at a time (breaking up groups and staggering meeting times accordingly).
- The following recommendations will be in place for all project personnel:
  - Remain more than 6 feet from each other, unless necessary to perform job function.
  - Maintain social spacing of 6 feet for meetings, with preference for tele-meetings.
  - Stay outside of individual offices (at doorways) when talking.
  - Use phones to communicate.
  - Sanitize commonly touched surfaces of company vehicles.

- Staff are discouraged from taking breaks and eating lunch in communal settings where it is difficult to maintain a distance of 6 feet from co-workers. Breaks and lunches should be taken in offices, cubicles, or personal vehicles.

Internal Reporting Requirements and Work Restrictions

- The following questions below will be asked of each employee/subcontract employee and any potential site/office visitors to help identify people that should be excluded from office/job site. If an employee or subcontractor answers yes to any of the questions below, they will be asked to leave the job site immediately and contact their Supervisors and/or their appropriate Human Resources Department(s) for further instruction.
    - Do you currently have fever, chills, a cough, sore throat, or shortness of breath?
    - Have you been in contact with someone who has been medically diagnosed with COVID-19?
    - Have you traveled to China, South Korea, Iran or Europe within the last 14 days?
    - Have you been in contact with anyone, including family members, who have traveled to any of the above locations with the last 14 days?
- COVID-19 Testing—Contact your personal doctor or healthcare provider and follow current Centers for Disease Control and Prevention (CDC) (www.CDC.gov) or local requirements related to testing. Contact your Supervisor with an update upon consulting with your doctor or healthcare provider.
- If absent from job site for 3 days or more due to common flu-like symptoms, employee must supply documentation from a doctor with approval to return to work.
- If an employee tests positive for COVID-19, they should follow their employer’s requirements for sick leave, benefits, and return to work. In addition, before returning to the project site, the employee must provide documentation of a negative test, a note from a doctor, or a state or local testing facility.

External Reporting Requirements:

- EA will notify the New York State Department of Environmental Conservation (NYSDEC) if:
    - Any NYSDEC project member is under a quarantine order (either voluntarily or by their local municipality).
    - Any NYSDEC project team member is confirmed infected with COVID-19.
    - Any NYSDEC project team member that exhibits flu-like symptoms AND has either traveled to a region that has a level 3 or higher CDC advisory, or been in contract in the last 14 days with someone who has travelled to a region that has a level 3 or higher CDC advisory.
    - Any NYSDEC project team member that has returned from Mainland China since
    - 2 February 2020 or returned from South Korea or Italy since 1 March 2020.

Use of Consultants/Contractors

- Subcontractors and vendors are permitted to continue work under EA's client engagements.
- Project Managers are encouraged to request consultants or contractors under contract to EA forward along their company's guidance concerning COVID-19 related travel restrictions and client site attendance so that we may adjust our expectations and operations.
- In the event that the government directs EA to close facilities, requiring EA's employees to work remotely, EA will expect consultants to similarly work remotely.

We will continue to monitor the situation and may update the policy as things evolve.
Most importantly, please remember:

- Remain diligent by washing your hands often with soap and warm water for at least 20 seconds.
- Use hand sanitizer if you cannot wash your hands.
- Cover your mouth and nose with a tissue when you cough or sneeze or use the inside of your elbow.
    - Throw used tissues in the trash.
    - Immediately wash your hands with soap and water for at least 20 seconds.
    - If soap and water are not readily available, clean your hands with a hand sanitizer that contains at least 60% alcohol.
- Avoid shaking hands and provide for personal space (social distancing) whenever possible.
- Use disinfectant wipes daily on your mouse, keyboard, cell phone, steering wheel, counter and workspaces.
- Most importantly, stay home if you are sick. In many cases, if you have a fever, you are likely contagious with some type of illness.

As always, if you have any other concerns, please talk with your supervisor. You may also reach out to EA's Corporate Director of Health & Safety, Pete Garger (pgarger@eaest.com or 410-527-2425) with any specific questions or concerns. In all cases, use your best judgment. Once again, your health and safety are our highest priorities.

The main Centers for Disease Control and Prevention (CDC) website for the Coronavirus Disease 2019 (COVID-19) is https://www.cdc.gov/coronavirus/2019-ncov/index.html

If you have any questions or wish to discuss this basis of order cost estimate further, please do not hesitate to call.

Attachments:

Social Distancing Guidelines
Activity Hazard Analysis

SOCIAL DISTANCING GUIDELINES AT WORK

1 **Avoid in-person meetings. Use online conferencing, email or the phone when possible, even when people are in the same building.**

2 **Unavoidable in-person meetings should be short, in a large meeting room where people can sit at least three feet from each other; avoid shaking hands.**

3 **Eliminate unnecessary travel and cancel or postpone nonessential meetings, gatherings, workshops and training sessions.**

4 **Do not congregate in work rooms, pantries, copier rooms or other areas where people socialize. Keep six feet apart when possible.**

5 **Bring lunch and eat at your desk or away from others (avoid lunchrooms and crowded restaurants).**

6 **Avoid public transportation (walk, cycle, drive a car) or go early or late to avoid rush-hour crowding on public transportation.**

7 **Limit recreational or other leisure classes, meetings, activities, etc., where close contact with others is likely.**

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Activity/Work Task:	**COVID-19 Hazard Mitigation**	Overall Risk Assessment Code (RAC) (use highest code from all subtasks):				**M**	
Project Location:		Risk Assessment Code (RAC) Matrix					
Project Number:		Severity	Probability				
Date Prepared:	23 March 2020		1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
Prepared By:	D. Wilt, P.G.	1 Catastrophic	E	E	H	H	M
		2 Critical	E	H	H	M	L
Reviewed By:	P. Garger, CIH, CSP	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L
Competent Person:	SSHO					RAC Chart E = Extremely High Risk H = High Risk M = Moderate Risk L = Low Risk	

Probability = the likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.
Severity = the outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.

TASK BREAKDOWN, HAZARDS AND CONTROLS

Work Task Steps	**Hazards**	**Controls**	**RAC Severity/ Probability /RAC**
All Tasks	Inhalation of virus from infected individual (symptomatic or asymptomatic) by other individuals	Remain more than 6 feet from each other, unless necessary to perform job function. Daily safety tailgate meetings will continue to be held in the warehouse but will be limited to no more than 10 people at a time (breaking up groups and staggering meeting times accordingly). Maintain social spacing of 6 feet for meetings, with preference for tele-meetings. Stay outside of individual offices (at doorways) when talking. Use phones to communicate. Maintain diligent use of personal protective equipment (PPE) including safety glasses to limit contact with eyes and nitrile gloves. Face shields may be worn for work that cannot be completed without maintaining a distance of 6 feet between individuals. Staff are discouraged from taking breaks and eating lunch in communal settings where it is difficult to maintain a distance of 6 feet from co-workers. Breaks and lunches should be taken in offices, cubicles or personal vehicles. Staff are encouraged to practice social distancing when not on the jobsite. Staff are required to comply with all Federal, State, and local requirements and recommendations.	2/4/M

Work Task Steps	Hazards	Controls	RAC Severity/ Probability /RAC
All Tasks	Dermal Contact with contaminated surfaces by individual personnel	Wash hands often with soap and water for at least 20 seconds especially if in a public place, or after blowing your nose, coughing, or sneezing. If soap and water are not readily available, use a hand sanitizer that contains at least 60% alcohol. Cover all surfaces of hands and rub them together until they feel dry. Avoid touching your eyes, nose, and mouth with unwashed hands.	2/4/M
	Dermal Contact - Contamination on Surfaces	Clean AND disinfect frequently touched surfaces daily. This includes field equipment, personal mobile phones, vehicle surfaces (steering wheel, door handles, shift stick), tables, doorknobs, light switches, countertops, handles, desks, phones, keyboards, toilets, faucets, and sinks. If surfaces are dirty, clean them: Use detergent or soap and water prior to disinfection. Use disinfectant capable of killing the virus on surfaces including: • Bleach – mix 5 tablespoons (1/3 cup) bleach per gallon of water or 4 teaspoons bleach per quart of water • Alcohol solutions with at least 70% alcohol • Other approved disinfectants listed at https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2 The field office will be professionally cleaned twice weekly, with a focus on sanitizing/disinfecting all commonly touched surfaces such as doors, doorknobs and hardware, handrails, tabletops, windowsills, light switches, toilets, sinks, etc.	2/4/M
All Tasks	Infected individual(s)/ personnel at work	The following questions below will be asked of each employee/subcontract employee and any potential site/office visitors to help identify people that should be excluded from office/job site. If an employee or subcontractor answers yes to any of the questions below, he/she will be asked to leave the job site immediately and contact their Supervisor and/or appropriate Human Resources Department for further instruction. • Do you currently have fever, chills, a cough, sore throat, or shortness of breath? • Have you been in contact with someone who has been medically diagnosed with COVID-19? • Have you traveled to China, South Korea, Iran or Europe within the last 14 days? • Have you been in contact with anyone, including family members, who have traveled to any of the above locations within the last 14 days? The field office will be professionally cleaned if an infected individual is identified onsite, with a focus on sanitizing/disinfecting all commonly touched surfaces such as doors, doorknobs and hardware, handrails, tabletops, windowsills, light switches, toilets, sinks, etc.	2/4/M

REQUIRED EQUIPMENT, INSPECTION AND TRAINING

Equipment Anticipated	Inspection Requirements	Training Requirements
• Emergency equipment including first aid kit, eye wash, fire extinguishers • Safety glasses, nitrile gloves, face shields • Hand soap or hand sanitizer • Disinfectant	• Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher) • Confirm disinfectant is approved to kill COVID-19	**All Personnel:** • COVID-19 awareness training covering symptoms, routes of transmission, mitigation efforts required

Appendix C

Quality Assurance Project Plan

Generic Quality Assurance Project Plan for Work Assignments

NYSDEC Standby Contract No. D009806

Prepared for

New York State Department of Environmental Conservation
Division of Environmental Remediation

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
269 W. Jefferson Street
Syracuse, New York 13202

April 2020

Generic Quality Assurance Project Plan for Work Assignments

NYSDEC Standby Contract No. D009806

Prepared for

New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
269 West Jefferson Street
Syracuse, New York 13202

Revision No.	Description of changes	Date Revisions Completed	Author(s)
00	Original submittal	Not applicable	AE
01	Added reference to NYSDEC guidance on PFAS analysis and sampling	4/2/2020	AE

April 2020
Revision: 01
EA Project No. 0731111

Generic Quality Assurance Project Plan for Work Assignments

NYSDEC Standby Contract No. D009806

Prepared for

New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233

NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
269 West Jefferson Street
Syracuse, New York 13202

Donald Co
3 April 2020
Donald Conan, P.E., P.G., Program Manager — Date
EA Engineering, P.C.

Daniel Hinckley
3 April 2020
Daniel Hinckley, Ph.D., Project Chemist — Date
EA Science and Technology

April 2020
Revision: 01
EA Project No. 0731111

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LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
mg/kg	Milligram(s) per kilogram
µg/L	Microgram(s) per liter
µg/m^3	Microgram(s) per cubic meter
CLP	Contract laboratory program
DQO	Data quality objective
DUSR	Data Usability Summary Report
EA	EA Engineering, P.C. and Its Affiliate EA Science and Technology
EDD	Electronic data deliverable
EPA	U.S. Environmental Protection Agency
IDL	Instrument detection limit
MDL	Method detection limit
No.	Number
NYSDEC	New York State Department of Environmental Conservation
PFAS	Per- and polyfluoroalkyl substances
QAPP	Quality assurance project plan
QA	Quality assurance
QC	Quality control
SOP	Standard operating procedure
SVOC	Semi-volatile organic compound
VOC	Volatile organic compound

1. PURPOSE AND OBJECTIVES

1.1 PURPOSE

This Generic Quality Assurance Project Plan (QAPP) has been prepared as a generic companion document to accompany site-specific Work Plans for the Standby Subcontract Work Assignments issued to EA Engineering, P.C. and its affiliate EA Science and Technology (EA) by the New York State Department of Environmental Conservation (NYSDEC) under Standby Contract Number (No.) D009806. The principal purpose of this document is to specify quality assurance (QA)/quality control (QC) procedures for the collection, analysis, and evaluation of data that will be legally and scientifically defensible. A site-specific QAPP Addendum will be provided when required to supplement this document for individual work assignments.

1.2 QUALITY ASSURANCE PROJECT PLAN OBJECTIVES

The QAPP provides general information and references Standard Operating Procedures (SOPs) applicable to the analytical sampling program detailed in each site-specific Work Plan. This information includes definitions and generic goals for data quality and required types and quantities of QA/QC samples. The procedures address field documentation; sample handling, custody, and shipping; instrument calibration and maintenance; auditing; data reduction, validation, and reporting; corrective action requirements; and QA reporting specific to the analyses performed by the laboratories (to be determined) under a standby subcontract agreement with EA.

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2. PROJECT ORGANIZATION AND RESPONSIBILITIES

Each work assignment will be managed through an organized effort of scientific and engineering personnel and technical resources. These efforts will employ pre-approved field procedures, sampling techniques, and analytical methods to accomplish the work assignment objectives. Effective program organization will accommodate these requirements while maintaining a manageable degree of control over these activities.

2.1 OVERALL PROJECT ORGANIZATION

The project-specific organizational and management plan will be detailed in each site-specific Work Plan. Each site-specific Work Plan will include an organizational chart that illustrates the project organization for the accomplishment of each effort.

The key technical management of work assignments will be accomplished by a designated Project Manager and an assigned project team. Additional individuals will be made available, if warranted. Each of the laboratories will have a designated Laboratory Project Manager who will serve as the liaison between the laboratory staff and the overall Project Manager.

For the purpose of QA/QC, each work assignment will have an assigned Project QA/QC Officer to provide guidance on technical matters and review technical documents relating to the work assignments. He/she will assess the effectiveness of the QA/QC program and recommend modifications when applicable. Additionally, the QA/QC Officer may delegate technical guidance to specially trained individuals under his/her direction.

The Program Health and Safety Officer, Mr. Peter Garger, is also an integral part of the project implementation teams. He will be responsible for the development, final technical review, and approval of the Generic Health and Safety Plan and project-specific Health and Safety Plans. In addition, he will provide authorization, if warranted, to modify personal protective equipment requirements based on field conditions. He will also provide final review of all health and safety monitoring records and personal protective equipment changes to ensure compliance with the provisions of the Health and Safety Plans.

2.2 LABORATORIES

The laboratories will perform chemical analyses of environmental samples collected for each work assignment, as necessary. The laboratories are capable of providing a complete range of analytical services consistent with U.S. Environmental Protection Agency (EPA) protocols. These laboratories will maintain their certification by the New York State Department of Health Environmental Laboratory Approval Program.

The laboratories will have their own provisions for conducting an internal QA/QC review of the data before they are released to EA. The Laboratory Project Managers will contact EA's Project Managers with any sample discrepancies or data concerns.

Hardcopy and electronic data deliverables (EDDs) and formatted QA/QC reports will be filed by the analytical laboratories when data are submitted to EA. Corrective actions (**Section 11**) will be reported to the EA Project Managers along with the QA/QC reports. The laboratories may be contacted directly by EA or NYSDEC personnel to discuss QA concerns.

3. QUALITY ASSURANCE/QUALITY CONTROL OBJECTIVES FOR DATA MEASUREMENT

3.1 INTRODUCTION

This section discusses QA objectives for work assignments. QA objectives are requirements specifying the quality of environmental data needed to support the decision-making process. The uncertainty must be maintained at levels that will allow the resultant data to be used for its intended purposes.

Data collected during work assignments typically will include field measurements and laboratory analytical data. This section reviews the various types of data anticipated and presents QA objectives for data collected in conjunction with work assignments.

3.2 DATA QUALITY CONTROL OBJECTIVES

Data quality objectives (DQOs) are qualitative and quantitative statements, which specify the quality of data required to support the decision-making process. DQOs are developed to achieve the level of data quality required for anticipated data use. DQOs are implemented so that, for each task, the data are legally and scientifically defensible. The development of DQOs for a specific site and measurement considers work assignment goals; data uses, types, and needs; and data collection. These factors determine whether the quality and quantity of data are adequate for its end use. Sampling protocols have been developed and sampling documentation and handling procedures have been identified to realize the required data quality.

DQOs are established prior to data collection and are not considered a separate deliverable. Rather, the DQO development process is integrated with the work assignment planning process, and the results are incorporated into the site-specific QAPP Addendum for the site location. DQOs will be specified for each planned data collection activity. The DQO process results in an effective plan, which details the chosen sampling and analysis options, and the statements of confidence in decisions made during the corrective action process. Confidence statements are possible through the application of statistical techniques to the data. The DQO process consists of the following steps:[1]

1. State the problem
2. Identify the goals of the study
3. Identify information inputs
4. Define the boundaries of the study
5. Develop the analytic approach
6. Specify performance or acceptance criteria
7. Develop the plan for obtaining data.

---

[1] EPA. 2016. Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA/240/B-06/001, February.

3.3 LABORATORY QUALITY ASSURANCE OBJECTIVES

The fundamental mechanisms that will be employed to achieve these quality goals in laboratory analyses can be categorized as prevention, assessment, and correction. These include:

- Prevention of defects in the quality through planning and design; documented instructions and procedures; and careful selection of skilled, qualified personnel.

- Quality assessment through a program of regular audits and inspections to supplement continual informal review.

- Permanent correction of conditions adverse to quality through a closed-loop corrective action system.

Overall compliance with laboratory QC procedures will be evaluated against the criteria specified for each method. Deviations will be reported in the narrative, which contains comments or problems encountered during fractional analyses of the samples. The narrative includes the laboratory's assessment of the impact on data usability and will address QC issues related to the following:

- ***Laboratory Method Performance*****—**QC criteria for method performance must be met for target analytes for data to be reported. These criteria generally apply to instrument tune, calibration, method blanks, surrogates, and laboratory control samples.

- ***Sample Matrix Effects*****—**QC samples are analyzed to determine measurement bias due to the sample, and may include surrogates, matrix spikes, matrix spike duplicates, and laboratory duplicates. If criteria are not met, matrix interferences are confirmed either by reanalysis or by inspection of the laboratory control sample results to verify that laboratory method performance is in control. Data are reported with appropriate qualifiers or discussion.

3.4 FIELD PARAMETERS AND QUALITY ASSURANCE OBJECTIVES

Water quality parameters consisting of pH, conductivity, dissolved oxygen, salinity, temperature, and turbidity will be measured to provide general surface water and groundwater quality information. These parameters will also be monitored for stability during purging of groundwater monitoring wells. Field test methods that will be utilized to measure these specific parameters will be presented in detail in site-specific Field Activity Plans.

Field screening of soil samples using a photoionization detector will be performed to assess the presence and relative concentrations of volatile organic vapors. The method for quantification of soil volatile organic compounds (VOCs) using headspace measurement, as well as operational protocols of the photoionization detector, will be presented in site-specific Field Activity Plans. Soil vapor, indoor/outdoor air, and soil/sediment sampling locations and monitoring wells will be surveyed with the accuracy and precision requirements discussed in site-specific Field Activity

Plans. Ground surface and top-of-casing elevations for each newly installed monitoring wells will be measured to the nearest 0.01 feet as referenced to the National Geodetic Vertical Datum of 1929.

For field QC data, no QA objectives have been determined by the NYSDEC. Field QC data will be maintained primarily for descriptive purposes and data variability. The Site Manager will be responsible for reviewing and evaluating the field QC data.

Similar samples will be collected using consistent sampling methods, analyzed using consistent analytical procedures, and reported in conventional units (e.g., micrograms per liter [µg/L], milligram per kilogram [mg/kg], and micrograms per cubic meter [$\mu g/m^3$] for analytical results). Therefore, the data will be comparable throughout the project.

3.5 DETECTION AND QUANTITATION LEVELS

In addition, analytical sensitivity is an important component of data quality, and is evaluated using analyte detection and quantitation levels.

3.5.1 Detection Limits

A detection limit has been defined by the Committee on Environmental Improvement of the American Chemical Society (Anal. Chem. 55:2210-2218 [1983]) as “the lowest concentration that can be determined to be statistically different from a blank.” Various methods are available for determining detection limits, most of which are based on the standard deviation of measurements in the region near the blank responses. The following detection limits are determined routinely in the laboratory.

Instrument detection limits (IDLs) are determined using the protocols given in the inorganic and organic statements of work for the EPA Contract Laboratory Program (CLP). A standard deviation is calculated from replicate measurements of a low-level standard and multiplied by 3 to give the IDL. IDLs are used as an index of instrument performance that does not include sample effects; and therefore, represent the lowest detection limit achievable. IDLs can vary between instruments of the same type and can change when re-determined.

Method detection limits (MDLs) are determined using the EPA procedure published in 40 Code of Federal Regulations 136 Appendix B. The MDL is defined as “the minimum measured concentration of a substance that can be reported with 99 percent confidence that the measured concentration is distinguishable from method blank results.” This procedure requires that sample processing steps of the analytical method be included in the determination of the MDL. Therefore, the sample matrix and sample preparation process, as well as the analytical instrumentation, influence MDLs. The value calculated from the spiked samples is called the MDLs. Spiked samples are prepared by the lab from a clean reference matrix, such as reagent water, and spoked with a known quantity of the analyteThe method blank samples are used to calculate the MDL_b, which is a very similar calculation that also calculates the 99 percent confidence level that the result is derived from the sample rather from contamination/noise. The MDL is the higher of the two values (either the MDL_S calculated using spiked samples or the MDL_b calculated using method blanks). Because of the wide variety of matrix types analyzed by the laboratory, MDLs are routinely determined in reagent water or standard solid matrix. These MDLs represent; therefore, the optimum values, and the MDLs for actual sample matrices are likely to be higher. MDLs can be determined for specific matrices when requested by NYSDEC.

Unless superseded by other program, work assignment, or NYSDEC requirements, IDLs and MDLs are determined annually by the laboratories. In addition, IDLs and MDLs are re-determined after an instrument is moved or modified, and MDLs are re-determined after a method has been significantly changed. Where more than one instrument is used in sample analyses by a given technique (e.g., gas chromatograph/mass spectrometry, gas chromatograph, graphite furnace atomic absorption, or inductively coupled plasma), detection limit studies are performed for each instrument. A standard laboratory reporting limit is determined for each analyte based on the highest detection limit determined. Data for instruments are maintained for use in reporting data when project-specific requirements dictate lower detection limits.

When interpreting data and detection limits, it is important to remember that, when a measured concentration is greater than the detection limit, the analyte has the specified probability of actually being present (i.e., of having a true concentration greater than zero); however, the detection limit cannot be used to say anything about the presence or absence of an analyte that has a measured concentration less than the detection limit. From the definition of the MDL, there is a 1 percent chance that a sample with no analyte will produce a concentration greater than or equal to the MDL (false-positive). The probability is 50 percent; however, that a sample with a concentration at the MDL will be measured at less than the MDL (false-negative).

3.5.2 Quantitation Levels

To ensure better precision in low-level data and to reduce the false-negative error rate, quantitation limits have been proposed as the minimum concentration at which an analyte can be quantified with an acceptable degree of confidence. The American Chemical Society Committee on Environmental Improvement has recommended that quantitation limits be calculated by multiplying 10 times the standard deviation, giving a relative standard deviation of 10 percent. The Committee further advised that quantitative interpretation, decision making, and regulatory actions should be limited to data at or above the limit of quantitation. The laboratories will use the term “reporting limit” for the laboratory quantitation limit.

3.5.3 Project-Specific Quality Control and Reporting Limits

Reporting limits applicable to work assignments are presented in Tables 1A-1J. The relevant tables were prepared based on New York State Department of Health Soil Vapor/Indoor Air Decision Matrices, 6 New York Code of Rules and Regulations Part 375 Soil Cleanup Objectives, and NYSDEC Groundwater Criteria and EPA CLP Contract Required Quantitation Limits, which will be reviewed by the contracting laboratories. Any site-specific revisions will be addressed in the site-specific QAPP Addendums.

4. SAMPLING AND SAMPLE CUSTODY PROCEDURES

4.1 FIELD SAMPLING OPERATIONS

The collection and subsequent laboratory analyses of environmental samples will provide the majority of the data collected during the standby contract work assignments. The number and types of analyses to be performed and the matrix of each of the samples will be detailed in each site-specific Work Plan.

4.1.1 Sample Bottle Preparation

Chain-of-custody procedures begin with preparation of sample containers and preservatives to be used in sample collection. The contract laboratories will provide cleaned sample containers. Batch or Individual certified-clean Summa® canisters will be provided by contract laboratories. Sample kits (coolers containing chain-of-custody forms, custody seals, sample containers, preservatives, and packing materials) will be prepared by the contract laboratories in response to receipt of the analytical task order submitted by the Project Manager.

Container, preservation, and holding time requirements for aqueous and soil samples will be summarized in site-specific QAPP Addendums.

4.1.2 Sampling Procedures

Sampling protocols will be presented in site-specific Field Activity Plans. The protocols include standard sampling procedures for sample collection, accurate sample identification, and packing of samples for shipment. Each sample container is provided with a sample label, which is filled out at the time of sample collection. During sample collection, a chain-of-custody form is initiated, which accompanies the samples during shipment to the analytical laboratory.

4.2 LABORATORY SAMPLE RECEIPT

Upon receipt at the laboratory, a laboratory representative inspects the samples for integrity and checks the shipment against the chain-of-custody/analytical task order form. Discrepancies are addressed at this point and documented on the chain-of-custody form and the cooler checklist (an example will be provided in site-specific Field Activity Plans). Discrepancies are reported to the Laboratory Project Manager who contacts the Project Manager for resolution.

When the shipment and the chain-of-custody are in agreement, the custodian enters the samples into the Laboratory Information Management System and assigns each sample a unique laboratory number. This number is affixed to each sample bottle. The custodian then enters the sample and analysis information into the laboratory computer system.

4.2.1 Laboratory Sample Custody

The laboratory must satisfy the sample chain-of-custody requirements by implementing the following SOPs for laboratory/sample security:

- Samples are stored in a secure area
- Access to the laboratory is through a monitored area
- Visitors sign a visitor’s log and are escorted while in the laboratory
- Only the designated sample custodians have keys to sample storage area(s)
- Transfers of samples in and out of storage are documented.

4.2.2 Sample Storage, Security, and Disposal

While in the laboratory, the samples and aliquots that require storage at 4 degrees Celsius (°C) ± 2°C are maintained in a locked refrigerator unless they are being used for analysis. The laboratory is responsible for sample storage and security to ensure that:

- Samples and extracts are stored for 60 days after the final analytical data report has been forwarded to the client. The samples, extracts, and digestates are then discarded in accordance with Occupational Safety and Health Administration guidance.

- Samples are not stored with standards or sample extracts.

5. CALIBRATION PROCEDURES AND FREQUENCY

Instruments and equipment used for analytical procedures are controlled by a formal calibration program, which verifies that equipment is of the proper type, range, accuracy, and precision to provide data compatible with specified requirements. Instruments and equipment that measure a quantity, or whose performance is expected at a stated level, are subject to calibration. Calibration is performed using reference standards or externally by calibration agencies or equipment manufacturers.

5.1 CALIBRATION SYSTEM

The following sections contain a discussion of the elements comprising the calibration system.

5.1.1 Calibration Procedures

Written procedures are used for all instruments and equipment subject to calibration. Whenever possible, recognized procedures, such as those published by the American Society of Testing and Materials or EPA, or procedures provided by manufacturers, are adopted. If established procedures are not available, a procedure is developed considering the type of equipment, stability characteristics of the equipment, required accuracy, and the effect of operational error on the quantities measured.

5.1.2 Calibration Frequency

Calibration frequency is based on the type of equipment, inherent stability, manufacturer’s recommendations, values provided in recognized standards, intended data use, specified analytical methods, effect of error upon the measurement process, and prior experience.

5.1.3 Calibration Reference Standards

Two types of reference standards will be used by the contract laboratories for calibration:

- **Physical standards**, such as weights for calibrating balances and certified thermometers for calibrating working thermometers, refrigerators, and ovens, are generally used for periodic calibration.

- **Chemical standards**, such as Standard Reference Materials provided by the National Institute of Standards and Technology or EPA. These may include vendor-certified materials traceable to National Institute of Standards and Technology or EPA Standard Reference Materials. These are primarily used for operational calibration.

5.1.4 Calibration Failure

Equipment that cannot be calibrated or becomes inoperable is removed from service. Such equipment must be repaired and satisfactorily recalibrated before re-use. For laboratory equipment that fails calibration, analysis cannot proceed until appropriate corrective action is taken and the analyst achieves an acceptable calibration. This is documented in a Non-Conformance Record, which is discussed in Section 11. Laboratory managers are responsible for development and implementation of a contingency plan for major equipment failure. The plan includes guidelines on waiting for repairs, use of other instrumentation, subcontracting analyses, and evaluating scheduled priorities.

5.1.5 Calibration Records

Records are prepared and maintained for each piece of equipment subject to calibration. Records demonstrating accuracy of preparation, stability, and proof of continuity of reference standards are also maintained. Copies of the raw calibration data are kept with the analytical sample data.

5.2 OPERATIONAL CALIBRATION

Operational calibration is generally performed as part of the analytical procedure and refers to those operations in which instrument response (in its broadest interpretation) is related to analyte concentration. Included are the preparation of standard response (calibration) curves and often the analysis of blanks.

5.2.1 Preparation of Calibration Curve

Preparation of a standard calibration curve is accomplished by the analysis of calibration standards, which are prepared by adding the analyte(s) of interest to the solvent that is introduced into the instrument. The concentrations of the calibration standards are chosen to cover the working range of the instrument or method. Sample measurements are made within this working range. The calibration curve is prepared by plotting or regressing the instrument responses versus the analyte concentrations. Concentrations of the analyzed samples are back-calculated from the calibration curve.

5.2.2 Blanks

Reagent and/or solvent blanks are analyzed to assess if the materials used to prepare the standards are free from interfering substances that could affect the analysis. A method blank is prepared whenever samples are processed through steps that are not applied to the calibration standards.

5.3 PERIODIC CALIBRATION

Periodic calibrations are performed for equipment (e.g., balances, thermometers) that is required in the analytical method, but that is not routinely calibrated as part of the analytical procedure. The periodic calibration requirements used by contract laboratories are provided in Table 2.

5.4 FIELD EQUIPMENT CALIBRATION

The procedures and frequencies for the calibration of field equipment are provided in Table 3.

6. ANALYTICAL PROCEDURES

6.1 FIELD ANALYTICAL PROCEDURES

Field analytical procedures include the measurement of temperature, conductivity, dissolved oxygen, pH, turbidity, organic vapors, and groundwater levels. Specific field measurement protocols will be described in greater detail in site-specific Field Activities Plans. Field measurement QC limits in terms of precision and accuracy are presented in Table 4.

6.2 LABORATORY ANALYTICAL PROCEDURES

Laboratory analytical requirements presented in the subsections below include a general summary of requirements related to each sample matrix to be analyzed.

Concentrations of target compounds and analytes will be analyzed according to the laboratory-specific method SOPs approved by the NYSDEC Analytical Services Protocol[2] and EPA SW-846 Methods listed in the table below. Low-level analysis of 1,4-dioxane is performed using SW846 Method 8270 or 8260, although 8270 can offer lower reporting limits. Per- and polyfluoroalkyl substances (PFAS) analytical methods are presently limited to groundwater EPA Method 537.1 , and ISO Method 25101 for drinking water. site-specific QAPPs should reflect the current understanding of analyses at the time of sampling, and reference NYSDEC's January 2020 *Guidelines for Sampling and Analysis of PFAS*. Additional information regarding the number and types of samples to be collected at each area of concern will be presented in site-specific Work Plans.

Analyte List	**Matrices**	**Method No.**
EPA CLP Target Compound List organics (VOCs/semi-volatile organic compounds [SVOCs])(1)	Groundwater, surface water, surface and subsurface soil, sediment, and debris	CLP Method OLM02.4 for VOCs CLP Method OLM02.4 for SVOCs including 1,4-dioxane by SIM ***or*** EPA SW-846 Method 8260 for VOCs EPA SW-846 Method 8270 for SVOCs EPA SW-846 Method 8270 SIM for 1,4-dioxane (aqueous)
EPA CLP Target Analyte List metals	Groundwater, surface water, surface and subsurface soil, sediment, and debris	CLP Method ISM02.4 or EPA SW-846 Method 6010 Mercury by EPA SW-846 Method 7470 (liquid) or 7471 (solid)
Polychlorinated biphenyls	Groundwater, surface water, surface and subsurface soil, sediment, and debris	EPA SW-846 Method 8082 or CLP Method OLM02.4
PFAS Analyte List (21 compounds)	Groundwater, surface water, drinking water, surface and subsurface soil, sediment, and debris	EPA Method 537.1 ISO 25101 (drinking water)
VOCs	Air and Soil Vapor	EPA TO-15
(1) Specific method to be used for VOC or SVOC analyses will be identified in each project-specific QAPP Addendum (2) SIM Selected Ion Monitoring.		

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[2] NYSDEC. 2001 (as revised). *Analytical Services Protocol.*

Samples will be analyzed by the laboratory within the holding times presented in site-specific Field Activities Plans on a standard turnaround schedule.

6.3 SAMPLE MATRICES

6.3.1 Water

No filtering of groundwater samples will be performed unless pre-approved under a site-specific Field Activities Plan. Field filtration of surface water may be required and will be addressed in the project-specific QAPP Addendum, if necessary. Analytical results for analyses will be reported in units identified in Tables 1A-1J.

6.3.2 Soil, Sediment, and Debris

Analytical results of soil, sediment, and debris samples will be reported in terms of dry weight in the units identified in Tables 1A-1J.

6.3.3 Soil Vapor and Indoor/Outdoor Air

Analytical results for soil vapor and indoor/outdoor air samples will be reported in terms of volume in the units identified in Tables 1A-1J.

6.4 STANDARD OPERATING PROCEDURES

The contract laboratories will maintain a manual of procedures other than laboratory-specific analytical methods in a document-controlled SOP Manual. Laboratory Method SOPs will be maintained as controlled documents in the laboratory’s Methods Manuals.

6.5 RECORDKEEPING

The requirements for laboratory recordkeeping are given in the laboratory’s SOP Manual. Data entries are made in indelible, water-resistant ink. The date of the entry and the observer are clear on each entry. The observer uses his/her full name or initials. An initial and signature log is maintained so that the recorder of every entry can be identified. Information is recorded in a notebook or on other records at the time the observations are made. Recording information on loose pieces of paper is not allowed.

When a mistake is made, the wrong entry is crossed out with a single line initialed and dated by the person making the entry, and the correct information recorded. Obliteration of an incorrect entry or writing over it is not allowed; neither is the use of correction tape or fluid on any laboratory records.

7. FIELD AND LABORATORY QUALITY CONTROL CHECKS AND FREQUENCY

QC measurements for analytical protocols are designed to evaluate laboratory performance and measurement biases resulting from the sample matrix and field performance.

- ***Laboratory Method Performance***—QC criteria for method performance must be met for all target analytes for data to be reported. These criteria generally apply to instrument tune, calibration, method blanks, laboratory control samples, and Standard Reference Materials.

- ***Sample Performance***—The accuracy and precision of sample analyses are influenced by both internal and external factors. Internal factors are those associated with sample preparation and analysis. Internal factors are monitored by the use of laboratory QC samples. QC field samples are analyzed to determine any measurement bias due to the sample matrix based on evaluation of matrix spikes, matrix spike duplicates, and laboratory duplicates.

- ***Field Performance***—QC samples are used to evaluate the effectiveness of the sampling program to obtain representative samples, eliminating any cross contamination.

7.1 LABORATORY QUALITY CONTROL SAMPLES

Laboratory QC samples are included in each analysis to provide information on both method performance and sample measurement bias and are included in each analytical batch. A batch is defined as a group of field samples of similar matrix, not to exceed 20, which are processed as a unit using the same method and the same lots of standards and reagents. The laboratory QC samples discussed in the following sections are not counted in the maximum batch size of 20.

7.1.1 Method Blank

The method blank is used to monitor laboratory contamination. This is usually a sample of laboratory reagent water, or a standard solid matrix, processed through the same analytical procedure as the sample (i.e., digested, extracted, distilled). One method blank is prepared and analyzed with each analytical batch.

7.1.2 Laboratory Control Sample

A fortified method blank is analyzed with each analysis. These samples generally consist of a standard solid matrix or laboratory water fortified with the analytes of interest for single-analyte methods and selected analytes for multi-analyte methods according to the appropriate analytical method. The analyte recovery from each is used to monitor analytical accuracy and precision.

7.1.3 Matrix Spike

A matrix spike is an aliquot of a field sample, which is fortified with the analyte(s) of interest and analyzed to monitor measurement bias associated with the sample matrix. A matrix spike duplicate will be performed for every analytical batch.

7.1.4 Surrogates

Surrogates are organic compounds that are similar to analytes of interest in chemical composition, extraction, and chromatography, but are not normally found in environmental samples. Surrogates are added to field and QC samples in every batch. These compounds are used to monitor system performance, as well as sample measurement bias. Percent recoveries are calculated for each surrogate and evaluated against acceptance criteria.

7.2 FIELD QUALITY CONTROL SAMPLES

These samples are not included specifically as laboratory QC samples but are analyzed when submitted. Data for these QC samples are reported with associated samples.

7.2.1 Field/Rinsate Blanks

Field/rinsate blanks will be collected to evaluate the cleanliness of aqueous sampling equipment and sampling bottles, and the potential for cross-contamination of samples due to equipment handling and/or contaminants in the air. Field blanks will be collected at a frequency of one per 20 decontamination event for each type of sampling equipment (e.g., a groundwater bailer for groundwater) and, at a minimum, one per equipment type and/or media per day. Field/rinsate blanks will not be collected in conjunction with the air/vapor samples.

Field/rinsate blanks will be collected prior to the occurrence of any analytical field sampling event by pouring deionized or potable water over a piece of sampling equipment and into a sample container. The analytical laboratory will provide field blank water and sample jars with preservatives for the collection of all field blanks. Glass jars will be used for organic blanks. The field blanks, as well as the trip blanks, will accompany field personnel to the sampling location. The field blanks will be analyzed for the same analytes as the environmental samples being collected that day and shipped with the samples.

Field blanks will be collected in accordance with the procedures described below:

- Decontaminate sampler using the procedures specified in the site-specific QAPP addendum.

- Pour distilled/deionized water over the sampling equipment and collect the rinsate water in the appropriate bottles.

- Immediately place sample in a cooler and maintain a temperature of 4ºC until receipt by the laboratory.

- Fill out sample log, labels, and chain of custody forms, and record in field logbook.

7.2.2 Trip Blanks

The trip blank will be used to determine if any volatile organic cross-contamination occurs between aqueous samples during shipment. They are only appropriate for volatile organic samples in water. Trip blanks will be supplied by the analytical laboratory as aliquots of distilled, deionized water that will be sealed in a sample bottle prior to initiation of each day of field work. Glass vials (40 milliliters) with Teflon®-lined lids will be used for trip blanks. The sealed trip blank bottles will be placed in a cooler with the empty sample bottles and shipped to the site by laboratory personnel. If multiple coolers are necessary to store and transport aqueous VOC samples, then each cooler must contain an individual trip blank. Trip blanks will not be collected in conjunction with the air/vapor samples.

7.2.3 Field Duplicates

Field duplicates are two samples of the same matrix, which are collected, to the extent possible, from the same location at the same time using the same techniques. Field duplicates provide information on the precision of the sampling and analysis process. Field duplicates will be collected at a frequency of 1 duplicate per 20 sample media. Separate duplicate samples will be collected for the following media: surface and subsurface soil, sediment, surface water, groundwater, air, and soil vapor samples.

7.2.4 Temperature Blanks

Laboratory will use either an infrared instrument to measure the temperature of liquid samples or a temperature blank will be used to measure the temperature of liquid samples. If used, temperature blanks will be supplied by the analytical laboratory. If multiple coolers are necessary to store and transport aqueous samples, then each cooler must contain an individual temperature blank.

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8. PREVENTIVE MAINTENANCE

Periodic preventive maintenance is required for all sensitive field equipment. Instrument manuals will be kept on file for reference if equipment needs repair. The troubleshooting chapter of factory manuals may be used in assisting personnel in performing maintenance tasks. The frequency of preventive maintenance for field equipment is indicated in each operating instruction manual. Field equipment is checked by field personnel under the supervision of the Site Manager. It is the responsibility of EA's Technical Services Group's Site Manager to conduct preventive maintenance. A summary of a general preventative maintenance schedule is provided in Table 5.

Major instruments in the laboratory are covered by annual service contracts between the laboratory and the manufacturers. Under these agreements, regular preventive maintenance visits will be made by trained service personnel. Maintenance is documented and maintained in permanent records by the individual responsible for each instrument.

Laboratory management is responsible for preparation and implementation of the program, including verification of compliance. The laboratory preventive maintenance program includes the following:

- Listing of the instruments and equipment that are included in the program
- Frequency of maintenance considering manufacturer's recommendations and/or previous experience with equipment
- For each instrument in the program, a file is maintained for the following information:
  - List of spare parts maintained by the laboratory
  - External service contracts
  - Items to be checked and/or serviced during maintenance and directions for performing maintenance (if external service is not provided of if not stated in manufacturer's instrument manuals).

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9. QUALITY ASSURANCE PERFORMANCE AND SYSTEM AUDITS

Audits are systematic checks to determine the quality of operation of some activity or function in the field or laboratory. One field audit will be conducted to assure adherence to proper field and sampling procedures. Audits are of two types:

- ***Performance audits*** are independent safety and health, procedure, and/or sample checks made by a supervisor or auditor to arrive at a **quantitative** measure of the quality of the data produced by one section or the entire measurement process.

- ***System audits*** are onsite **qualitative** inspections and reviews of the QA system used by some part of or the entire measurement system. The audits are performed against the QAPP. A checklist is typically generated from the requirements and becomes the basis for the audit. The results of any deficiencies noted during the audit are summarized in an audit report.

Laboratory performance and system audits are performed by the QA staff to assess the effectiveness of the quality system. These internal audits are performed on a routine basis. Audits are also performed by certifying agencies. Audit reports and corrective actions are available to NYSDEC for review.

9.1 RESPONSIBILITY, AUTHORITY, AND TIMING

QA audits to be conducted for the project may include system, performance, and data audits. The Project QA Officer will keep a tentative schedule on record that details the number and types of audits.

9.2 FIELD AUDITS

Field performance audits will be conducted on an ongoing basis during a work assignment as field data are generated, reduced, and analyzed. Numerical manipulations, including manual calculations, will be documented. Records of numerical analyses will be legible, of reproduction quality, and sufficiently complete to permit logical reconstruction by a qualified individual other than the originator.

Indicators of the level of field performance include the analytical results of the blank and replicate samples. Each blank analysis will be considered an indirect audit of the effectiveness of measures taken in the field to ensure sample integrity (e.g., field decontamination procedures). The results of the field replicate analyses are an indirect audit of the ability of each field team to collect representative sample portions of each matrix type.

System audits of site activities will be accomplished by an inspection of all field site activities. During this audit, the auditor(s) will compare current field practices with standard procedures. The following elements will be evaluated during a field system audit:

- Activities conducted in accordance with the Work Plan
- Procedures and analyses conducted according to procedures outlined in the QAPP and Addendum
- Sample documentation
- Working order of instruments and equipment
- Level of QA conducted per each field team
- Contingency plans in case of equipment failure or other event preventing the planned activity from proceeding
- Decontamination procedures
- Level of efficiency with which each team conducts planned activities at one site and proceeds to the next
- Sample packaging and shipment.

After completion of the audit, any deficiencies will be discussed with the field staff and corrections identified. If any of these deficiencies could affect the integrity of the samples being collected, the auditor(s) will inform the field staff and corrections will be implemented immediately. The audit will be performed by the Project QA/QC Coordinator or the Site Manager.

9.3 LABORATORY PERFORMANCE AND SYSTEM AUDITS

The New York State Department of Health Environmental Laboratory Analytical Program CLP-certified laboratory that has satisfactorily completed performance audits and performance evaluation samples will be used for all sample analysis. The results of the most recent performance audits and performance evaluations will be made available upon request.

9.4 AUDIT PROCEDURES

Prior to an audit, the designated lead auditor prepares an audit checklist. During an audit and upon its completion, the auditor(s) will discuss the findings with the individuals audited and discuss and agree on corrective actions to be initiated. The auditor will then prepare and submit an audit report to the manager of the audited group and the Project Manager.

The manager of the audited group will then prepare and submit, to the Project QA Officer and the Project Manager, a plan for implementing the corrective action to be taken on non-conformances indicated in the audit report, the date by which such corrective action will be completed, and actions taken to prevent reoccurrence. If the corrective action has been completed, supporting documentation should be attached to the reply. The auditor will ascertain (by re-audit or other means) if appropriate and timely corrective action has been implemented.

Records of audits will be maintained in the project files.

9.5 DOCUMENTATION

To ensure that the previously defined scope of the individual audits is accomplished and that the audits follow established procedures, a checklist will be completed during each audit. The checklist will detail the activities to be executed and ensure that the auditing plan is accurate. Audit checklists will be prepared in advance and will be available for review. Following each system, performance, and data audit, the Quality Services Manager will prepare a report to document the findings of the specific audit.

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10. DATA REDUCTION, VALIDATION, AND REPORTING

10.1 DATA REDUCTION

10.1.1 Field and Technical Data Reduction

Field personnel will record field data in bound field logbooks and on standard forms. After checking the validity of the data in the field notes, the Site Manager or his/her designee will reduce the data to tabular form, when possible, by entering the data into data files. Where appropriate, the data files will be set up for direct input into a work assignment database. Subjective data will be filed as hard copies for later review by the Project Manager and incorporation into technical reports, as appropriate.

10.1.2 Laboratory Data Reduction

Data reduction is the process by which raw analytical data generated from laboratory instrument systems is converted into usable concentrations. The raw data, which may take the form of area counts, instrument responses, or observations, are processed by the laboratory and converted into concentrations expressed in the parts per million or parts per billion range. Raw data from these systems include compound identifications, concentrations, retention times, and data system print-outs. Raw data are usually reported in graphic form, bar graph form, or tabular form. The laboratory will follow SOPs consistent with the data handling requirements of the applicable methods.

The laboratory reporting limits for each site must be less than or equal to those stipulated by each work assignment. The reporting limits will be presented in site-specific QAPP Addendum.

10.2 VALIDATION

10.2.1 Field and Technical Data Validation

Validation of objective field and technical data will be performed at two different levels. The first level of data validation will be performed at the time of collection by following standard procedures and QC checks. The Site Manager, who will review the data to ensure that the correct codes and units have been included, will complete the second level of data validation. After data reduction into tables and arrays is complete, the Site Manager will review data sets for anomalous values. The Project Manager, who will review field reports for reasonableness and completeness, will validate subjective field and technical data. In addition, the Site Manager will conduct random checks of sampling and field conditions.

10.2.2 Analytical Data Validation

If a work assignment requires the validation of analytical data, data validation will be performed to establish the data quality for work assignment data that are to be considered when making project decisions. Laboratories will submit results that are supported by sufficient back-up data and QA/QC results to enable the reviewer to conclusively determine the quality of the data. The laboratory will review data prior to its release from the laboratory. Objectives for review are in accordance with the QA/QC objectives stated in each site-specific QAPP Addendum. The laboratory is required to evaluate their ability to meet these objectives. Outlying data will be flagged in accordance with laboratory SOPs and corrective action will be taken to rectify the problem.

A NYSDEC-approved qualified independent third-party data validator will review the data package to determine completeness and compliance in accordance with Attachment 1 (Scope of Services), Work Element V (Analytical QA/QC Activities) of the Standby Contract No. D009806 (**Appendix A**).

A narrative describing how the data did or did not meet the validation criteria is part of the data validation procedure. The validation assessment will describe the overall quality of the data and the data validation report will provide a written statement upon completion of the validation indicating whether or not the data are valid and usable and include a percent completeness value of usable data.

10.2.3 Data Usability Summary Report

A Data Usability Summary Report (DUSR) provides a thorough evaluation of analytical data without the third-party data validation. The primary objective of a DUSR is to determine whether or not the data, as presented, meet the site/project specific criteria for data quality and data use. If a work assignment requires a DUSR, the DUSR will be developed by a NYSDEC-approved qualified environmental scientist in accordance with Attachment 1 (Scope of Services), Work Element V (Analytical QA/QC Activities) of the Standby Contract No. D009806 (**Appendix A**).

10.3 REPORTING

10.3.1 Field Measurements

Any field analysis results will be recorded in a dedicated field logbook at the time the results are available. The results will be tabulated and plotted in the office as part of the reporting tasks. Reports also will consist of the field logbook, required standard forms, photographic documentation, and daily QC reports.

10.3.2 Analytical Data

The content of analytical laboratory data packages designed for work conducted during a work assignment are site-specific and will include the following information:

- Pertinent physical data presented in concise, easy to follow formats (i.e., sample, number, client, date of sample preparation, date analyzed, percent moisture, etc.)

- Reference for analytical methodology used

- General discussion including a description of sample types, tests performed, any problems encountered, and general comments

- Data from each discrete sample reported using cross-referencing between normal samples and QC samples and including all pertinent dates, information, and reporting limits

- Reported data to include associated QC samples such as blanks, spikes and spike duplicates, laboratory duplicates, field duplicates, and appropriate check standards

- EDD that meet the NYSDEC EDD requirements

- Copies of chain-of-custody sheets

- Raw data.

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11. CORRECTIVE ACTION PROCEDURE DESCRIPTION

11.1 OBJECTIVES

The objectives of the corrective action procedures presented below are to ensure that recognized errors in performance of sample and data acquisition lead to effective remedial measures and that those steps are documented to provide assurance that any data quality deficiencies are recognized in later interpretation and are not recurrent.

11.2 RATIONALE

Many times, corrective measures are undertaken in a timely and effective fashion but go undocumented. In other cases, corrective actions are of a complex nature and may require scheduled interactions between departmental groups. In either case, documentation in a formal or informal sense can reinforce the effectiveness and duration of the corrective measures taken.

11.3 CORRECTIVE ACTION METHODS

11.3.1 Immediate Corrective Actions

Immediate corrective actions are of a minor or routine nature such as correcting malfunctioning equipment, correction of data transcription errors, and other such activities routinely made in the field, laboratory, or office by technicians, analysts, and other project staff.

11.3.2 Long-Term Corrective Actions

Long-term corrective action will be used to identify and eliminate causes of non-conformances which are of a complex nature and that are formally reported between management groups.

11.3.2 Corrective Action Steps

For long-term corrective actions, steps comprising closed-loop corrective action systems are as follows:

- Define the problem
- Assign responsibility for investigating the problem
- Investigate and determine the cause of the problem
- Determine a corrective action to eliminate the problem
- Assign and accept responsibility for implementing the corrective action
- Verify that the corrective action has eliminated the problem.

Non-conformance events associated with analytical work are documented by the laboratories' Non-Conformance Records, which are reviewed and approved by the Quality Services Manager.

11.3.3 Audit-Based Non-Conformances

Following audits, corrective action is initiated by documenting the audit finding and recommended corrective action on an audit finding report.

11.4 CORRECTIVE ACTION REPORT REVIEW AND FILING

Immediate and long-term corrective actions require review to assure that, during the time of non-conformance, erroneous data were not generated or that, if possible, correct data were acquired instead. Such confirmation and review is the responsibility of the supervisor of the staff implementing the corrective action. Confirmation will be acknowledged by notation and dated signature on the affected data record or appropriate form or by memorandum to cognizant project management.

11.5 CORRECTIVE ACTION REPORTS TO MANAGEMENT

The Project QA Officer will provide project management with corrective action reports. The Project Manager is informed verbally of non-conformance events as soon as possible and decisions made after evaluation are documented in the Non-Conformance Records. A copy of each Non-Conformance Record is maintained in the report.

12. QUALITY ASSURANCE/QUALITY CONTROL REPORTS

Fundamental to the success of this QA/QC is the active participation of the Project Manager and the Project QA Officer. The Program QA Officer will be advised of work assignment activities and will participate in development, review, and operation of the project. Project management will be informed of QA activities through the receipt, review, and/or approval of:

- Project-specific QA project plans
- Corporate and project-specific QA/QC plans and procedures
- Corrective action notices
- Non-conformance records.

Periodic assessment of field and laboratory QA/QC activities and data accuracy, precision, and completeness will be conducted and reported by the laboratory. Items to be included in the QA reports are the summary of results for the performance or the system audit, and where applicable:

- Assessment of adherence to work scope and schedule for the audited task

- Assessment of the precision, accuracy, and completeness of sample batches and subsequent status of data processing and analyses

- Significant QC problems and the status of any ongoing corrective actions

- Changes to the site-specific Work Plan

- Status of implementation of the site-specific Work Plan.

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Tables

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Table 1-A Analytical Reporting Limits EPA Method 8260b
Volatile Organic Compounds: Water and Soil

Analyte	Reporting Limit	
	Groundwater (µg/L)	**Soil (ppm)**
1,1,1,2-Tetrachloroethane	0.5	0.005
1,1,1-Trichloroethane	0.5	0.005
1,1,2,2-Tetrachloroethane	0.5	0.005
1,1,2-Trichloroethane	0.5	0.005
1,1-Dichloroethane	0.5	0.005
1,1-Dichloroethene	0.5	0.005
1,1-Dichloropropene	0.5	0.005
1,2,3-Trichloropropane	0.04	0.005
1,2-Dibromo-3-chloropropane	0.04	0.005
1,2-Dibromoethane	0.5	0.005
1,2-Dichlorobenzene	0.5	0.005
1,2-Dichloroethane	0.5	0.005
1,2-Dichloropropane	0.5	0.005
1,3-Dichlorobenzene	0.5	0.005
1,3-Dichloropropane	0.5	0.005
1,4-Dichlorobenzene	0.5	0.005
2,2-Dichloropropane	0.5	0.005
2-Butanone	10	0.01
2-Chlorotoulene	0.5	0.005
2-Hexanone	10	0.01
4-Chlorotoulene	0.5	0.005
4-Methyl-2-pentanone	0.5	0.005
Acetone	10	0.02
Benzene	0.5	0.005
Bromobenzene	0.5	0.005
Bromochloromethene	0.5	0.01
Bromodichloromethane	0.5	0.005
Bromoform	1	0.005
Bromomethane	1	0.01
Carbon disulfide	0.5	0.005
Carbon tetrachloride	0.5	0.005
Chlorobenzene	0.5	0.005
Chloroethane	1	0.01
Chloroform	0.5	0.005
Chloromethane	1	0.01
cis-1,2-dichloroethene	0.5	0.005
cis-1,3-dichloropropene	0.5	0.005
Dibromochloromethane	0.5	0.005
Dibromomethane	0.5	0.005
Dichlorodifluoromethane	0.5	0.005
Ethylbenzene	0.5	0.005
Isopropylbenzene	0.5	0.005
Methlyene chloride	5	0.02
n-Propylbenzene	0.5	0.005
Styrene	0.5	0.005
Tetrachloroethene	0.5	0.005
Toluene	0.5	0.005
trans-1,2-dichloroethene	0.5	0.005
trans-1,3-dichloropropene	0.5	0.005
Trichloroethene	0.5	0.005
Vinyl chloride	0.5	0.01
Xylene (Total)	0.5	0.005

NOTES: µg/L = Microgram(s) per liter
ppm = Parts per million

Table 1-B Analytical Reporting Limits EPA Method 8270c Semi-Volatile Organic Compounds: Water and Soil

Analyte	Reporting Limit ppb	
	Groundwater (µg/L)	Soil (ppm)
1,4-Dioxane	0.2	0.067
1,2,4-Trichlorobenzene	5	0.067
1,2-Dichlorobenzene	3	0.33
1,3-Dichlorobenzene	3	0.33
1,4-Dichlorobenzene	3	0.33
2,2-oxybis(1-Chloropropane)	10	0.33
2,4,5-Trichlorophenol	10	0.33
2,4,6-Trichlorophenol	10	0.33
2,4-Dichlorophenol	5	0.33
2,4-Dimethylphenol	10	0.33
2,4-Dinitrophenol	10	0.67
2,4-Dinitrotoulene	5	0.33
2,6-Dinitrotoulene	5	0.33
2-Chloronapthalene	10	0.33
2-Chlorophenol	10	0.33
2-Methylnapthalene	10	0.33
2-Methylphenol	10	0.33
2-Nitroaniline	5	0.67
2-Nitrophenol	20	0.67
3,3-Dichlorobenzidine	5	0.67
3-Nitroaniline	5	0.67
4,6-Dinitro-2-methylphenol	20	0.67
4-Bromophenyl phenyl ether	10	0.33
4-Chloroaniline	5	0.33
4-Chlorophenyl phenyl ether	10	0.33
4-Cholor-3-methylphenol	10	0.33
4-Methylphenol	10	0.33
4-Nitroaniline	5	0.67
4-Nitrophenol	20	0.67
Acenaphthene	10	0.067
Acenaphthylene	10	0.067
Anthracene	10	0.067
Benzo(a)anthracene	0.002	0.33
Benzo(a)pyrene	10	0.067
Benzo(b)fluoranthene	0.002	0.067
Benzo(g,h,I)perylene	10	0.067
Benzo(k)fluoranthene	0.002	0.067
Bis(2-Chloroethoxy)methane	5	0.33
Bis(2-chloroethyl)ether	1	0.33
Bis(2-Ethylhexyl)phthalate	5	0.33
Butyl benzyl phthalate	10	0.33
Carbazole	10	0.067
Chrysene	0.002	0.067
Dibenz(a,h)anthracene	10	0.33
Dibenzofuran	10	0.33
Diethyl phthalate	10	0.33
Dimethyl phthalate	10	0.33
Di-n-butyl phthalate	10	0.33
Di-n-octyl phthalate	10	0.33
Fluoranthene	10	0.067

Table 1-B Analytical Reporting Limits EPA Method 8270c Semi-Volatile Organic Compounds: Water and Soil

Analyte	Reporting Limit ppb	
	Groundwater (µg/L)	**Soil (ppm)**
Fluorene	10	0.067
Hexachlorobenzene	0.04	0.33
Hexachlorobutadiene	0.5	0.33
Hexachlorocyclopentadiene	5	0.67
Hexachloroethane	5	0.33
Indeno[1,2,3-cd]pyrene	0.002	0.067
Isophorone	10	0.33
Naphthalene	10	0.067
N-Nitroso-di-n-propylamine	10	0.33
Pentachorophenol	1	0.67
Phenanthrene	10	0.067
Phenol	1	0.33
Pyrene	10	0.067

NOTES:
µg/L = Microgram(s) per liter
ppm = Parts per million

Table 1-C Analytical Reporting Limits EPA Method 6010 (Target Analyte List Metals) and EPA Method 7470 (water) or 7471 (soil) for Mercury: Water and Soil

Analyte	Reporting Limit ppm	
	Groundwater (µg/L)	**Soil (ppm)**
Aluminum	2,000	2.0
Antimony	3	0.6
Arsenic	25	0.1
Barium	1,000	2.0
Beryllium	3	0.05
Cadmium	5	0.05
Calcium	50,000	50.0
Chromium	50	0.1
Cobalt	500	0.5
Copper	200	0.25
Iron	300	1.0
Lead	25	0.03
Magnesium	35,000	50.0
Manganese	300	0.15
Mercury (Method 7470)	0.7	0.002
Nickel	100	0.4
Potassium	50,000	50.0
Selenium	10	0.05
Silver	50	0.1
Sodium	20,000	50.0
Thallium	0.5	0.1
Vanadium	500	0.5
Zinc	5,000	0.2

NOTES:
µg/L = Microgram(s) per liter
ppm = Parts per million

Table 1-D Analytical Reporting Limits EPA Method TO-15 Standard Volatile Organic Compounds: Air

Analyte	Reporting Limit (µg/m3)	
	Standard	Low Level
1,1,1-Trichloroethane	100	1
1,1,2,2-Tetrachloroethane	100	1
1,1,2-Trichloroethane	100	1
1,1,2-Trichlorotrifluoroethane	100	1
1,1-Dichloroethane	100	1
1,1-Dichloroethene	100	1
1,2,4-Trichlorobenzene	100	1
1,2,4-Trimethylbenzene	100	1
1,2-Dibromoethane	100	1
1,2-Dichlorobenzene	100	1
1,2-Dichloroethane	100	1
1,2-Dichloropropane	100	1
1,3,5-Trimethylbenzene	100	1
1,3-Butadiene	100	1
1,3-Dichlorobenzene	100	1
1,4-Dichlorobenzene	100	1
1,4-Dioxane	100	1
2,2,4-Trimethylpentane	100	1
2-Butanone	100	1
2-Hexanone	100	1
4-Ethyltoluene	100	1
4-Methyl-2-Pentanone	100	1
Acetone	100	1
Allyl Chloride	100	1
Benzene	100	1
Benzyl Chloride	100	1
Bromodichloromethane	100	1
Bromoethene	100	1
Bromoform	100	1
Bromomethane	100	1
Carbon Disulfide	100	1
Carbon Tetrachloride	5	0.25
Chlorobenzene	100	1
Chloroethane	100	1
Chloroform	100	1
Chloromethane	100	1
cis-1,2-Dichloroethene	100	1
cis-1,3-Dichloropropene	100	1
Cyclohexane	100	1
Dibromochloromethane	100	1
Dichlorodifluoromethane	100	1
Dichlorotetrafluoroethane	100	1
Ethyl Acetate	100	1
Ethyl Benzene	100	1
Heptane	100	1
Hexachloro-1,3-Butadiene	100	1
Hexane	100	1
Isopropyl Alcohol	100	1

Table 1-D Analytical Reporting Limits EPA Method TO-15 Standard Volatile Organic Compounds: Air

Analyte	Reporting Limit (µg/m3)	
	Standard	Low Level
m/p-Xylene	100	1
Methyl tert-Butyl Ether	100	1
Methylene Chloride	100	1
o-Xylene	100	1
Propene	100	1
Styrene	100	1
t-1,3-Dichloropropene	100	1
Tetrachloroethene	100	1
Tetrahydrofuran	100	1
Toluene	100	1
trans-1,2-Dichloroethene	100	1
Trichloroethene	5	0.25
Trichlorofluoromethane	100	1
Vinyl Acetate	100	1
Vinyl Chloride	100	1

NOTES:
µg/m3 = Microgram(s) per cubic meter

Table 1-E Analytical Reporting Limits EPA Method 8082 (Polychlorinated Biphenyl Compounds Water, Soil, and Sediment)

Constituent	**Reporting Limits[a]**	
	Water (µg/L)	**Soil, Sediment, Debris (ppm)**
Aroclor 1016	0.1	0.1
Aroclor 1221	0.1	0.1
Aroclor 1232	0.1	0.1
Aroclor 1242	0.1	0.1
Aroclor 1248	0.1	0.1
Aroclor 1254	0.1	0.1
Aroclor 1260	0.1	0.1
Total polychlorinated biphenyls (b)	0.7	0.1

(a) Reporting limits shown are based on NYSDEC 2000 Analytical Services Protocol contract required quantitation limits and are for guidance purposes.
(b) Reporting limits shown for total polychlorinated biphenyls are the summation of the reporting limits for each Aroclor listed.
NOTES:
µg/L = Microgram(s) per liter
ppm = Parts per million

Table 1-F Analytical Reporting Limits EPA Superfund Analytical Services/CLP Method OLM02.4 Volatile Organic Compounds: Water, Soil, and Sediment

Constituent	Reporting Limits[a] (ppb) Low Water	Low Soil, Sediment, Debris	Medium Soil, Sediment, Debris
Chloromethane	5	5	250
Bromomethane	5	5	250
Vinyl Chloride	5	5	250
Chloroethane	5	5	250
Methylene chloride	5	5	250
Acetone	5	5	250
Carbon disulfide	5	5	250
1,1-Dichloroethene	5	5	250
1,1-Dichloroethane	5	5	250
1,2-Dichloroethene (total)	5	5	250
Chloroform	5	5	250
1,2-Dichloroethane	5	5	250
2-Butanone	5	5	250
1,1,1-Trichloroethane	5	5	250
Carbon tetrachloride	5	5	250
Bromodichloromethane	5	5	250
1,2-Dichloropropane	5	5	250
cis-1,3Dichloropropene	5	5	250
Trichloroethene	5	5	250
Dibromochloromethane	5	5	250
1,1,2-Trichloroethane	5	5	250
Benzene	5	5	250
trans-1,3-Dichloropropene	5	5	250
Bromoform	5	5	250
4-Methyl-2-pentanone	5	5	250
2-Hexanone	5	5	250
Tetrachloroethene	5	5	250
Toluene	5	5	250
1,1,2,2-Tetrachloroethane	5	5	250
Chlorobenzene	5	5	250
Ethylbenzene	5	5	250
Styrene	5	5	250
Total Xylenes	5	5	250

(a) Reporting limits presented are EPA Superfund Analytical Services/Contract Laboratory Program (CLP) contract required quantitation limits. Quantitation limits for soil, sediment, and debris are based on dry-weight. Specific quantitation limits are highly matrix dependent.

NOTES:
ppb = Parts per billion

Table 1-G Analytical Reporting Limits EPA Superfund Analytical Services/CLP Method OLM02.4 Semi-volatile Organic Compounds: Water, Soil, and Sediment

Constituent	Reporting Limits[(a)] (ppb)		
	Water	Low Soil, Sediment, Debris	Medium Soil, Sediment, Debris
1,4-Dioxane	2	67	2,000
Phenol	5	170	5,000
bis(2-chloroethyl)ether	5	170	5,000
2-Chlorophenol	5	170	5,000
1,2-Dichlorobenzene	5	170	5,000
1,3-Dichlorobenzene	5	170	5,000
1,4-Dichlorobenzene	5	170	5,000
2-Methylphenol	5	170	5,000
2,2'-oxybis (1-chloropropane)	5	170	5,000
4-Methylphenol	5	170	5,000
N-Nitroso-di-n-propylamine	5	170	5,000
Hexachloroethane	5	170	5,000
Nitrobenzene	5	170	5,000
Isophorone	5	170	5,000
2-Nitrophenol	5	170	5,000
2,4-Dimethylphenol	5	170	5,000
bis(2-chloroethoxy)methane	5	170	5,000
2,4-Dichlorophenol	5	170	5,000
1,2,4-Trichlorobenzene	5	170	5,000
Naphthalene	5	170	5,000
4-Chloroaniline	5	170	5,000
Hexachlorobutadiene	5	170	5,000
4-Chloro-3-methylphenol	5	170	5,000
2-Methylnaphthalene	5	170	5,000
Hexachlorocyclopentadiene	5	170	5,000
2,4,6-Trichlorophenol	5	170	5,000
2,4,5-Trichlorophenol	10	330	10,000
2-Chloronaphthalene	5	170	5,000
2-Nitroaniline	10	330	10,000
Dimethylphthalate	5	170	5,000
Acenaphthylene	5	170	5,000
2,6-Dinitrotoluene	5	170	5,000
3-Nitroaniline	5	330	10,000
Acenaphthene	5	170	5,000

Table 1-G Analytical Reporting Limits EPA Superfund Analytical Services/CLP Method OLM02.4 Semi-volatile Organic Compounds: Water, Soil, and Sediment

Constituent	**Reporting Limits[(a)] ppb**		
	Water	**Low Soil, Sediment, Debris**	**Medium Soil, Sediment, Debris**
2,4-Dinitrophenol	10	330	10,000
4-Nitrophenol	10	330	10,000
Dibenzofuran	5	170	5,000
2,4-Dinitrotoluene	5	170	5,000
Diethylphthalate	5	170	5,000
4-Chlorophenyl phenyl ether	5	170	5,000
Fluorene	5	170	5,000
4-Nitroaniline	10	330	10,000
4,6-Dinitro-2-methylphenol	10	330	10,000
N-nitrosodiphenylamine	5	170	5,000
4-Bromophenyl phenyl ether	5	170	5,000
Hexachlorobenzene	5	170	5,000
Pentachlorophenol	10	330	10,000
Phenanthrene	5	170	5,000
Anthracene	5	170	5,000
Carbazole	5	170	5,000
Di-n-butyl phthalate	5	170	5,000
Fluoranthene	5	170	5,000
Pyrene	5	170	5,000
Butyl benzyl phthalate	5	170	5,000
3,3’-Dichlorobenzidine	5	170	5,000
Benz(a)anthracene	5	170	5,000
Chrysene	5	170	5,000
bis(2-Ethylhexyl)phthalate	5	170	5,000
Benzo(b)fluoranthene	5	170	5,000
Benzo(k)fluoranthene	5	170	5,000
Benzo(a)pyrene	5	170	5,000
Indeno(1,2,3-cd)pyrene	5	170	5,000
Dibenzo(a,h)anthracene	5	170	5,000
Benzo(g,h,i)perylene	5	170	5,000

(a) Reporting limits presented are EPA Superfund Analytical Services/Contract Laboratory Program (CLP) contract required quantitation limits. Quantitation limits for soil, sediment, and debris are based on dry-weight. Specific quantitation limits are highly matrix dependent.

NOTES:
ppb = Parts per billion

Table 1-H Analytical Reporting Limits EPA Superfund Analytical Services/CLP Method ISM02.4 Metals: Water, Soil, and Sediment

Constituent	Reporting Limits[(a)]	
	Water (ppb)	**Soil, Sediment, Debris (ppm)**
Aluminum	200	20
Antimony	60	6
Arsenic	10	1
Barium	200	20
Beryllium	5	0.5
Cadmium	5	0.5
Calcium	5,000	500
Chromium	10	1
Cobalt	50	5
Copper	25	2.5
Iron	100	10
Lead	10	1
Magnesium	5,000	500
Manganese	15	1.5
Mercury	0.2	0.1
Nickel	40	4
Potassium	5,000	500
Selenium	35	3.5
Silver	10	1
Sodium	5,000	500
Thallium	25	2.5
Vanadium	50	5
Zinc	60	6
Cyanide	10	2.5

(a) Reporting limits presented are EPA Superfund Analytical Services/Contract Laboratory Program (CLP) contract required detection limits for inorganics analyzed with ICP-AES (Inductively Coupled Plasma-Atomic Emission Spectroscopy.

NOTES:
ppb = Parts per billion
ppm = Parts per million

Table 1-I Analytical Reporting Limits EPA Clean Water Method 537.1 Per- and Polyfluoroalkyl Substances (PFAS)

Constituent[(a)]	Reporting Limits	
	Water (ng/L)	Soil, Sediment, Debris (µg/kg)
Perfluorooctanesulfonic acid (PFOS)	2	1
Perfluorooctanoic acid (PFOA)	2	1
Perfluorobutanoic acid (PFBA)	2	1
Perfluoropentanoic acid (PFPeA)	2	1
Perfluorohexanoic acid (PFHxA)	2	1
Perfluorobutanesulfonic acid (PFBS)	2	1
Perfluoroheptanoic acid (PFHpA)	2	1
Perfluorohexanesulfonic acid (PFHxS)	2	1
Perfluorononanoic acid (PFNA)	2	1
Perfluorodecanoic acid (PFDA)	2	1
Perfluoroundecanoic acid (PFUdA or PFUnA)	2	1
Perfluorodecanesulfonic acid (PFDS)	2	1
Perfluorododecanoic acid (PFDoA)	2	1
Perfluorotridecanoic acid (PFTrDA)	2	1
Perfluorotetradecanoic acid (PFTeDA)	2	1
Perfluorohexadecanoic acid (PFHxDA)	2	1
Perfluorooctadecanoic acid (PFODA)	2	1
N-methyl perfluorooctane sulfonamidoacetic acid (N-MeFOSAA)	2	1
N-ethyl perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	2	1
Propanoic acid, 2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) (PFPrOPrA*)	2	1
Dodecafluoro-3H-4,8-dioxanonanoate (NaDONA*)	2	1

(a) PFAS Analyte List (21 compounds). The site-specific QAPP should list all PFAS compounds of interest.

NOTES:

ng/L = Nanogram(s) per liter

µg/kg = Microgram(s) per liter

Table 1-J Analytical Reporting Limits ISO Method 25101 Per- and Polyfluoroalkyl Substances (PFAS)

Constituent	Reporting Limits
	Drinking Water (ng/L)
Perfluorooctanesulfonic acid (PFOS)	2
Perfluorooctanoic acid (PFOA)	2
Perfluorononanoic acid (PFNA)	2
Perfluorobutanesulfonic acid (PFBS)	2
Perfluoroheptanoic acid (PFHpA)	2
Perfluorohexanesulfonic acid (PFHxS)	2

NOTES:
ng/L = Nanogram(s) per liter

Table 2 Summary of Periodic Laboratory Calibration Requirements

Instrument	Calibration Frequency	Acceptance Limits	Corrective Actions
Analytical Balances	Daily: Sensitivity (with a Class P weight)	0.001 g	Adjust sensitivity
	Monthly: Checked with Class S weights	Standard deviation of <0.1 mg	Service balance
	Annually: Calibrated by outside vendor against certified Class S weights	Standard deviation of <0.1 mg	Service balance
Thermometers	Annually: Calibrated against certified National Institute of Standards and Technology thermometers by outside vendor	± 0.5°C	Tag and remove from service
Automatic Pipettors	Quarterly: Gravimetric check	High volume (>100 mL): ≤1.0% relative error as relative standard deviation	Service or replace
		Low volume (<100 mL): ≤2.0% relative error as relative standard deviation	

Table 3 Field Instrumentation Calibration Frequency

Instrument	Frequency of Calibration Check	Calibration Standard
pH Meter	Prior to use – daily	Commercially prepared pH buffer solutions (4.01, 7.00, 10.00)
Conductivity Meter	Prior to use – daily	Commercially prepared saline solution (12.9 mS/cm)
Water Level Meter	Prior to initiating field work	100-ft engineer’s tape
Dissolved Oxygen Meter	Per sampling event	Saturation
Photoionization Detector	Prior to use – daily	100 ppm isobutylene
Turbidity	Prior to use – daily	10 NTU, 200 NTU

NOTES:
ft = Foot (feet)
mS/cm = MilliSiemens(s) per centimeter
NTU = Nephelometric turbidity units
ppm = Part(s) per million

Table 4 Field Measurement Quality Control Objectives

Field Parameter	Precision[(a)]	Accuracy
Water Temperature	±1°C	±1°C (instrument capability)
pH	±1 pH Standard Unit	±1 pH Standard Unit (instrument capability)
Conductivity	±1 mS/cm	±5% standard
Dissolved Oxygen	±0.02 mg/L	±5%
Turbidity	±1.0 Nephelometric turbidity units	±2% standard
Water Level	±0.1 ft	±0.01 ft

(a) Precision units presented in applicable significant figures.
% = Percent
°C = Degrees Celsius
ft = Foot (feet)
mS/cm = milliSiemen(s) per centimeter
mg/L = Milligram(s) per liter

Table 5 Preventive Maintenance Summary

Maintenance	Frequency
Conductivity, pH, Dissolved Oxygen Meters	
Store in protective casing	D
Inspect equipment after use	D
Clean probes	D
Keep logbook in instrument	D
Have replacement meter available	D
Replace probes	X
Return to manufacturer for service	X
Calibration	D
Turbidity Meter	
Store in protective casing	D
Inspect equipment after use	D
Clean sample cells	D
Clean lens	M or X
Check and recharge batteries	D
Keep logbook in instrument	D
Have replacement meter available	D
Return to manufacturer for service	X
Calibration	D
Thermometer	
Store in protective casing	D
Inspect equipment after use	D
Have replacement thermometer available	D
Water Level Meter	
Store in protective covering	D
Inspect equipment after use	D
Check indicators/batteries	D
Keep logbook on instrument	D
Have replacement meter available	X
Photoionization Detector	
Store in protective casing	D
Inspect equipment after use	D
Check and recharge batteries	D
Clean ultraviolet lamp and ion chamber	M or X
Keep logbook in instrument	D
Have replacement meter available	D
Return to manufacturer for service	X
Calibration	D

NOTES:

D = Daily
M = Monthly
X = Operator’s discretion

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Appendix A

Data Usability Summary Report Guidelines

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completed and meets the requirements of the Construction Contract. Once this inspection has been performed, the Consultant shall deliver to the Department a written notice with regard to the disposition of the project. If the Consultant determined that the project has been satisfactorily completes according to the Construction Contract plans and specifications, certification to this fact shall be made to the Department by the Consultant.

- All files, reports, and other documentation are to be turned over to the Department at the completion of the project, including one copy in an electronic format that complies with the Department's Electronic Document Standards or as otherwise directed by the Department. All data generated under the Contract shall be submitted in an electronic data deliverable (EDD) that complies with the Department's Electronic Data Warehouse Standards or as otherwise directed by the Department.

Task VII. Site Management Plans

In many instances there is a requirement for some degree of regular operation and maintenance activity associated with completed remedial action projects. A Site Management Plan, prepared in accordance with Section 6.2 of DER-10, is needed to provide detailed description, schedules, budgets, HASP, and reporting/recordkeeping requirements (e.g., OM&M and the environmental easement) for the operation and maintenance of a remedial site.

Task VIII. Construction Certification Report

The Consultant shall prepare a construction certificate report acceptable to the Department. The report shall describe all variations from the Construction Contract documents, confirmatory soil sampling results, final qualities, aerial and vertical survey of the extent of the work including the location of confirmatory samples, and summary record drawings. The report shall include a New York State Licensed P.E. certification that work was completed in accordance with the approved design.

Task IX. Final Remediation Report

At the request of the Department, prepare a site-wide final remediation report, in accordance with Section 5.8 of DER-10, acceptable to the Department. The report shall describe all previous components of remedial work performed at the site. It shall describe the overall implementation of the remedy as described in the Record of Decision (ROD). It shall incorporate by reference all previous construction certification reports and include drawings that show any and all required engineering controls to maintain the integrity of the remedy. The report shall include a New York State Licensed P.E. certification that work was completed in accordance with the ROD.

Work Element V – Analytical Quality Assurance/Quality Control Activities (QA/QC)

General: This work element may include development of Quality Assurance Project Plans, oversight of independent third-party validation, and/or data usability assessments by the Consultant's Quality Assurance Officer (QAO).

Subtask A: Data Validation Scope of Work

Data Validation is the systemic process by which the data quality is determined with respect to data quality criteria that are defined in project and laboratory quality control programs and in the referenced analytical methods. The data validation process consists of an assessment of the acceptability or validity of project data with respect to stated project goals and requirements for data usability. Data validation consists of editing, screening, checking, auditing, certification, review, and interpretation. The purpose of data validation is to define and document analytical data quality and determine if the data quality is sufficient for the intended use(s) of the data. In accordance with DEC requirements, all project data must be of known and acceptable quality. Data validation is performed to establish the data quality for all data which are to be considered when making project decisions. Laboratories will be required to submit results which are supported by sufficient back-up data and QA/QC results to enable the reviewer to conclusively determine the quality of data.

Subtask B: Duties and Qualifications of a Data Validator

- The following qualifications and requirements are established for the Consultant or subcontractor to the Consultant or retained by a responsible party functioning under the guidance and direction of an order of consent. The data validator shall be independent of the laboratory generating the data.
- The data validator shall demonstrate that all staff members involved in the date validation process have:
  - A Bachelor’s degree in chemistry or natural sciences
  - One (1) year experience in implementation and application of the protocol(s) used in generating the date for which they are responsible, the successful completion of an EPA data validation training course or equivalent, as evidenced by a certificate of completion, may be substituted for the analytical experience requirement
  - A minimum of one (1) year experience evaluating data packages for contract and protocol compliance.
- Consistent with the Division of Environmental Remediation’s Quality Assurance Program Plan (QAPP), all laboratory data generated in support of any investigation, remediation, or monitoring activity carried out under the Division’s program responsibility shall be developed under the administrative and operational control of a QAPP. To this end, the QAPP shall become an integral part of the Project and those portions that pertain to the development and production of analytical data shall define the task of the laboratory charged with developing and producing this data. The site-specific variances to the QAPP shall include the following:
  - The number and types of sampling to be analyzed
  - Sampling holding times to be observed and the time from which these holding times shall be measured
  - Site specific limits of concern for each of the analytes listed in each of the matrices to be sampled

  - The matrix specific method detection limits that must be obtained for each of the analytes and matrices listed (this value should be in the neighborhood of 1/5 the site-specific limit of concern)
  - Analytical protocols that shall be employed including any special handling or required cleanup procedures
  - The frequency and types of any required quality control samples (e.g., trip blanks, rise blanks, replicates, matrix samples, matrix spike duplicates, and matrix spike blanks)
  - Identification of any critical samples and any special analytical treatment that may be required
  - Required deliverables and supporting documentation where these differ from or are not part of the required analytical protocols
  - Library search of the top ten (1) Tentatively Identified Compounds.
- In order to facilitate the date validation process, copies of the QAPP (addressing the above referenced points of information), together with the project required deliverables and supporting documentation, and laboratory subcontract shall be submitted to the Data Validator contracted to carry out the data validation portion of the Contract.

Task I. Completeness

- The Data Validator (DV) shall review the data package to determine completeness. A completed data package will consist of the following components:
  - Chain of Custody forms for all samples
  - The case narrative(s) including all sample/analysis summary forms
  - QA/QC summaries including all supporting documentation
  - Instrument and method of performance data, including equipment and process blanks
  - Documentation showing the laboratory’s ability to attain the Contract specific method detection limits for all target analytes in all required matrices
  - All data report forms including examples of the calculations used in determining final concentrations
  - All raw data used in the identification and quantitation of the Contract specific target limits.
- All deficiencies in the requirement for completeness shall be reported to the Consultant immediately. The laboratory shall be contacted by the Consultant’s QAO and shall be given ten (10) days to produce the documentation necessary to remove the deficiencies.

Task II. Compliance

- The DV shall review the data package to determine compliance with those portions that pertain to the production of laboratory data. Compliance is defined by the following criteria:
  - The date package is complete as defined in Task I above

  - The date has been produced and reported in a manner consistent with the requirements of the QAPP and the laboratory subcontract
  - All protocol required QA/QC criteria have been met
  - All instrument tuning and calibration requirements have been met for the time frame during which the analyses were completed
  - All protocol requiring initial and continuing calibration data is present and documented
  - All data reporting forms are complete for all samples submitted (including all sample dilution/concentration factors and all premeasurement sample cleanup procedures)
  - All problems encountered during the analytical process have been reported in the case narrative along with any and all corrective actions taken by the laboratory.
- This task requires that the DV conduct a detailed comparison of the reported data with the raw data submitted as part of the supporting documentation package. It is the responsibility of the DV to determine that the reported data can be completely substantiated by applying protocol defined procedures for the identification and quantification of the individual analytes. To assist the DV in this determination the following documents are recommended, however the EPA Functional Guidelines will be used for format only. The specific requirements noted in the project QAPP are prerequisite (e.g., holding times or specific analytical project needs), to those noted in the Functional Guidelines:
  - The particular protocol(s) under which the date was generated (e.g., EPA SW-845; EPA Series 500 Protocols)
  - Data validation guidance documents such as:
    - "National Functional Guidelines for Inorganic Superfund Methods Data Review (ISM02.4)" at https://www.epa.gov/clp/national-functional-guidelines-inorganic-superfund-methods-data-review-ism024
    - Table 2: Region 2 RCRA and CERCLA Field and Data Validation Standard Operating Procedures (SOPs) at https://www.epa.gov/quality/region-2-quality-assurance-guidance-and-standard-operating-procedures
  - NOTE: These documents undergo periodic revisions, the most current documents and guidance apply.
- The DV shall submit a final report covering the results of the data review process. This report shall be submitted to the Department Project Manager or his/her designee and shall include the following:
  - A general assessment of the data packages as determined by the accomplishment of Tasks I-II above
  - Detailed description of any and all deviations from required protocols, including references to the portion of the protocols involved in the alleged deviations
  - Any and all failures in the DV's attempt to reconcile the reported data with the raw data from which it was derived, including telephone logs should be included in the validation report

- A detailed assessment by the DV of the degree the data has been compromised by any deviations from the protocol, QA/QC breakdowns, lack of analytical control, etc., that occurred during the analytical process
- The report shall include, a copy of the laboratory's case narrative including the Department required sample analysis summary sheets, as an attachment
- The report shall include an overall appraisal of the data package
- The validation report shall include a chart presented in spreadsheet format, consisting of site name, sample numbers, data submitted to the laboratory, year and number of the analytical protocol used, matrix, fractions analyzed (e.g., volatiles, semi-volatiles, pesticides/PCBs, Metals, CN). Space should be provided for notations of non-compliance and a column for an explanation of such violation (see following form):

Group #	Date	Protocol No.	Sample No.	Matrix	VOA Compliancy	Pest/PCB Compliancy	BCN Compliancy	Metals Compliancy	CN	Totals	NonCompliance

Task III. Data Usability Summary Report (DUSR) Scope of Work

- The Data Usability Summary Report (DUSR) provides a thorough evaluation of analytical data without the costly and time-consuming process of third party validation. The primary objective of a DUSR is to determine whether the data, as presented, meets the site-specific criteria for data quality and data use.
- The development of the DUSR must be performed by an experienced environmental scientist, such as the project QAO, fully capable of conducting a full data validation. Furthermore, the DUSR is developed from Department approved guidelines or a USEPA Contract Laboratory Protocol (CLP) deliverables package.
- The DUSR and the data deliverables package will be reviewed by quality assurance staff in the Department's Bureau of Technical Support. In most cases, this review will result in agreement or minor differences that can be reconciled. If data validation is found to be necessary (e.g., pending litigation) this can be carried out at a later date on the same package used for the development of the DUSR.

The environmental scientist preparing the DUSR must hold a bachelor's degree in relevant natural or physical science or field of engineering and must submit a resume documenting experience in environmental sampling, analysis, and data review.

Task IV. Preparation of the DUSR

- The DUSR is developed by reviewing and evaluating the analytical data package. During the course of this review the following questions must be asked and answered:
    - Is the data package complete as defined under the requirements for the most current version of Department approved guidelines or USEPA CLP deliverables?
    - Have all holding times been met?
    - Do all the QC data: (blanks, instrument tunings, calibration standards, calibration verifications, surrogate recoveries, spike recoveries, replicate analyses, laboratory controls, and sample data) fall within the protocol required limits and specifications?
    - Have all the data been generated using established and agrees upon analytical protocols?
    - Does an evaluation of the raw data conform the results provided in the data summary sheets and quality control verification forms?
- Evaluation of Matrix Spike Blanks (MSB) data – If the MSB recovery is less than the Department criteria the positive results should be qualified as J, estimated biased low. If the MSB recovery is less than the Department criteria but greater than ten percent (10%), the nondetects should be qualified J, biased low. If the MSB recovery is less than ten percent (10%), the nondetect data must be rejected.
- Any QC exceedances must be numerically specified in the DUSR and the corresponding QC summary sheet from the data package should be attached to the DUSR.
- All data that would be rejected by the EPA Region 2 Data Validation Guidelines must also be rejected in the DUSR.
- Once the data package has been reviewed and the above questions answered the DUSR describes the samples and analytical parameters. Data deficiencies, analytical protocol deviations and quality control problems are identified and their effect on the data discussed. The DUSR shall also include recommendations on resampling/reanalysis. All data quantifications must be documented following the most current version of the Department approved guidelines or the USEPA Region 2 Validation Guidelines.

Work Element VI – Site Response Activities/Interim Remedial Measures (IRM)

General: This work element may include short term response activities to alleviate environmental or health risk at a site. Interim remedial measures such as excavation, drum removals, short term operation of facilities, and other activities may also be included.

- Conditions at sites with hazardous waste, hazardous substance or petroleum contamination often require immediate response actions to protect human health and the environment. The Consultant is expected, whether directly or through subcontract, to perform the following response activities/interim remedial measures (IRMs):