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SUPPLEMENTAL REMEDIAL INVESTIGATION AND FEASIBILITY STUDY WORK PLAN

**HONDA OF FIFE
FIFE, WASHINGTON**

DRAFT

Supplemental Remedial Investigation and Feasibility Study Work Plan
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ACRONYMS AND ABBREVIATIONS

µg/L:	micrograms per liter
AES:	Associated Environmental Services
APH:	Aliphatic and Aromatic Petroleum Hydrocarbons
BTEX:	Benzene, Toluene, Ethylbenzene, and Total Xylenes
CUL:	Method A Cleanup Levels
cy:	cubic yards
Ecology:	Washington State Department of Ecology
EDB:	ethylene dibromide
EDC:	1,2 dichloroethane
EPA:	United States Environmental Protection Agency
ETBE:	ethyl tertiary-butyl ether
ft bgs:	feet below ground surface
GPR:	Ground-Penetrating Radar
GRO:	Gasoline-Range Organics
Honda:	Honda of Fife
IDW:	Investigation Derived Waste
mg/kg:	milligrams per kilogram
MTBE:	methyl tert-butyl ether
MTCA:	Model Toxics Control Act
NFA:	No Further Action
PCS:	Petroleum Contaminated Soil
PID:	Photoionization Detector
Ramboll:	Ramboll US Consulting
SEC:	Sound Environmental Consulting
TAME:	tertiary-amyl methyl ether
TBA:	tertiary-butyl alcohol
TPCHD:	Tacoma-Pierce County Health Department
TPH:	Total Petroleum Hydrocarbons
UST:	Underground Storage Tank
VOC:	Volatile Organic Compound

1. INTRODUCTION

Ramboll US Corporation (Ramboll) has prepared this Supplemental Remedial Investigation Work Plan for the Honda of Fife (Honda) property located at 4301 20th Street East in Fife, Washington (“the Site”; Figure 1) to support completion of site remediation and a future request for a “No Further Action” (NFA) designation from Washington State Department of Ecology (Ecology) and Tacoma Pierce County Health Department (TPCHD). The Site is identified by Ecology as an “Independent Action” with Cleanup Site ID #10299, Facility Site ID #72856623, Underground Storage Tank (UST) Site ID #10218, and by TPCHD as Permit #RO0000170.

Multiple soil and groundwater investigations have been conducted at the Site since at least 1998, and based on those investigations, petroleum hydrocarbons (including gasoline range hydrocarbons and associated volatile organic compounds [VOCs] such as benzene) have been identified in soil and groundwater beneath the Site at concentrations exceeding Washington State Department of Ecology (Ecology) Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs).

This work plan provides a summary of the site setting and background (Section 2) and a scope of work for conducting additional investigations at the Site in a phased manner to address data gaps regarding soil, groundwater, and soil vapor conditions, followed by evaluation of potential remedial alternatives which may lead to obtaining regulatory closure (Sections 3 through 6). Appendices include the most recent report documenting a limited passive soil vapor survey (Appendix A), a collection of historical boring logs and monitoring well construction logs (Appendix B), and a selection of Ramboll’s field guidance documents and safe work practices documents relevant to the field program (Appendices C and D respectively).

2. SITE SETTING AND BACKGROUND

The approximately 3.5-acre Site is in a mixed commercial and residential area of Fife, Washington (Pierce County), southeast of downtown Tacoma, and adjacent to Interstate Highway 5 (Figure 1). The Port of Tacoma/Commencement Bay are located approximately 1-mile northwest at their nearest point to the Site. The nearest surface water is Wapato Creek, which flows northward towards Commencement Bay, and passes within 50 feet of the southwest corner of the Site. Approximately 3,200 feet southwest of the Site, the Puyallup River flows northwest towards Commencement Bay. The Site is in use an active car dealership spanning two parcels, with a dealership structure on the eastern parcel containing sales offices and service garages, and the western parcel predominantly paved as a parking lot for storage and sales of automobiles (Figure 2).

2.1 Geology and Hydrogeology

The primary surface soils at this site, as mapped by the Soil Survey of Pierce County Area, U.S. Department of Agriculture, are Sultan silt loam, a moderately well-drained soil located on the bottomlands of the Puyallup and White Rivers. Soil permeability is moderately slow, with a high available water capacity.

The subsurface geology in the Site vicinity consists of loose, stratified fine- and coarse-grained sediments consistent with deposition in terminal river valleys. The Site is located within the Lower Puyallup River Valley, which serves as a discharge zone for ground water from the Puyallup River Valley and neighboring upland areas¹. The regional depth to groundwater generally ranges from 0 to 30 feet below ground surface (ft bgs) and may be influenced by tides and seasonal fluctuations.

Previous investigations on the Site by others, including the completion of at least 21 temporary soil borings and the installation of nine monitoring wells, have identified gravelly sand (imported fill material) from the ground surface to depths ranging from approximately two to six feet below ground surface (ft bgs), overlying silty sands with various layers of clayey silts, gravels, and organic debris to the maximum depth of exploration (18 ft bgs in 2019). Boring logs from previous investigations are provided in Appendix B. Historical soil boring locations and monitoring well locations are illustrated on Figures 3 and 4.

Groundwater has reportedly been encountered between approximately five to ten ft bgs depending on the time of year; groundwater levels are typically highest (shallowest) in spring and summer, and lowest (deepest) in the fall and winter. Historical measurements of groundwater elevations are presented in Table 1.

2.2 Chronology of Previous Assessments

Petroleum contamination is present in soil and groundwater at the Site because of a release from a former gasoline UST that was removed from the Site by 1998. In addition to removal of the former UST, soils surrounding the UST were removed in 1998 and 2000. Based on records in Ecology's cleanup site database, numerous reports were submitted to Ecology related to the leaking UST at the Site between 1999 and 2019. Ramboll completed a Limited Passive Soil Vapor Survey in November 2022. These reports are summarized below.

¹ United States Geological Survey, 1999. *Ground-Water Hydrology of the Tacoma-Puyallup Area, Pierce County, Washington*. Water-Resources Investigations Report 99-4013. <https://pubs.er.usgs.gov/publication/wri994013>

2.2.1 1998 – UST Closure and Site Assessment (Associated Environmental Services; Sound Environmental Consulting)

In 1998, Honda of Fife retained Associated Environmental Services (AES) to provide construction contractor services for the removal of a fueling system including a 2,000-gallon gasoline UST, a 500-gallon waste oil UST, a fuel dispenser, and associated fuel and vent lines. The fueling system and waste oil UST were installed in 1985 and operated continuously until 1997 when the system was deactivated due to a suspected leak. On September 14, 1998, AES contracted Sound Environmental Consulting (SEC) to complete a site assessment following decommissioning of the USTs and associated fueling system.

During excavation in the vicinity of the gasoline UST, fuel odors were reportedly observed in soil surrounding the tank, and the excavation was expanded to approximately 20 ft wide by 28 ft long, to a depth of up to 10 ft bgs. Groundwater was encountered at approximately 8 ft bgs during excavation activities, and a sheen was reportedly observed on the surface of water infiltrating the excavation.

The waste oil UST was decommissioned by removal from an excavation measuring approximately 7 ft wide by 10 ft long with a depth of about 10 ft bgs. No signs of soil contamination were observed during removal of the waste oil UST.

A total of 100 cubic yards (cy) of soil were reportedly excavated from the site, and approximately 50 cy of the exported soil were determined to be contaminated with petroleum hydrocarbons ("oil") in excess of the applicable CUL (200 ppm) at the time.

A total of 21 soil samples were collected from the UST removal excavations and soil stockpiles. Detected concentrations of gasoline (analyzed via Ecology Method NWTPH-Gx) in samples from the vicinity of the gasoline UST excavation ranged from 26 milligrams per kilogram (mg/kg) to 10,746 mg/kg. Detected concentrations of Total Petroleum Hydrocarbons (TPH; analyzed via method TPH-418.1) in soils samples taken from the vicinity of the waste oil UST ranged from 24 to 8,100 mg/kg. Both excavations were backfilled with clean fill. Confirmation sampling results indicated that petroleum contaminated soils were left in place east of the former gasoline UST due to proximity to the adjacent building foundation.

2.2.2 2000 – Remedial Activities (Saltbush Environmental Services)

In November of 1999, Saltbush Environmental Services (Saltbush) installed three monitoring wells (MW-1 to MW-3) in the vicinity of the former gasoline UST, south, west, and east of the backfilled excavation. Groundwater samples were analyzed for gasoline-range TPH (TPH-GRO), and benzene, toluene, ethylbenzene, and xylenes (BTEX). Subsequent groundwater sampling detected benzene at a concentration of 1,600 micrograms per liter (µg/L), toluene at 380 µg/L, ethylbenzene at 550 µg/L, xylenes at 1,300 µg/L, and gasoline at 9,700 µg/L in MW-3, located south-adjacent to the gasoline UST excavation area. Additionally, a soil boring was completed in the footprint of the former waste oil UST excavation, and analysis of soil samples from the boring detected oil-range hydrocarbons at a concentration of 7,800 mg/kg within the former excavation. Saltbush recommended additional delineation of latent contamination in the vicinity of both former USTs and quarterly groundwater sampling.

In March of 2000, Saltbush completed 10 soil borings in the vicinity of the former gasoline UST (B1 through B10), and soil samples were analyzed for TPH-GRO, and BTEX. Analytical results indicated the presence of concentrations of TPH-GRO and BTEX in excess of the

respective CULs in the vicinity of the former gasoline UST and potentially extending under the existing structure.

In May of 2000, the overhead canopy and concrete pad covering the former gasoline UST excavation area were demolished in preparation for remedial excavation. Saltbush oversaw the completion of an approximately 78 ft by 22 ft excavation reaching an average depth of 6 ft bgs. Field screening of excavated soils noted that soils ranging from 4.5 ft bgs to the surface of groundwater (6 ft bgs) were contaminated. This depth range was noted to span the "smear zone" of annual groundwater elevation change. A total of 26 confirmation samples (HF-1 through HF-26) were collected from the second gasoline UST area excavation and analyzed for TPH-GRO and BTEX. Analytical results showed that contamination remained in Site soils. Saltbush reported that a decision was made in concurrence with the Tacoma-Pierce County Health Department to leave remaining contaminated soils in place to protect a sewer pipe discovered in the vicinity of the excavation. Saltbush estimated approximated 20 cubic yards of petroleum-contaminated soil (PCS) were left in place below the sewer line, and that concentrations of gasoline and BTEX in groundwater and soil would naturally attenuate over time.

Following backfill of the second gasoline UST area excavation, a second excavation of the waste oil UST area was completed, reaching 12.7 ft by 9 ft with an approximate depth of 8.5 ft bgs. Five confirmation samples (HF-1A through HF-5A) were collected from this second waste oil UST excavation and analyzed for heavy oil. No heavy oil was detected above laboratory reporting limits in these confirmation samples.

Saltbush recommended quarterly groundwater sampling to monitor the natural attenuation of petroleum contamination in groundwater.

2.2.3 2000 to 2007 – Quarterly Groundwater Monitoring (Saltbush; Robinson Noble & Saltbush)

From November of 1999 through January of 2007, Saltbush (becoming Robinson, Noble & Saltbush Inc., in 2003) completed quarterly groundwater monitoring events at the Site. During each event, groundwater samples were collected from each of the three monitoring wells installed in 1999, and the samples were analyzed for TPH-GRO, BTEX, and total lead. In 2004, groundwater sampling frequency was reduced to semi-annual events. After 21 events completed over 7 years, no discernable pattern of natural attenuation was established, and no dominant groundwater flow direction was observed. Benzene and gasoline (TPH-GRO) continued to be detected in MW-3 at concentrations above the respective CULs.

2.2.4 2006 – Shop Area Limited Phase II Subsurface Investigation (Robinson, Noble & Saltbush)

In July of 2006, Robinson, Noble & Saltbush completed seven soil borings to a depth of 8 ft bgs within the interior of the maintenance shop of the Site, east-adjacent to the former gasoline UST (B1, B3, B4, B5, B6, and B7) and one boring outside the shop area, south of MW-3 (B10). The borings were completed to delineate the extent of contamination underneath the Honda of Fife building. Soil samples were taken from each boring and submitted for analysis of gasoline by NWTPH-Gx and BTEX by EPA Method 8021B. Analytical results reported detected concentrations of benzene exceeding the CUL in two borings (B6 and B7). No other contaminants of concern were detected above the respective CULs.

Based on the results of the limited Phase II and historical results, Saltbush concluded that contamination was likely to exist north of MW-3 and boring B-6, under the Honda of Fife structure.

After the conclusion of the Limited Phase II, groundwater monitoring was discontinued following the final reported event in January of 2007.

2.2.5 2018 – Additional Remedial Investigation and Cleanup Action (Robinson Noble)

According to a Remedial Investigation and Cleanup Action Plan Letter (January 2018) prepared by Robinson Noble (formerly Robinson, Noble & Saltbush Inc.), residual soil contamination at the Site was believed to remain in the groundwater “smear zone”, which is a zone of soils where petroleum hydrocarbon contamination occurs at the groundwater table (which fluctuates in elevation over time). Soils in the smear zone can vary from being saturated to unsaturated depending on temporal and seasonal water table fluctuations. Based on available data, soils in the area beneath and northwest of the Site building were impacted with TPH-GRO and benzene, which were both detected at concentrations that exceed MTCA Method A CULs. Groundwater in the area of impacted soils was similarly impacted with TPH-GRO and associated VOCs (e.g., benzene). Previous excavation work at the Site reportedly did not extend below the water table, which was determined to be approximately five to ten below ground surface depending on the time of year.

As reported in a December 2019 Chemical Injection Pilot Test Report (Robinson Noble 2019), between October 30 and November 1, 2018, as part of an effort to remediate the impacts to soil and groundwater, chemical oxidation injections using PersulfOx® were conducted in an area surrounding existing monitoring well MW-8 on the western side of the Site building (the “Cleanup Action” or “Remedial Action”). Borings were installed at 12 injection point locations to a depth of 16 feet below ground surface (bgs) and PersulfOx® was applied from 4 to 16 feet bgs, which spans the smear zone around the fluctuating water table surface depth range, and below that zone further into the saturated zone.

Groundwater monitoring was conducted before (October 2018) and after (January, June, and October 2019) the chemical injections to evaluate the success of the remedial action. The injections resulted in an immediate decrease in benzene concentrations in one well (MW-8) from pre-injection concentrations of approximately 13,800 µg/L in October 2018 to approximately 360 µg/L in January 2019. However, subsequent groundwater monitoring events in 2019 identified rebounding conditions and residual benzene concentrations of approximately 4,360 µg/L in October 2019. Soil sampling conducted by Robinson Noble in 2019 identified approximately 7,603 mg/kg of TPH-GRO in soil (approximately 6 ft bgs) immediately adjacent to monitoring well MW-8. These soil and groundwater concentrations are sufficiently elevated to suggest the potential presence of “free product” (also referred to as light nonaqueous phase liquid, LNAPL) remaining beneath the site.²

Sampling data from prior investigation and remedial activities are summarized in Tables 2 through 4 and presented on Figures 3 and 4.

² Guidance from the Interstate Technology Regulatory Council (ITRC; Table 3-2. <https://lnapl-3.itrcweb.org/3-key-lnapl-concepts/>) suggests that dissolved benzene concentrations in excess of 1,000 ug/L, and TPH-GRO in excess of 250 mg/kg can be an indicator of the presence of free-product in soil.

2.2.6 2022 – Limited Passive Soil Vapor Survey (Ramboll)

In November 2022, Ramboll completed a passive survey of soil vapor conditions in the vicinity of previously identified impacts to soil and groundwater at the Site, measured depth to groundwater, and reviewed historical groundwater elevation information, as reported in the Limited Passive Soil Vapor Survey (the “Survey Report”). Analytical results of the Limited Passive Soil Vapor Survey are summarized in Table 5 and presented on Figure 5.

The passive vapor survey provided additional delineation of areas of the Site affected by petroleum hydrocarbons. The survey results indicated the presence of two areas of impacted soil vapor (one west of the dealership, and the other beneath the dealership structure), but these areas may be associated with a single contiguous area of impacted soil and groundwater. The appearance of separation between these two areas may be due to increased air exchange within landscaped areas outside the dealership as compared with areas covered by structural foundations and pavement. However, based on detected impacts to soil vapor along the western edge of the survey grid, impacts to soil and groundwater may extend further to the west than previously identified. Based on the results of the survey, Ramboll determined that additional investigation west of the injection area is necessary to determine the westward extent of impacts on the Site, and that permanent sub-slab soil vapor sampling points should be installed within the Site structure.

During Ramboll’s initial visit to the Site in July 2022, measurements of depth to groundwater ranged from approximately 5.5 to 6.3 ft bgs across the Site. Ramboll’s review of historical available groundwater elevation data showed that historically, groundwater has been reported as shallow as 4.5 ft bgs, and as deep as 10 ft bgs, indicating the presence of an approximately 5.5-foot “smear zone”, i.e., the depth interval of petroleum impacts to soil as the petroleum-impacted groundwater table surface rises and falls over the course of the year. Ramboll indicated that this smear zone is the likely source of vapors captured by the passive soil vapor survey.

Finally, based on the shallow depth to water, wide range of reported groundwater flow directions, and shallow gradient, Ramboll determined that groundwater elevation at the Site is likely primarily influenced by seasonal precipitation. Additionally, Ramboll inferred that the mobility of petroleum hydrocarbons in groundwater is likely to be limited by the lack of a consistent groundwater flow direction and the presence of low-permeability soils reported to underly the site.

2.3 Data Gaps

Based on a review of available documentation discussed above, which includes 13 groundwater monitoring reports from July 2000 through January 2007, a 2006 Phase II Investigation conducted at the site, a 2018 Remedial Investigation and Cleanup Action Plan, a 2019 Chemical Injection Pilot Test Report, various correspondence letters with Ecology, and Ramboll’s 2022 Passive Soil Vapor Survey, Ramboll has identified the following data gaps remaining at the site:

- **Lateral Bounding of Soil and Groundwater Contamination.** Benzene and TPH-GRO contamination present in the soil and groundwater at the Site has not been laterally bounded to the southwest and northwest, and impacts to soil have not been assessed following the Remedial Action completed in 2018. The results of Ramboll’s Limited Passive Soil Vapor Survey indicate that contamination may extend further west than previously identified.

- **Documentation of MW-4, MW-5, and MW-6 Installation.** Documentation regarding the installation of these three groundwater monitoring wells (e.g., installation dates and boring logs) was not available in the document collection that we have reviewed.³ Information such as well depth, and screen intervals have not been identified in the available reports.
- **Groundwater Flow Direction.** Groundwater flow direction has not been fully evaluated at the Site. According to the groundwater monitoring reports from July 2000 through January 2007, the direction of groundwater flow has been estimated to vary from flowing toward the northeast to the west to the southwest.
- **Survey Data for On-Site Monitoring Wells.** Although at least some of the wells have apparently been surveyed previously,⁴ no survey data for on-site monitoring wells was found in the documents compiled and reviewed by Ramboll. Reportedly, monitoring wells MW-1, MW-2, and MW-3 were surveyed in November 1999, and monitoring wells MW-4, MW-5, and MW-6 were surveyed prior to 2016. However, no records of the survey results were found.

³ A January 2016 email correspondence between Robinson Noble and Ecology, Robinson Noble indicates that three monitoring wells (likely MW-4, MW-5, and MW-6) were installed, and the locations of all on-site groundwater monitoring wells were surveyed.

⁴ Reportedly, monitoring wells MW-1, MW-2, and MW-3 were surveyed in November 1999, and monitoring wells MW-4, MW-5, and MW-6 were surveyed prior to 2016. However, no records of the survey results were provided to Ramboll.

3. FIELD PROGRAM

This Work Plan describes activities that will be completed as part of a Supplemental Remedial Investigation designed to address the data gaps described above and provide a basis for identifying and evaluating potential remedial alternatives that may lead to obtaining regulatory closure.

Ramboll will oversee the drilling of at least 10 soil borings via direct-push technology to a depth of 15 ft bgs. Work will be implemented by a subcontracted driller licensed in the state of Washington. Two of the 10 boreholes will be completed as permanent monitoring wells (MW-10 and MW-11) with slotted screens from approximately 5 to 15 ft bgs. Ramboll will also oversee the installation of two permanent sub-slab soil vapor sampling points within the dealership structure in the vicinity of impacts identified by the passive soil vapor survey. These activities are described in greater detail below. Planned locations of temporary soil borings, permanent monitoring wells, and sub-slab soil vapor sampling points are presented on Figure 6.

3.1 Field Work Preparations

Prior to initiating field activities, Ramboll will update its site-specific health and safety plan (HASP) and other plans as necessary to ensure the health and safety of Ramboll employees, subcontractors, and workers at the Site. A selection of applicable Ramboll Safe Work Practice (SWP) documents is included in Appendix D.

Ramboll will then conduct a site visit to mark locations of planned subsurface boring locations, notify public utility locators of the intent to complete vertical borings, and oversee the locating of private utilities on the Site by a subcontractor who will use a ground-penetrating radar (GPR) device to identify and demarcate subsurface utilities and other features on the Site.

3.2 Soil Borings

At least 10 soil borings will be advanced to a maximum depth of 15 ft bgs via direct-push technology to assess current subsurface soil and groundwater conditions within the areas of affected soil and groundwater, and to provide bounding of these areas to the northwest and southwest. Specifically, planned borings include the following:

- Four borings are planned for locations north (SB-01 and MW-10) and south (SB-02 and MS-11) of MW-1 to assess the western extent of identified impacts to subsurface media
- Five borings (SB-03 through SB-07) are planned in a north-south oriented transect in the vicinity of MW-8 to assess impacts in the vicinity of highest-recorded concentrations of contamination in subsurface soils
- One boring is planned (SB-08) north of the former gasoline service station to assess soil and groundwater conditions within the identified plume, north of known impacts to soil and groundwater

These planned locations are depicted on Figure 6. To improve the efficacy and completeness of the planned field program, Ramboll may instruct the driller to complete up to six additional borings (SB-09 through SB-15) to further delineate impacts to soil and groundwater if field evidence indicates impacts to soil and groundwater beyond the previously identified extent, as time and materials allow.

Based on review of soil borings logs reported by previous investigators, Ramboll expects to encounter three depth intervals of interest: unsaturated soils above the smear zone (approximately 0-5 ft bgs), the groundwater interface within the smear zone (approximately 5-10 ft bgs), and saturated soils below the smear zone (approximately 10 to 15 ft bgs). In general accordance with Ecology's *Guidance for Remediation of Petroleum Contaminated Sites*⁵ (hereinafter referred to as Ecology's Petroleum Guidance), Ramboll field staff, overseen by a Washington-state Licensed Geologist, will record soil properties, any visual and/or olfactory evidence of petroleum contamination observed in soil cores, and screen the soil for VOC content via a photoionization detector (PID). Ramboll field staff will then collect approximately three soil samples for laboratory analysis from each temporary boring, prioritizing sampling of depth intervals with strongest evidence of contamination in the three zones described above.

Soil samples from the shallow unsaturated zone (approximately 0 to 5 ft bgs) will be collected from the depth interval with the strongest field evidence of contamination, or from the 4-5 ft bgs interval if there is no field evidence of contamination. These samples are intended to characterize the extent of contamination in shallow soils beyond the boundaries of the remedial excavations completed in 1998 and 2000.

Soil samples from the "smear zone" (approximately 5-10 ft bgs) will be collected from the depth interval of unsaturated soil with the strongest field evidence of contamination, or from the interval representing the capillary fringe immediately above saturated soils. These samples are intended to characterize the extent of soil contamination in the smear zone resulting from lateral migration and seasonal vertical water table fluctuations.

Soil samples from the saturated zone (approximately 10-15 ft bgs) will be collected from the depth interval of unsaturated soil with the strongest field evidence of contamination, or from the 14-15 ft bgs interval if there is not field evidence of contamination. These samples are intended to characterize the extent of soil contamination within the lower bounds of the smear zone resulting from lateral migration and seasonal vertical water table fluctuations.

3.3 Groundwater Grab Samples

In each soil boring (except for two to be completed as permanent monitoring wells, see next section) temporary 1-inch PVC casing will be installed with a slotted screen from approximately 5 to 15 ft bgs to facilitate the collection of "grab" groundwater samples. Groundwater grab samples from each soil boring location will provide data for improved delineation of contaminant concentrations in groundwater within the monitoring well network.

3.4 Permanent Monitoring Wells

There are nine existing permanent groundwater monitoring wells (MW-1 through MW-9) installed on the Site. Currently, the monitoring well network provides good constraint on the potential extent of contamination in groundwater to the north, east, and south of known impacts to environmental media. However, the well network features gaps to the northwest and southwest of known impacts, and review of historical groundwater elevation data indicates a lack of a dominant groundwater flow direction.

⁵ Washington State Department of Ecology Toxics Cleanup Program. *Guidance for Remediation of Petroleum Contaminated Sites*, Publication No. 10-09-057, revised June 2016.

Ramboll will complete two of the previously described soil borings as permanent monitoring wells northeast (planned MW-10) and southeast (planned MW-11) of MW-1. Once the new wells are developed, Ramboll field staff will measure depth to groundwater with an interface probe decontaminated between each well and collect groundwater samples from each well using a low-flow groundwater purging techniques.

Ramboll will contract a Washington-state Licensed Land Surveyor to complete a survey of the complete monitoring well network.⁶ After the survey is completed, Ramboll will calculate groundwater elevations across the network to obtain a more detailed understanding of groundwater flow conditions at the Site.

3.5 Permanent Sub-Slab Soil Vapor Sampling Points

The results of Ramboll's Limited Passive Soil Vapor Survey indicated the presence of impacted soil vapor beneath the Site structure. In general accordance with Ecology's Vapor Intrusion Guidance,⁷ To assess potential impacts to indoor air, Ramboll will install two permanent sub-slab soil vapor sampling points within the dealership structure on the Site: one within the commercial offices of the dealership, and the other within the service bay of the dealership. These two locations are located within the two main operational areas of the dealership building, and specific locations were chosen to be centered on elevated concentrations of petroleum contamination detected in the passive soil vapor survey. The sampling points will be installed as permanent features to enable repeat sampling of the same location(s) as needed during investigation and remediation activities.

3.6 Investigation Derived Waste

Investigation derived waste (IDW) is expected to consist of waste soils from the soil borings, wastewater generated by the development and sampling of groundwater wells, and rinsate generated during the routine cleaning of drilling and sampling equipment. All IDW will be presumed to be impacted by contamination known to be present on the Site and disposed of as non-hazardous contaminated soil and groundwater.

IDW will be containerized in standard steel 55-gallon drums and labelled with the following information:

- Description of contents (soil, water, or solid waste)
- Source of material by soil boring and/or well
- Date placed in the drum
- Drilling company which completed the work
- Ramboll's company name and contact information

Drums will be temporarily stored on the Site up to 90 days and disposed of at appropriate permitted receiving facilities after laboratory analysis is concluded.

⁶ In accordance with Ecology's Petroleum Guidance, elevations will be recorded relative to the North American Vertical Datum of 1988 (NAVD88), unless a monument with vertical control to NAVD88 is not readily available, in which case elevations will be recorded relative to the National Geodetic Vertical Datum of 1929 (NGVD29). Horizontal coordinates will be recorded in reference to the North American Datum of 1983, updated in 1991 (NAD83(1991)), and projected onto the Washington State Plane North coordinate system.

⁷ Washington State Department of Ecology Toxics Cleanup Program. *Guidance for Evaluating Vapor Intrusion in Washington State: Investigation and Remedial Action*, Publication No. 09-09-047, revised March 2022.

3.7 Sample Handling and Analysis

Ramboll maintains Field Guidance Documents (FGDs) describing standard operation procedures for field staff. Appropriate FGDs for each activity of the planned Field Program are included in Appendix C. General sample handling procedures are summarized per media (soil, groundwater, and sub-slab soil vapor) in subsequent sections.

As described in Ecology's Petroleum Guidance, environmental media (soil, water, or air) impacted by release(s) of gasoline should be analyzed for the following chemicals of concern:

- Gasoline-range total petroleum hydrocarbons (TPH-GRO)
- Volatile petroleum compounds including benzene, toluene, ethylbenzene, and xylenes (m-, o-, and p-) (BTEX)
- Fuel additives and blending compounds including methyl tert-butyl ether (MTBE), ethylene dibromide (EDB), 1,2 dichloroethane (EDC), ethanol, methanol, tertiary-butyl alcohol (TBA), tertiary-amyl methyl ether (TAME), and ethyl tertiary-butyl ether (ETBE)⁸
- Other petroleum components including total naphthalene
- Metals including lead

Ecology's Petroleum Guidance indicates that the extent of use of some fuel additives (e.g. TBA, TAME, and ETBE) is uncertain. Since the gasoline product released on the Site is no longer available for testing, Ecology's Petroleum Guidance recommends testing three to five soil and groundwater samples each for these additives to determine the presence or absence of these chemicals of concern in contaminated media.

Laboratory analyses completed during previous investigations have detected the following contaminants in soil and groundwater at the Site:

- Gasoline-range petroleum hydrocarbons
- Benzene, toluene, ethylbenzene, xylenes (BTEX)
- Methyl tert-butyl ether (MTBE) and naphthalene

Previous laboratory analyses did not detect the presence of lead, EDB, or EDC in soil or groundwater at the site, but analysis of the fuel additives TBA, TAME, and ETBE have not been reported in previous investigations. Ramboll will request analysis of TBA, TAME, and ETBE in at least three to five samples of soil and groundwater, as suggested by Ecology's Petroleum Guidance, to confirm these fuel additives are also not present in environmental media at the Site.

⁸ For ethanol and methanol, Ecology's Petroleum Guidance states that "While the current Method A cleanup levels do not take these alcohols into account and the lack of a reference dose limits the ability to calculate cleanup levels under Method B, these alcohols can be indicators of where gasoline has come to be located and, at high concentrations, may influence the mobility of other components."

Ramboll will subcontract the laboratories certified in Washington state for analysis of the collected samples as indicated below.

Soil and Groundwater Sample Analyses:

Pace Analytical

Address: 12065 Lebanon Road, Mt. Juliet, Tennessee 37122

Telephone: 615-758-5858

Sub-Slab Soil Vapor Sample Analyses:

Friedman & Bruya, Inc.

Address: 5500 4th Avenue South, Seattle, Washington 98108

Telephone: 206-285-8282

3.7.1 Soil Samples

Per applicable Ramboll FGDs (included in Appendix C) soil samples will be collected by Ramboll field staff wearing clean nitrile gloves into laboratory-supplied containers, packaged in ice, and shipped to Pace Analytical under chain of custody documentation.

Soil samples will be analyzed for the following contaminants of concern:

- Gasoline-Range Total Petroleum Hydrocarbons (TPH-GRO) via Method NWTPH-Gx
- Benzene, toluene, ethylbenzene, xylenes, naphthalene, and MTBE via Environmental Protection Agency (EPA) Method 8260

As discussed above, a select set of three to five soil samples with strong field evidence of petroleum contamination will be analyzed for the following additional contaminants:

- EDB, EDC, TBA, TAME, and ETBE via EPA Method 8260
- Ethanol and methanol via EPA Method 8015

If a specific additive is detected at concentrations likely to be detectable at in other soil samples, Ramboll will request reanalysis of other samples potentially impacted by that additive.

3.7.2 Groundwater Samples

Per applicable Ramboll FGDs (included in Appendix C), groundwater samples from temporary and permanent wells will be collected by Ramboll field staff via low-flow purging techniques into laboratory-supplied containers, packaged in ice, and shipped to Pace Analytical under chain of custody documentation.

Groundwater samples will be analyzed for the following contaminants of concern:

- TPH-GRO via Ecology Method NWTPH-Gx
- Benzene, toluene, ethylbenzene, xylenes, naphthalene, and MTBE via EPA Method 8260

To establish the presence or absence of potential contaminants which may have been present as additives in the historical gasoline product released into environmental media, a select set of three to five groundwater samples from temporary borings with strong field

evidence of petroleum contamination and the groundwater samples from MW-8 and MW-3 will be analyzed for the following additional contaminants:

- EDB, EDC, TBA, TAME, and ETBE via EPA Method 8260
- Ethanol and methanol via EPA Method 8015

If a specific additive is detected at concentrations likely to be detectable at in other groundwater samples, Ramboll will request reanalysis of samples potentially impacted by that additive.

In general accordance with Ecology's *Guidance for Remediation of Petroleum-Contaminated Ground Water by Natural Attenuation* (Ecology's MNA Guidance),⁹ Ramboll's FGD for low-flow groundwater sampling (included in Appendix C) includes measurement of the following standard groundwater quality parameters via field meter(s):

- Dissolved Oxygen (DO)
- Oxidation-Reduction Potential (ORP)
- pH
- Specific Conductivity (SPC)
- Temperature
- Turbidity

Also, in general accordance with Ecology's MNA Guidance, a subset of groundwater samples (approximately five) from permanent wells will be analyzed for the following secondary geochemical parameters to support evaluation of monitored natural attenuation (MNA) as a remedial action alternative:

- Soluble manganese and ferrous iron via EPA Method 200.7
- Nitrate and sulfate via EPA Method 300.0
- Alkalinity via EPA Method 310.2
- Methane via EPA Method RSK175

3.7.3 Sub-Slab Soil Vapor Samples

In general accordance with Ecology's *Guidance for Evaluating Vapor Intrusion in Washington State, Investigation and Remedial Action*,¹⁰ sub-slab soil vapor samples will be collected at each sub-slab soil vapor sampling point by Ramboll field staff using a helium shroud and standard soil vapor sampling techniques to prevent atmospheric contamination, as described in Ramboll's applicable FGDs (included in Appendix C). Soil vapor samples will be collected into laboratory-provided evacuated canisters and delivered to Friedman & Bruya Laboratory in Seattle, Washington, under chain of custody documentation.

⁹ Washington State Department of Ecology Toxics Cleanup Program. *Guidance for Remediation of Petroleum-Contaminated Ground Water by Natural Attenuation*, Publication No. 05-09-091, July 2005.

¹⁰ Washington State Department of Ecology Toxics Cleanup Program. *Guidance for Evaluating Vapor Intrusion in Washington State, Investigation and Remedial Action*, Publication No. 09-09-047, March 2022.

To assess potential impacts to indoor air by petroleum hydrocarbons and associated VOCs, Soil vapor samples will be analyzed for the following under standard turnaround time:

- Aliphatic and Aromatic Petroleum Hydrocarbons (APH), VOCs, and total helium by EPA Method TO-15

3.8 Data Quality Objectives and Quality Assurance Review

The primary objective of the planned Supplemental Remedial Investigation is to effectively address the identified gaps in data regarding the status of soil, groundwater, and soil vapor contamination present at the Site. This objective is planned to be met by collecting samples of soil from above, within, and below the smear zone identified by previous investigations, and by collecting samples of groundwater from inside and outside the previously identified extent of petroleum contamination. With the supplemental data and the historical data, the combined data set is expected to be sufficient to conduct a preliminary assessment of the feasibility of potential remedial actions.

3.9 Sample Quality Assurance

To ensure the reliability of sample results, Ramboll will submit anonymized field duplicate samples constituting at least 10% of the total number of analyzed samples per sample media. Results of the analysis of duplicate samples will be compared to analytical results from the primary samples with the objective no more than 20% relative percent difference between the primary and duplicate measurements.

To identify any compromised data resulting from the potential cross-contamination of samples via improperly cleaned reusable sampling equipment, equipment blanks constituting at least 10% of the total submitted samples will be collected at various times between decontamination of sampling equipment and subsequent sampling activities and submitted for the same analyses as the sample media.

3.10 Analytical Reporting Limits

To ensure analytical results (particularly non-detect results) are reliable, the laboratories will be requested to report quantitation limits equal to or lower than the practical quantitation limits recommended by Ecology in Table 7.3 of Ecology's Petroleum Guidance.

3.11 Analytical Quality Assurance

To ensure measurements reported by the laboratories analyzing samples collected during the supplemental remedial investigation are of sufficient quality to be used as planned, Ramboll will request "Level II" data packages as the analytical deliverable, which include reporting of the following:

- Analytical Results
- Case Narrative
- Surrogate Recoveries
- Chain-of-Custody
- Method Blank Analytical Results
- Laboratory Control Sample Summaries
- Laboratory Control Sample Duplicates
- Matrix Spike Summaries

- Matrix Spike Duplicates
- Laboratory Replicates/Duplicates (as appropriate)

Ramboll will internally check the results of the laboratory reports against the laboratory's stated measurement quality objectives to ensure all appropriate objectives have been met or otherwise flagged by the laboratory, as appropriate.

4. SUPPLEMENTAL REMEDIAL INVESTIGATION AND FEASIBILITY STUDY REPORT

Following completion of the Field Program described above, Ramboll will complete a Supplemental Remedial Investigation/Feasibility Study (Supplemental RI/FS) report. The Supplemental RI will document the current field program and building on prior remedial investigation work implemented at the Site. Specifically, the Supplemental RI will combine results from previous investigations with the results of Ramboll's work to characterize the Site, construct an updated Conceptual Site Model, and propose cleanup standards and potential Points of Compliance.

The FS portion of the report will build on the framing of past work and findings presented in the Supplemental RI, identify remedial action objectives, evaluate three or more potentially applicable remedies including MTCA model remedies,¹¹ complete a disproportionate cost analysis for each alternative as needed,¹² and select a proposed remedy.

Upon completion of the draft Supplemental RI/FS report, Ramboll will provide a draft report to Ecology and TPHCD.

¹¹ Model Remedies are described in Ecology's *Model Remedies for Sites with Petroleum Impacts to Groundwater*, Publication No. 15-09-043, revised December 2017.

¹² Evaluation of a Model Remedy does not require a disproportionate cost analysis, per Ecology's Model Remedy Guidance.

5. ANTICIPATED FUTURE WORK

Future tasks that we anticipate may will be necessary, following the completion of the Supplemental RI/FS, include the following:

- **Quarterly groundwater sampling and elevation measurements.** At least four consecutive quarters of groundwater sampling are typically necessary to establish evidence of plume stability. The results of the sampling completed as part of the SRI will constitute the first quarter of groundwater sampling, and with Client approval, Ramboll would continue quarterly groundwater sampling in 2023.
- **Disposal of Investigation Derived Waste.** After laboratory analytical reports are received for the collected samples of soil and groundwater, accumulated IDW will be disposed of at a permitted receiving facility, with Client approval.
- **Implementation of selected remedy.** As appropriate, a selected remedy will be implemented based on the findings and selected remedy presented in the RI/FS report.

6. SCHEDULE AND REPORTING

A tentative schedule for completing the above-described investigation and report (not including next step items) is as follows:

Table 2: Work Plan Implementation Schedule	
Description	Estimated Schedule¹
<u>Supplemental RI Field Program</u> Planned order of activities: 1. Subsurface utility clearance 2. Installation and development of additional groundwater monitoring wells 3. Installation of permanent sub-slab soil vapor sampling points 4. Completion of soil borings with laboratory analysis of soil and grab groundwater samples 5. Sub-slab soil vapor sampling and analysis 6. Groundwater sampling from monitoring wells and analysis (first quarterly groundwater monitoring event) 7. Survey of monitoring well locations and elevations	December 2022
Second Quarterly Groundwater Monitoring Event ²	March 2023
Submittal of Supplemental RI/FS Report for Agency Review	April 2023
Notes: ¹ Dates of report finalization are subject to laboratory turnaround times and Client review. ² Results of the groundwater monitoring event may not be available prior to submittal of the Supplemental RI/FS for agency review.	

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TABLES

Table 1 - Summary of Groundwater Measurements**DRAFT**

Honda of Fife
 4301 20th Street East
 Fife, Washington

Date	Depth to Groundwater (feet below top of casing)								
	MW1	MW2	MW3	MW4	MW5	MW6	MW7	MW8	MW9
11/23/1999	4.90	5.14	5.37	Not Present	Not Present	Not Present	Not Present	Not Present	Not Present
3/28/2000	6.60	5.52	6.11						
7/13/2000	5.59	6.31	6.18						
11/1/2000	5.75	5.75	6.10						
2/23/2001	5.56	5.73	5.89						
5/18/2001	5.61	5.73	5.90						
8/9/2001	5.89	6.52	6.41						
11/19/2001	5.05	5.05	5.25						
2/11/2002	4.94	5.40	5.37						
6/6/2002	5.05	6.65	6.25						
8/8/2002	8.37	8.99	8.17						
11/14/2002	9.40	9.90	10.15						
2/27/2003	6.05	6.20	6.75						
5/12/2003	6.11	6.40	6.49						
8/27/2003	7.59	7.98	7.63						
4/29/2004	6.00	6.37	6.32						
10/13/2004	6.02	6.25	6.52						
4/21/2005	5.26	5.60	5.61						
10/20/2005	6.77	7.00	7.27						
4/27/2006	5.81	6.11	6.11						
1/8/2007	4.19	4.52	4.59						
11/6/2017	--	--	5.30	--	--	--	--	--	--
10/22/2018	--	--	--	--	--	--			
1/30/2019	--	--	--	--	--	--			
6/26/2019	--	--	--	--	--	--			
10/30/2019	--	--	--	--	--	--			
7/13/2022	5.95	6.22	6.08	6.07	6.26	5.70	6.29	5.57	6.15

Notes:

- Measurements were taken from the top of casing on the north side of the monitoring well.
 - Survey data was not found in the available documentation for use in calculating groundwater elevations.
 - Dates without available groundwater measurements are dates when groundwater analytical data was available in documentation. Groundwater analytical data is summarized in Table 2.
- indicates the depth to groundwater measurements were not found in the available documentation.

Table 2 - Summary of MTCA Exceedances in Soil Samples Collected from Former Gasoline UST Area

Honda of Fife
4301 20th Street East
Fife, Washington

Analyte					Gasoline Range Organics	Benzene	Ethyl Benzene	Toluene	Xylenes (total)	Naphthalene
MTCA Method A CUL					30 ¹	0.03	6	7	9	5
Sample Location	Start Depth (feet bgs)	End Depth (feet bgs)	Sample Date	Sample Status	Analytical Results (mg/kg)					
1998 Gasoline UST Excavation Confirmation Soil Samples										
Ex-1-Base	8	8	9/14/1998	Removed during Excavation	101	NA	NA	NA	NA	NA
Ex-1-Base2	10	10	9/24/1998	Left in Place	< 20	NA	NA	NA	NA	NA
Ex-1-East	8	8	9/15/1998	Removed during Excavation	1,378	NA	NA	NA	NA	NA
Ex-1-East2	7	7	9/24/1998	Left in Place	< 20	NA	NA	NA	NA	NA
Ex-1-N/W	7	7	9/24/1998	Left in Place	< 20	NA	NA	NA	NA	NA
Ex-1-South	8.5	8.5	9/15/1998	Removed during Excavation	238	NA	NA	NA	NA	NA
Ex-1-West	10	10	9/15/1998	Removed during Excavation	26	NA	NA	NA	NA	NA
Ex-1-West2	7	7	9/24/1998	Left in Place	36	NA	NA	NA	NA	NA
2000 Remedial Investigation Soil Samples										
B1_2000	4	5	3/28/2000	Left in Place	ND	0.72	ND	ND	ND	NA
B1_2000	6	7	3/28/2000	Left in Place	ND	0.4	ND	ND	0.3	NA
B2_2000	8	9	3/28/2000	Left in Place	ND	ND	ND	ND	ND	NA
B3_2000	7	8	3/28/2000	Left in Place	700	22	22	70	110	NA
B4_2000	7	8	3/28/2000	Left in Place	8,900	270	280	1,200	1,400	NA
B5_2000	2	3	3/28/2000	Left in Place	45	1.2	0.5	0.83	1.8	NA
B5_2000	6	7	3/28/2000	Left in Place	330	34	9	60	47	NA
B6_2000	6	7	3/28/2000	Left in Place	ND	ND	ND	ND	ND	NA
B7_2000	5	6	3/28/2000	Left in Place	2,300	48	66	220	350	NA
B8_2000	6	7	3/28/2000	Left in Place	330	17	8.8	44	44	NA
B9_2000	7	8	3/28/2000	Left in Place	31	9.7	0.56	1.3	3.4	NA
B10_2000	6	7	3/28/2000	Left in Place	ND	ND	< 20	ND	< 20	NA
2000 Gasoline UST Second Excavation Confirmation Soil Samples										
HF-1	4	6	5/23/2000	Left in Place	41	0.32	0.38	0.07	1.63	NA
HF-2	6	6	5/23/2000	Left in Place	< 10	0.24	0.05	0.05	0.1	NA
HF-3	4	6	5/23/2000	Left in Place	15	< 0.05	0.08	< 0.05	0.32	NA
HF-4	4	6	5/23/2000	Left in Place	42	2.8	1.51	4.47	2.44	NA
HF-5	4	6	5/23/2000	Left in Place	< 10	0.62	0.84	0.25	3.58	NA
HF-6	4	6	5/23/2000	Left in Place	12.04	1.17	0.79	0.11	4.42	NA
HF-7	4	6	5/23/2000	Left in Place	19	1.11	1.32	1.1	14.3	NA
HF-8	4	6	5/23/2000	Left in Place	85	4.06	5.04	0.46	23.2	NA
HF-9	6	6	5/23/2000	Left in Place	844	32.8	24.4	235	78.2	NA
HF-10	6	6	5/23/2000	Left in Place	33	7.31	0.87	7.71	4.67	NA
HF-11	4	6	5/23/2000	Left in Place	10	2.01	1.08	1.39	2.84	NA
HF-12	4	6	5/23/2000	Left in Place	74	11.7	4.57	3.67	20.3	NA
HF-13	4	6	5/23/2000	Left in Place	321	13.9	10.9	0.25	54.8	NA
HF-14	4	6	5/23/2000	Left in Place	5,980	205	238	1540	1430	NA
HF-15	6	6	5/23/2000	Left in Place	52	5.45	5.31	< 0.05	35.2	NA
HF-16	6	6	5/23/2000	Left in Place	112	50.1	4.49	6.46	26.1	NA
HF-17	6	6	5/23/2000	Left in Place	878	3.17	3.97	< 0.05	24.2	NA
HF-18	6	6	5/23/2000	Left in Place	117	6.04	23.9	98.9	145	NA
HF-19	6	6	5/23/2000	Left in Place	69	2.04	2.79	11.3	18.5	NA
HF-20	6	6	5/23/2000	Left in Place	10,200	239	220	1,780	1,540	NA
HF-21 (Sidewall)	4	6	5/23/2000	Left in Place	4,360	25	62	291	566	NA
HF-21 (Base)	6	6	5/23/2000	Left in Place	4,360	25	62	291	566	NA
HF-22	4	6	5/23/2000	Left in Place	8,420	218	259	842	1,210	NA
HF-23	6	6	5/23/2000	Left in Place	571	23	20	100	115	NA
HF-24	6	6	5/23/2000	Left in Place	5,250	101	145	704	1,280	NA
HF-25	6	6	5/23/2000	Left in Place	370	7.99	9.79	42.9	57.4	NA
HF-26	6	6	5/23/2000	Left in Place	171	12.1	5.72	33.7	38.3	NA
2006 Phase II Environmental Site Assessment Soil Samples										
B1	5	5	7/25/2006	Left in Place	< 10	< 0.03	< 0.05	< 0.1	< 0.15	NA
B3	5	5	7/25/2006	Left in Place	< 10	< 0.03	< 0.05	< 0.1	< 0.15	NA
B4	5	5	7/25/2006	Left in Place	< 10	< 0.03	< 0.05	< 0.1	< 0.15	NA
B5	5	5	7/25/2006	Left in Place	< 10	< 0.03	< 0.05	< 0.1	< 0.15	NA
B6	5	5	7/25/2006	Left in Place	< 10	0.45	< 0.05	0.05	0.45	NA
B7	5	5	7/25/2006	Left in Place	< 10	0.44	< 0.05	0.11	0.19	NA
B10	5	5	7/25/2006	Left in Place	< 10	< 0.03	< 0.05	< 0.1	< 0.15	NA
2017 Additional RI Soil Samples										
MW-7	6	6	10/25/2017	Left in Place	< 10	< 0.02	< 0.05	< 0.1	< 0.15	< 0.1
B11	4	4	10/25/2017	Left in Place	< 10	< 0.02	< 0.05	< 0.1	0.2	< 0.1
B12	6	6	10/25/2017	Left in Place	< 10	< 0.02	< 0.05	< 0.1	< 0.15	< 0.1
B13	5	5	10/25/2017	Left in Place	12.5	0.028	< 0.05	< 0.1	< 0.15	< 0.1
B14	6	6	10/25/2017	Left in Place	< 10	< 0.02	< 0.05	< 0.1	< 0.15	< 0.1
B15	6	6	10/25/2017	Left in Place	< 10	0.028	< 0.05	< 0.1	< 0.15	0.13
B16	6	6	10/25/2017	Left in Place	< 10	0.05	< 0.05	< 0.1	< 0.15	< 0.1
B17	6	6	10/25/2017	Left in Place	198	0.14	2.3	< 0.1	6.3	1.8
B18	6	6	10/25/2017	Left in Place	< 10	< 0.02	0.048	< 0.1	0.14	0.3
2018 Pre-Injection Soil Samples										
B19	6	6	10/19/2018	Left in Place	< 10	< 0.02	< 0.05	< 0.1	< 0.15	0.3
B19	9	9	10/19/2018	Left in Place	< 10	< 0.02	< 0.05	< 0.1	< 0.15	0.2
B19	12	12	10/19/2018	Left in Place	< 10	0.1	< 0.05	< 0.1	< 0.15	0.4
B19	15	15	10/19/2018	Left in Place	< 10	0.5	< 0.05	< 0.1	< 0.15	< 0.1
B19	17	17	10/19/2018	Left in Place	< 10	0.7	< 0.05	< 0.1	< 0.15	< 0.1
B20	6	6	10/19/2018	Left in Place	7,603	4.6	106	87	503	29
B20	8	8	10/19/2018	Left in Place	246	6.7	7.4	0.8	22	3
B20	10	10	10/19/2018	Left in Place	21	4	0.1	< 0.1	0.3	0.5
B20	12	12	10/19/2018	Left in Place	13	4.3	< 0.05	< 0.1	< 0.15	0.1
B20	15	15	10/19/2018	Left in Place	< 10	2.7	< 0.05	< 0.1	< 0.15	< 0.1
B21	6	6	10/19/2018	Left in Place	< 10	< 0.02	< 0.05	< 0.1	< 0.15	< 0.1
B21	9	9	10/19/2018	Left in Place	< 10	< 0.02	< 0.05	< 0.1	< 0.15	< 0.1
B21	12	12	10/19/2018	Left in Place	< 10	< 0.02	< 0.05	< 0.1	< 0.15	< 0.1
B21	15	15	10/19/2018	Left in Place	< 10	< 0.02	< 0.05	< 0.1	< 0.15	< 0.1

Notes:

1. MTCA CUL for gasoline range organics is 30 mg/kg when benzene is present.
2. Analytical results are compared to Washington State Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) for unrestricted land use.

Bold = Analytical result is above MTCA Method A CUL.

< X = concentration is less than the lab reporting limit

MTCA CUL = Washington Model Toxics Control Act Cleanup Level

ND = Not detected; reporting limit was not provided in the historical report provided to Ramboll.

NA = Not analyzed

bgs = below ground surface

mg/kg = milligrams per kilogram

Table 3 - Summary of Soil Samples Collected from Former Waste Oil UST Area

Honda of Fife
 4301 20th Street East
 Fife, Washington

Analytes					Total TPH (by Method E418.1)	Diesel Range Organics	Oil Range Organics
MTCA Method A CUL						2000	2000
Sample Location	Sample Start Depth	Sample End Depth	Sample Date	Sample Status	Analytical Results (mg/kg)		
Ex-2-Base	10.5	10.5	9/14/1998	Removed during Excavation	26	NA	NA
Ex-2-East	10	10	9/14/1998	Removed during Excavation	30	NA	NA
Ex-2-North	7	7	9/14/1998	Removed during Excavation	24	NA	NA
B4	6	6	11/9/1999	Removed during Excavation	NA	< 25	7,800
B4	8	8	11/9/1999	Removed during Excavation	NA	NA	NA
HF-1A	6.5	6.5	5/24/2000	Left in Place	NA	< 20	< 40
HF-2A	6.5	6.5	5/24/2000	Left in Place	NA	< 20	< 40
HF-3A	8	8	5/24/2000	Removed during Excavation	NA	< 20	< 40
HF-4A	6.5	6.5	5/24/2000	Left in Place	NA	< 20	< 40
HF-5A	6.5	6.5	5/24/2000	Left in Place	NA	< 20	< 40

Notes:

1. MTCA CUL for gasoline range organics is 30 mg/kg when benzene is present.
 2. Analytical results are compared to Washington State Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) for unrestricted land
- < X = concentration is less than the lab reporting limit

MTCA CUL = Washington Model Toxics Control Act Cleanup Level

ND = Not detected; reporting limit was not provided in the historical report provided to Ramboll.

NA = Not analyzed

bgs = below ground surface

mg/kg = milligrams per kilogram

Bold = Analytical result is above MTCA Method A CUL.

Table 4 - Summary of MTCA Exceedances in Groundwater Samples

Honda of Fife
4301 20th Street East
Fife, Washington

Analyte		Gasoline Range Organics (TPH-GRO)	Benzene	Ethyl Benzene	Toluene	Xylenes (total)	Methyl tert-butyl ether (MTBE)	Naphthalene
MTCA Method A CUL		800	5	700	1000	1000	20	160
Sample Location	Sample Date	Sample Results (µg/L)						
Grab Groundwater Samples								
B1	7/25/2006	< 100	< 1	< 1	< 2	< 3	NA	NA
B3	7/25/2006	< 100	< 1	< 1	< 2	< 3	NA	NA
B4	7/25/2006	< 100	< 1	< 1	< 2	< 3	NA	NA
B5	7/25/2006	< 100	5.2	< 1	< 2	< 3	NA	NA
B6	7/25/2006	2,240	333	68.2	2.9	36.3	NA	NA
B7	7/25/2006	210	38.5	3.7	< 2	3	NA	NA
B8	7/25/2006	< 100	1.3	< 1	< 2	2.1	NA	NA
B11	10/25/2017	341	< 1.0	< 1.0	< 1.0	< 2.0	61.8	10
B14	10/25/2017	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
B15	10/25/2017	49,600	14,700	760	1,310	2,510	741	105
B16	10/25/2017	3,400	123	8.2	1.1	8.3	< 5.0	105
Monitoring Well Groundwater Samples								
MW-1	11/23/1999	< 100	< 1	< 1	< 1	< 1	NA	NA
	3/28/2000	< 100	< 1	< 1	< 1	< 1	NA	NA
	7/13/2000	< 100	< 1	< 1	< 1	< 1	NA	NA
	11/1/2000	< 100	1.5	< 1	< 1	3.1	NA	NA
	2/23/2001	< 100	< 1	< 1	< 1	< 1	NA	NA
	5/18/2001	< 100	5.3	< 1	1.9	6	NA	NA
	8/9/2001	< 100	< 1	< 1	< 1	< 1	NA	NA
	2/11/2002	< 100	5.2	13	8.3	25	NA	NA
	6/6/2002	< 1	< 1	< 1	< 1	< 1	NA	NA
	8/8/2002	< 100	< 1	< 1	< 1	< 1	NA	NA
	11/14/2002	< 100	< 1	< 1	< 1	< 1	NA	NA
	2/27/2003	< 100	< 1	< 1	< 1	< 1	NA	NA
	5/12/2003	< 100	< 1	< 1	< 1	< 1	NA	NA
	8/27/2003	< 100	< 1	< 1	< 1	< 1	NA	NA
	4/29/2004	< 100	< 1	< 1	< 1	< 1	NA	NA
	10/13/2004	< 100	< 1	< 1	< 1	< 1	NA	NA
	4/21/2005	< 100	< 1	< 1	< 1	< 1	NA	NA
	10/20/2005	< 100	< 1	< 1	< 1	< 1	NA	NA
	4/27/2006	< 100	< 1	< 1	< 1	< 1	NA	NA
	1/8/2007	< 100	< 1	< 1	< 1	< 1	NA	NA
	11/7/2017	< 100	5.8	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
	10/22/2018	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
MW-2	11/23/1999	< 100	< 1	< 1	< 1	< 1	NA	NA
	3/28/2000	< 100	< 1	< 1	18	< 1	NA	NA
	7/13/2000	< 100	< 1	< 1	< 1	< 1	NA	NA
	11/1/2000	< 100	< 1	< 1	< 1	< 1	NA	NA
	2/23/2001	< 100	< 1	< 1	< 1	< 1	NA	NA
	5/18/2001	< 100	< 1	< 1	< 1	< 1	NA	NA
	8/9/2001	< 100	< 1	< 1	< 1	< 1	NA	NA
	2/11/2002	1,300	17	< 1	18	43	NA	NA
	6/6/2002	< 1	< 1	< 1	< 1	< 1	NA	NA
	8/8/2002	< 100	< 1	< 1	< 1	< 1	NA	NA
	11/14/2002	< 100	< 1	< 1	< 1	< 1	NA	NA
	2/27/2003	< 100	< 1	< 1	< 1	< 1	NA	NA
	5/12/2003	< 100	< 1	< 1	< 1	< 1	NA	NA
	8/27/2003	< 100	1.1	< 1	< 1	< 1	NA	NA
	4/29/2004	< 100	< 1	< 1	< 1	< 1	NA	NA
	10/13/2004	< 100	< 1	< 1	< 1	< 1	NA	NA
	4/21/2005	< 100	< 1	< 1	< 1	< 1	NA	NA
	10/20/2005	< 100	< 1	< 1	< 1	< 1	NA	NA
	4/27/2006	< 100	< 1	< 1	< 1	< 1	NA	NA
	1/8/2007	< 100	< 1	< 1	< 1	< 1	NA	NA
	11/7/2017	234	2.7	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
	10/22/2018	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
1/30/2019	320	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0	
6/26/2019	274	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0	
10/30/2019	310	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	NA	

Table 4 - Summary of MTCA Exceedances in Groundwater Samples

Honda of Fife
4301 20th Street East
Fife, Washington

Analyte		Gasoline Range Organics (TPH-GRO)	Benzene	Ethyl Benzene	Toluene	Xylenes (total)	Methyl tert-butyl ether (MTBE)	Naphthalene
MTCA Method A CUL		800	5	700	1000	1000	20	160
Sample Location	Sample Date	Sample Results (µg/L)						
Monitoring Well Groundwater Samples								
MW-3	11/23/1999	727	95	14	44	121	NA	NA
	3/28/2000	9,700	1,600	550	380	1,300	NA	NA
	7/13/2000	4,000	2,700	390	600	1,400	NA	NA
	11/1/2000	12,000	2,400	350	80	35	NA	NA
	2/23/2001	7,000	570	110	110	340	NA	NA
	5/18/2001	8,800	1,700	330	370	1,300	NA	NA
	8/9/2001	15,000	3,400	720	370	3,000	NA	NA
	2/11/2002	70,000	2,500	480	240	1,800	NA	NA
	6/6/2002	12,000	2,300	560	260	1,900	NA	NA
	8/8/2002	11,000	920	280	270	810	NA	NA
	11/14/2002	560	41	10	< 1	29	NA	NA
	2/27/2003	240	65	< 1	< 1	< 1	NA	NA
	5/12/2003	18,000	590	710	110	2,100	NA	NA
	8/27/2003	30,000	920	1,040	193	3,800	NA	NA
	4/29/2004	12,500	699	1,010	68	1,660	NA	NA
	10/13/2004	8,200	932	811	6.7	492	NA	NA
	4/21/2005	14,100	840	1,350	21	2,970	NA	NA
	10/20/2005	8,060	137	571	12	647	NA	NA
	4/27/2006	6,700	389	341	24.9	669	NA	NA
	1/8/2007	3,400	310	134	8.9	206	NA	NA
	11/7/2017	3,080	19.1	58.2	2.2	6.3	40.1	38.9
	10/22/2018	843	3.7	2	< 1.0	< 2.0	< 5.0	< 5.0
1/30/2019	3,900	15	56	< 1.0	2.4	12	10	
6/26/2019	2,070	1.9	10	< 1.0	< 2.0	< 5.0	5.4	
10/30/2019	2,010	6.1	13.4	< 1.0	< 2.0	7.4	NA	
MW-4	11/7/2017	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
	10/22/2018	< 100	< 1.0	< 1.0	< 1.0	< 2.0	32	< 5.0
MW-5	11/7/2017	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
	10/22/2018	< 100	< 1.0	< 1.0	< 1.0	< 2.0	22	< 5.0
MW-6	11/7/2017	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
	10/22/2018	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
MW-7	11/7/2017	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
	10/22/2018	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
MW-8	11/7/2017	81,000	33,000	522	2,840	2,170	1,320	276
	10/22/2018	22,000	13,800	280	878	1,230	210	60
	1/30/2019	2,340	360	15	27	55	110	107
	6/26/2019	27,300	3,180	928	1,640	3530	97.2	139
	10/30/2019	23,900	4,360	479	1,050	< 2.0	87	NA
MW-9	11/7/2017	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0
	10/22/2018	< 100	< 1.0	< 1.0	< 1.0	< 2.0	< 5.0	< 5.0

Notes:

- Analytical results are compared to Washington State Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) for unrestricted land use.

Bold = Analytical result is above MTCA Method A CUL.

< X = concentration is less than the lab reporting limit

MTCA CUL = Washington Model Toxics Control Act Cleanup Level

ND = Not detected; reporting limit was not provided in the historical report provided to Ramboll.

NA = Not analyzed

bgs = below ground surface

mg/kg = milligrams per kilogram

Table 5 - Summary of Passive Soil Vapor Sample Analytical Results

Honda of Fife
4301 20th Street East
Fife, Washington

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Results (µg / m³)	TPH			VOCs															
	TPH C4-C9 µ	TPH C10-C15 µ	Total TPH C4-C15* µ	Benzene	Toluene	Ethylbenzene	o-Xylene	p & m-Xylene	Total Xylenes*	1,1,1-Trichloroethane	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	1,4-Dioxane	2-Methylnaphthalene	Chloroform	Isopropylbenzene (cumene)	Methyl-t-butyl ether (MTBE)	Naphthalene	Tetrachloroethene (PCE)
PSV-01	2,100	5,730	7,830	4.79	208	7.74	22.6	48.7	71.3	< 0.48	9.89	4.24	< 1.22	36.6	< 1.43	< 1.51	< 2.50	7.7	2.94
PSV-02	566	< 362	747	< 2.36	54.6	2.38	4.65	11.7	16.35	< 0.48	< 1.51	< 1.51	< 1.22	< 1.64	< 1.43	< 1.51	< 2.50	< 1.56	< 1.22
PSV-03	1,600	754	2,354	6.06	96.8	6.97	9.11	27.3	36.41	< 0.48	< 1.51	< 1.51	< 1.22	< 1.64	< 1.43	< 1.51	< 2.50	< 1.56	< 1.22
PSV-04	33,000	8,350	41,350	< 2.32	191	8.79	14.9	31.3	46.2	< 0.47	2.03	< 1.48	< 1.20	5.78	< 1.41	< 1.48	< 2.46	< 1.54	< 1.20
PSV-05	62,600	3,620	66,220	24.5	123	11	12.5	20.4	32.9	< 0.48	5.19	3.00	< 1.22	23.5	< 1.43	2.12	< 2.50	4.91	< 1.22
PSV-06	703	510	1,213	3.34	< 3.13	< 1.47	< 1.42	< 1.42	< 2.8	< 0.48	< 1.51	< 1.51	< 1.22	< 1.64	< 1.43	< 1.51	< 2.50	< 1.56	< 1.22
PSV-07	34,000	610	34,610	352	9.33	1.54	< 1.41	3.16	3.865	< 0.47	2.45	< 1.50	< 1.21	< 1.64	< 1.42	< 1.50	135	< 1.56	1.81
PSV-08	2,230	831	3,061	6.66	14.6	< 1.46	2.01	4.54	6.55	< 0.47	2.52	< 1.50	4.51	< 1.64	< 1.42	< 1.50	202	< 1.55	2.06
PSV-09	607	< 362	788	< 2.36	59.5	3.83	5.72	17.2	22.92	< 0.48	< 1.51	< 1.51	< 1.22	< 1.64	1.7	< 1.51	< 2.50	< 1.56	< 1.22
PSV-10	< 423	< 362	< 785	2.53	< 3.12	< 1.47	< 1.42	< 1.42	< 2.8	< 0.48	< 1.50	< 1.50	1.49	< 1.64	< 1.43	< 1.50	< 2.49	< 1.56	< 1.22
PSV-11	32,500	1,440	33,940	65.4	90	3.7	3.96	10.1	14.06	< 0.48	< 1.51	< 1.51	< 1.22	2.2	< 1.43	< 1.51	< 2.50	< 1.56	< 1.22
PSV-12	90,500	1,930	92,430	398	153	82.1	144	1,020	1,164	< 0.48	16.9	22.7	< 1.22	6.59	< 1.43	7.4	< 2.50	1.7	< 1.22
PSV-13	869	4,350	5,219	< 2.37	11.3	< 1.47	9	7.31	16.31	< 0.48	492	297	< 1.22	< 1.65	4.06	4.62	< 2.51	2.31	< 1.22
PSV-14	10,700	529	11,229	322	10.2	< 1.47	< 1.42	2.41	3.12	< 0.48	2.52	< 1.50	< 1.22	< 1.64	< 1.43	< 1.50	100	< 1.56	8.94
PSV-15	1,150	360	1,510	3.59	7.22	< 1.46	< 1.41	2.1	2.805	< 0.47	< 1.49	< 1.49	< 1.21	< 1.63	< 1.42	< 1.49	< 2.48	< 1.55	3.26
PSV-17	10,300	691	10,991	614	233	62.2	80.6	247	327.6	< 0.48	24.2	21.7	< 1.22	< 1.65	< 1.43	4.66	< 2.50	< 1.56	< 1.22
PSV-18	2,000	564	2,564	53.4	8.35	1.54	9.79	8.13	17.92	< 0.48	6.47	< 1.51	< 1.22	< 1.65	122	< 1.51	8.92	< 1.56	4.62
PSV-19	33,100	1,380	34,480	< 2.36	15.3	< 1.47	< 1.42	< 1.42	< 2.8	< 0.48	< 1.51	< 1.51	< 1.22	3.65	< 1.43	< 1.51	< 2.50	< 1.56	< 1.22
PSV-20	117,000	1,540	118,540	46.6	153	8.96	5.69	20	25.69	< 0.48	< 1.50	< 1.50	< 1.22	< 1.64	< 1.43	< 1.50	< 2.50	< 1.56	< 1.22
PSV-21	50,600	1,740	52,340	1,300	114	81	73	508	581	< 0.48	46.8	38	< 1.22	4.28	< 1.43	16.8	< 2.50	< 1.56	< 1.22
PSV-22	1,390	385	1,775	3.5	11.7	< 1.47	1.71	4.02	5.73	3.96	2.28	< 1.50	< 1.22	< 1.64	< 1.43	< 1.50	< 2.50	< 1.56	6.09
PSV-23	18,600	1,240	19,840	14.2	6.19	< 1.47	< 1.42	1.51	2.22	< 0.48	< 1.50	< 1.50	< 1.22	< 1.64	< 1.43	< 1.50	< 2.50	< 1.56	6.56
PSV-24	958	914	1,872	< 2.36	121	5.87	11.9	25.6	37.5	< 0.48	< 1.50	< 1.50	< 1.22	< 1.64	7.09	< 1.50	< 2.50	< 1.56	< 1.22
PSV-25	1,500	831	2,331	21.8	108	4.7	7.33	19.8	27.13	< 0.48	< 1.50	< 1.50	< 1.22	2.92	< 1.43	< 1.50	< 2.50	< 1.56	< 1.22
PSV-26	109,000	10,700	119,700	62.3	43.4	5.63	2.52	5.25	7.77	< 0.48	3.73	2.17	< 1.22	11	< 1.43	< 1.50	< 2.50	2.56	< 1.22
PSV-27	22,100	1,000	23,100	23.6	129	5.36	10.4	21.7	32.1	< 0.48	< 1.50	< 1.50	< 1.22	< 1.64	< 1.43	< 1.50	< 2.50	< 1.56	< 1.22
PSV-28	1,460	435	1,895	6.43	9.95	< 1.47	< 1.42	2.84	3.55	0.96	1.7	< 1.50	< 1.22	< 1.64	11.8	< 1.50	< 2.50	< 1.56	2.90
PSV-29	1,140	381	1,521	4.65	8.7	< 1.47	< 1.42	2.85	3.56	2.09	1.64	< 1.50	< 1.22	< 1.64	< 1.43	< 1.50	< 2.50	< 1.56	10.0

- Notes:
- 1. Only analytes detected at concentrations above the laboratory reporting limit are shown. See Laboratory Report for complete analyte list.
 - µg/m³ = micrograms per cubic meter
 - µ Compound not on scope of accreditation of laboratory.
 - * Total TPH and Total Xylenes were calculated assuming a concentration of 1/2 the laboratory reporting limit for non-detected constituents.
 - indicates there is no established CWSL for the associated analyte.
 - < indicates the detected concentration is less than the laboratory reporting limit.

TPH = Total Petroleum Hydrocarbons
VOCs = Volatile Organic Compounds

Table 6 - Soil, Groundwater, and Sub-Slab Soil Vapor Sample Analytical Specifications

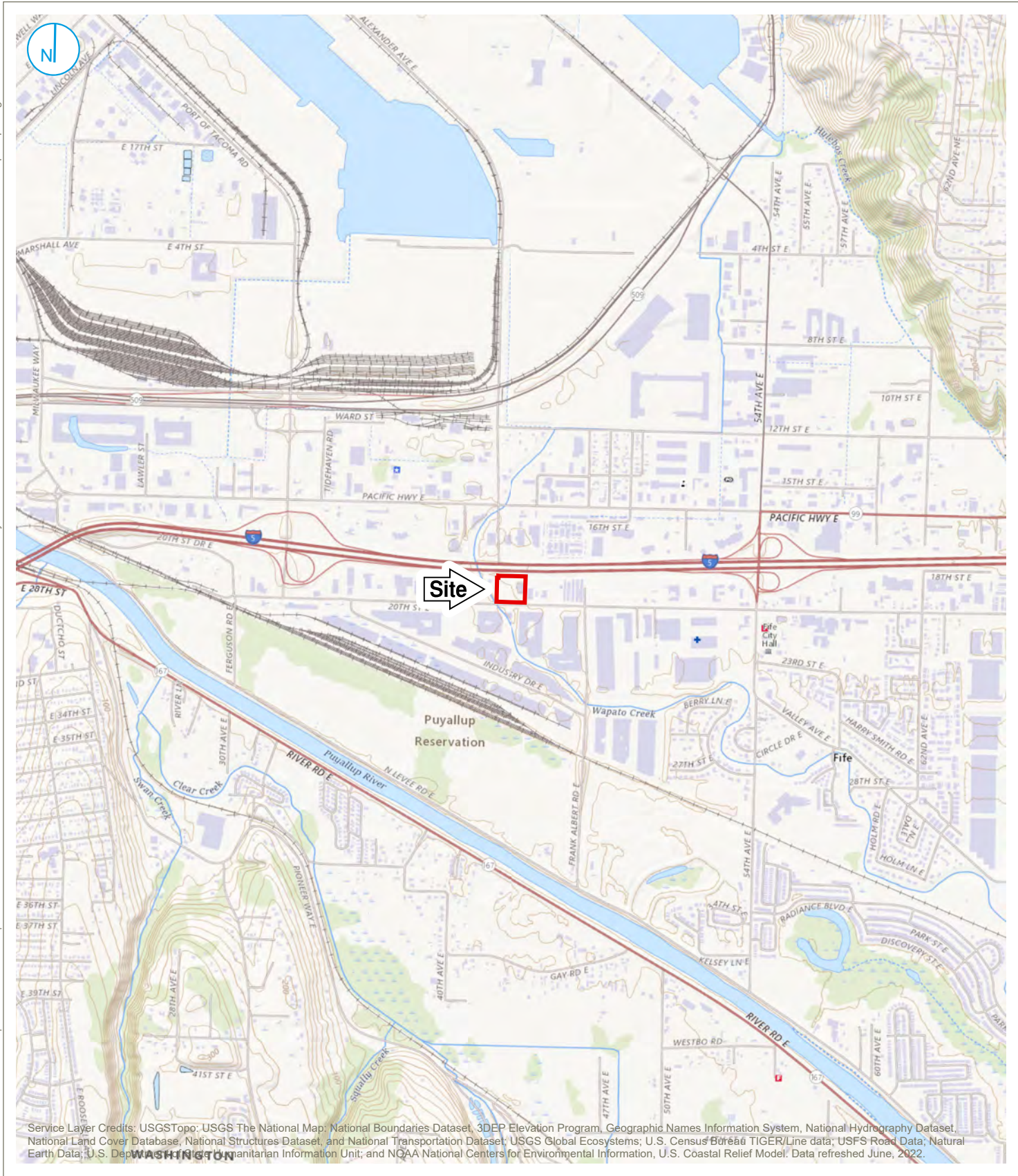
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Honda of Fife
4301 20th Street East
Fife, Washington

Media	Analyte Group	Analytical Method	Maximum Hold Time	Container	Preservative; Maximum Temperature
Soil	Gasoline-Range Petroleum Hydrocarbons (TPH-GRO)	NWTPH-Gx	48 hours	One 40mL Amber VOA Vial	Methanol; 4°C
Groundwater			14 days	One 40mL VOA Vial	HCl pH <2; 4°C
Soil	Volatile Organic Compounds (VOCs)	EPA Method 8260	48 Hours	Three 40mL VOA Vials	Two VOAs: Sodium Bisulfate; One VOA: Methanol; 4°C
Groundwater			14 days	One 40mL VOA Vial	HCl pH <2; 4°C
Soil	Ethanol & Methanol	EPA Method 8015	48 hours	Two 4oz Clear Glass Jars	None; 4°C
Groundwater			14 days	Three 40mL VOA Vials	HCl pH <2; 4°C
Groundwater	Soluble Manganese and Ferrous Iron	EPA Method 200.7	6 Months	250ml LDPE Bottle	Nitric Acid pH <2; 4°C
Groundwater	Nitrate	EPA Method 300.0	48 Hours	250ml LDPE Bottle	None; 4°C
Groundwater	Sulfate	EPA Method 300.0	28 Days	250ml LDPE Bottle	None; 4°C
Groundwater	Alkalinity	EPA Method 310.2	14 Days	250ml LDPE Bottle	None; 4°C
Groundwater	Methane	EPA Method RSK175	14 Days	Three 40mL VOA Vials	HCl pH <2; 4°C
Sub-Slab Soil Vapor	Aliphatic and Aromatic Petroleum Hydrocarbons (APH) and VOCs	TO-15	28 Days	1L Evacuated Canister	None; 20°C

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FIGURES



Service Layer Credits: USGSTopo; USGS The National Map; National Boundaries Dataset; 3DEP Elevation Program; Geographic Names Information System; National Hydrography Dataset; National Land Cover Database; National Structures Dataset; and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of the Interior, National Wetlands Inventory; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed June, 2022.

Map Scale: 1:24,000 | Map Center: 122°22'19"W 47°14'23"N



KEY MAP (not to scale)

LEGEND

 Approximate Site Boundary

SITE LOCATION

FIGURE 1

Honda of Fife
4301 20th Street East
Fife, Washington

RAMBOLL US CONSULTING, INC.
A RAMBOLL COMPANY





LEGEND

- Monitoring Well
- Interior Wall (Approximate)
- Sewer Line Encountered in Excavation Area
- Former USTs

- Approximate Excavation Areas
- Initial UST Excavation Boundaries (1998)
 - Second UST Excavation Boundaries (2000)
 - Visible Boundary of Disturbed Asphalt (Observed 2022)

- Approximate Site Boundary

0 25 50 Feet

Notes

1. Excavation boundaries derived from historical reporting.

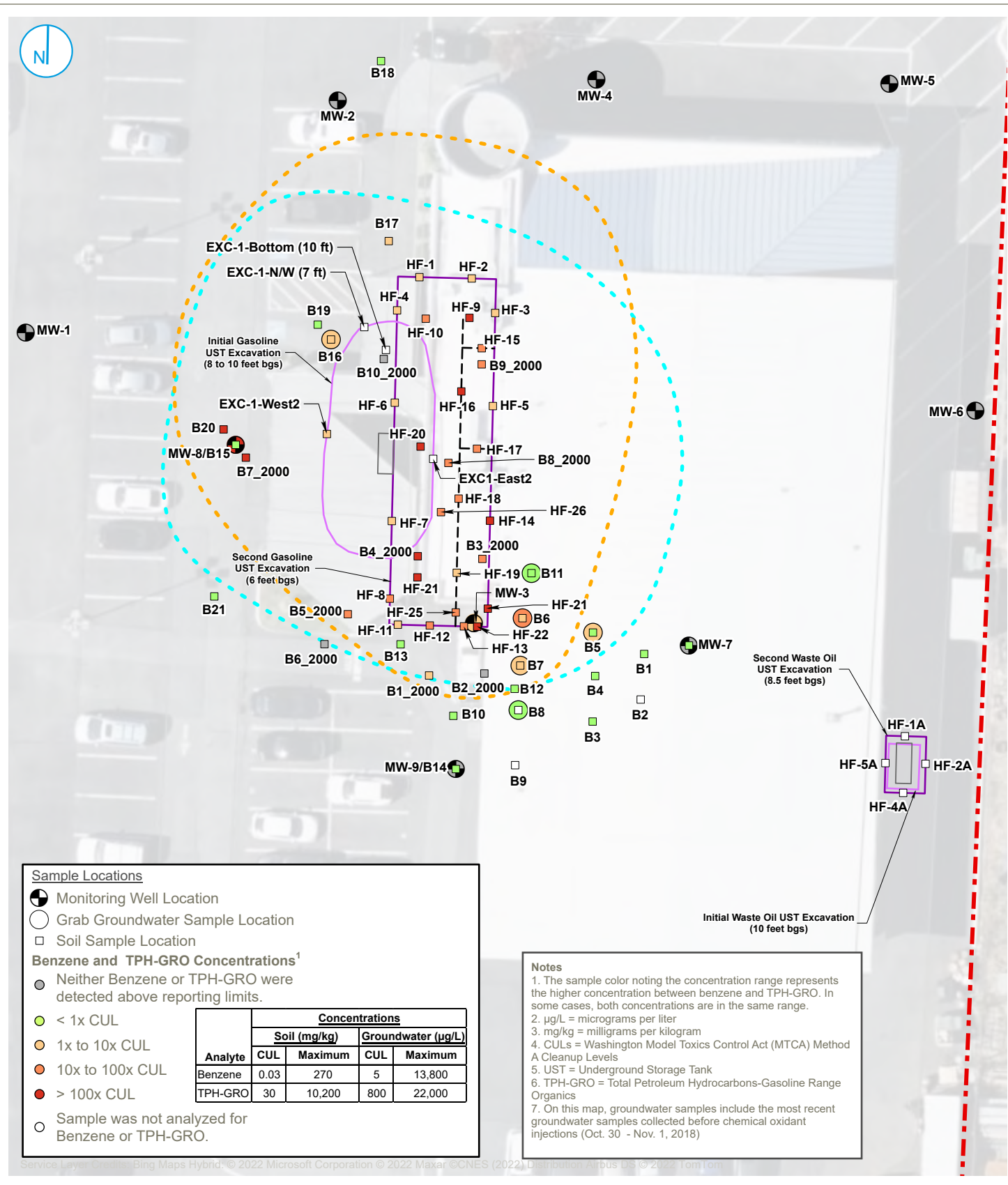
SITE PLAN

Honda of Fife
4301 20th Street East
Fife, Washington

FIGURE 2

RAMBOLL US CONSULTING, INC.
A RAMBOLL COMPANY





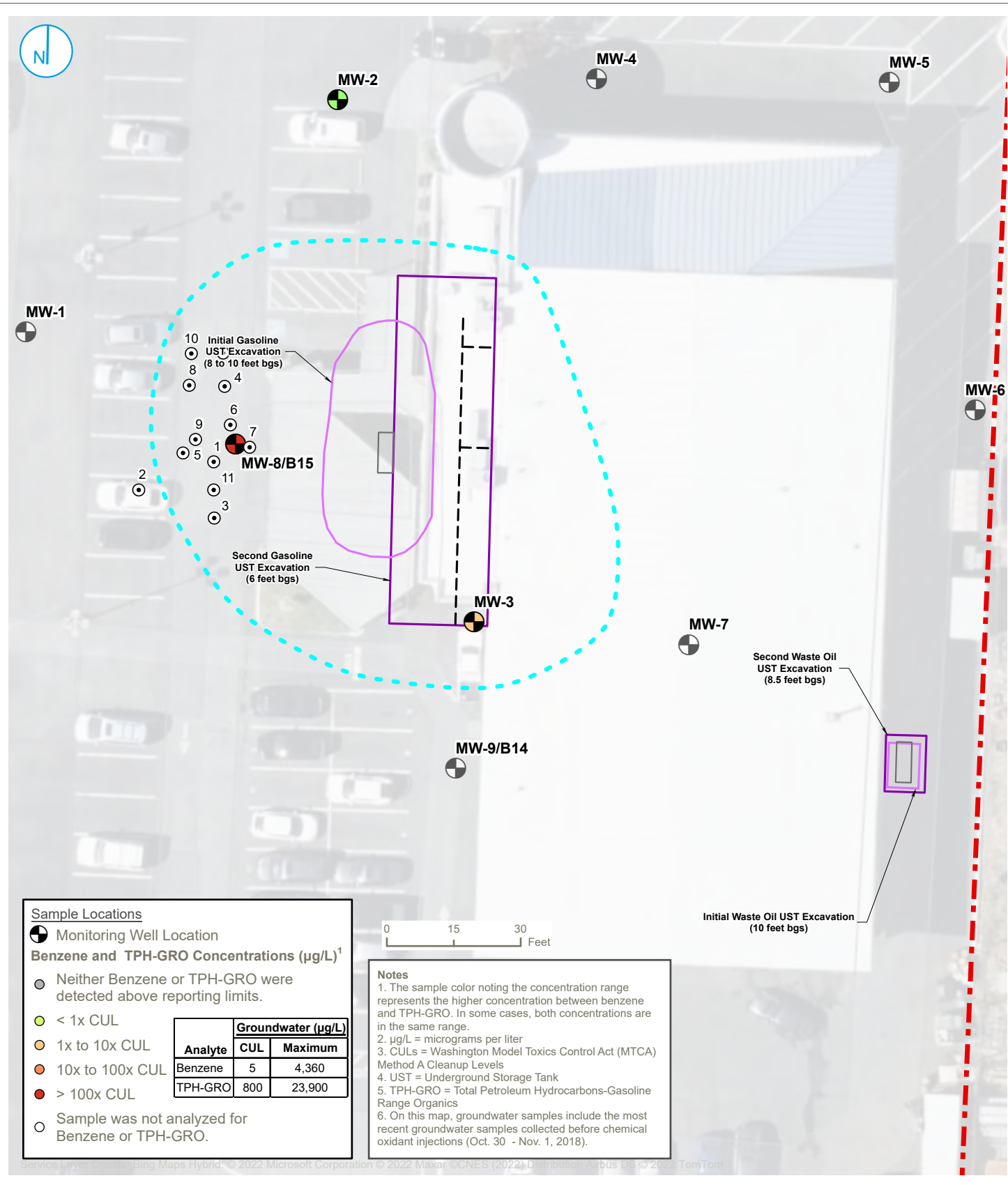
CUL EXCEEDANCES IN SOIL AND GROUNDWATER SAMPLES BEFORE 2018 REMEDIAL ACTION

FIGURE 3

RAMBOLL US CONSULTING, INC.
A RAMBOLL COMPANY

Honda of Fife
4301 20th Street East
Fife, Washington

RAMBOLL



LEGEND

- Approximate Site Boundary
- Former USTs
- Initial UST Excavation Boundaries (1998)
- Second UST Excavation Boundaries (2000)
- Sewer Line Encountered in Excavation Area
- Injection Locations (Oct. 30 - Nov. 1 2018)
- Area of Benzene and/or TPH-GRO Exceedance (MTCA)**
- Estimated extent of affected groundwater

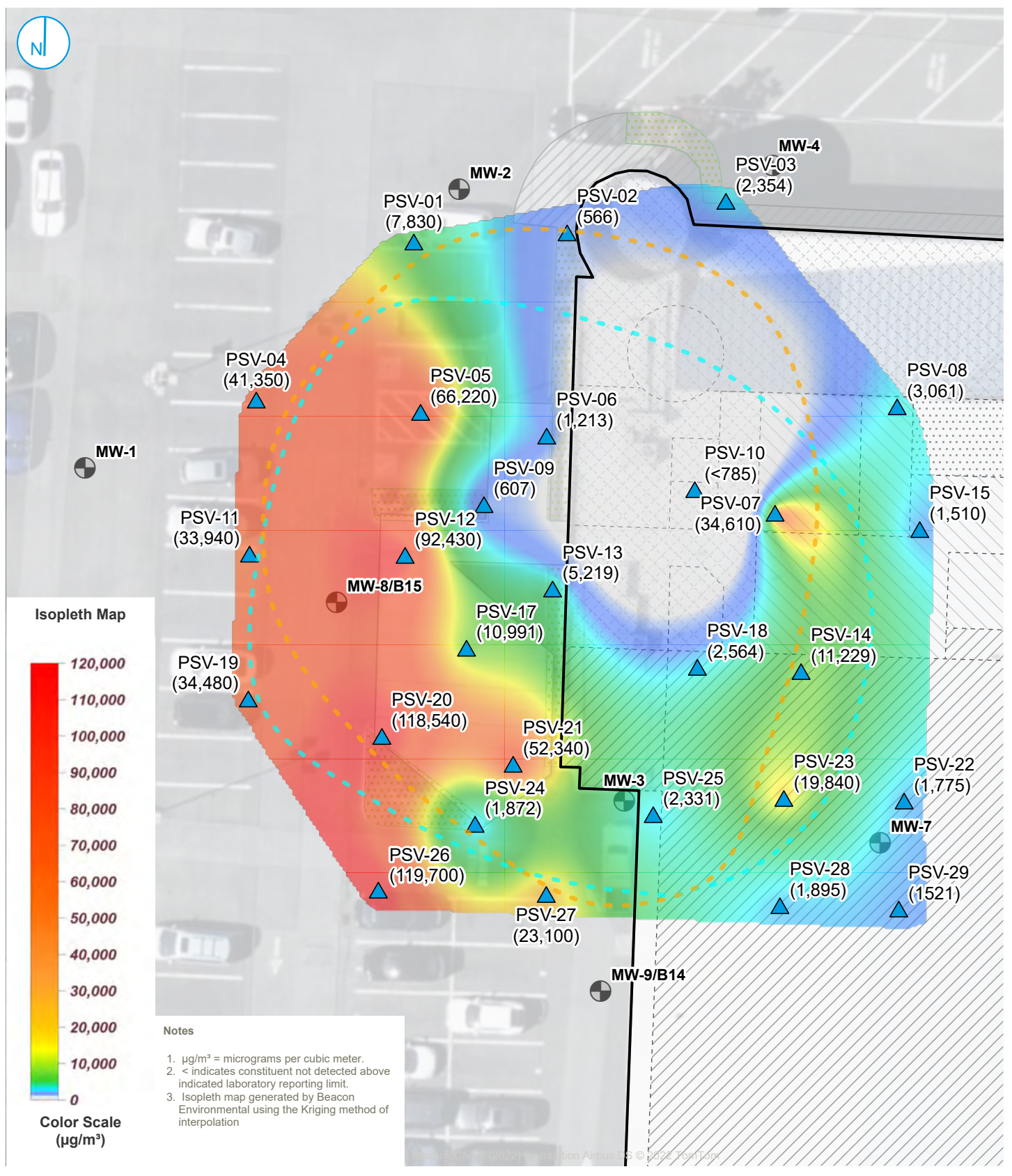
**CUL EXCEEDANCES IN
GROUNDWATER SAMPLES
AFTER 2018 REMEDIAL ACTION**

FIGURE 4

RAMBOLL US CONSULTING, INC.
A RAMBOLL COMPANY

Honda of Fife
4301 20th Street East
Fife, Washington

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LEGEND

- ▲ Passive Soil Vapor Sample (Detected Concentration in µg/m³)
- Groundwater Monitoring Well
- Estimated Extent of Impacted Groundwater (2019)
- - - Estimated Extent of Impacted Soil (2017)
- ▭ Dealership Building
- ▭ Overhead Cover
- ▨ Exterior Concrete
- ▨ Landscaping
- ▨ Carpet on Concrete
- ▨ Interior Exposed Concrete
- ▨ Epoxy on Concrete
- ▨ Tile on Concrete
- ▭ Dealership Building
- Interior Wall (Approximate)

PASSIVE SOIL VAPOR ANALYTICAL RESULTS TOTAL TPH

0 12½ 25 Feet

Honda of Fife
4301 20th Street East
Fife, Washington

FIGURE 5

RAMBOLL US CONSULTING, INC.
A RAMBOLL COMPANY

RAMBOLL



LEGEND

- Monitoring Well
- Interior Wall (Approximate)
- Sewer Line Encountered in Excavation Area
- Former USTs
- Approximate Site Boundary

Planned Exploration Locations (Maximum Depth)

- Monitoring Well (15 ft bgs)
- Soil Boring (15 ft bgs)
- Contingency Soil Boring (15 ft bgs)
- Sub-Slab Soil Vapor Sampling Point

PLANNED SUPPLEMENTAL REMEDIAL INVESTIGATION

Notes

- 1. ft bgs = feet below ground surface
- 2. Excavation boundaries derived from historical reporting.

Honda of Fife
4301 20th Street East
Fife, Washington

FIGURE 6

RAMBOLL US CONSULTING, INC.
A RAMBOLL COMPANY



DRAFT

APPENDIX A

Limited Passive Soil Vapor Survey Report

Renee Lee
Honda of Fife
4301 20th Street East
Fife, Washington 98424
rlee@hondaoffife.com

**LIMITED PASSIVE SOIL VAPOR SURVEY
4301 20TH STREET EAST
FIFE, WASHINGTON**

Dear Ms. Lee,

Ramboll US Consulting, Inc. (Ramboll) has prepared this Passive Soil Vapor Survey Report for the Honda of Fife (Honda) property located at 4301 20th Street East in Fife, Washington ("the Site"; Figure 1) to support decision-making regarding completion of site remediation and pursuit of a "No Further Action" (NFA) designation. The Site is identified by the Washington State Department of Ecology (Ecology) as an "Independent Action" with Cleanup Site ID #10299 and Facility Site ID #72856623, and as Underground Storage Tank (UST) Site ID #10218.

Ramboll previously prepared a Soil, Soil Vapor, and Groundwater Investigation Work Plan (the "2022 Work Plan") dated June 21, 2022, which summarized the results of previous investigations of the Site and proposed the completion of a limited soil vapor survey and groundwater measurements to gain additional information regarding the lateral extent of impacted soil and groundwater.

This letter presents the results of the groundwater well evaluation and the passive soil vapor survey and provides recommendations for future investigations guided by these findings.

SITE SETTING

The approximately 3.5-acre Site is in a mixed commercial and residential area of Fife, Washington (Pierce County), southeast of downtown Tacoma, and adjacent to Interstate Highway 5 (Figure 1). The Port of Tacoma/Commencement Bay are located approximately 1-mile northwest at their nearest points to the Site. The nearest surface water is Wapato Creek, which flows northward towards Commencement Bay, and passes within 50 feet of the southwest corner of the Site. Approximately 3,200 feet southwest of the Site, the Puyallup River flows northwest towards Commencement Bay.

Geology and Hydrogeology

The primary surface soils at this site, as mapped by the Soil Survey of Pierce County Area, U.S. Department of Agriculture, are Sultan silt loam, a moderately well-drained soil located on the bottomlands of the Puyallup and White Rivers. Soil permeability is moderately slow, with a high available water capacity.

November 29, 2022

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The subsurface geology in the Site vicinity consists of loose, stratified fine- and coarse-grained sediments consistent with deposition in terminal river valleys. The Site is located within the Lower Puyallup River Valley, which serves as a discharge zone for ground water from the Puyallup River Valley and neighboring upland areas¹. The regional depth to groundwater generally ranges from 0 to 30 feet below ground surface (ft bgs) and may be influenced by tides and seasonal fluctuations.

Previous Site investigations, including the completion of 21 soil borings and the installation of nine monitoring wells by others, have identified gravelly sand (imported fill material) from the ground surface to depths ranging from approximately two to six feet below ground surface (ft bgs), overlying silty sands with various layers of clayey silts, gravels, and organic debris to the maximum depth of exploration (18 ft bgs in 2019). Boring logs from previous investigations are provided in Appendix B. Soil boring locations and monitoring well locations are illustrated on Figure 3.

Groundwater has reportedly been encountered between approximately five and ten ft bgs depending on the time of year; groundwater levels are typically highest (shallowest) in spring and summer, and lowest (deepest) in the fall and winter. Groundwater measurements from previous investigations are summarized in Table 1.

Previous Assessments

Petroleum contamination is present in soil and groundwater at the Site due to the historical release from a former gasoline UST and fueling system which was removed from the Site by 1998. In addition to removal of the former UST and fueling system, soils surrounding the UST were removed in 1998 and 2000. Based on records in Ecology's cleanup site database, numerous reports were submitted to Ecology related to monitoring and remediation efforts at the Site between 1999 and 2019. Specifically, three groundwater wells were installed in 1999 (MW-1, MW-2, and MW-3) in the vicinity of the former UST system, followed by completion of 10 soil borings (B1 through B10) in 2000. Sampling of MW-1, MW-2, and MW-3 was completed on a quarterly basis between 1999 and 2003, then on a semi-annual basis from 2004 to 2007. In 2016, three monitoring wells were installed (MW-4, MW-5, and MW-6), and in 2017, 11 soil borings (B11 through B21) were completed. In 2018, three groundwater wells (MW-7, MW-8, MW-9) were installed as part of a supplemental remedial investigation in preparation for additional remedial activities. The additional remedial action consisted of an initial subsurface injection of a chemical oxidant (PersulfOx®, a Regenes Inc. product) used to reduce contaminant mass in the vicinity of the "core" of the known contamination on the Site. The initial chemical oxidant injection resulted in an immediate decrease of gasoline and benzene concentrations in MW-8 but increasing concentrations in MW-3. Subsequent groundwater sampling indicated rebounding contaminant concentrations, and groundwater sampling ceased after 2019.

Existing data were summarized in Ramboll's June 21, 2022, work plan, and used to estimate the extent of exceedances of regulatory criteria in soil and groundwater as of the latest available sampling in each media (2017 for soil; 2019 for groundwater). The cumulative set of sample locations, exceedances of regulatory criteria, and estimated extents of exceedances in soil and groundwater are shown on Figure 3.

Data gaps identified in the work plan included:

- Lateral bounding of soil and groundwater contamination
- Documentation associated with MW-4, MW-5, and MW-6
- Evaluation of groundwater flow direction

¹ United States Geological Survey, 1999. *Ground-Water Hydrology of the Tacoma-Puyallup Area, Pierce County, Washington*. Water-Resources Investigations Report 99-4013. <https://pubs.er.usgs.gov/publication/wri994013>

- Survey data for on-Site monitoring wells

To characterize the locations of remaining subsurface contamination, and support decision-making regarding next steps, Ramboll implemented the field program described in the June 21, 2022, work plan. This work is summarized below, followed by the findings from the program.

SUMMARY OF FIELD PROGRAM

Ramboll implemented a field program that included the following components:

- Evaluate condition of existing monitoring wells and measure depth to water and total depth in each well.
- Implement a passive soil vapor survey, the scope of which is described below.

This section summarizes each component of the field program, the results of which are discussed in subsequent sections.

Field Preparation

Prior to initiation of subsurface investigation activities, the following activities were performed:

- A site-specific Health and Safety Plan (HASP) was prepared to manage and minimize exposure of Ramboll's field personnel to potentially hazardous materials and field conditions.
- A Site visit was conducted on July 13, 2022, to identify the proposed boring locations and measure groundwater elevations in the existing monitoring wells.
- The Utility Notification Center (UNC) was contacted to notify public and private utility agencies of Ramboll's intent to drill at the Site. Utility companies notified included Puget Sound Energy (gas and electric), Lumen (formerly CenturyLink; telecommunications), Comcast Cable, Rainier Connect North, Tacoma PWR and Click Network.
- Ramboll retained the following subcontractors:
 - Underground Detection Services (UDS), a private utility-locating and ground-penetrating radar (GPR) scanning company was contracted to identify on-Site utilities and/or potential subsurface features (e.g., tanks) or anomalies in the vicinity of the proposed soil vapor locations. No unknown subsurface utilities or other anomalies were detected during the survey.
 - Beacon Environmental, a NELAP-certified² laboratory, was contracted to provide sample installation tools, passive sample collection media, and laboratory analysis of passive soil vapor samples collected during the Site investigation activities.

Groundwater Measurements

On July 13th, 2022, Ramboll collected depth-to water measurements for the nine monitoring wells (MW-1 through MW-9). The depth-to-water meter was decontaminated following measurement at each location using Liquinox and distilled water wash. Measured groundwater elevations are presented in Table 1. Groundwater elevation isocontours can be mapped for this set of measurements after a survey of well casing elevations is completed at a later date. The survey should be completed after installation of additional monitoring wells, as recommended. A compilation of boring logs and well completion reports is provided in Appendix B.

² National Environmental Laboratory Accreditation Program. Beacon Environmental is currently in the process of receiving recognition of 3rd-party accreditation by the Washington State Department of Ecology.

Passive Soil Vapor Sample Collection and Analysis

On August 4, 2022, passive soil vapor samplers were temporarily installed at 28 locations across the Site at a depth of approximately 6 inches below ground surface (in bgs; Figure 4). Soil vapor samplers (consisting of sorbent media contained in glass vials, which have closed caps which are temporarily replaced with mesh-screened caps during sampling) were provided by Beacon Environmental Services, and the sampling was conducted in general accordance with Ecology guidance³ for soil vapor investigations and best practices for passive soil vapor sampling.

At each location, a hammer drill was used to drill an approximately 1.5-inch diameter upper boring to approximately 14 in bgs. From the base of the upper boring, an approximately 0.5-inch diameter boring was advanced an additional approximately 32 inches, for a total boring depth of approximately 50 inches. An approximately 1-inch diameter, 12-inch-long stainless-steel tube was then inserted into the upper boring. A passive soil vapor sampler fitted with a screened cap was then suspended by a retrieval wire from the tube at the target depth of 6 in bgs. The top of the tube and upper boring was then plugged with aluminum foil and the surface patched with soil or concrete to match the surrounding ground surface. Time and date of installation was recorded for laboratory reference.

On August 17, 2022, the soil vapor sample media were retrieved after an exposure period of two weeks. Following removal, the samplers were wiped clean of soil debris, sealed with unscreened caps, labelled, and stored in preparation of shipping. At all locations, the stainless-steel tube was removed, the boring backfilled with clean sand, and patched to match the surrounding surface. Date and time of removal was documented for laboratory reference. After retrieving the samples, they were shipped by Ramboll field personnel to Beacon Environmental under chain-of-custody documentation. A total of 28 samples were submitted for analysis of volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH) by Environmental Protection Agency (EPA) Method 8260C.⁴ Laboratory reports are provided in Appendix B.

Concentration Isopleth Maps

Beacon Environmental provided concentration isopleth maps of detected concentrations of specific analytes at Ramboll's request. These isopleth maps were generated using the Kriging method of interpolation to estimate the distribution of contaminants between individual sample locations.

Concentration isopleth maps were generated for the following analytes:

- TPH C4-C9⁵
- TPH C10-C15
- Total TPH (summation of the TPH C4-C9 and TPH C10-C15 concentrations)
- Benzene
- Total BTEX (i.e., summation of detected concentrations of benzene, toluene, ethylbenzene, and xylenes)

The concentration isopleth map report produced by the laboratory is included in Appendix B.

³ Washington State Department of Ecology, *Guidance for Evaluating Vapor Intrusion in Washington State, Investigation and Remedial Action*, Publication No. 09-09-047, March 2022.

⁴ Refer to the laboratory reports for the full list of analyzed compounds.

⁵ C4-C9 refers to petroleum hydrocarbon compounds with equivalent carbon values between 4 and 9 which are commonly associated with gasoline; C10-C15 refers to petroleum hydrocarbon compounds with equivalent carbon values between 10 and 15 which are commonly associated with gasoline and diesel.

RESULTS

Depth to Groundwater Measurements

Ramboll accessed the nine monitoring wells installed on the Site and measured depth to groundwater in feet below top of casing (ft btoc) in each well. Depth to water ranged from 5.57 ft btoc (in MW-8) to 6.29 ft btoc (in MW-7), consistent with previous measurements at the Site. Well casing elevation survey data were not available in the existing Site reports. As such, a current groundwater elevation contour map could not be prepared but will be developed as part of future activities, following installation of any additional monitoring wells as needed. Based on previous reporting, groundwater appears to have a relatively low flow gradient, predominantly ranging in direction from north to northeast. However, historical groundwater flow directions towards the southeast, southwest, and northwest have also been reported. Depth to water measurements were not available for the monitoring wells installed in 2016 (MW-4 to MW-6) or 2018 (MW-7 to MW-9) and Ramboll has not identified surveyed elevations for those wells.

Passive Soil Vapor Samples and Concentration Maps

Of the 37 constituents analyzed by the laboratory, 17 constituents were detected in passive soil vapor samples above laboratory reporting limits: TPH C4-C9; TPH C10-C15; benzene; toluene; ethylbenzene; o-xylene; m,p-xylene; 1,1,1-trichlorobenzene, 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; 1,4-dioxane; 2-methylnaphthalene; chloroform; isopropylene (cumene); methyl-t-butyl ether (MTBE); naphthalene; and tetrachloroethene (PCE). These detections are presented on Table 2, and results are shown on concentration isopleth maps ("concentration maps"). Concentration maps of total TPH, benzene, TPH C4-C9, TPH C10-C15, and total BTEX are presented on Figure 5, 6, 7, 8, and 9, respectively.

The concentration maps indicated that TPH and BTEX compounds were detected in similar spatial patterns across the survey area, with two distinct areas of impacted soil vapor within the survey area: one area located beneath the central portion of the dealership building, and the other area located west of the dealership building. Detected concentrations of TPH (C4-C9, C10-C15, and total), benzene, and total BTEX were relatively low in soil vapor on the northeast, east, and southeast boundaries of the survey area, and in the central portion of the survey area (Figures 7, 8, 5, 6, and 9, respectively).

Beneath the central portion of the dealership building, concentration maps showed elevated concentrations of TPH C4-C9, total TPH, benzene, and total BTEX (Figures 7, 5, 6, and 9, respectively), relative to areas along the west, north, and eastern walls of the building. This survey did not detect TPH C10-C15 at significantly elevated concentrations beneath the dealership building (Figure 8).

West of the dealership building, the concentration maps indicated that elevated concentrations of benzene and total BTEX (Figures 6 and 9, respectively) were limited to an area which corresponds approximately to the southern end of the historical UST excavations, between the locations of MW-8 and MW-3. Concentrations of TPH C4-C9 and total TPH were also mapped as being most elevated in this area (Figures 7 and 5, respectively). However, mapped concentrations of TPH C4-C9 and total TPH remained elevated along the western edge of the survey area, indicating that the western extent of TPH-impacted soil vapor was not captured by this survey.

Concentration mapping of TPH C10-C15 indicated that elevated concentrations of this hydrocarbon range were present in the northwest and southwest corners of the survey area (Figure 8).

DISCUSSION AND RECOMMENDATIONS

Ramboll conducted a limited passive soil vapor sampling survey and measured depth to groundwater at the request of Honda of Fife to support decision-making regarding completion of site remediation and pursuit of an NFA determination. Results of this work indicate the following regarding the present state of petroleum impacts at the Site:

- A total of 28 passive soil vapor samples were collected from approximately 6 inches below ground surface across the Site, including 10 locations within the interior of the Honda of Fife dealership, and 18 outdoor locations west and north of the dealership structure. The samples were analyzed by Beacon Environmental for TPH and associated VOCs, and Beacon Environmental produced color isopleth maps of TPH C4-C9, TPH C10-C15, Total TPH, Benzene, and Total BTEX.
- The spatial distribution of detected concentrations of TPH C4-C9 (Figure 5) and benzene (Figure 6) indicate the presence of an area of impacted soil vapor beneath the central portion of the dealership structure, and an area of impacted soil vapor west of the dealership. The highest concentration of impacts in the western area are generally spatially aligned with previously identified impacts in soil and groundwater, with the highest concentrations of TPH C4-C9 and Benzene detected in the vicinity of MW-8. However, the northwestern, western, and southwestern extents of impacts to soil vapor are not well constrained, with several samples on the edge of the sampling grid (e.g. PSV-04, PSV-11, PSV-19, and PSV-26) containing elevated concentrations of TPH C4-C9 (Figures 5 and 6). This implies that impacts to soil and groundwater may extend further to the west than previously identified. Recommendations for further investigation to delineate the western extent of impacts in soil and groundwater are discussed below.
- Laboratory analysis of passive soil vapor samples collected from landscaped areas with exposed soil (e.g. PSV-02, PSV-09, PSV-13, PSV-20, and PSV-24) generally detected lower concentrations of TPH, benzene, and total BTEX in these samples than in nearby samples which were collected from locations capped with asphalt or concrete. These lower concentrations (relative to nearby samples) may be due to a “venting” effect enabled by the exposure of soil to free air, which may limit hydrocarbon vapors from accumulating in shallow soil in these locations. This effect may be driving some of the observed spatial patterns on the soil vapor concentration maps. As such, differences between the previously identified source of petroleum contamination at the Site (the former gasoline system) and the identified area of impacted soil vapor beneath the dealership building may be the result of soil vapor venting through exposed soils in planters along the western face of the dealership. Therefore, what appears in the concentration maps to be two distinct areas of impacted soil vapor may actually be a single contiguous area of impacted soil and groundwater.
- Ramboll measured depth to groundwater ranging from approximately 5.5 to 6.3 ft btoc across the Site. Historically, groundwater has been reported as shallow as 4.5 feet btoc, and as deep as 10 ft btoc, indicating an approximately 5.5-foot “smear zone”, i.e., the depth interval of petroleum impacts to soil as the petroleum-impacted groundwater table surface rises and falls over the course of the year. This smear zone is the likely source of vapors captured by the passive soil vapor survey.
- The shallow depth to water, wide range of reported groundwater flow directions, and shallow gradient indicate that groundwater elevation at the Site is likely primarily influenced by seasonal precipitation. The lack of a consistent groundwater flow direction and the reported presence of low-permeability soils underling the site are likely limiting the mobility of petroleum hydrocarbons in groundwater at the Site.

Based on the results of this passive soil vapor survey evaluated in combination with previous investigation results on the Site, Ramboll provides the following recommendations for future investigations in pursuit of regulatory closure:

- Installation of two additional monitoring wells to a depth of 15 feet below ground surface to address results of the passive soil vapor survey that indicate that petroleum impacts to groundwater may extend northwest and southwest of the former UST system and historical excavations (Figure 3, Figures 5 through 9; proposed new well locations MW-10 and MW-11 are presented on Figure 10). MW-10 and MW-11 are anticipated to complete the ring of wells bounding the known impacts to groundwater at MW-3 and MW-8, and improve the likelihood that migration of impacted groundwater would be detected in consideration of variable groundwater flow direction.
- Survey the locations and elevations of all wells (after installation of the proposed additional wells) to enable determination of groundwater elevations and flow direction(s).
- Resume routine groundwater sampling to determine the stability of the impacted groundwater plume, which would then be used to determine a specific pathway towards regulatory closure.
- Completion of eight shallow soil borings to approximately 15 feet below ground surface west of the dealership structure and collection of 2-to-3 soil samples per boring to assess current petroleum concentrations in soil north and west of MW-8 (Figure 3, Figures 5 through 9) as a follow-up to the 2018 subsurface injection of oxidizing chemicals (proposed locations presented on Figure 10). Two of these borings (proposed SB-01 and SB-02), in conjunction with analysis of soils collected during installation of proposed MW-10 and MW-11, would constrain the western extent of impacts within the shallow "smear zone" along a rough north-south transect west of the estimated western extent of impacts in soil and groundwater. Five of these borings (proposed SB-03 through SB-07) would be completed along a second north-south transect which would cross the zone of remedial injections completed in 2018 to assess current state of petroleum impacts to smear-zone soils in the zone of highest detected TPH impacts to soil vapor. One boring (proposed SB-08) would be completed in the vicinity of historical soil samples and would provide contemporary insight into the character and extent of impacted and yet-untreated soil north of the historical gasoline system. Groundwater grab samples from these soil borings would provide insight into the current extent of impacts in groundwater, as well.
- Installation of low-profile, permanent sub-slab soil vapor sampling points in the vicinity of PSV-07 and PSV-14 where screening levels protective of indoor air quality for commercial workers were exceeded beneath the dealership structure (proposed locations presented on Figure 10), to allow for assessment of the potential for vapor intrusion from impacted soil vapor, and to enable repeat sampling of the same locations following implementation of any further cleanup actions.
- Evaluate options for additional source-zone treatment based on delineation of the current lateral extent of impacted soil and hydrocarbon isoconcentration mapping following the proposed additional investigations.

LIMITATIONS

This letter has been prepared for the exclusive use of Honda of Fife and may not be relied upon by any other person or entity without Ramboll's prior express written permission.

This report has been prepared in conformance with generally accepted standards of practice in the fields of environmental sciences and engineering at the time the services were rendered. Ramboll makes no other warranty or representation, either expressed or implied, with respect to its services.

This investigation provided a limited survey of soil vapor conditions and current groundwater elevations. The level of detail carried out during Ramboll's investigation is appropriate to meet the

study objectives as defined in this report; however, there is no warranty or guarantee, expressed or implied, that this investigation has uncovered all potential latent environmental liabilities associated with the Property.

CLOSING

We appreciate the opportunity to assist you with your environmental projects. Please contact the undersigned if you have any questions.

Very truly yours,



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Attachments:

Tables:

Table 1: Summary of Groundwater Measurements

Table 2: Summary of Passive Soil Vapor Sample Analytical Results

Figures:

Figure 1: Site Location

Figure 2: Site Plan

Figure 3: Previous Investigations

Figure 4: Passive Soil Vapor Sample Locations

Figure 5: Passive Soil Vapor Total TPH Analytical Results

Figure 6: Passive Soil Vapor Benzene Analytical Results

Figure 7: Passive Soil Vapor TPH C4-C9 Analytical Results

Figure 8: Passive Soil Vapor TPH C10-C15 Analytical Results

Figure 9: Passive Soil Vapor Total BTEX Analytical Results

Figure 10: Estimated Extent of Impacted Media and Proposed Additional Exploration Locations

Appendices:

Appendix A: Laboratory Reports

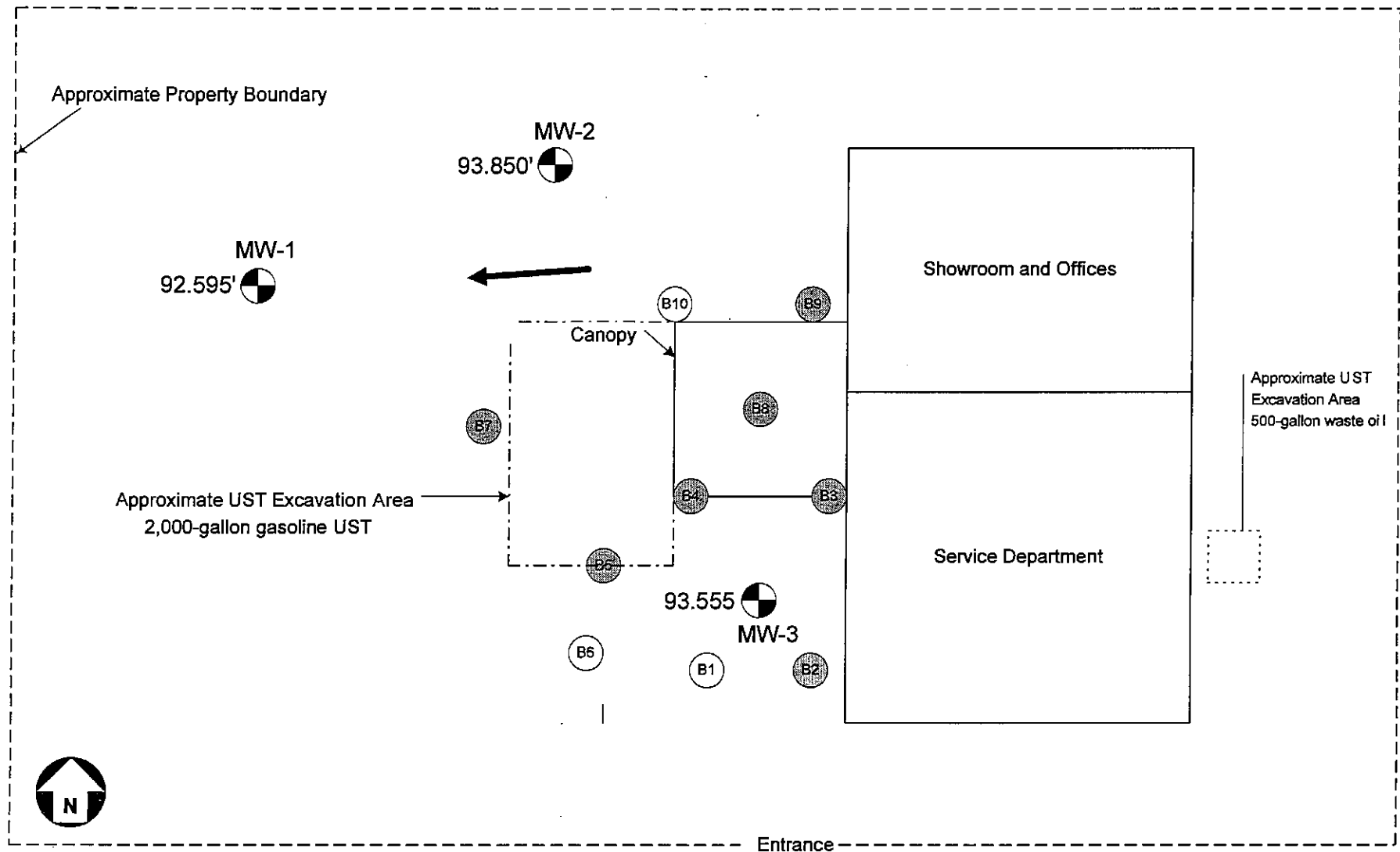
Appendix B: Historical Boring Logs & Monitoring Well Construction Logs

DRAFT

APPENDIX B

Historical Boring Logs and Monitoring Well Construction Logs

INTERSTATE 5



DESCRIPTION

**Honda of Fife
Boring Locations**

DATE

03/28/00

Saltbush
Environmental
Services, Inc.
TWS



Boring Location



Contamination Found above
MTCA Method A



Ground Water Monitoring Well Location



Assumed Ground Water Flow Direction

Test Pit/Bore/Well Log

Project Name: Honda of Fife				Date: 3-28-00	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Drilling Contractor: TEG, Inc.				Drilling Method: Direct Push	Boring Number: B1
Sampling Method: Continuos					
Licensed Driller:				Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See site diagram
			1	Gravely sand No staining or odor PID: 0.0	
			2		
			3		
			4		
			5	Sandy silts No staining or odor PID: 0.0	
			6		
			7		
			8		
			9	Bottom of Boring	
			10		
			11		
			12		
			13		
			14		
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

Test Pit/Bore/Well Log

Project Name: Honda of Fife				Date: 3-28-00	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Drilling Contractor: TEG, Inc.				Drilling Method: Direct Push	Boring Number: B2
Sampling Method: Continuos					
Licensed Driller:				Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See site diagram
			1	Gravely sand No staining or odor PID: 0.0 Sandy silts No staining or odor PID: 0.0 Bottom of Boring	
			2		
			3		
			4		
			5		
			6		
			7		
			8		
			9		
			10		
			11		
			12		
			13		
			14		
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

Test Pit/Bore/Well Log

Project Name: Honda of Fife				Date: 3-28-00	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Boring Number: B3					
Drilling Contractor: TEG, Inc.		Drilling Method: Direct Push		Sampling Method: Continuos	
Licensed Driller:		Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite			
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See site diagram
			1	Gravely sand No staining or odor PID: 0.0	
			2		
			3		
			4		
			5	Sandy silts Petroleum odor PID: 20.0	
			6		
			7		
			8		
			9	Bottom of Boring	
			10		
			11		
			12		
			13		
			14		
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

Test Pit/Bore/Well Log

Project Name: Honda of Fife				Date: 3-28-00	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Boring Number: B4		Drilling Contractor: TEG, Inc.		Drilling Method: Direct Push	
Sampling Method: Continuos		Licensed Driller:		Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See site diagram
			1	Gravely sand Strong petroleum odor PID: 2,500.0 Sandy silts Heavy Petroleum odor Dark staining of soil PID: 2,500.0	
			2		
			3		
			4		
			5		
			6		
			7		
			8		
			9	Bottom of Boring	
			10		
			11		
			12		
			13		
			14		
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

Test Pit/Bore/Well Log

Project Name: Honda of Fife				Date: 3-28-00	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Boring Number: B5		Drilling Contractor: TEG, Inc.		Drilling Method: Direct Push	
Sampling Method: Continuos		Licensed Driller:		Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See site diagram
			1	Gravely sand No staining or odor PID: 2,500.0 Light gray sand Sandy silts Heavy Petroleum odor PID: 2,500.0 Bottom of Boring	
			2		
			3		
			4		
			5		
			6		
			7		
			8		
			9		
			10		
			11		
			12		
			13		
			14		
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

Test Pit/Bore/Well Log

Project Name: Honda of Fife				Date: 3-28-00	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Drilling Contractor: TEG, Inc.		Drilling Method: Direct Push		Boring Number: B6	
Licensed Driller:		Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite		Sampling Method: Continuos	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See site diagram
			1	Gravely sand No staining or odor PID: 0.0 Sandy silts No staining or odor PID: 0.0 Bottom of Boring	
			2		
			3		
			4		
			5		
			6		
			7		
			8		
			9		
			10		
			11		
			12		
			13		
			14		
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

Test Pit/Bore/Well Log

Project Name: Honda of Fife				Date: 3-28-00	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Boring Number: B7		Drilling Contractor: TEG, Inc.		Drilling Method: Direct Push	
Sampling Method: Continuos		Licensed Driller:		Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See site diagram
			1	Gravely sand Petroleum odor PID: 1,200.0 Light gray sand	
			2		
			3		
			4		
			5	Sandy silts Petroleum odor PID: 150.0	
			6		
			7		
			8		
			9	Bottom of Boring	
			10		
			11		
			12		
			13		
			14		
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

Test Pit/Bore/Well Log

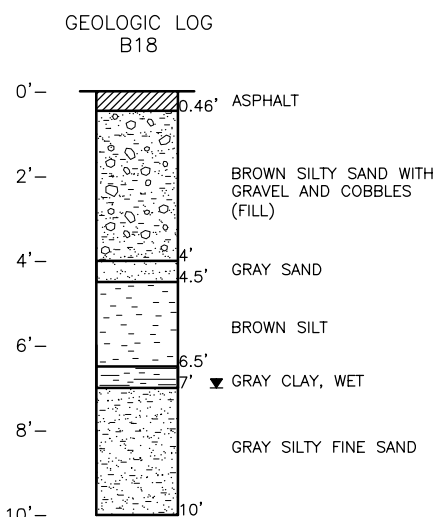
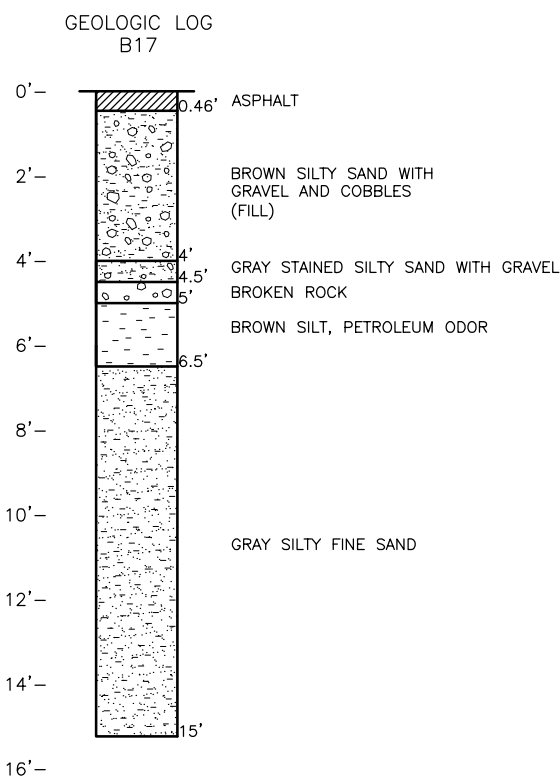
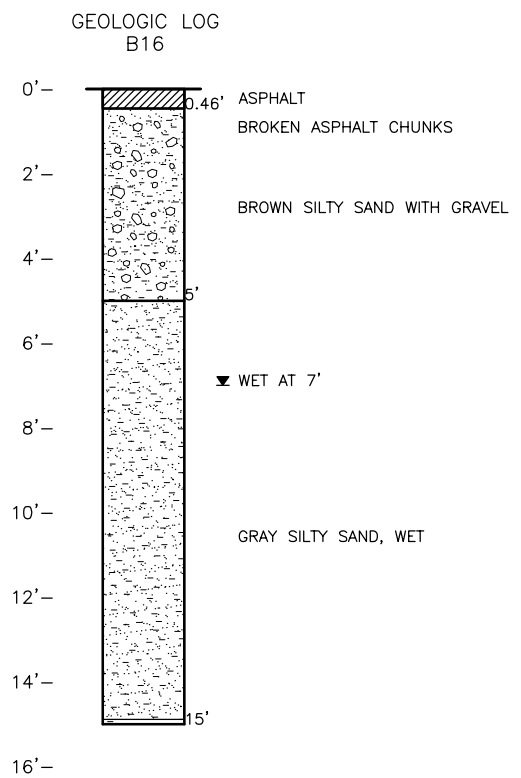
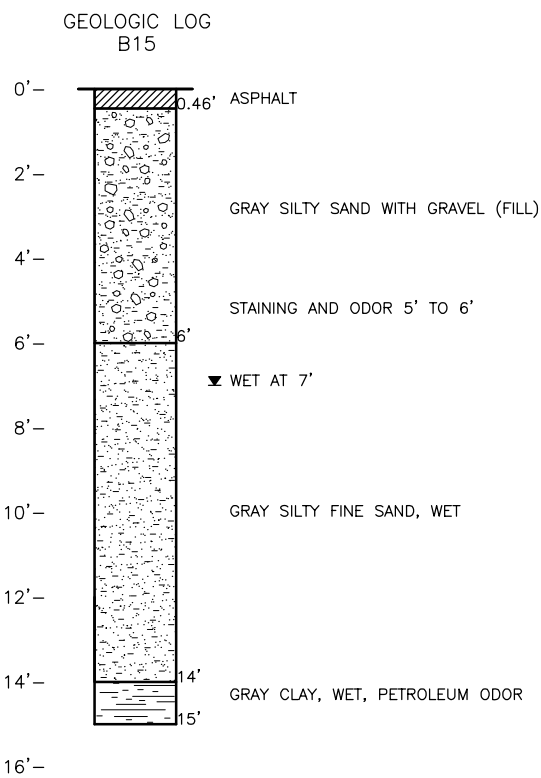
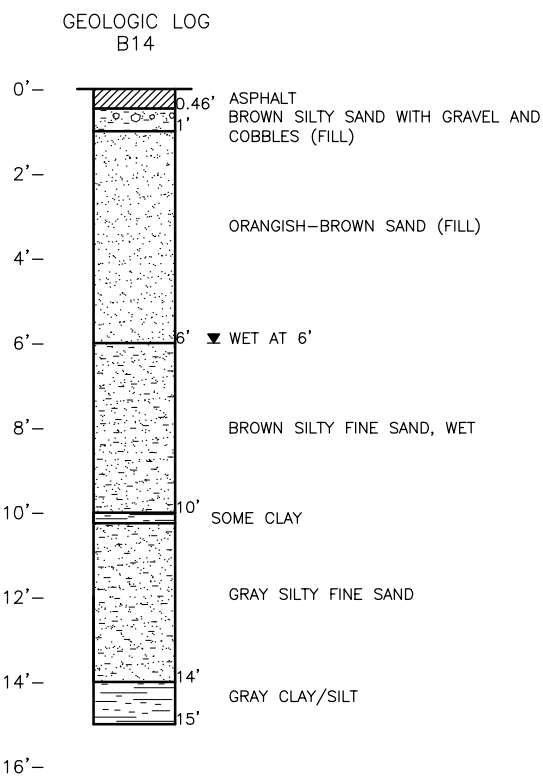
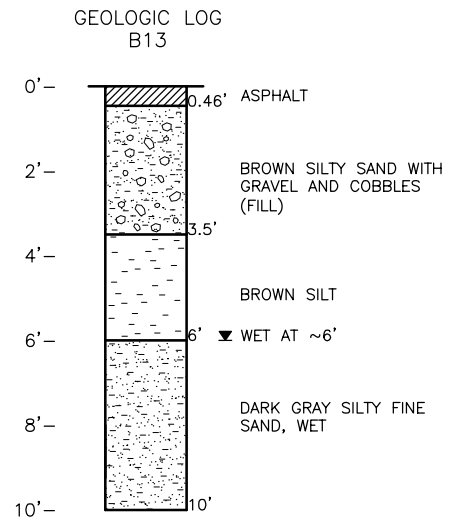
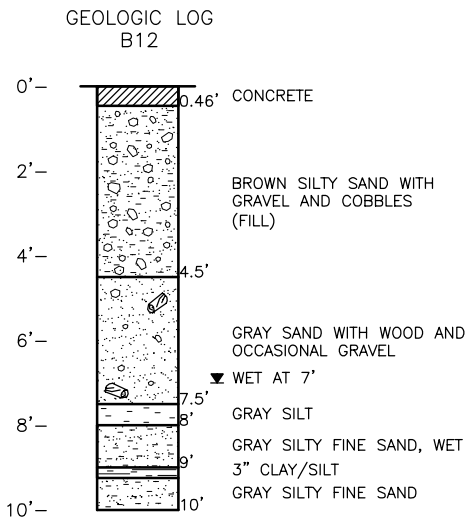
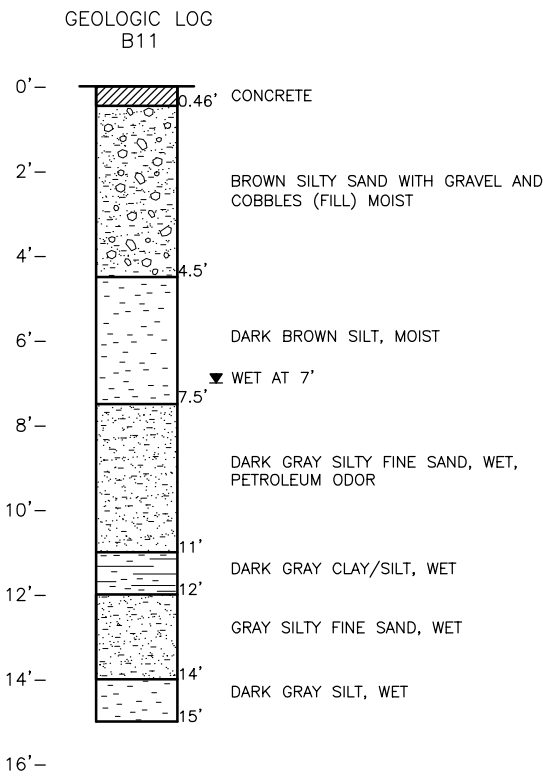
Project Name: Honda of Fife				Date: 3-28-00	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Boring Number: B8		Drilling Contractor: TEG, Inc.		Drilling Method: Direct Push	
Sampling Method: Continuos		Licensed Driller:		Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Concrete	Bore Location: See site diagram
			1	Gravely sand Petroleum odor PID: 2,500.0 Sandy silts Petroleum odor PID: 1,700.0 Bottom of Boring	
			2		
			3		
			4		
			5		
			6		
			7		
			8		
			9		
			10		
			11		
			12		
			13		
			14		
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

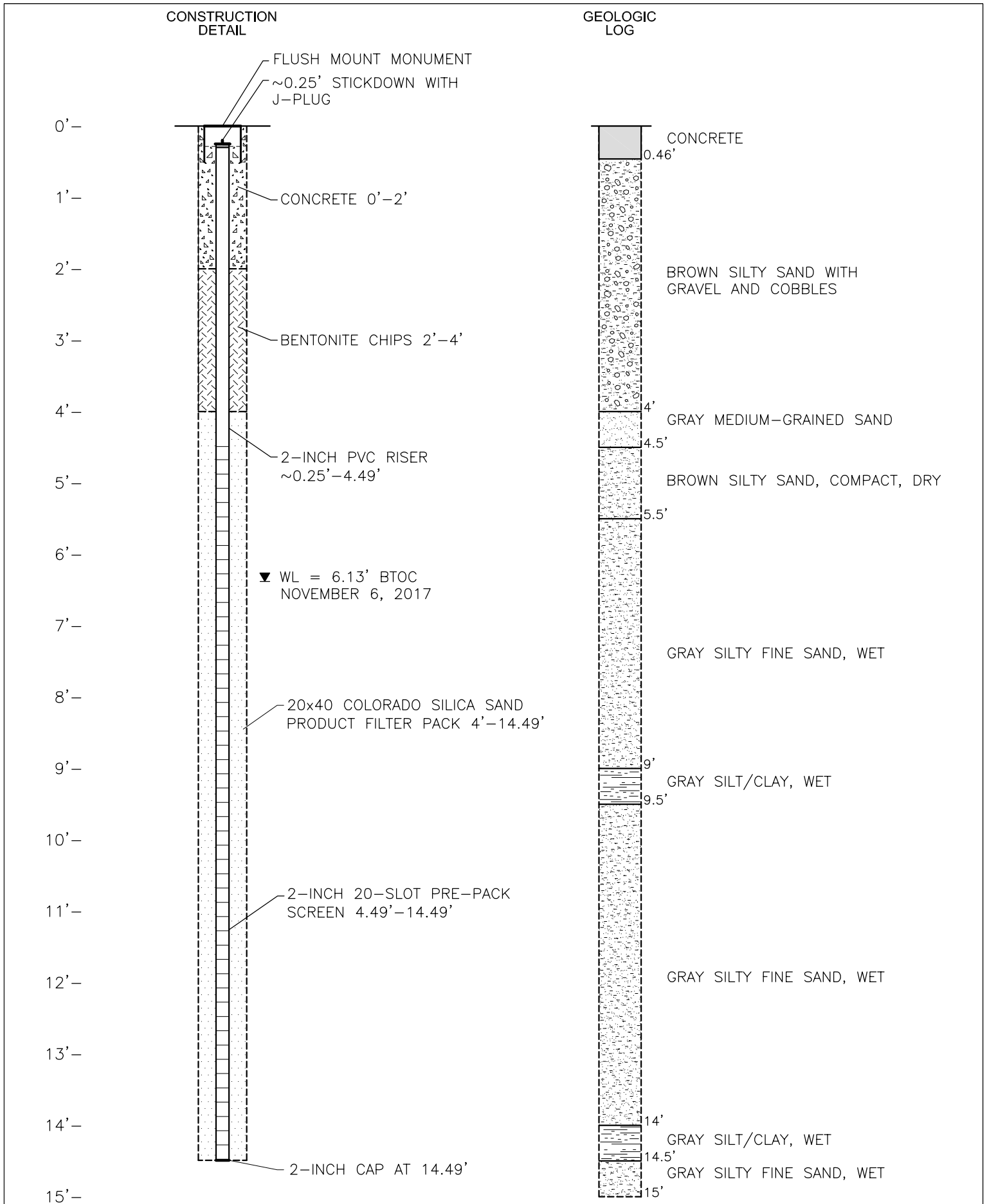
Test Pit/Bore/Well Log

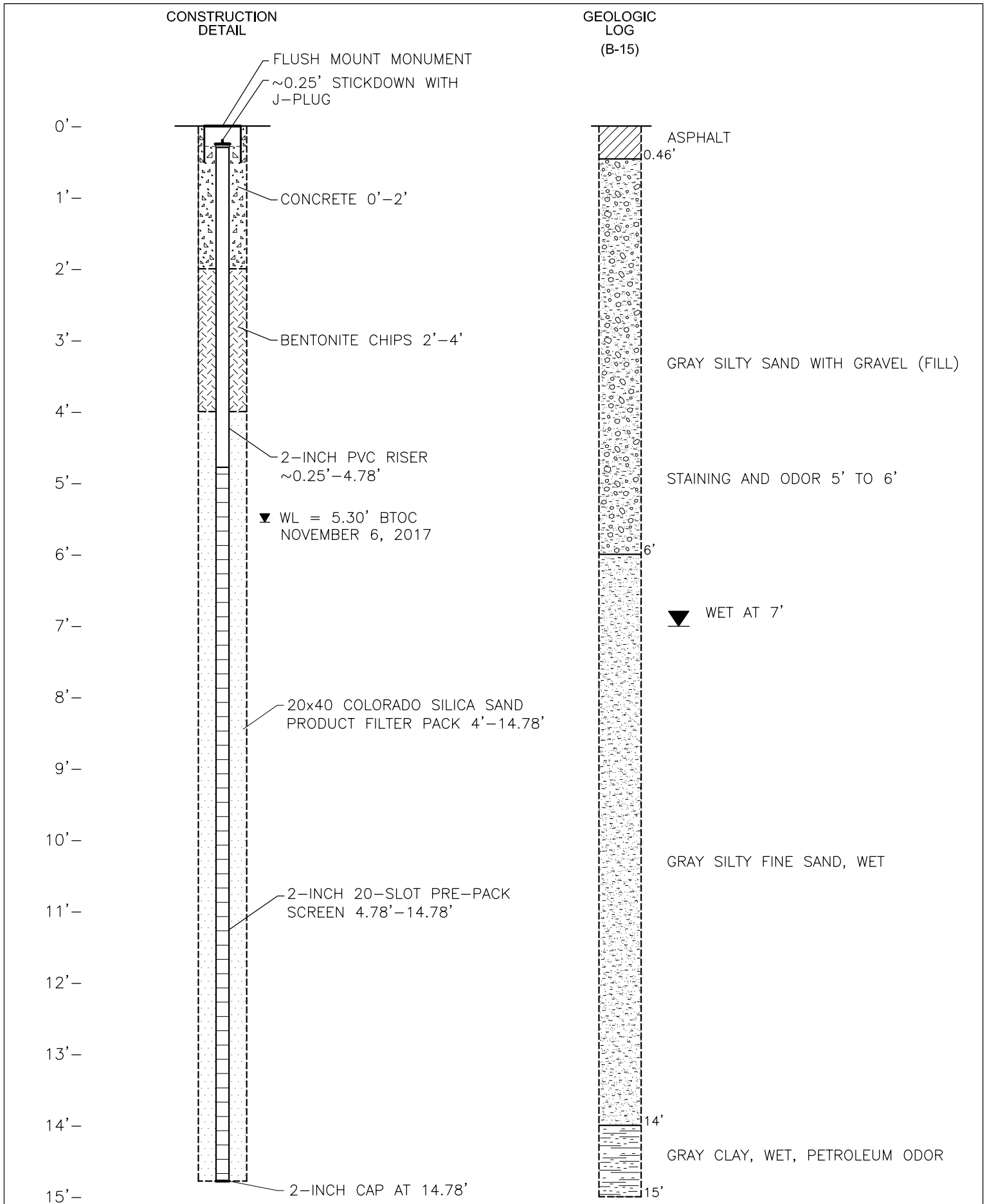
Project Name: Honda of Fife				Date: 3-28-00	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Drilling Contractor: TEG, Inc.		Drilling Method: Direct Push		Boring Number: B9	
Licensed Driller:		Sampling Method: Continuos			
		Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite			
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Concrete	Bore Location: See site diagram
			1	Gravely sand No staining or odor PID: 0.0	
			2		
			3		
			4		
			5		
			6		
			7		
			8		
			9	Sandy silts No staining or odor PID: 0.0 Bottom of Boring	
			10		
			11		
			12		
			13		
			14		
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

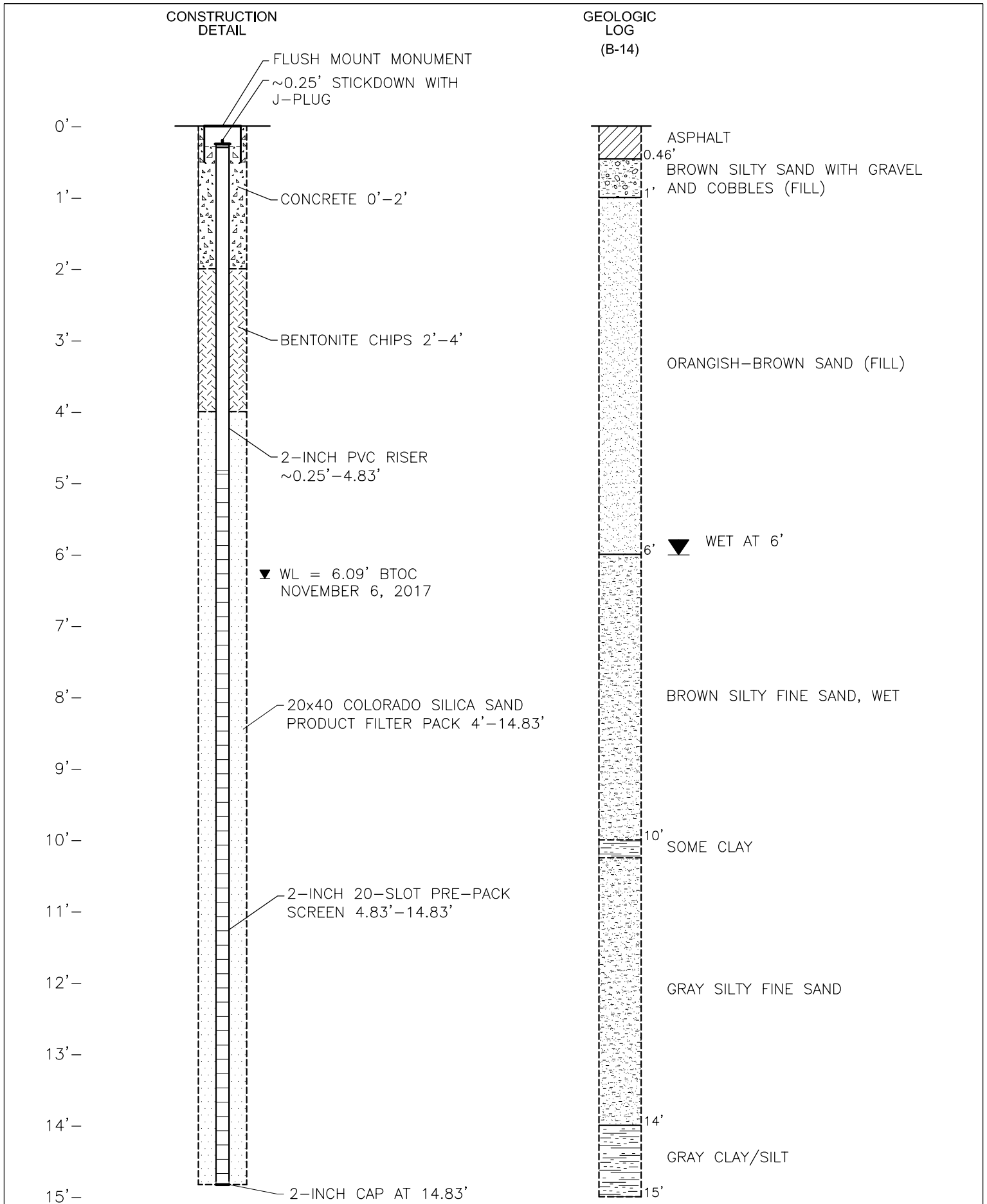
Test Pit/Bore/Well Log

Project Name: Honda of Fife				Date: 3-28-00		Sheet 1 of 1	
Project Number: 1060-2		Logged By: TWS		Start Time:		Finish Time:	
Drilling Contractor: TEG, Inc.				Drilling Method: Direct Push		Boring Number: B10	
Licensed Driller:				Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite		Sampling Method: Continuos	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Concrete	Bore Location: See site diagram		
			1	Gravely sand No staining or odor PID: 0.0			
			2				
			3				
			4				
			5				
			6				
			7				
			8				
			9				
			10	Sandy silts No staining or odor PID: 0.0			
			11				
			12				
			13				
			14				
			15				
			16				
			17				
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log			

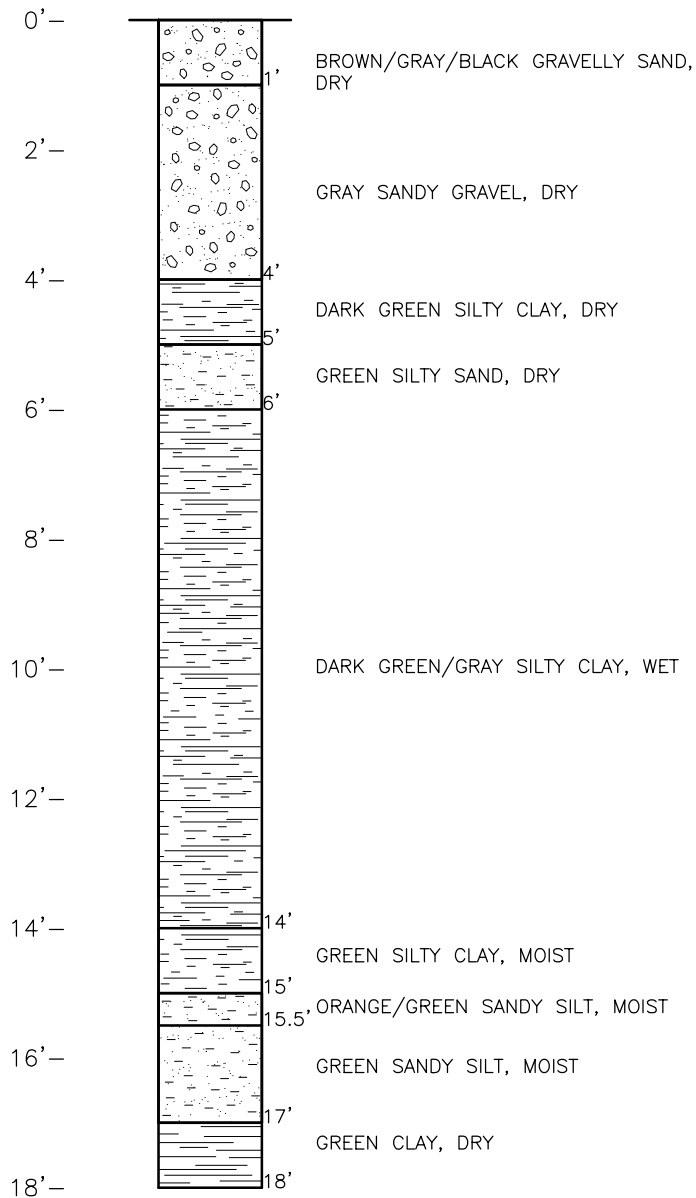






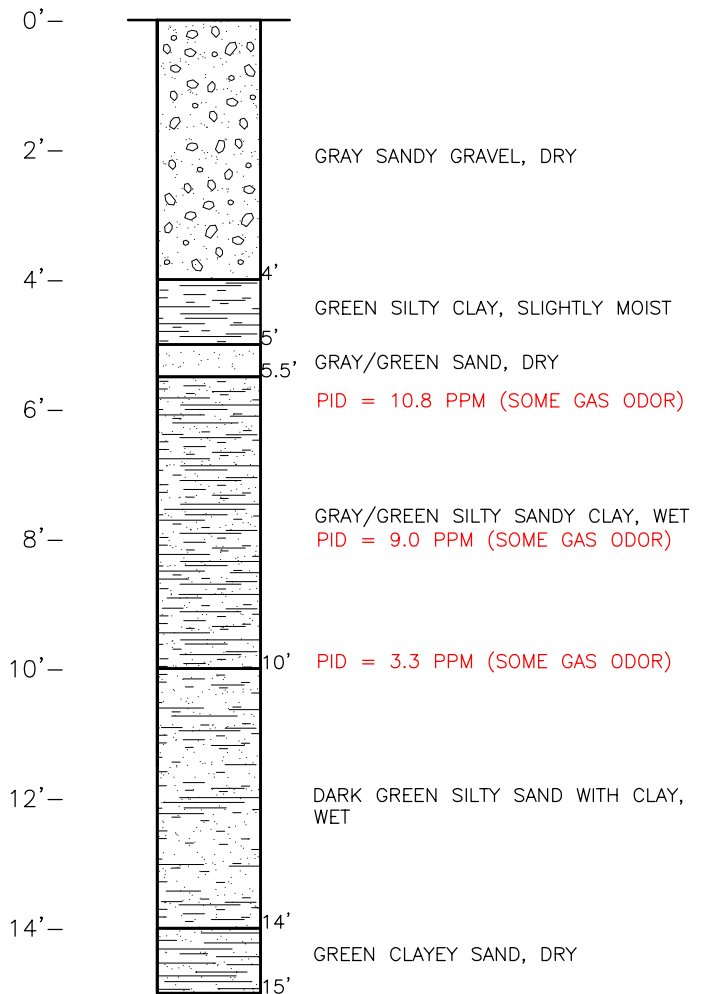


GEOLOGIC LOG
B19

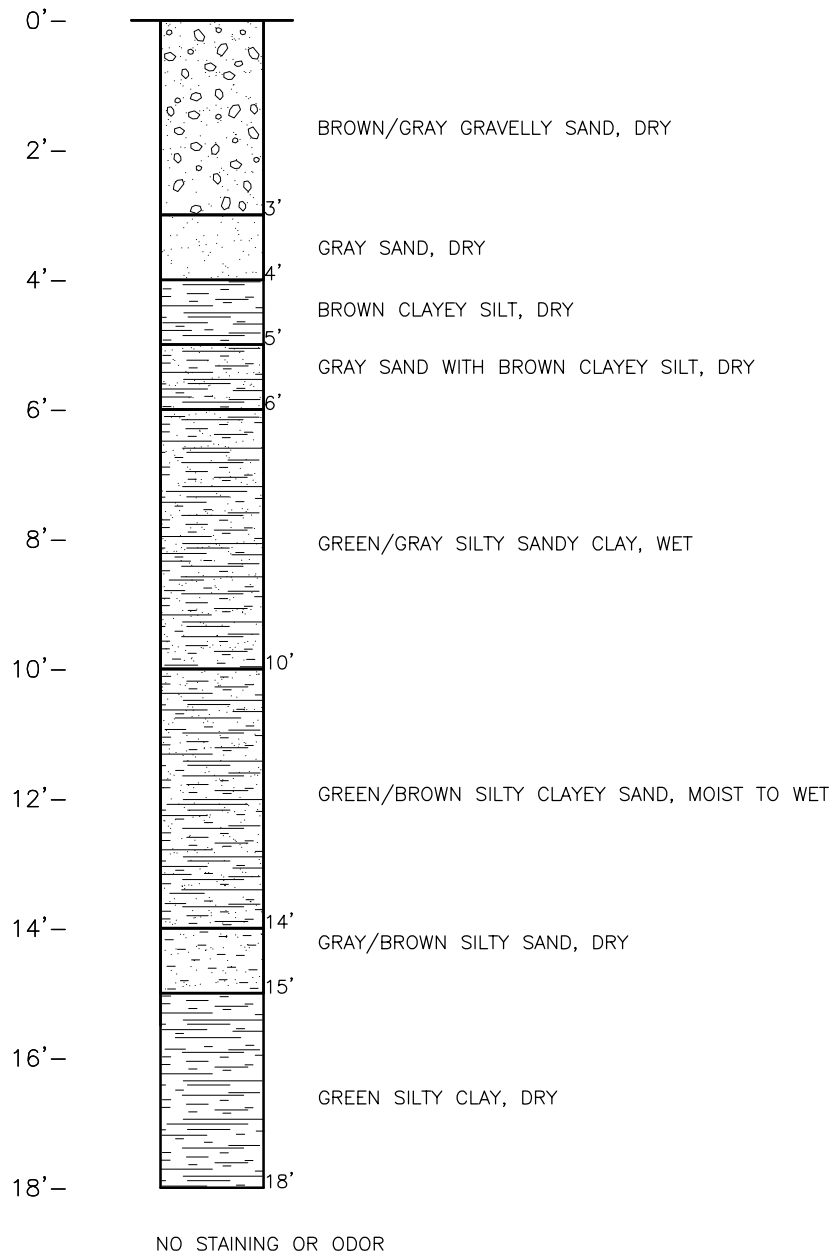


NO STAINING OR ODOR

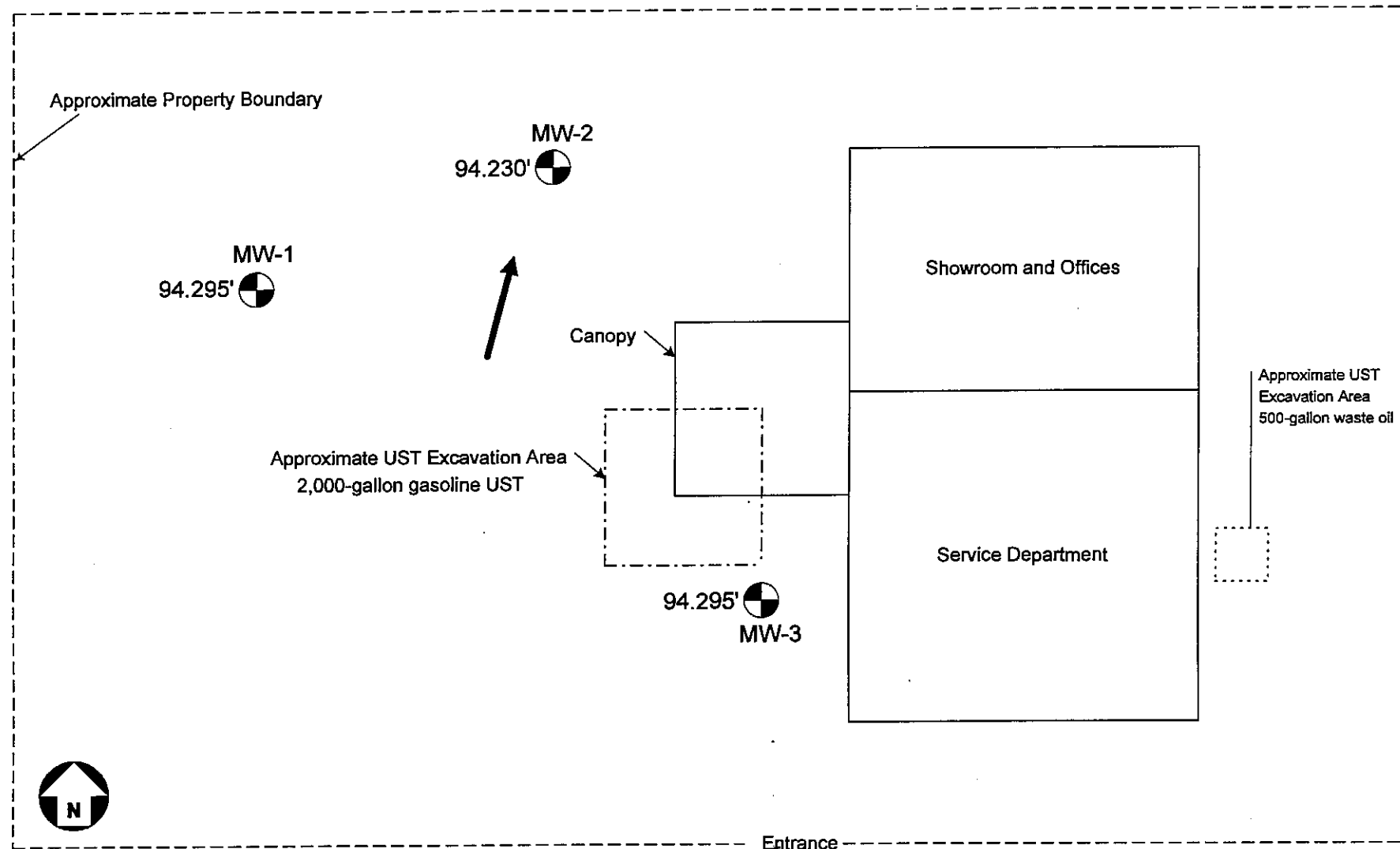
GEOLOGIC LOG
B20



GEOLOGIC LOG
B21



INTERSTATE 5



DESCRIPTION

Honda of Fife
Ground Water Flow Direction

DATE

12/17/99

Saltbush Environmental Services, Inc.

JFH



Ground Water Monitoring Well Location



Assumed Ground Water Flow Direction

Project Name: Honda of Fife				Date: 12-17-99		Sheet 1 of 1	
Project Number: 1060-2		Logged By: TWS		Start Time:		Finish Time:	
Boring Number: MW-1				Drilling Contractor: Holt		Drilling Method: Hollow Stem Auger	
Sampling Method: Split-Spoon				Licensed Driller: Clyde Moore			
Hole Completion ☒ Monitoring Well ☐ Piezometer ☐ Abandoned, sealed with bentonite							
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See Site Diagram		
			1	Sands and Gravels No odor			
			2				
		3/1/1	3	Sandy Silts No Odor			
			4				
			5				
			6				
			7	◀ Water Level			
			8				
		2/1/1	9	Sandy, Clayey, Silts No Odor			
			10				
			11				
			12				
			13				
		1/2/1	14	Sandy, Clayey, Silts No Odor			
			15	Bottom of Hole			
			16				
			17				
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log			

Project Name: Honda of Fife				Date: 12-17-99	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Boring Number: MW-2		Drilling Contractor: Holt		Drilling Method: Hollow Stem Auger	
Sampling Method: Split-Spoon		Licensed Driller: Clyde Moore		Hole Completion ☒ Monitoring Well ☐ Piezometer ☐ Abandoned, sealed with bentonite	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See Site Diagram
			1	Sands and Gravels No odor	
			2		
		4/3/1	3	Sandy Silts No Odor	
			4		
			5		
			6		
			7	◀ Water Level	
			8		
		2/1/1	9	Sandy, Clayey, Silts No Odor	
			10		
			11		
			12		
			13	Sandy, Clayey, Silts No Odor	
		3/2/1	14		
			15	Bottom of Hole	
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

Project Name: Honda of Fife				Date: 12-17-99	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Drilling Contractor: Holt				Boring Number: MW-3	
Drilling Method: Hollow Stem Auger				Sampling Method: Split-Spoon	
Licensed Driller: Clyde Moore				Hole Completion ☒ Monitoring Well ☐ Piezometer ☐ Abandoned, sealed with bentonite	
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See Site Diagram
			1	Sands and Gravels No odor	
			2		
		4/5/3	3	Sandy Silts Odor of Petroleum Hydrocarbons	
			4		
			5		
			6		
			7	◀ Water Level	
			8		
		4/2/1	9	Sandy, Clayey, Silts Odor of Petroleum Hydrocarbons	
			10		
			11		
			12		
		3/2/1	13	Sandy, Clayey, Silts Odor of Petroleum Hydrocarbons	
			14	Bottom of Hole	
			15		
			16		
			17		
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

HOLT DRILLING, INC.

Resource Protection Well Report

Project Name Honda of Fife
 Well Identification # MW-1 MW-2 MW-3
 Drilling Method 4" HSA
 Driller Clyde Moore
 License # 1939

Date 11-9-99
 County Pierce, NE 1/4 NE 1/4
 Section 12 T. 20N R. 3E
 Street Address 4301 20th St E
 Start Card R45154
 Consulting Firm Saltbush Environmental

AS-BUILT	WELL DATA	FORMATION DESCRIPTION
	MONUMENT TYPE: <u>Flush</u>	
	CONCRETE SURFACE SEAL <u>1 ft.</u>	<u>0 - 2 ft. Fill</u>
	PVC BLANK <u>2" x 5'</u>	<u>2 - 15 ft. Sand & Silt</u>
	BACKFILL <u>2 ft.</u> TYPE: <u>Bentonite Chips</u>	<u>- ft.</u>
	PVC SCREEN <u>2" x 10'</u> SLOT SIZE: <u>020</u> TYPE: <u>PVC</u>	<u>- ft.</u>
	GRAVEL PACK <u>12 ft.</u> MATERIAL: <u>10-20 SILICA SAND</u>	<u>- ft.</u>
	WELL DEPTH <u>15'</u>	
		REMARKS

Signature Clyde Moore

Test Pit/Bore/Well Log

Project Name: Honda of Fife				Date: 12-17-99	Sheet 1 of 1
Project Number: 1060-2		Logged By: TWS		Start Time:	Finish Time:
Drilling Contractor: Holt		Drilling Method: Hollow Stem Auger			Boring Number: B-4
Licensed Driller: Clyde Moore		Hole Completion ☐ Monitoring Well ☐ Piezometer ☒ Abandoned, sealed with bentonite			
Sample ID	Sample Recovered	Blow Count	Depth In Feet	Surface Conditions Asphalt	Bore Location: See Site Diagram
			1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17	Sands with Odor of Petroleum Hydrocarbons ◀ Water Level Sandy, Clayey, Silts No Odor Bottom of Hole	
Saltbush Environmental Services, Inc. 805 Pacific Avenue Tacoma, Wa				Boring Log	

DRAFT

APPENDIX C

Ramboll Field Guidance Documents

FIELD GUIDANCE DOCUMENT NO. 1.01

FIELD RECORDS AND NOTES

FIELD GUIDANCE DOCUMENT NO. 1.01

FIELD RECORDS AND NOTES

Prepared By:	Clem Ockay Sharon Burkett Jason Swankert Jinjun Wang
Peer Reviewed By:	Michael Potts Jose Sananes Stan Popelar Jessica Donovan Nestor Soler
Approved By:	J. Mark Nielsen
Applicable To:	All North American offices
Effective Date:	February 21, 2014
Revision Date:	July 12, 2016
Revision Notes:	1. Revised company name and format.
Documents Used as Reference During Preparation:	

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ATTACHMENTS

Attachment A: Sample Project-Specific Daily Report

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for recording and maintaining field notes associated with field activities, site visits, and sampling efforts.

Although this FGD provides guidelines for recording information, it should be understood that for certain projects more specific procedures may be applicable, including state-specific or regulatory program-specific guidelines, requirements or procedures. Specific requirements for these types of projects and activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, sampling plan and/or project-specific FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by procedures recommended in this FGD. The Ramboll Environ PIC and PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information is maintained in the project file. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

Equipment and materials necessary to conform to this FGD include:

- Bound Notebook – lined high-grade 50 percent rag paper with a hard-cover and water-resistant surface (e.g., "Rite-in-the-Rain"). Soft-bound field books are acceptable for limited duration projects.
- All Weather Pens or (weather permitting) other indelible ballpoint pens with black or blue ink.
- Watch (or other time keeping device).

Based on the field activity and project, the following also may be needed:

- Field Log Forms (preferably produced on "Rite-in-the-Rain" water-resistant paper).
- Ruler/Straight Edge.
- Stop-Watch.
- Calculator.
- Laptop Computer.
- Lookup tables for well volume calculation, tank size estimation, etc.

- Clipboard/field case.
- Gallon-size or larger plastic zip top bag or other clear plastic to cover note book and forms in wet weather.

In some cases, such as those involving long-term construction management activities, project specific daily reports, may be produced from the field notes and maintained electronically in portable document format (pdf). An example of Ramboll Environ's daily report form is provided in **Attachment A**.

3. PROCEDURES REFERENCED

The following FGDs and Standard Practice Instruction (SPI) are related to this FGD and should be referenced, as needed:

- **SPI 27**, Utility Clearance.
- All field sampling and installation FGD categories.

The list above is not intended to be all inclusive. Other SPIs and FGDs may need to be referenced based on the specific requirements of the site-specific sampling plan (e.g., field screening FGDs, FGDs for sampling, etc.).

4. PROCEDURES

4.1 General Information

Information from all pertinent field activities, site visits, and sampling efforts should be recorded in a field book during each day of field activities. The following information should be considered when recording field notes:

- Field notes should present a complete record of the field activities observed. The author of the field notes, project manager (PM) or others may need to refer to the field notes at a later date to confirm facts and/or field interpretations. Thus, the notes should be complete enough to enable reviewers to reconstruct the field activities and observations.
- Field books are part of the official project record, and could become legal records; therefore, a separate bound field book should be used for each project.
- Records should be kept in ink (waterproof ink, when necessary). Indelible ballpoint pens with black or blue ink should be used. Felt tip or red pens, erasable ink, and pencil are unacceptable being neither permanent nor archival.
- When an entry to the field book needs to be corrected, a single line should be drawn through the error, initialed and dated. Never erase or obliterate any field notes.
- The ownership information should be provided inside the front cover of the field book as follows: "If found, please return to Ramboll Environ." Include the office address and general phone number as well as case/project number and name. This increases the chances of the notebook being returned if lost.

- Generally, each page of the notes should be initialed or signed by the author (or authors). If multiple individuals are involved in activities at the site or for projects involving long-term construction management activities, multiple logbooks may be maintained.
- Pages left intentionally blank should be marked with an "X" and labeled "left intentionally blank".
- Blank spaces at the bottom of a field book page should be stricken across the page.
- Data entries should be recorded in the field book immediately upon obtaining the data. Avoid making temporary notes in other locations for later transfer to the field book, as this increases the potential for transcription errors or loss of data.
- If using field forms to record data, note in the field book which forms are being used and the number of forms. All pages of forms should be numbered sequentially and cross-referenced in the field book. Each page of the forms should be signed and dated. Finally, ensure that forms are securely filed in the project file upon return to the office each day.
- Scan and/or photocopy the field notes regularly (at least weekly if long-term field work is ongoing).
- Descriptions of activities should be objective, not subjective.
- Descriptions should be consistent with the level of certainty of the observation, for example record "odor like gasoline," rather than a definitive note such as gasoline odor.
- Explain any deviations or omissions from the work specified in the work plan, especially when such deviations result in measurements/samples not being collected, or additional measurements/samples being collected.
- Avoid writing extraneous commentary in the field book.

4.2 Organization of Field Notes

- Field notes should generally be kept in chronological order throughout the day.
- Use military time (e.g., 0900 for 9:00 am or 1645 for 4:45 pm).
- Start each new day on a new page.
- Sign and date your notes at the end of each day and draw a line through any remaining blank lines. Initial each page.
- If collecting a large number of samples, prepare a summary at the end of each day including a list of samples collected and reference to the chain-of-custody form or airbill number, as appropriate.
- To help easily locate information for subsequent reference and report preparation, consider including a sketch and designating a separate page or pages for certain items such as:
 - Photograph Log
 - Water Level Measurements

- Groundwater purging/sampling information and related field measurements for each well
- Drum Log that would include drum number (which corresponds to number presented on each drum), date filled, contents, percent full and location on site. Note that drums should not be given numbers such as D001, D002, etc., as these designations could be confused with hazardous waste codes.
- Refer to sampling plans or if unavailable or deviating from a plan, include sketches of sampling locations or photograph locations/directions to reflect actual locations.

4.3 Daily Entries

At a minimum, daily entries in a field book should include:

- Pagination and date on each page of the notes.
- Date and time of starting work.
- Names of all field people on-site and their titles (field supervisor, etc.).
- Record of the daily “tailgate” health and safety briefing, including attendees and their affiliation and a list of topics discussed. Note that detailed information can be included on a form in the HASP but the meeting should be documented in the field book as well.
- Names and affiliations of all contractors, subcontractors, clients, agency representatives and visitors.
- Visitors to the site – when they came, when they left, who they represent, and purpose for their visit on-site.
- Subcontractor (if used). Include company name, names of any personnel and their role (e.g., driller’s helper).
- General weather conditions – add additional notes if weather changes during the day (i.e., starts/stops raining, snowing, changes in temperature).
- General purpose of proposed work effort (e.g. “to collect groundwater samples from all on-site monitoring wells”). Do not add information on the legal strategies or implications of the work unless specifically directed to do so by the PM or PIC.
- Description of work area including direction of and information on photographs taken.
- Location of work area including map references (include a sketch map in field book).
- Detail of work effort, particularly any deviation from the sampling plan or standard operating procedures, including why the deviation was made and responsible person who approved the deviation.
- Objective field observations.
- Field measurements (e.g., pH, PID readings).
- Field analysis results (results from any field test kits used).
- Type of equipment used in sampling, type and model of PID, pH meter, other meters, etc. and calibration information (e.g., calibrated OVM Model 580B PID using 100 ppm isobutylene).

- Personnel and equipment decontamination procedures (describe the method once and state that it will always be used unless otherwise noted. Then note when there are deviations and the reason for each deviation.)
- Records of conversations/decisions made with others in the field such as the PM, on-site personnel, or regulatory personnel.

In addition to the General Information and Daily Entries (**Sections 4.1 and 4.3** above), specific details for each type of work should be included in the field notes as indicated on the FGD corresponding to the activity performed. Typical field activities for Ramboll Environ personnel fall into the following major categories of field activities:

- Drilling of Soil Borings.
- Soil and Sediment Sample Collection.
- Monitoring Well Installation and Development.
- Surface water and Groundwater Sampling.
- Oversight of Remedial Activities.
- Vapor Intrusion Sampling/Soil Gas Sampling.
- Indoor Air/Ambient Air Sampling.

4.4 Utility Clearance

In accordance with Standard Practice Instruction (SPI) 27, where available, public and private utility clearance is required for all work that will involve ground disturbance. For each field activity that includes ground disturbance, certain information must be recorded in the field book as discussed below and in SPI 27. In addition, the subsurface clearance form included in the health & safety plan should be completed.

4.4.1 Public Utility Locating

- If a subcontractor contacted the One-Call Service to request a public utility location, obtain the file/ticket number issued by the One-Call Service from the subcontractor.
- Verify and record completion and closure of the ticket before proceeding with work.
- Include a sketch map of the work area and/or entire site and show locations of marked and suspected utilities in relation to the work area. If appropriate, photograph the area before ground disturbance.

4.4.2 Private Utility Locating

- A private utility locator is typically a subcontractor to Ramboll Environ. Record the name of the company and individuals performing this service.
- Record utility clearance findings as above for the public locate.

4.4.3 Site Reconnaissance

- After a site reconnaissance is performed to identify possible utilities in the area, record pertinent information regarding site reconnaissance findings in the field notebook.

4.4.4 Documenting a Health and Safety or Utility Incident

- After attending to emergency needs, document all pertinent information in the field book including notifications made and details of the incident such as personnel and equipment involved, and measurements as appropriate.
- Include a description of each photograph in your field book including the information outlined in **Section 4.6** (Photographs).

4.5 Oversight of Remedial Activities

While record keeping requirements for remedial or construction projects must remain consistent with the procedures of this FGD, additional information may need to be tracked and recorded. Discuss the specific requirements with the PM or PIC prior to going to the field to understand the context of the oversight role and what types of information may be critical to the oversight. In some cases, such as those involving long-term construction management activities, in addition to field books, project specific daily reports, such as that included in Attachment A, should be completed and maintained electronically in portable document format (pdf).

4.6 Photographs

If photographs are taken, the following information should be recorded in the field book for each photograph:

- Date and time.
- Name of site and field task.
- General orientation and description of the subject.
- Location on-site.
- Sequential number of the photograph and roll number if using film. Image number if using a digital camera.
- When appropriate, include a person or object for scale (a coin, tape measure, vehicle, etc.).

If taking a large number of photographs, designate one or more pages of the field book as a photo-log and record photograph information in that log format. In addition, include a sketch of the relative photograph locations and directions. Upload photographs to the networked files for that project. For film photographs, label the outside envelope from the photos and negatives clearly with case/project number, names, dates, etc.

5. PRECAUTIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while recording the required information. It is important to always remain alert and aware of your surroundings.

- Avoid walking while recording information. Sites may have excavations, equipment, debris and other obstacles that pose slip, trip or fall hazards.
- Step away from roadways and high traffic areas before commencing note-taking. Do not assume that drivers can see you standing on the shoulder of a road, especially in bad weather. Many workplace traffic accidents involve distracted drivers hitting a worker standing/working on the shoulder of a roadway. Wear a safety vest or brightly colored (yellow or orange) clothing and remain alert at all times.
- Stand a safe distance away from the driller or excavator when taking notes. Be aware that the operator may not be able to see you, equipment/cable accidents can happen very quickly, and you need to be alert and ready to move.

6. RECORDKEEPING

Field books should be managed in accordance with Ramboll Environ's Document Retention Policy and project-specific requirements. For ongoing projects, field notes should be copied periodically (at least weekly), including a digital copy saved to the project folder on the office's secure network. Upon upload, a network link to the digitized field notes should be provided to the Project Manager (PM). When an individual field book is complete, the book should be submitted to the administrative staff for final cataloging and filing. The field books should be stored in the Project File.

If additional details or modifications are necessary after completion of field activities, such changes should be made in contrasting color ink and signed and dated. Upon completion of the work, the field book should be kept in a secure location on company property (i.e. local office) with previous field books from the designated project.

00WSITESOP\PRIN_WP\41894v1

ATTACHMENT A
SAMPLE PROJECT-SPECIFIC DAILY REPORT

Project No.	00-WSITESOP	Report No.	087
Project Name	Sediment Remediation	Date	October 22, 2012
Location	123 Main St., One City, One State	Weather	Sunny, 71°F Wind: 8 mph W Precipitation: 0.00 inches

Contractors	Visitors
Contractor Environmental Services (CES) – (61) Ramboll Environ (John Doe, Jane Doe, John Roe, Jane Roe)	Lift Crane (1) Rise Crane (2)

Equipment On Site
WA380 Loaders (2); DSC Booster Pumps (3); Godwin Pumps (2); Dozers (3); 20' Sea Containers (3); Fusion Welder (2); Light Plant (1); 2,000-gal fuel tank (3); Tugboat (1); PC490 Excavator (1); PC220 Excavator (1); PC300 Excavator (1); Cap Spreader Barges (2); JCB Forklift (1); Crane Mats (19); Tender Boat (3); Work Boat w/ Crane Mount (1); 750 lb Danforth Anchors (18); Slurry Mix Tanks (2); Hopper Feed Tanks (2); CAT 330 Excavator (1); Kubota RTV (2); Stacking Conveyor (3); Roller (1); Scows (2); Site Truck (1); Clamshell & Conventional Buckets (1); Pontoon Boat (1); 500-gal Fuel Tank (1); 500-gal Gasoline Tank (1); 20 cy dumpster (1); 30'x80' Deck barges (2); 10'x40' Section Barges (6); 125 Kva Generator (1); Portable toilets (5); Manitowac 222 Crane (1); Fence Panels (22); 21,000 gal-Frac Tank (1); 500-gal Towable Water Tank (1); 10'x20' Section Barges (4); small scows (2); 70 Kva Genset (1); Telebelt Conveyor (1); 135'x50' Deck barge (1); 140'x48' Deck barge (1); Crawler crane (1); WITTE 1409 deck barge (1).

Imported/Exported Material
No material was delivered to the site or to the dock facility today.

Activities
Ramboll Environ and CES on 24-hour operation from 07:00 on Monday. 06:00 John Doe on-site (beginning of shift). 06:30 Jane Doe on-site (beginning of shift). - At 07:00, CES conducted safety meeting. - At 8:00 CES began armor material placement in Cap Area 17 (mechanical placement using the PC 490 excavator). - At 08:30 CES and Ramboll Environ began filter thickness verification in Cap Area 29b. - CES retrieved 8-inch verification pans #29-18, 29-21, and 29-22.

Activities
– Ramboll Environ measured and documented filter thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 09:40 the hydraulic filter malfunctioned on the crane barge. The crane barge was towed to the dock for repair at 12:00. 12:00 John Roe on-site (beginning of shift). • During daytime operations, Ramboll Environ and CES continued inspections of SESC measures. No issues were observed. • During daytime operations, Ramboll Environ continued to monitor cap material delivery pipes over the bulkhead to ensure adequate clearance is maintained at the bulkhead. No issues were observed. • At 14:00 repairs to the crane barge were completed and the crane barge returned to Cap Area 29b to continue filter thickness verification. – CES retrieved 8-inch verification pan #29-25. – Ramboll Environ measured and documented filter thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 14:20 a small hydraulic leak (less than a quart) was observed on the PC 490 and CES used absorbent pads to clean it up. The leak originated from a hydraulic hose sections that CES did not have a replacement for. No additional mechanical placement was completed for the rest of the day. • At 14:45 Ramboll Environ and CES began sand thickness verification in Cap Area 25. – CES advanced a push core at location #BS-25-229 for sand thickness verification. – Ramboll Environ measured and documented sand thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 15:35 CES towed the WITTE 1409 deck barge to dock for reloading of material and replaced it with the WITTE 1403 barge which was loaded with sand, filter material (ASTM 57), and armor material (ASTM 4). • At 15:37 Ramboll Environ and CES began sand thickness verification in Cap Area 23. – CES advanced a push core at locations #23-1, 23-2, and QA-23-1. – Ramboll Environ measured and documented sand thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 15:50 CES began placement of 1-inch armor stone in Cap Area 6a. 16:00 John Doe off-site (end of shift). • At 16:15 Ramboll Environ and CES began armor thickness verification in Cap Area 6a. – CES retrieved a 6-inch verification pan at BH #2. – Ramboll Environ measured and documented armor thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 16:30 CES completed armor placement in Telebelt Setup Location 1 (which includes Cap Areas 6a and 13b) and began repositioning the Telebelt system to Setup Location 2 (placement area includes Cap Areas 6a and 13a). 17:00 Jane Doe off-site (end of shift). • At 17:15 CES made repairs to the safety latch for the crane hook on the crane barge. • At 18:42 CES began placement of sand in Cap Area 6a and 13a. Placement was halted from 19:50 to 21:17 for the shift change.

Activities
- At 21:40 sand placement was completed in Cap Area 6a and 13a and CES removed incidental debris from the adjoining portion of the cap area south of the active area. 20:00 Jane Roe on-site (beginning of shift) - From 21:45 to 22:30 Ramboll Environ and CES continued sand thickness verification in Cap Areas 6a and 13. - CES advanced cores at locations #6-8, #6-14, #13-37, and #13-69. - Ramboll Environ measured and documented sand thickness placed. - A summary of the cap verification measurements is provided in the attached table. - CES placed 8-inch layer thickness verification pans at locations #6-8 and #6-14. - At 22:45 CES continued placement of sand in Cap Area 13a (mechanical placement using Telebelt). 23:20 John Roe off-site (end of shift) - From 23:35 to 23:50 Ramboll Environ and CES placed 8-inch layer thickness verification pans in Cap Area 29b at locations #29-30 and 29-31.

Activities



Photo 1: Mechanical placement of armor in Cap Area 17.



Photo 2: Filter thickness verification in Cap Area 29B.

Activities



Photo 3: Armor thickness verification in Cap Area 6A.



Photo 4: Placement of sand using Telebelt in Cap Areas 6 and 13.

CAP Verification Thickness, Sediment Remediation, 123 Main St., One City, One State												
Date	Time	Cap Area	Lane ID	Pan ID	Type (Full Depth, Intermediate, Core, Manual, Vibra-core)	Sand Thickness (in)	Filter Thickness (in)	Armor Thickness (in)	Verification Thickness (in)	Consent Order Total Thickness	Maximum Allowable Total Thickness	Comments
10/22/2012	9:01	29B	218	29-18	Intermediate		2			6	12	
10/22/2012	9:15	29B	221	29-22	Intermediate		3			6	12	
10/22/2012	9:23	29B	219/220	29-21	Intermediate		<1			6	12	Filter stone was piled to less than 1 inch in only one corner of the pan.
10/22/2012	14:22	29B	222	29-25	Intermediate	<1				6	12	
10/22/2012	14:47	25	229	BS-25-229	Core	9				6	12	
10/22/2012	15:30	23		23-2	Core	11				18	30	
10/22/2012	16:15	6A		BH 2	Intermediate	11	7.6	>6		18	30	
10/22/2012	16:32	23		QA-23-1	Core	9.25				18	30	
10/22/2012	21:55	6A		6-8	Core	3.5				6	16	
10/22/2012	22:05	13A	100	13-37	Core	5				12	19	
10/22/2012	22:10	13A	99	QA-13	Core	3				12	19	
Note: The measurements for pans shifted from their target location (possibly the result of barge/boat interference) may not be representative and will be subject to review for thickness verification purposes.												

FIELD GUIDANCE DOCUMENT NO. 1.02
**SAMPLE NAMING, LABELING, HANDLING,
SHIPPING AND CHAIN OF CUSTODY**

FIELD GUIDANCE DOCUMENT NO. 1.02
SAMPLE NAMING, LABELING, HANDLING, SHIPPING
AND CHAIN OF CUSTODY

Prepared By:	Chris Buzgo Taryn Correll Melanie Charles
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Approved By:	J. Mark Nielsen
Applicable To:	All North American offices
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Documents Used as Reference During Preparation:	US EPA Region 4, 2007. <i>Sample and Evidence Management</i> .

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ATTACHMENTS

Attachment A: Sample Completed COC Form

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines and procedures established by Ramboll Environ for sample management including identification, labeling, handling/packaging, chain-of-custody, and transport. A sampling event could be dismissed if sample containers are broken in transport, samples are improperly labeled and unable to be reconciled, or chain-of-custody practices are not followed. Therefore, proper sample management is essential to the production of data of reliable quality that can be used for decision-making.

Although this FGD provides guidelines for managing samples from the time of collection through transfer to the laboratory for analysis, it should be understood that for certain projects more specific procedures may be applicable, including state-specific or regulatory program-specific guidelines, requirements or procedures.

Similarly, these guidelines may not be applicable to ongoing projects with a previously established sample nomenclature that does not correspond to the naming conventions outlined in this FGD, which may be important to adhere to for the sake of continuity and consistency. Specific requirements for these types of projects and activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, sampling plan and/or project-specific FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements. In addition, PICs and PMs are encouraged to provide additional direction or training to junior scientists and engineers for the implementation of the procedures outlined in this FGD.

Procedures discussed herein are primarily for the most common types of sampling conducted – soil, water, sediment, soil vapor, and/or air. Other types of sampling events (e.g., sampling of concrete, biota, etc.) may require additional steps to those described in this FGD. For media that are not as commonly sampled, this FGD should be reviewed in the context of project-specific sampling requirements, and modified as applicable.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail.

2. EQUIPMENT / MATERIALS

Equipment and materials necessary to conform to this FGD include:

2.1 Sample Labeling /Chain-of-Custody

- Paper towels.
- Laboratory Sample Label.
- Bound Field Notebook – lined high-grade 50 percent rag paper with a hard-cover and water-resistant surface (e.g., “Rite-in-the-Rain”) or appropriate field forms.
- All Weather Pens or (weather permitting) other indelible ballpoint pens with black or blue ink.
- Watch (or other time keeping device).
- Clear tape.
- Laboratory Chain-of-Custody (COC) Forms.
- Gallon-size or larger plastic zip top bags or other clear plastic to insert the COC form.

2.2 Sample Packaging / Transport

- Coolers (or original Summa canister shipping container for air or soil vapor sampling).
- Ice.
- Ice scoop.
- Gallon-size or larger plastic zip top bags or other clear plastic to fill with ice.
- Quart and gallon-size plastic zip top bags for sample containers (solids or aqueous).
- Padding (bubble wrap, Styrofoam packing material, etc.).
- Packing tape.
- Scissors.
- Custody seals.
- Black indelible ink pen.
- Post-it notes.
- Tape, zip tie, or other items to attach COC to coolers/sample shipping containers.
- Shipping air bill (FedEx pre-filled forms with Ramboll Environ’s account info are available).

3. PROCEDURES REFERENCED

- All field sampling FGD categories.
- **FGD 1.01**, Field Notes and Records.
- **FGD 1.03**, Data Management.

4. PROCEDURES

After collection, samples will be managed in conformance with the provisions outlined in the following sections. After sample shipment, copies of the final signed COC should be kept in the project file. A completed COC (inclusive of signatures from the laboratory), which should be provided with the laboratory data deliverables, should also be kept in the project file. An example completed COC is included in **Attachment A**.

In general, a standard sample naming convention should be used. The sample identification scheme should ensure that samples, including quality control samples (e.g., trip blanks), will be uniquely identified between events. Thus, in developing the sample identification scheme, historical data and reports should be reviewed to establish a location identification scheme which ensures that locations will be uniquely identified.

4.1 Sample Identification

Every sample collected must be associated with a unique identifier. Prior to mobilization, field personnel should confirm with the PM or PIC the sample name format to be used since there may be occasions when the standard sample identification (ID) format detailed in this FGD is not applicable. For example, an ongoing project with a previously established sample nomenclature that does not correspond to the naming conventions outlined in this FGD, which may be important to adhere to for the sake of continuity and consistency. Similarly, field personnel should confirm with the laboratory any limitations on the number of characters that can be used to identify a sample (a partial list of the analytical laboratories typically used by Ramboll Environ is provided in Attachment B of **FGD 1.03**, Data Management). In the absence of project specific instructions, the following scheme, which limits the sample ID to 18 characters, is recommended.

The recommended sample name or ID will consist of an alphanumeric describer that will identify the site name, sample type, sample location, sample depth (if applicable), and sample collection date using the following convention:

- The first three identifiers in the sample name will consist of a three-letter acronym for the study site (e.g., samples collected from an ABC Industries site might have ABC as the first three identifiers in the sample ID) or alternatively, if the name of the study site is too long or the borings are being advanced on properties adjacent to the study site, the first three identifiers could also be RE (short for Ramboll Environ).
- Following the site name portion of the sample ID will be a dash and one of the following modifier designating the type of sample:
 - Outdoor Air – OA;
 - Duplicate Sample – DS;
 - Effluent – EF;
 - Indoor Air – IA;
 - Influent – IN;
 - Injection Well – IW;

- Midfluent – MD;
 - Monitoring Well (permanent) – MW;
 - Monitoring Well (temporary) – TW;
 - Hydropunch HP;
 - Piezometer – PZ;
 - Production Well – PW;
 - Recovery or Extraction Well – RW or EW;
 - Rinse Blanks – RB;
 - Sediment Sample – SE;
 - Soil Boring – SB;
 - Soil Vapor (i.e., outside of a building) – SV;
 - Sub-Slab Soil Vapor – SSV;
 - Surface Soil – SS;
 - Surface Water – SW;
 - Trip Blank – TB;
 - Waste Characterization – WC; or
 - Investigation-Derived Waste – IDW.
- Following the sample location code will be a two or three digit numeric designation indicating a unique location for that type of sample. For example, a soil sample collected from boring number 3 would have a sample type code of SB and a two digit numeric designation of 03. Thus, samples from this location would be referred to as SB03 or SB003, rather than SB3).
 - For aqueous media (i.e., groundwater, surface water, QA/QC samples), and soil vapor sampling (i.e., indoor air, ambient air, soil vapor) the depth code will be followed by a six digit numeric code indicating the date the sample was collected (yyymmdd). Non-aqueous samples such as soil and sediment samples will utilize a four digit acronym designating the top of the sampling interval in feet (e.g., 07.5 representing a sample collected from 7.5 feet below the ground surface or 10.5 representing a sample collected from 10.5 feet below the ground surface).
 - Field duplicates will be labeled as ordinary field samples with a unique identification number. Duplicate samples should not be identifiable by sample ID alone so as to reduce the potential for bias and allow the laboratory to analyze them as “blind” quality control samples. Thus, in the event that multiple samples are collected on the same day from the same location (i.e., a duplicate sample), the designation “DS” (duplicate sample) will be used in place of the parent sample’s sample type code and a sequential numeric designation will be assigned in place of the numeric location code. This sequential numeric designation will be “01” for the first duplicate sample collected that day, “02” for the second duplicate sample collected that day (from another sample location, media, etc.), and so on. Subsequent duplicate samples collected on multi-day

sampling events should be numbered sequentially (e.g., -"03" from the previous day's sampling). Since obvious links between the parent and duplicate samples in the Sample ID are to be avoided, it is very important to document in the field logbook or field notes which sample is the parent sample to each duplicate.

- Additional sample volumes collected for matrix spike (MS) and matrix spike duplicate (MSD) analysis will be noted on the COC forms, and no special designations will be used in the sample container labels.

For aqueous media (i.e., groundwater, surface water, QA/QC samples), the sample location code can also be followed by a single-letter acronym designating the well depth (e.g., bedrock (B), deep (D), intermediate (I) or shallow (S)) or the approximate depth the sample was collected.

Following are some sample name examples:

- A shallow soil sample collected from 3.5 feet collected from soil boring location 12 at ABC Industries on March 22, 2012 would be designated as "ABC-SB012-03.5". The complete depth sample range would be recorded in the field logbook or field notes.
- Groundwater samples collected from three different intervals at temporary well point location 3 at ABC Industries on March 22, 2012 could be designated as "ABC-TW003S-120322," "ABC-TW003I-120322," and "ABC-TW003D-120322" depending on the requirements of the project-specific Work Plan, sampling plan and/or project-specific FGDs.
- Paired indoor air and sub-slab soil vapor samples collected from location 3 at ABC Industries on March 22, 2012 would be designated as "ABC-IA03-120322" and "ABC-SSV03-120322", respectively.
- A duplicate of the groundwater sample collected from temporary well point location 3 at ABC Industries on March 22, 2012 (see example above), which is the second duplicate sample collected that day, would be designated as "ABC-DS02-120322". Document in the field logbook or field notes which sample is the parent sample to each duplicate.

4.2 Sample Labeling

Sample labels shall be attached or otherwise adhered to all sample containers. If multiple containers comprise a sample, the label should identify the container number relative to the total number of containers (e.g., 3/4 or 3 of 4). The following procedures should be followed when labeling samples:

- Properly label samples immediately before or immediately following sample collection. Record the following information on each label in indelible black or blue ink (non-Sharpie):
 - Project/Site name;
 - Sample location/sample ID;
 - Sampling date;
 - Sampling time (except for Quality Assurance/Quality Control "QA/QC" samples);

- Analyses to be performed;
 - Preservative;
 - Ramboll Environ as the company name; and
 - Sampler initials.
- Wipe sample containers clean of any debris/water to allow the label to be attached.
- Double-check the label information to make sure it is correct. Remove the backing from the label and apply the label to the sample container. Cover label with clear tape.
- Bag the sample and place it in the designated sample cooler. Make sure there is plenty of ice in the cooler at all times. Maintain the samples at $4\pm 2^{\circ}\text{C}$ from the time of sample collection until delivery to the laboratory.
- Summa canisters and regulators should be returned to their original shipping container (e.g., typically cardboard boxes).
- Sampling information, including the QA/QC sampling time, should be reflected in the field notebook or on field forms, along with the following information:
 - The location of the sample in relation to reference points.
 - Field screening measurements (e.g., photoionization detector [PID] readings), when appropriate.
 - Whether the sample is a QC sample (e.g., split sample, field duplicate, or rinse sample).
 - Any unusual or pertinent observations (oily sheen on groundwater sample, odors).
 - For soil vapor samples record the summa canister and corresponding regulator serial numbers, building interior and outdoor temperatures, sample start and stop times, negative pressure start and stop readings, summa canister size, and atmospheric pressure.

4.3 Sample Packaging

While samples should be kept in the sampling cooler(s) at $4\pm 2^{\circ}\text{C}$ from the time of collection, it is not always feasible during sampling to pack samples as required for transport to the laboratory. At the end of the sampling day, sample packaging for transport to the laboratory should be conducted in an organized and clean area (free of potential cross-contaminants). The following procedure should be followed to prepare the sample(s) and cooler(s) for transport:

- Gather coolers/sample shipping containers, ice, zip-lock bags, and padding, as appropriate.
- Containerize ice in zip-lock bags (double bag) and place a layer of ice bags on the bottom of the cooler.
- Place a layer of padding on top of the ice bags and then begin placing the properly labeled samples in the cooler. Do not bulk pack – be sure to provide padding between sample bottles.

- Once the layer of padded sample containers is full (but not over-packed), place another layer of padding material on top of the sample containers.
- An additional layer of double-bagged ice can be added on top of the padding layer for additional cooling.
- Use multiple coolers if one cooler does not provide sufficient capacity to hold all samples along with appropriate amounts of padding and ice. It is preferable to use more coolers and more padding rather than over-packing and crowding the samples, as sample integrity may be compromised during transport.
- Confirm that each cooler used contains a temperature blank.
- Confirm that a trip blank has been included with the samples if the sampling plan and analyses (e.g., volatile organic compounds [VOCs]) call for use of a trip blank. Ensure that all samples to be analyzed for VOCs are placed in the same cooler as the associated trip blank. If necessary, use more than one trip blank.
- Close coolers/shipping containers and group them together for transport.

4.4 Sample Chain-of-Custody

Sample Chain-of-Custody (COC) forms shall be filled out as soon as practicable after collection of the samples, but can also be cross-checked during the packaging of the samples for transport to confirm that all samples/blanks have been accounted for on the COC. COCs are legal documents and should be filled out carefully and accurately. An example completed COC is included in **Attachment A**.

- The following information should be provided when completing the COC (use indelible black or blue ink ball-point):
 - Project Manager Name and Contact information for report submittal.
 - Sampler's name.
 - Analyses Turn-Around Time (typically standard unless otherwise directed).
 - Project/Site name and location (municipality/state). Try to use a consistent Project/Site Name when re-visiting a site for multiple sampling events.
 - Regulatory Program.
 - Sample ID for each sample.
 - Sample collection date and time for each sample.
 - Sample matrix for each sample.
 - Number of sample containers for each sample.
 - Analyses requested for each sample.
 - Sample matrix and air sample volume, if appropriate.
 - Sample preservation method.
 - Indicate whether samples are field filtered or require filtering in the laboratory.

- Special instructions or notes to the laboratory (for example, expedited turnaround or holding samples for analysis pending results of other samples).
 - Signatory information when relinquishing samples (signature, company, date and time of recipient and sample releaser) – see below.
 - Note Delivery Service (e.g., laboratory courier or Federal Express) and air bill Number (if applicable).
 - For vapor samples, record the summa canister and regulator serial numbers, building interior and outdoor temperatures, sample start and stop times, negative pressure start and stop readings, summa canister size, and atmospheric pressure, if required by the laboratory, a project-specific Work Plan, sampling plan and/or project-specific FGDs.
- If a minor mistake is made when filling out the COC, cross out the error with a single line and write your initials and date next to the error. Major errors in transcription require that a new COC form be completed to ensure legibility of information on the original and carbon copy pages of the COC form.
 - The use of quotation marks or other terms to indicate repetitive information within a column should be avoided. If several entries in a row are repetitive, place a continuous vertical arrow through the cells from the first entry to the next different entry.
 - If additional instructions or information is necessary to provide to the laboratory, provide these details on the COC (usually within the “remarks” section) – do not enclose additional pages of instructions.
 - If more than one COC form is necessary to accommodate all of the samples being transported to the laboratory use consecutive numbers to identify the additional COC forms (i.e., Page 1 of ___, Page 2 of ___, etc.).

4.5 Sample Transport

Maintaining the chain-of-custody is just as important during sample transport as it is during sampling activities. Note that a sample is considered to be in custody if:

- It is in the actual possession of an investigator (sampler);
- It is in the view of an investigator (sampler), after being in their physical possession;
- It was in the physical possession of an investigator (sampler) and then they secured it to prevent tampering; and/or
- It is placed in a designated secure area.

Option 1

The preferred method of transporting the collected samples under chain-of-custody to the laboratory is for the sampler/field personnel to hand-deliver the cooler(s)/container(s) of samples to the laboratory. When this transport method is possible, the following procedure must be followed:

- Once you have finished completing the COC, place it in a zip-lock bag without signing the “relinquished by”/“received by” (or equivalent) signatory boxes. Keep this outside of, but with, the packaged cooler(s).
- Place two (2) custody seals on opposite corners of each packaged sample cooler (across the opening) and sign/date each custody seal.
- Transport the properly packed and padded cooler(s) and the COC to the laboratory.
- The sampler/field staff must meet with the laboratory representative that accepts sample drop-offs (it is unacceptable to leave samples at a front desk or anywhere without having a laboratory representative sign off on receipt).
- Upon meeting the laboratory representative, sign your name on the COC in the “relinquished by” signatory block. Write the current date and time next to your signature.
- The laboratory representative will then sign their name in the “received by” signatory block using the same date and time. The samples are no longer under the sampler/field staff’s custody and chain-of-custody will continue with the laboratory throughout analysis of the samples.
- The laboratory representative will provide you with one of the carbon copies of the COC, which you should maintain with the project files/field logbooks.

Option 2

The second most preferred method of transporting samples to the laboratory is to arrange a laboratory courier pick-up at the site at the end of the sampling day. The arrangements should be made with the laboratory in advance (usually during the ordering of sampling containers) to plan when and where the laboratory courier service will meet the field staff at the site. When this transport method is used, the following procedure must be followed:

- Once you have finished completing the COC, place it in a zip-lock bag without signing the “relinquished by”/“received by” (or equivalent) signatory boxes. Keep this outside of, but with, the packaged cooler(s).
- Take the properly packaged cooler(s) and COC and meet with the laboratory courier service representative at the predetermined time and location at the site.
- Upon meeting the laboratory courier representative, sign your name on the COC in the “relinquished by” signatory block. Write the current date and time next to your signature.
- Place two (2) custody seals on opposite corners of each packaged sample cooler (across the opening) and sign/date each custody seal.
- The laboratory courier representative will then sign their name in the “received by” signatory block using the same date and time. The samples are no longer under the sampler/field staff’s custody and chain-of-custody will continue with the laboratory courier service and the laboratory throughout transport and analysis of the samples.
- The laboratory courier representative will provide you with one of the carbon copies of the COC, which you should maintain with the project files/field logbooks.

Option 3

If it is not possible for the field staff to drop off the samples at the laboratory or a laboratory courier service to pick up the samples on the same day of collection at the project site, arrangements can be made for the laboratory courier service to pick up the samples the following day at the Ramboll Environ office (assuming next day pick up is consistent with the stipulated hold time for all samples). The courier pickup arrangements should be made with the laboratory in advance (usually during the ordering of sampling containers), if possible. When this third transport method is used, the following procedure must be followed:

- Once you have finished completing the COC, place it in a zip-lock bag without signing the "relinquished by"/"received by" (or equivalent) signatory boxes. Keep this outside of, but with, the packaged cooler(s).
- Place two (2) custody seals on opposite corners of each packaged sample cooler (across the opening) and sign/date each custody seal.
- Transport the properly packaged coolers/shipping containers and COC from the site back to the Ramboll Environ office.
- Place the properly packaged coolers/shipping containers in the field room (a locked, secure space).
- Remove the COC from the zip-lock bag and sign your name on the COC in the "relinquished by" signatory block. Write the current date and time next to your signature.
- Do not write anything else or sign anywhere else in the "relinquished by" or "received by" signatory spaces.
- Place a post-it note on the COC that indicates the number of coolers/shipping containers (if more than one) that should accompany that COC. Return the COC to the zip-lock bag.
- Leave the COC with the coolers in a fashion that will ensure the COC does not get separated from the coolers. For example, the COC could be taped to the cooler/shipping container; a zip-tie could be placed through the zip-lock bag and attached to the handle of a cooler, etc.
- If there are multiple cooler/shipping containers that will be left with the one COC, place notes or some other indicator on each of the coolers to denote which coolers/shipping containers belong to the same group.
- Leave coolers/shipping containers and COC in secure field room, ensuring that the door to the field room is locked behind you.
- For sampling events that require leaving more than one cooler/shipping container in the field room with the COC, the sampler should notify and send photo-documentation of the sample locations to office personnel (those that might possibly get called when the laboratory courier arrives for pick-up the following day) to alert them to the group of coolers/shipping containers and any marks/notes placed on the coolers to group them together.
- When the pre-arranged laboratory courier pickup occurs, it is possible that another field staff member (other than the original sampler) will receive the call to transfer the

samples to the laboratory courier. Whoever receives a call to meet with the laboratory courier should meet the courier at the field room if the original sampler is not able to.

- The Ramboll Environ staff member meeting the courier should review the COC/post-it note to confirm how many coolers/shipping containers should be included in the grouping. This staff member should also confirm that the correct number of coolers/shipping containers are grouped together with the COC. If the staff member is unsure or has any questions about what coolers correspond to the COC, the staff member should call the original sampler.
- Once the staff member has confirmed that all the coolers/shipping containers are accounted for with the COC, they should remove the COC from the zip-lock bag.
- The staff member then signs the "received by" signatory block next to the original sampler's signature. The staff member should put the date and time next to their signature that was used by the original sampler on the previous day. For example, if Sampler A signed the COC at 17:55 on 3/22/12 and Staff Member B met with the courier the following day, Staff Member B signs the COC as "received by" on the same line as Sampler A signed "relinquished by" and Staff Member B also puts the date and time of their signature as 17:55 and 3/22/12. This accounts for the samples being in a secured Ramboll Environ space after the original sampler placed them there (i.e., in Ramboll Environ's custody) and Staff Member B signs off at the same time/date as the original sampler because they are acting as a representative of Ramboll Environ.
- The staff member then signs off on the second line in the "relinquished by" signatory block and writes the CURRENT date and time (current as of when the courier is there for pick-up).
- The laboratory courier representative will then sign in the "received by" block on the second line and will use the same current date/time. At this time, the samples are no longer under Ramboll Environ's custody and the chain-of-custody will continue with the laboratory courier and the laboratory through transport and analysis of the samples.
- The laboratory courier representative will provide you with one of the carbon copies of the COC, which you should maintain with the project files/field logbooks.

Option 4

Some sampling events may take place at sites that are not in the same general geographic region or that require analyses that are only performed at laboratories that are not located within driving distance. In these cases, samples may need to be shipped to the laboratory from the project site (or the Ramboll Environ office). Due to the variations in out-of-state laboratories and transportation requirements based on preservatives and sample material, a specific plan for sample transport should be discussed between the sampling field team and the project's PM or PIC to ensure that all laboratory and Federal/State transportation requirements are met. In general, the following steps should be considered when planning sample transport using a shipping service (e.g., FedEx, UPS, etc.):

- Package samples with more padding than would normally be used in field vehicle/laboratory courier road transport.
- Consider the amount of ice required to keep samples cool for the duration of the trip to the laboratory.

- Samplers should sign the “relinquished by” signatory block of the COC with the date and time when they drop off the samples for shipment. Then place the COC in a zip-lock bag and place it in the cooler to be shipped. Place signed custody seals on the cooler and then secure the cooler closed with tape around the entire seal of the opening and then around the cooler (perpendicular to the opening) to ensure the cooler is secure during shipping.
- Consider the preservatives used with the samples. Based on United States Environmental Protection Agency (USEPA) research and subsequent negotiation with the US Department of Transportation (USDOT), environmental samples do not need to be declared as “hazardous materials” when they (or the preservative used with them) fall below a certain weight percent limit for certain acids/bases. The concentration of constituents expected in samples and preservatives should be compared to regulations to see if special hazardous materials handling applies.
- Consider USDOT, International Air Transport Association (IATA), and any other Federal/State transportation regulations governing the shipment of hazardous materials or dangerous goods.
- Shipping papers need to be retained with the COC, and sampling staff must confirm tracking to receipt by lab. The sampler must verify that all of the containers shipped arrived at the lab.

5. PRECAUTIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while preparing samples for shipment and recording the required information.

- It is important to always remain alert and aware of your surroundings and wear a high visibility safety vest. Activities associated with the labeling and preparation of samples for shipment should be performed away from active work areas or traffic areas, preferably in a field office or on the back of a field truck.
- To prevent laboratory bias in analysis of QA/QC samples (e.g., field duplicates), do not name or assign times to quality control samples with a similar sample ID as the parent sample. Since the duplicate sample’s sample ID will not have a direct indication of what parent sample it is related to, the parent and quality control sample information should be recorded in field logbooks or forms.
- Should samples need to be preserved over longer time periods (e.g., weekend), replenish ice in the cooler as needed to ensure that the samples are preserved at $4\pm 2^{\circ}\text{C}$ until delivery to the laboratory. Avoid placing samples in refrigerators or freezers.
- Consider potential for hazardous materials within sample media or sample preservatives. Consult Federal and State regulations to determine if special hazardous materials handling procedures must be followed on a project by project basis.

6. RECORDKEEPING

Record all information related to the release of samples in accordance with **FGD 1.01**, Field Notes and Records. After the COC is signed, by both the releaser and receiver of samples and the samples are transferred, obtain a copy of the signed COC. A completed COC (inclusive of signatures from the laboratory) should be provided with the laboratory data deliverables. Maintain both copies of the COC with the project files along with copies of associated shipping air bills (if used) and other sampling documentation.

Records should be managed in accordance with Ramboll Environ's Document Retention Policy, with copies of COCs, air bills, lab bottle order documentation, and sampling plans specific to a sampling event maintained together within the project files.

00WSITESOP\PRIN_WP\38000v2

ATTACHMENT A
SAMPLE COMPLETED COC FORM

CHAIN-of-CUSTODY

No 09901

PAGE 1 of 1

☐	18100 Von Karman Ave., Suite 600 Irvine, CA 92612 (949) 261-5151 (949) 261-6202 (fax)	☒	707 Wilshire Blvd., Suite 4950 Los Angeles, Calif. 90017 (213) 943-6300 (213) 943-6301 (fax)	☐	1702 E Highland Avenue, Suite 412 Phoenix, AZ 85016 (602) 734-7700 (602) 734-7701 (fax)

MSA#: SNBU-2015-123 WO#: SNBU-2014-122

PROJECT NAME / FACILITY ID: ABC INDUSTRIES

FIELD PERSON: JOHN DOE

PROJECT NUMBER: 05-12345A DATE: 03-24-14

PROJECT MANAGER: JANE SMITH

PROJECT LOCATION: 123 LOS ALAMOS RD., LOS ANGELES, CA

LABORATORY: TEST AMERICA

IS THIS A UST PROJECT OR IS EDF REQUIRED? Y (N) IF YES, GLOBAL ID #: _____

[illegible]

FIELD GUIDANCE DOCUMENT NO. 1.04
DOCUMENTING SAMPLING LOCATIONS

FIELD GUIDANCE DOCUMENT NO. 1.04

DOCUMENTING SAMPLE LOCATIONS

Prepared By:	Burke Brooks
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Applicable To:	All North American Offices
Effective Date:	July 27, 2021
Revision Date:	
Revision Notes:	
Documents Used as Reference During Preparation:	<i>Technical Guidance for Site Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil</i> (NJDEP, March 2015) <i>Field Sampling Procedures Manual</i> (NJDEP, August 2005) <i>Official U.S. government information about the Global Positioning System (GPS) and related topics</i> https://www.gps.gov/systems/gps/performance/accuracy/ .

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ATTACHMENTS

Attachment A: Global Positioning System (GPS) Devices

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines for use by Ramboll employees operating in the United States and Canada for documenting sample locations in the field. Documenting sampling locations is critical because it provides a locational record of the samples that are used throughout the life cycle of a project and for future reference. Recording the location of the samples accurately and consistently is important so that results can be interpreted in their proper spatial context and can be relocated in the field if necessary. There are many ways to record sample locations, including measurement from permanent landmarks, using global positioning system (GPS) equipment (with appropriate accuracy for the task), or subcontracting the services of a Licensed Professional Land Surveyor.

Although this FGD provides guidelines for documenting sample locations associated with typical field activities and projects, it should be understood that for certain projects more specific procedures or alternative methods, including state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable. Specific requirements of each project will be reviewed by the Ramboll Principal-in-Charge/Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, Sampling Plan and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans, but rather provide a reference for developing project specific requirements.

This FGD does not supersede Ramboll Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. Ramboll employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by approved site-specific procedures, which may include those in this FGD. The Ramboll PIC and PM must ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information is maintained in the project file for the duration of the project or as established by applicable Ramboll document handling and retention policies. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT AND MATERIALS

A checklist of equipment generally required for documenting sampling efforts is provided below. Additional equipment may be specified in the project-specific HASP and/or Work Plan/Sampling Plan and the following list should not be considered exhaustive.

- Site information (e.g., maps, contact numbers, keys or lock codes for gates or access points);
- Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records); and
- Personal Protective Equipment (PPE) and field monitoring equipment as required by the site-specific HASP.

- Global Positioning System (GPS) Enabled Device;
- Stadia Rod and Optic Level;
- Tape Measure or measuring wheel (decimal feet or decimal meter, whenever possible);
- Compass;
- Field supplies for visual marking, such as paint, stakes, or flags, and
- Mobile phone, tablet and camera.

If certified locations and elevations of sampling locations are required (e.g., establishing the top of casing of a monitoring well), a Professional Land Surveyor licensed in the state where the work is being performed should be subcontracted. General information on equipment typically used to document sampling locations is provided in **Attachment A**.

3. PROCEDURES REFERENCED

The following FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **FGD 1.01**, Field Notes and Records
- **FGD 1.02**, Sample Naming, Labeling, Handling, Shipping, and Chain of Custody
- **FGD 1.03**, Data Management
- **FGD 1.06**, Field Surveying and Monitoring Well Elevation Surveying
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping
- **FGD 4.06**, Equipment Calibration

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPIs) may need to be referenced based on the specific requirements of the site-specific Work Plan/Sampling Plan (e.g., field screening FGDs).

4. PROCEDURES

4.1 Planning and Design Considerations

All significant decisions regarding documenting sampling locations shall be approved by the PIC and/or PM before the initiation of associated field activities. The Work Plan/Sampling Plan should clearly establish procedures for documenting sampling locations. The Work Plan/Sampling Plan will generally provide some discretion for modifications in the field depending on encountered conditions; however, any significant departure from prescribed sampling activities shall be discussed with and approved by the PIC and/or PM prior to implementation.

When planning how to document sampling locations, the following, which may dictate what procedures should be used, should be considered:

- The required level of accuracy (refer to **Attachment A** which provides some information on equipment typically used to document sampling locations). A Licensed Professional Land Surveyor can document sampling locations with a high degree of accuracy (typically, 0.1 ft horizontal accuracy and 0.01 ft vertical accuracy).
- The conditions surrounding the sampling locations that may limit the effectiveness of GPS enabled devices (heavily forested areas, areas with many large buildings or areas with terrain changes).
- Whether the elevations of the sampling locations are needed, in addition to the horizontal positions.
- Whether certified locations and elevations of sampling locations are required, which in most cases can only be performed by a Professional Land Surveyor licensed in the state where the work is being performed. The level of accuracy, and deliverables (format of the data, signed and sealed drawings, etc) from the surveyor should be clearly defined.
- When using GPS units, consult with your local GIS or CAD specialist on the limitations of the various GPS units, post-processing requirements, and the applicable projected coordinate system. Similarly, if using a Licensed Professional Land Surveyor, consult with your local GIS or CAD specialist to define the survey requirements and deliverables.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review, and complete pertinent tasks identified in **FGD 2.02**, Site Preparation, Inspection and Housekeeping. At a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the site-specific HASP;
- Coordinate and obtain permission for site access;
- Review project-specific Work Plan/Sampling Plan, where applicable;
- Review project-specific Quality Assurance Project Plan (QAPP), where applicable;
- Review and discuss with the PIC and/or PM the proposed Work Plan/Sampling Plan;
- Confirm with the PM and/or PIC the project-specific sample name format to be used (refer to **FGD 1.02**, Sample Naming, Labeling, Handling, Shipping, and Chain of Custody). The sample identification scheme should ensure that sampling locations can be clearly differentiated and matched with location data recorded by project personnel in field notebooks or forms;
- Confirm the project geodesy and that sampling equipment is documenting data in the correct datum/ coordinate system;
- Confirm number and general location of sampling locations;
- Ensure that all equipment/materials required to complete the work have been packed and that they have been inspected to ensure their suitability. Ramboll staff should be familiar with the equipment to be utilized; and
- Perform a GPS control check to confirm the performance and initial setup of the sampling equipment (i.e., coordinate system and vertical/horizontal datum) by occupying a field

verified ground control point (e.g., National Geodetic Survey disk, monitoring well, fire hydrant, pk nail).

Prior to the commencement of the field effort, inspect, test, and/or ensure that the equipment has been calibrated (refer to **FGD 4.06**, Equipment Calibration) and, when possible, obtain calibration documentation from the equipment vendor.

4.3 General Documentation of Sampling Location Guidelines

The exact location of sampling points should be documented in an approved geographically referenced format. Five methods are commonly used: (a) Compass Traverse; (b) Triangulation Measurements; (c) Distance Offset Measurements; (d) GPS-Enabled Devices; and (e) Licensed Professional Land Surveyor.

The following provides a recommended practice for documenting sampling locations:

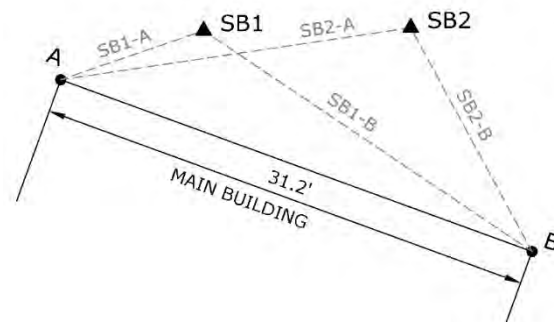
- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.
- Confirm the unique sample identification for the sampling locations (refer to **FGD 1.02**, Sample Naming, Labeling, Handling, Shipping, and Chain of Custody).
- Document the make and model of the equipment used for sample locating (i.e. GPS-enabled device make, model and serial number, etc.), geodetic parameters in which the system is working (datum, coordinate system, units) and source of correctors (SBAS, RTX, NTRIP or other internet based correction source).
- If using the Compass Traverse method:
 - Identify a monument (or other stationary permanent point) as a ground control point from which all sampling points can be measured using a compass and measuring tape. If a building or other stationary structure exists, a corner may act as this ground control point. Otherwise, a permanent physical object that can be identified in both the map and in the field such as a monitoring well, fire hydrant, or utility pole could be used as a ground control point. If no such ground control point exists it may be necessary to have a licensed Professional Land Surveyor install a monument, or if allowed by State regulations create your own temporary monument using a PK nail, survey marker with washers, or driven steel reinforcement bar. Otherwise an alternate method for determining locations should be used. Provide a description of the monument in the field notebook (e.g., NW corner of baghouse #3, or USGS Monument # 12345).
 - Standing at the monument and facing the sampling point, use the compass hairlines to determine degree and direction. The line of sight should run from the monument, through both hairline needles on the compass, to the sampling point.
 - Measure the distance between the monument and the sampling point using the measuring tape.
 - Record the degree and direction reading from the compass along with the distance measurement in the field notebook and provide a description of the sampling location. For example, a description of a soil boring location would read: Sample ABC-SB02-150325 is located 26 feet north and 7 feet west of the NW corner of

Baghouse #3, or 30 feet at a bearing of 340° NNW heading from the NW corner of Baghouse # 3. Detailed compass measurements which further qualify the location may be included in the description (use NNW example above).

- If using triangulation measurements, the location of the sampling point is determined by measuring the distance to from the sampling location from two ground control points (e.g. two building corners) using a measuring tape, as follows:

- Identify two monuments (or other stationary permanent point) as a ground control point from which all sampling points can be measured using a measuring tape. If a building or other stationary structure exists, a corner may act as this ground control point. Otherwise, a permanent physical object that can be identified in both the map and in the field such as a monitoring well, fire hydrant, or utility pole could be used as a ground control point. If no such ground control point exists it may be necessary to have a licensed Professional Land Surveyor install a monument, or if allowed by State regulations create your own temporary monument using a PK nail, survey marker with washers, or driven steel reinforcement bar. Otherwise an alternate method for determining locations should be used. Provide a description of the monument in the field notebook (e.g., NW corner of baghouse #3, or USGS Monument # 12345).

- Standing at the first monument and facing the second monument, measure and record the distance between the two monuments using the measuring tape (line AB in Insert 1).



NOTES:
MAIN BUILDING A:B=31.20'
SB1: A=9.4', B=24.6'
SB2: A=22.0', B=15.8'

Insert 1 - Triangulation Measurements

- Standing at the first monument and facing the sampling point, measure and record the distance between the monument and the sampling point using the measuring tape (see Insert 1).

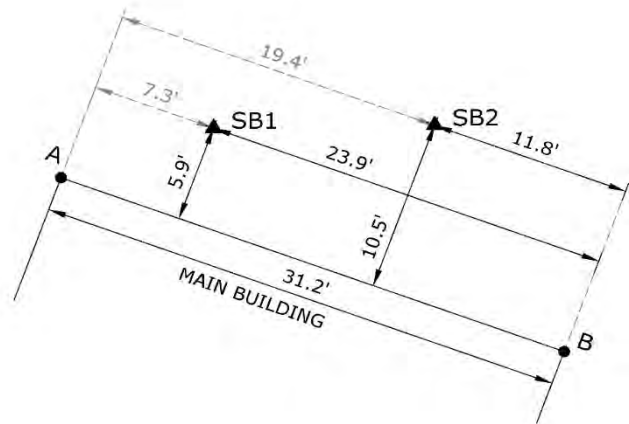
- Standing at the second monument and facing the sampling point, measure and record the distance between the monument and the sampling point using the measuring tape. The sampling point becomes the third point of a closed triangle that can be easily mapped (see Insert 1).

- Repeat the process for additional sampling locations

- If using distance offset measurements, the location of a sampling point is determined by measuring its position from a reference line using a measuring tape, as follows:

- Identify two stationary permanent ground control points along a physical reference line from which all sampling points can be measured using a measuring tape. If a building wall, fence or other physical stationary structure wall or edge exists, these may act as the physical reference line. Provide a description of the reference line in the field notebook (e.g., north wall of baghouse #3).

- Standing at the first monument and facing the second monument along the reference line, measure and record the distance between the two monuments using the measuring tape (line AB in Insert 2).



Insert 2 - Distance Offset Measurements

- Standing at the sampling point and facing the reference line, measure and record the perpendicular distance between the sampling point and the reference line using the measuring tape. Then measure and record the distance along the physical reference line using the measuring tape to define the parallel distance between the sampling point and the reference line (see Insert 2).
- Repeat the process for additional sampling locations. Note that a sample location point should not be used to locate additional sample location points as this will introduce inaccuracies in measurements (i.e., in Insert 2, do not use SB1 to locate SB2).
- If using GPS-Enabled Devices/ Mapping Grade GPS:
 - Perform a GPS control check to confirm the performance and initial setup of the sampling equipment by occupying a field verified ground control location near the site at the beginning of data collection.
 - Holding the GPS receiver over the sampling location (approximately 5 seconds for survey grade or RTK-enabled GPS, 30 seconds for mapping grade GPS), record the GPS coordinates provided by the device in the field notebook or by recording a point in the associated interface device (tablet, etc.) and documenting that point with the appropriate sample ID, photographs and other descriptive information specific to the project.
 - When documenting using a recreational grade GPS unit, be sure to manually document the datum, coordinate system, and the reported accuracy as outlined in FGD 1.01 (Field Notes and Records). If using a mapping grade (sub-meter) or a survey grade (centimetre) GPS unit, it should be configured to automatically record the datum, coordinate system, reported accuracy, and the correct number of decimal places depending on your surveying accuracy.
 - Perform a GPS control check to confirm the performance and initial setup of the sampling equipment by occupying a field verified ground control location near the site at the end of data collection.
 - When collecting mapping grade or a survey grade data, coordinate with your local GIS and CAD specialists for potential post-processing requirements.

- If using a Licensed Professional Land Surveyor:
 - Clearly mark and label all locations to be surveyed using paint, stakes, or flags before the surveyor is on site.
 - Confirm level of accuracy and documentation needs.
 - When the surveyor is on-site, show all the locations to be surveyed and upon completion of the survey, and ensure that all locations have been surveyed.
 - If locating structures or equipment, ensure enough points were collected to appropriately identify full extent of feature and where it is situated in relation to other key Site features, such as utilities, access roads, etc.
- Photo-document all sampling locations to allow secondary identification of the sampling point and include a sketch of the sampling location relative to other known site features in the field notebook to supplement the measurements. Photographs are the most accurate and convenient demonstration of the field personnel's observations. Photographs taken to document sampling points should include two or more reference points to facilitate relocating the point later. Each photograph should be noted in the field notebook with Date, Time, Name of Site, General Direction faced, description of the subject taken, and Sequential Number of the Photograph.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety and accuracy while documenting sampling locations.

- It is important to always remain alert and aware of your surroundings. Since activities associated with the recording of sample location can't always be performed away from active work areas or traffic areas it is essential that you stay aware of the happenings around you and make sure you are easily visible to those around you.
- Prior to mobilization, determine the sampling locations and evaluate the need for security, barricading, and/or traffic control (e.g., when wells are located on the right of way).
- When working out of sight of the general public or when site employees are in potentially hazardous areas (e.g., wooded habitats), all field staff should utilize the "buddy system" and should ensure that the project-specific HASP includes safety measures and procedures.
- The accuracy of the GPS receiver is a function of the number of satellites visible; the more satellites a GPS receiver can "see", the better the accuracy. Obstructions such as buildings, terrain, electronic interference, dense foliage and tree cover can block signal reception causing position errors or possibly no position reading at all. If the minimum required accuracy is not possible due to field conditions or interferences, contact the PIC and/or PM to discuss data quality objectives before proceeding.
- GPS units shall not be used in indoors, underwater or underground as they are not capable of meeting their operational level of accuracy in these conditions.

- When selecting ground control points ensure that these are fixed and located away from work areas that may be subject to disturbance (e.g., buildings to be demolished) or near water features.
- Measuring from a single known point is not an accurate method of measurement and should be avoided (e.g., 10 feet north of the clean out).

6. RECORDKEEPING

Document all information collected in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management).

ATTACHMENT A

GLOBAL POSITIONING SYSTEM (GPS) DEVICES

GPS devices may be used to determine sample coordinates; however, the location accuracy of the device should be evaluated to ensure it meets project-specific requirements. Descriptions of commonly types of GPS devices are provided below and following is a table comparing them.

Device Grouping	Sample Devices	Typical Horizontal Accuracy	Typical Vertical Accuracy	Advantages / Disadvantages
Recreational Grade GPS	Smartphone	5 - 10 Meters	10-20 meters	Convenience and Cost Efficient
	Handheld Outdoor GPS	3 - 10 Meters	10-20 meters	More Costly, Better Accuracy
Mapping/Resource Grade GPS (Non-Survey Data Collection)	Trimble R1, Arrow 100	1 Meter	2-3 meters	More costly, Submeter accuracy
Survey Grade GPS (Non-Survey Data Collection)	Trimble R2, Arrow Gold	0.01 meter	0.02 meter	Costly, Centimeter Accuracy

- **Survey Grade GPS.** Survey grade GPS receivers are capable of centimeter accuracy and are used by licensed Professional Land Surveyors for high accuracy measurements and fixed positions. Survey grade GPS receivers are commonly used for design, As-Builts, record drawings, final post-excavation confirmatory sampling, monitoring wells, or other project purposes that require survey level accuracy.



Figure A-1: Trimble R2 GPS Receiver (Source: Trimble)



Figure A-2: Trimble R1 GPS Receiver (Source: Trimble)

- **Mapping / Resource Grade GPS.** Mapping/Resource Grade GPS receivers are capable of submeter accuracy (<3ft). They are commonly used to locate soil borings, sediment cores, proposed sampling locations and site features for mapping that does not require survey level accuracy. An advantage of these GPS units is that they can operate in real time differential correction mode in the field, which eliminates the need for post-processing using software in the office to achieve the minimum accuracy requirements. It also allows the user to set the required coordinate system, which is not possible with Recreational grade receivers. Certain units should be avoided (e.g., Trimble Pro XRS mapping grade GPS units) as they require

that the coordinate system be defined before use and data cannot be imported in real time to Ramboll's mapping portal (i.e., it needs to be processed through the manufacturer's software first).

- **Recreational Grade GPS.** Recreational grade receivers include handheld outdoor GPS units and smart phones. They are limited to autonomous accuracy due to the lack of real time correction or post processing capabilities. GPS enabled smartphones such iPhone and Android operating systems and other handheld outdoor GPS units (e.g. Garmin eTrex) provide a horizontal accuracy which can range from 1 to 10 meters (depending on cellular coverage) and can be used when submeter accuracy is not necessary to meet project objectives or to georeference photographs. If used to document sampling locations, downloadable applications developed for assisting in GPS location documentation should be used (i.e., GPS Status & Toolbox, shown right) and ample time should be given for GPS/Satellite location and achieve the highest accuracy. Handheld outdoor GPS units (e.g. Garmin eTrex) have slightly better accuracy.



Figure A-3: GPS Status & Toolbox Smartphone Application
(Source: Ramboll)

FIELD GUIDANCE DOCUMENT NO. 2.02
**SITE PREPARATION, INSPECTION,
AND HOUSEKEEPING**

FIELD GUIDANCE DOCUMENT NO. 2.02

SITE PREPARATION, INSPECTION, AND HOUSEKEEPING

Prepared By:	David Cruikshank
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Approved By:	J. Mark Nielsen
Applicable To:	All North American offices
Effective Date:	February 21, 2014
Revision Date:	July 12, 2016
Revision Notes:	1. Revised company name and format.
Documents Used as Reference During Preparation:	

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ATTACHMENTS

Attachment A: Sample Project-Specific Daily Report

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for planning field work and conducting visual inspections of the areas where the work will be conducted prior to commencing intrusive field work activities. This FGD also establishes expectations for general housekeeping during implementation of field activities.

Site inspections provide valuable site information, identify and document conditions of environmental concern that may affect implementation of site activities. When possible, site inspections should be conducted during the planning stages of a project to ensure that there are no site specific conditions that will need to be addressed before or during field activities. In addition, the site inspection should be used to select staging areas and to notify potentially impacted community members before starting field activities (if appropriate and approved by the PIC or PM). If a site inspection visit is not possible prior to mobilizing to the site, prior reports and other available documentation should be reviewed (i.e., Phase I ESA and site investigation/remediation reports, as-built facility drawings, and/or aerial photos [e.g., Google Earth images]) before mobilizing to the site, and an on-site inspection should be conducted before commencing any field work activities.

Although this FGD provides guidelines for planning field work and conducting visual site inspections prior to commencing field work activities, it should be understood that for certain projects more specific procedures may be applicable, including state-specific or regulatory program-specific guidelines, requirements or procedures. Specific requirements for these types of projects and activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM), and any additional requirements will be defined in a project-specific Work Plans, sampling plans and/or project-specific FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP followed by procedures recommended in this FGD. The Ramboll Environ PIC and PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information is maintained in the project file. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

Equipment and materials necessary to conform to this FGD include:

- Bound Notebook – lined high-grade 50 percent rag paper with a hard-cover and water-resistant surface (e.g., "Rite-in-the-Rain"). Soft-bound field books are acceptable for limited duration projects.

- All Weather Pens or (weather permitting) other indelible ballpoint pens with black or blue ink.
- Digital Camera.
- Gallon-size or larger plastic zip top bag or other clear plastic to cover note book in wet weather.
- Updated Site Map/Site drawings or aerial photos.
- Keys (as necessary for site access).
- Measuring tape or GPS (recommended).
- Appropriate PPE (per the site HASP, as required by facility/site, and/or Ramboll Environ Health and Safety Manual).
- Marking paint, stakes or flagging (if needed).
- Flashlight (if needed).
- PID, 4-gas meter or other field monitoring devices (if needed).

Field tools (e.g. wrenches, screwdrivers, pry-bars that may be needed to open vaults)Based on the field activity and project, the following also may be needed:

- Field Log Forms (preferably produced on "Rite-in-the-Rain" water-resistant paper).
- Ruler/Straight Edge.
- Stop-Watch.
- Calculator.
- Laptop Computer.
- Lookup tables for well volume calculation, tank size estimation, etc.
- Clipboard/field case.
- Gallon-size or larger plastic zip top bag or other clear plastic to cover note book and forms in wet weather.

In some cases, such as those involving long-term construction management activities, project specific daily reports, may be produced from the field notes and maintained electronically in portable document format (pdf). An example of Ramboll Environ's daily report form is provided in **Attachment A**.

3. PROCEDURES REFERENCED

The following FGDs and Standard Practice Instruction (SPI) are related to this FGD and should be referenced, as needed:

- **SPI 27**, Utility Clearance.
- **FGD 1.01**, Field Notes and Records

- All field sampling FGD categories.

The list above is not intended to be all inclusive. Other SPIs and FGDs may need to be referenced based on the specific requirements of the site-specific sampling plan.

4. PROCEDURES

4.1 Pre-Field Work Preparation Procedures

The following tasks should be completed before initiating field activities, which will prepare field staff for what may be expected during a site inspection:

- Review and sign the site-specific Health and Safety Plan (HASP), if required by activities to be performed;
- Coordinate and obtain permission for site access;
- Request and review relevant site information, such as:
 - Site, building, construction/as-built, or utility drawings;
 - Previous environmental, hydrogeologic or geotechnical reports;
 - Environmental audits;
 - Permits;
 - Tank (AST and UST) registrations and sump/clarifier information;
 - Material Safety Data Sheets;
 - Community Right-to-Know plans;
 - Safety plans; and
 - Hazardous waste generator reports.
- Establish facility operational hours;
- Locate water, restroom, and electricity source(s) that may be needed for field work;
- Evaluate access constraints that may affect sampling locations (e.g., door sizes, ceiling height, ground cover, fences, overhead utilities, etc.);
- If work is to be conducted inside, assess ventilation options;
- If investigation-derived waste will be generated, coordinate with client / facility personnel to establish an acceptable waste staging area and a decontamination area;
- Confirm with the PM and client / facility personnel that HASP and field work plans are in compliance with client policies and procedures;
- Request and confirm completion subsurface utility clearance required by the HASP;
- Determine vehicle access routes and gate lock requirements necessary to access work locations and staging areas;
- If a figure showing sampling locations does not already exist, map out proposed sampling locations and review with the PM and facility personnel; and

- Locate nearby communication and emergency facilities.

If relevant site information is made available prior to site visit, it should be reviewed in the context of the planned site inspection and site activities to identify areas that may potentially interfere with the planned activities and that may warrant further assessment. The site map of proposed activities should be updated to reflect additional relevant information and areas warranting further assessment.

4.2 Site Inspection Procedures

Contact the identified key facility personnel upon arrival to the Site and assess proposed work areas and areas previously identified as warranting further assessment. The following are a list of items that should be observed, verified, and documented on the updated site map and/or in the field notebook during the site inspection (*Note: Record any observations that differ from information obtained as part of the pre-field work procedure activities*).

- Identify physical site features, such as locations and dimensions of buildings, paved areas (and type of paving [asphalt vs. concrete]), ground surface cover, terrain (e.g., level, sloped, terraced, etc.), areas of standing water, aboveground utilities, visual evidence of underground utilities (i.e., fire hydrants, vent lines, light poles, etc.), chemical storage areas, waste storage areas, main facility thoroughfares, current site activities in the vicinity of planned work areas, and areas of limited access. Locate the features accurately by measuring distances from existing features and dimension the features being described;
- Verify the completion of the subsurface utility locate by checking the site for indications of subsurface utilities markouts and verifying markings for all known utilities;
- Document known and other potential contamination source areas, which may include sources not identified during previous Phase I ESA's or site investigation activities (e.g., tanks, vent lines, floor drains, lifts, process areas, stained soil or pavement, stressed vegetation, septic systems, pavement cuts or patches);
- Describe the proximity of residences and public roadways and railways;
- Identify the location of nearby surface water bodies;
- Identify the location of drainage features (i.e., storm water drains, catch basins, sumps, manholes, swales, and floor drains);
- Identify the location of solid waste disposal areas or treatment areas (e.g., wastewater treatment facilities, pits/ponds/lagoons, septic/leaching fields);
- Identify the location of wells and purpose (i.e., production, monitoring, irrigation, and injection);
- Document the content and other pertinent information of labels on containers of suspect substances stored in proximity to the work area and staging area;
- Inspect proposed work locations to determine equipment access constraints due to building accessibility, proximity to interior or exterior working machinery, utilities, site fencing, and vegetation; and

- Describe photographs taken, conversations with site personnel or neighbors (if within the scope of work and permitted by the client and facility personnel), and visits to local authorities and information obtained.

4.3 Housekeeping Procedures

The following provides a recommended list of work practices while on site in order to maintain good housekeeping practices in project work areas:

- Establish common paths of travel and keep them free from spills and the accumulation of equipment and materials;
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions and slip hazards and adequately illuminated during work activities.
- Store tools, equipment, materials, and supplies in an orderly manner.
- Designate specific areas, as appropriate, for the proper storage of materials and decontamination of personnel and equipment.
- Clean up waste, debris, spills and leaks quickly and report these incidents to the PIC/PM.

5. PRECAUTIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while recording the required information. It is important to always remain alert and aware of your surroundings.

- Avoid walking while recording information. Sites may have excavations, equipment, debris and other obstacles that pose slip, trip or fall hazards.
- Step away from roadways and high traffic areas before commencing note-taking. Do not assume that drivers can see you standing on the shoulder of a road, especially in bad weather. Many workplace traffic accidents involve distracted drivers hitting a worker standing/working on the shoulder of a roadway. Wear a high visibility safety vest or brightly colored (yellow or orange) clothing and remain alert at all times.
- Stand a safe distance away from the operating equipment and/or high traffic areas when taking notes. Be aware that the operator may not be able to see you, equipment/cable accidents can happen very quickly, and you need to be alert and ready to move.

6. RECORDKEEPING

Record all information in accordance with **FGD 1.01**, Field Notes and Records.

ATTACHMENT A
SAMPLE PROJECT-SPECIFIC DAILY REPORT

Project No.	00-WSITESOP	Report No.	087
Project Name	Sediment Remediation	Date	October 22, 2012
Location	123 Main St., One City, One State	Weather	Sunny, 71°F Wind: 8 mph W Precipitation: 0.00 inches

Contractors	Visitors
Contractor Environmental Services (CES) – (61) Ramboll Environ (John Doe, Jane Doe, John Roe, Jane Roe)	Lift Crane (1) Rise Crane (2)

Equipment On Site
WA380 Loaders (2); DSC Booster Pumps (3); Godwin Pumps (2); Dozers (3); 20' Sea Containers (3); Fusion Welder (2); Light Plant (1); 2,000-gal fuel tank (3); Tugboat (1); PC490 Excavator (1); PC220 Excavator (1); PC300 Excavator (1); Cap Spreader Barges (2); JCB Forklift (1); Crane Mats (19); Tender Boat (3); Work Boat w/ Crane Mount (1); 750 lb Danforth Anchors (18); Slurry Mix Tanks (2); Hopper Feed Tanks (2); CAT 330 Excavator (1); Kubota RTV (2); Stacking Conveyor (3); Roller (1); Scows (2); Site Truck (1); Clamshell & Conventional Buckets (1); Pontoon Boat (1); 500-gal Fuel Tank (1); 500-gal Gasoline Tank (1); 20 cy dumpster (1); 30'x80' Deck barges (2); 10'x40' Section Barges (6); 125 Kva Generator (1); Portable toilets (5); Manitowac 222 Crane (1); Fence Panels (22); 21,000 gal-Frac Tank (1); 500-gal Towable Water Tank (1); 10'x20' Section Barges (4); small scows (2); 70 Kva Genset (1); Telebelt Conveyor (1); 135'x50' Deck barge (1); 140'x48' Deck barge (1); Crawler crane (1); WITTE 1409 deck barge (1).

Imported/Exported Material
No material was delivered to the site or to the dock facility today.

Activities
Ramboll Environ and CES on 24-hour operation from 07:00 on Monday. 06:00 John Doe on-site (beginning of shift). 06:30 Jane Doe on-site (beginning of shift). - At 07:00, CES conducted safety meeting. - At 8:00 CES began armor material placement in Cap Area 17 (mechanical placement using the PC 490 excavator). - At 08:30 CES and Ramboll Environ began filter thickness verification in Cap Area 29b. - CES retrieved 8-inch verification pans #29-18, 29-21, and 29-22.

Activities
– Ramboll Environ measured and documented filter thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 09:40 the hydraulic filter malfunctioned on the crane barge. The crane barge was towed to the dock for repair at 12:00. 12:00 John Roe on-site (beginning of shift). • During daytime operations, Ramboll Environ and CES continued inspections of SESC measures. No issues were observed. • During daytime operations, Ramboll Environ continued to monitor cap material delivery pipes over the bulkhead to ensure adequate clearance is maintained at the bulkhead. No issues were observed. • At 14:00 repairs to the crane barge were completed and the crane barge returned to Cap Area 29b to continue filter thickness verification. – CES retrieved 8-inch verification pan #29-25. – Ramboll Environ measured and documented filter thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 14:20 a small hydraulic leak (less than a quart) was observed on the PC 490 and CES used absorbent pads to clean it up. The leak originated from a hydraulic hose sections that CES did not have a replacement for. No additional mechanical placement was completed for the rest of the day. • At 14:45 Ramboll Environ and CES began sand thickness verification in Cap Area 25. – CES advanced a push core at location #BS-25-229 for sand thickness verification. – Ramboll Environ measured and documented sand thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 15:35 CES towed the WITTE 1409 deck barge to dock for reloading of material and replaced it with the WITTE 1403 barge which was loaded with sand, filter material (ASTM 57), and armor material (ASTM 4). • At 15:37 Ramboll Environ and CES began sand thickness verification in Cap Area 23. – CES advanced a push core at locations #23-1, 23-2, and QA-23-1. – Ramboll Environ measured and documented sand thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 15:50 CES began placement of 1-inch armor stone in Cap Area 6a. 16:00 John Doe off-site (end of shift). • At 16:15 Ramboll Environ and CES began armor thickness verification in Cap Area 6a. – CES retrieved a 6-inch verification pan at BH #2. – Ramboll Environ measured and documented armor thickness placed. – A summary of the cap verification measurements is provided in the attached table. • At 16:30 CES completed armor placement in Telebelt Setup Location 1 (which includes Cap Areas 6a and 13b) and began repositioning the Telebelt system to Setup Location 2 (placement area includes Cap Areas 6a and 13a). 17:00 Jane Doe off-site (end of shift). • At 17:15 CES made repairs to the safety latch for the crane hook on the crane barge. • At 18:42 CES began placement of sand in Cap Area 6a and 13a. Placement was halted from 19:50 to 21:17 for the shift change.

Activities
- At 21:40 sand placement was completed in Cap Area 6a and 13a and CES removed incidental debris from the adjoining portion of the cap area south of the active area. 20:00 Jane Roe on-site (beginning of shift) - From 21:45 to 22:30 Ramboll Environ and CES continued sand thickness verification in Cap Areas 6a and 13. - CES advanced cores at locations #6-8, #6-14, #13-37, and #13-69. - Ramboll Environ measured and documented sand thickness placed. - A summary of the cap verification measurements is provided in the attached table. - CES placed 8-inch layer thickness verification pans at locations #6-8 and #6-14. - At 22:45 CES continued placement of sand in Cap Area 13a (mechanical placement using Telebelt). 23:20 John Roe off-site (end of shift) - From 23:35 to 23:50 Ramboll Environ and CES placed 8-inch layer thickness verification pans in Cap Area 29b at locations #29-30 and 29-31.

Activities



Photo 1: Mechanical placement of armor in Cap Area 17.



Photo 2: Filter thickness verification in Cap Area 29B.

Activities



Photo 3: Armor thickness verification in Cap Area 6A.



Photo 4: Placement of sand using Telebelt in Cap Areas 6 and 13.

CAP Verification Thickness, Sediment Remediation, 123 Main St., One City, One State

Date	Time	Cap Area	Lane ID	Pan ID	Type (Full Depth, Intermediate, Core, Manual, Vibra-core)	Sand Thickness (in)	Filter Thickness (in)	Armor Thickness (in)	Verification Thickness (in)	Consent Order Total Thickness	Maximum Allowable Total Thickness	Comments
10/22/2012	9:01	29B	218	29-18	Intermediate		2			6	12	
10/22/2012	9:15	29B	221	29-22	Intermediate		3			6	12	
10/22/2012	9:23	29B	219/220	29-21	Intermediate		<1			6	12	Filter stone was piled to less than 1 inch in only one corner of the pan.
10/22/2012	14:22	29B	222	29-25	Intermediate	<1				6	12	
10/22/2012	14:47	25	229	BS-25-229	Core	9				6	12	
10/22/2012	15:30	23		23-2	Core	11				18	30	
10/22/2012	16:15	6A		BH 2	Intermediate	11	7.6	>6		18	30	
10/22/2012	16:32	23		QA-23-1	Core	9.25				18	30	
10/22/2012	21:55	6A		6-8	Core	3.5				6	16	
10/22/2012	22:05	13A	100	13-37	Core	5				12	19	
10/22/2012	22:10	13A	99	QA-13	Core	3				12	19	

Note: The measurements for pans shifted from their target location (possibly the result of barge/boat interference) may not be representative and will be subject to review for thickness verification purposes.

FIELD GUIDANCE DOCUMENT NO. 5.01

SOIL CLASSIFICATION

FIELD GUIDANCE DOCUMENT NO. 5.01

SOIL CL SOIL CLASSIFICATION

Prepared By:	James Moran
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Approved By:	J. Mark Nielsen
Applicable To:	All North American offices
Effective Date:	November 16, 2015
Revision Notes:	1. Revised descriptions in Table 5 (12/7/2015)
Documents Used as Reference During Preparation:	ASTM D1586 - 11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils; ASTM D 2487-00 Standard Practice for Classification of Soils for Engineering Purposes; ASTM D 2488-00 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure); New Jersey Department of Environmental Protection, 2005. Field Sampling Procedures Manual; Ontario Ministry of Environment and Energy Standards Development Branch. "Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario Version 1.1". December, 1996; and, Ontario Ministry of Environment Regulation 153/04 as amended by Ontario Regulation 511/09, 2011.

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1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ US Corporation (Ramboll Environ) for the field classification and description of soils using manual tests for geologically logging soil borings. Soil types and properties may vary significantly at a site and accurate soil(s) identification and geologic logging is an essential element of the site characterization process. A standardized classification and description procedure for soil logging is provided for consistency across phases of field work, as well as across sites as it provides for a clear, accurate, and complete summary of subsurface field conditions observed during the implementation of soil investigation activities. Consistent soil classification is imperative as it allows the use of logs created by one or multiple field staff in developing accurate conceptual site models developed to support characterization of the nature and extent of contamination, performing hydrogeological modeling, conducting site specific risk evaluations, evaluating the feasibility of remedial alternatives, and/or preparing remedial design specifications. Accurate soil classification is also necessary for estimating engineering properties of materials.

The visual identification techniques detailed herein are generally consistent with the Unified Soil Classification System (USCS). The USCS is based on grain size and response to physical manipulation at various water contents to define plasticity and texture. This system is commonly used for classifying soils encountered in boreholes, test pits and surface sampling. As a matter of background, this soil logging system was initially developed by Arthur Casagrande in the 1940s. The Airfield Classification System, as it was then known, was adopted with minor modifications by the United States Bureau of Reclamation and the United States Corps of Engineers in 1952. In 1969, the American Society for Testing and Materials (ASTM) adopted the system and it is currently designated as D-2488-09a.

Although this FGD provides guidelines for field classifying and describing soils for preparation of soil boring logs, it should be understood that more specific procedures may be applicable for certain projects, including state-specific or regulatory program-specific guidelines or requirements. Detailed classification criteria are summarized in the FGD, however, all of these criteria may not have to be applied to every project. Specific requirements will be reviewed by the Ramboll Environ Principal-in-Charge (PIC) and/or Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, sampling plan and/or project-specific FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements.

This FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by procedures recommended in this FGD. The Ramboll Environ PIC and PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information is maintained in the project file. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

A general checklist of equipment that may be required for typical soil classification procedures is provided below. Note that soil logging procedures are covered under **FGD 5.09**. This checklist only suggests general materials and equipment that may be necessary for a project or task and should not be considered an exhaustive compilation. More specialized equipment or materials may be required when describing soils in the field in conjunction with soil sample collection, completion of field soil boring logs, or installation of wells.

- Field notebook or pertinent field log forms and all-weather or permanent pens as outlined in FGD 1.01 - Field Notes and Records.
- Measuring Tape.
- Knife (for cleaning exposed soil surfaces).
- Plastic sheeting.
- Magnifying Glass.
- Digital Camera.
- Water.

Based on the field activity and project, the following may also be needed:

- Munsell Soil Color Book.
- Field sieves.
- Geotechnical Gauge (as manufactured by W. F. McCollough or equivalent).

3. PROCEDURES REFERENCED

The following FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- FGD 1.01 - Field Notes and Records,
- FGD 2.02 - Site Preparation, Inspection and Housekeeping, and
- FGD 5.09 - Soil Boring Log Preparation.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction may need to be referenced based on the specific requirements of the site-specific work plan/sampling plan (e.g., field screening FGDs, FGDs for sampling of media, etc.).

4. PROCEDURES

4.1 General Information

Information regarding all activities related to the classification of soil samples should be recorded in the Field Notebook or on a Soil Boring Log form (a comprehensive example is provided as Attachment A in FGD 5.09). The Field Notes or Soil Boring Log form should be populated concurrently with soil classification activities, and the person completing the log should pay close attention to the drilling activities when boreholes are advanced (refer to FGD 5.09 - Soil Boring Field Log Preparation).

Most generally, the primary soil grain size can be identified by assigning a group symbol and name or, in the case of soils with properties that do not distinctly place it into a single group, borderline symbols and names. For accurate description and identification of soils, the following key physical properties should be field-determined and recorded in the following order:

- Color including color variations within the same sample.
- Soil particle size identification name (synonymous with ASTM D2488-09a Group Name) with appropriate particle size modifiers. It is suggested that percentage by volume of each particle size be recorded).
- Soil description modifiers (as appropriate for the scope of work – discuss with the project manager ahead of time) including:
 - For coarse grained materials:
 - Gradation.
 - Grain shape and angularity.
 - Cementation.
 - Range of grain or particle sizes (sorting).
 - Maximum particle size.
 - Relative density (of sands).
 - For fine grained materials:
 - Consistency.
 - Dry strength.
 - Dilatancy.
 - Toughness and plasticity.
- Moisture content.
- Relative density or consistency.
- Signs of potential contamination (discoloration, odor, staining, etc.).
- Other general observations (micaceous, calcification, presence of shells, roots, iron-oxide staining, etc.).

4.2 Field Determination of the Soil Identification Name

Soils are generally subdivided into three types: coarse-grained soils, fine-grained soils and organic soils. Coarse-grained soils (also referenced as granular or non-cohesive) include gravel and sand. Fine-grained soils (also known as cohesive soils) include silts and clays. Soils that do not behave like a coarse- or fine-grained material and that have a high content of decaying vegetative matter are considered organic soils. Soil types are further subdivided into soil groups in accordance with the USCS.

4.2.1 Predominant Soil Classification

USCS soil identification is based on the portion of the soil sample that will pass a 3-inch sieve. The larger than 3-inch particles (i.e., cobbles and boulders) must be removed, manually for a loose sample or accounted for in an intact sample, before classifying the soil. The percentages by volume of cobbles and boulders or other debris should be estimated and recorded, and description of these materials recorded. Of the fraction of soil smaller than 3-inches, estimate and note the percentage of the gravel, sand and fines using the procedures outlined herein. The percentages shall be estimated to the closest 5% and the percentages of gravel, sand and fines must add up to 100%. If one of the components is present but not in sufficient quantity to be considered 5% of the smaller than 3-inch portion, indicate its presence by the term "trace" (e.g., fine to medium gravel with trace fines). A trace is not to be considered in the total of 100% for the components.

The following procedures outline how to determine the predominant soil type in the material

- Spread a representative soil sample on a flat surface.
- Determine whether or not the predominant size fraction is discernible with the naked eye or using the Geotechnical Gauge (also refer to **Table 1** below).
 - If the material contains less than 50% fines (i.e., clay, silt) it is considered a coarse-grained soil. Procedures and definitions for describing and identifying properties of coarse grained soils are presented in **Section 4.2.2**.
 - If the soil contains greater than 50% fines, it is a fine grained soil. Procedures and definitions for describing and identifying properties of fine grained soils are presented in **Section 4.2.3**.

If the material has a high content (greater than 50%) of decaying vegetative matter and does not behave like a silt or clay, it is classified as an organic soil (refer to **Section 4.2.4**). Soils containing moderate amounts of organic matter that still retain the properties of silts and clays should be described as fine-grained soils.

Table 1: Soil Types and Particle Sizes

Principal Soil Type	Descriptive Term	Size	U.S. Standard Sieve	Familiar Example Range
Coarse-grained (individual grains can be seen with the naked eye - see Section 4.2.2)	Boulder	Greater than 305 mm	Greater than 12 in.	Bigger than a basketball
	Cobble	76 to 305 mm	3 to 12 in.	Fist sized to basketball
	Coarse gravel	19 to 76 mm	3/4-in. to 3 in.	Thumb to fist sized
	Fine gravel	5 to 19 mm	#4 to 3/4-in.	Pea to thumb sized
	Coarse sand	2 to 5 mm	#10 to #4	Rock salt to pea sized
	Medium sand	0.4 to 2 mm	#40 to #10	Sugar to rock salt
	Fine sand	0.074 to 0.4 mm	#200 to #40	Fine sugar to table salt
Fine-grained (individual grains not visible - see Section 4.2.3)	Silt or clay	Microscopic	Passing No. 200	Flour sized and smaller
Organic (see Section 4.2.4)	Peat or muck	Microscopic	--	Decaying vegetable matter

Once the predominant soil type has been defined, proceed to the corresponding subsection for further guidance.

4.2.2 Coarse-grained Soils

If the soil has been determined to be predominantly coarse-grained, further examination is required to determine the grain size distribution, the grain shape, and the density of the in situ deposits (if applicable) so the materials can be classified into groups in accordance with the USCS. The procedure for field classifying coarse-grained soils is described below.

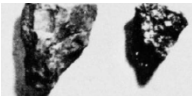
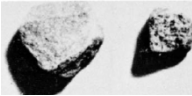
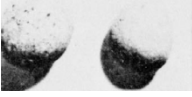
- Define the soil type based on the most prevalent particle size as follows:
 - The soil is gravel if the percentage of gravel is estimated to be more than the percentage of sand.
 - The soil is sand if the percentage of sand is estimated to be equal to or more than the percentage of gravel.
- Describe the gradation of coarse-grained soils as well graded, poorly graded or gap graded (note for geologists: this may be contrary to the terms well sorted or poorly sorted). A summary of the descriptive gradation of coarse-grained soils is provided in **Table 2**.

Table 2: Description of Gradation of Coarse-Grained Soils

Description	Meaning
Well graded/Poorly sorted	A good representation of all grain sizes is present.
Uniformly or poorly graded/sorted	All grains are approximately the same size.
Gap graded/Well sorted	Intermediate grain sizes are absent.
Note: Source ASTM D2488	

- If particles are sufficiently large, describe the particles according to a characteristic shape, which may vary from angular to rounded to flat or elongated. Appropriate descriptive terms are listed in **Table 3**.

Table 3: Description of Grain Shape of Coarse-Grained Soils

Descriptive Term	Criteria	Example
Angular	Irregular with sharp edges such as freshly broken rock	
Subangular	Irregular with smooth edges	
Subrounded	Irregular but smooth like a lump of molding clay	
Rounded	Marble- or egg-shaped; very smooth	
Flaky	Sheet of paper or flake of mica	
Flat	Ratio of width to thickness greater than 3	
Elongated	Ratio of length to width greater than 3	
Note: Adapted from ASTM D2488		

- Describe the cementation of intact coarse-grained soils as weak, moderate or strong, in accordance with the criteria defined in **Table 4**.

Table 4: Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure
Note: Source ASTM D2488	

- If the coarse-grained material is determined to be sand, describe its relative density in accordance with the criteria defined in **Table 5** based on blow counts. If you have not collected blow counts using standard ASTM procedures, it is recommended that you either not include density descriptions or clearly indicate in the field notes that the estimated density is not based on standard penetration tests (SPTs).

Table 5: Criteria for Describing Relative Density

Description	Uncorrected SPT N-Value (blows/foot)
Very Loose	4
Loose	4 to 10
Medium Dense	10-30
Dense	30-50
Very Dense	50 or greater
Note: SPT: Standard Penetration Test (ASTM D1586)	

4.2.3 Fine-grained Soils

If the soil has been determined to be predominantly fine-grained, manual tests need to be performed to classify the fine-grained material because the soil grains cannot be seen with the naked eye. One of the primary means of classifying fine-grained soil is to determine its plasticity. Plasticity generally increases with clay content so, for the purpose of field classification, one can estimate whether the fine fraction of a soil stratum is primarily silt or clay by determining the relative plasticity of the soil. Note, however, that this is a generalization which may lead to erroneous classification of plastic silts as clays.

An additional field test is to wet the soil and rub it between your fingers. If the soil feels gritty, the fines likely include a significant proportion of silt; if the soil feels smooth and can be spread into a thin ribbon without breaking, the soil likely contains a greater percentage of clay. Similar to estimates of plasticity, this is a generalization. If the distinction between silt

and clay is important on a project, a sample should be submitted to a soils laboratory for a hydrometer analysis (ASTM D422) to accurately classify the fine-fraction of the soil. The primary field tests for classifying fine-grained soils are consistency, dry strength, dilatancy (mobility of pore water), toughness, and plasticity. However, these field tests may not be required for all projects (refer to the project-specific Work Plan or Sampling Plan). The field-manual procedures are described below.

- Prior to manual testing a sample, remove particles that are medium sand-size and larger.
- Materials that had to be removed from the samples to perform the test should be described.

To perform the consistency test, push thumb onto a relatively undisturbed portion of the soil sample and describe the density/consistency of soils as very soft, soft, firm, hard or very hard, in accordance with the criteria in **Table 6**.

Table 6: Field Criteria for Describing Consistency

Description	Criteria	Uncorrected SPT N-Value (blows/foot)
Very Soft	Thumb will penetrate soil more than 1-inch	Less than 2
Soft	Thumb will penetrate soil approximately 1-inch	2 to 4
Firm	Thumb will indent soil approximately ¼-inch	4 to 15
Hard	Thumb will not indent soil but readily indented with thumbnail	15 to 30
Very Hard	Thumbnail will not indent soil	Greater than 30
Note: Adapted from ASTM D2488		

- To perform the dry strength test, select enough soil to mold material into a ball measuring approximately 1-inch in diameter.
 - Mold the material until it has the consistency of putty, adding water if necessary.
 - From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½-inch in diameter. If the test specimen contains natural dry lumps, those that are about ½-inch in diameter may be used in place of the molded balls.
 - Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 140°F.
 - Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accordance with the criteria in **Table 7**.

- Upon completion of the test, if the specimen is easy to crush it is probably a silt and if it is hard to crush it is probably a clay.

Table 7: Criteria For Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into a powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between thumb and a hard surface.
Note: Source ASTM D2488	

- To perform the dilatancy test, select enough soil to mold material into a ball about ½-inch in diameter.
 - Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.
 - Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula.
 - Shake horizontally, tapping the underside of the hand vigorously with the palm of other hand several times. Note the reaction of water appearing on the surface of the soil.
 - Squeeze the sample by closing the hand or pinching the soil between the fingers and note the reaction as none, slow, or rapid in accordance with the criteria in **Table 8**. The reaction is the speed with which water appears while shaking, and disappears while squeezing.
 - Upon completion of the test, if the specimen has a glassy, wet look it is probably a silt and if it has a dry look it is probably a clay.

Table 8: Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear, or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.
Note: Source ASTM D2488	

- To perform the toughness test, the test specimen used in the dilatancy test is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about 1/8-inch. If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.
 - Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8-inch. The thread will crumble at a diameter of 1/8-inch when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread as none, low, medium, high, or very high in accordance with the criteria in **Table 7**.
 - After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading. Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in the **Table 9**.
 - Upon completion of the test if a thread cannot be rolled it is probably a silt and if the specimen can be rolled into a thin thread it is probably a clay. Note: some silts are plastic (i.e., able to be rolled into a thread) so this generalization should be confirmed by other tests.

Table 9: Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.
Note: Source ASTM D2488	

- On the basis of the observations made during the toughness test above, describe the plasticity of the material in accordance with the criteria provided in **Table 10**.

Table 10: Criteria for Describing Plasticity

Description	Criteria
Non-plastic	A 1/8 inch thread cannot be rolled at any moisture content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.
Note: Source ASTM D2488	

4.2.4 Organic Soils

If the material does not behave like a silt or clay and has a high content of decaying vegetative matter, it is classified as an organic soil and not subjected to the identification procedures detailed in the FGD. Following are some typical attributes of organic soil:

- Organic soils are composed primarily of vegetative matter in various stages of decomposition and have a fibrous to amorphous texture.
- Organic soil is usually dark brown or black and may have an organic odor.
- Often organic soil will change color (e.g., black to brown) when exposed to air. Some organic soil will lighten in color significantly when air-dried.
- Organic soil normally will not have a high toughness or plasticity.

Organic soils can be broadly grouped into two categories:

- Topsoil: a surficial organic soil layer that may contain organic matter. Note that topsoil may be encountered below the surface if buried by geological processes or man-made fill.
- Peat: an organic soil composed primarily of plant remains in various stages of decomposition. There are no standardized criteria for describing peat, however, It is generally described in terms of its degree of decomposition and strength:
 - Firm - the soil matrix is comprised of fibers that are compressed into a layer.
 - Spongy - the soil is very compressible and has an open structure.

- Plastic - the soil can be molded like a clay and smears on surfaces.
- Fibrous - the plant remains are recognizable and have retained some strength.
- Amorphous - plant remains are not recognizable.

4.2.5 Soil Name Designation

The basic name of a soil should be consistent with the ASTM D2488-09 Group Name, based on visual estimates of gradation and plasticity, and should be capitalized. The acceptable soil names for coarse and fine grained soils are those listed in **Figures 1, 2 and 3**. Note that, if the soil appears to be fill material (e.g., fragments of brick, glass, slag, etc.), the soil grain sizes should be described, but the soil type should be identified as "FILL" rather than using one of the other two letter identifiers.

- As detailed in **Figure 1**, for coarse grained materials,
 - If the percentage fines is less than or equal to 5%, the coarse-grained material is considered to be "clean" and the following USCS symbols are applicable:
 - GW for well graded gravel;
 - SW for well graded sand;
 - GP for poorly graded or gap-graded gravel; and
 - SP for poorly graded or gap-graded sand.
 - If the percentage fines is more than or equal to 15%, the coarse-grained material is considered to be "with fines" and the following USCS symbols are applicable:
 - GC if the predominant soil type is gravel and the fines are determined to be clayey;
 - SC if the predominant soil type is sand and the fines are determined to be clayey;
 - GM if the predominant soil type is gravel and the fines are determined to be silty; and
 - SM if the predominant soil type is sand and the fines are determined to be silty.
 - If the percentage fines is more than 5% or less than 15%, dual USCS symbols are applicable. The first group symbol would correspond to the "clean" coarse-grained material designation and the second group symbol would correspond to the "coarse-grained material "with fines" designation (e.g., poorly graded SAND with silt would be SP-SM). If dual USCS cannot be assigned, the soil should be only described in terms of the percentage of each soil group (e.g., 85% sand and 15 % silt).

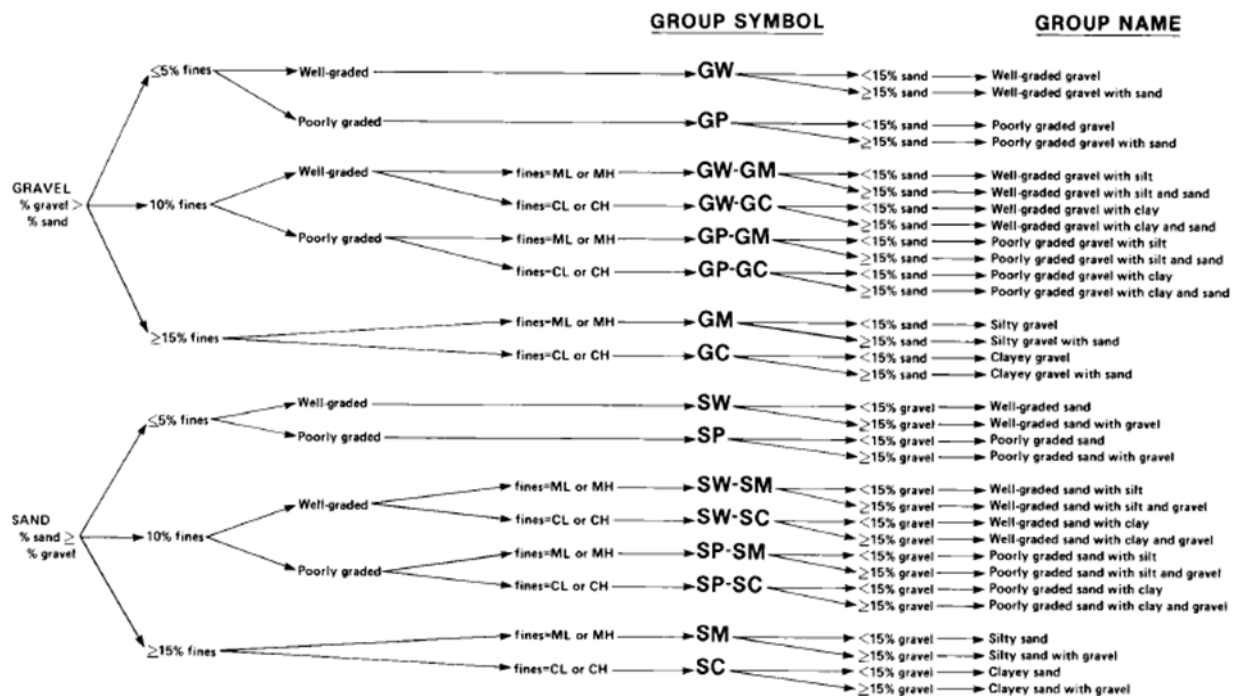


Figure 1:

Flow Chart for Identifying Coarse-Grained Soil (Source ASTM D2488-09)

- For fine grained inorganic materials,
 - On the basis of the manual tests, identify the inorganic fine grained soils in accordance with the criteria provided in **Table 11**.
 - Expand the group name description as detailed in **Figure 2** based on the percent sand or gravel that the fine-grained material contains.

Table 11: Identification of Inorganic Fine-Grained Soils from Manual Tests				
USCS Symbol	Soil Description	Dry Strength	Dilatancy	Toughness and Plasticity
ML	Silt	None to low	Slow to rapid	Low or thread cannot be formed
CL	Lean clay	Medium to high	None to slow	Medium
MH	Elastic silt	Low to medium	None to slow	Low to medium
CH	Fat clay	High to very high	None	High
Note: Source ASTM D2488				

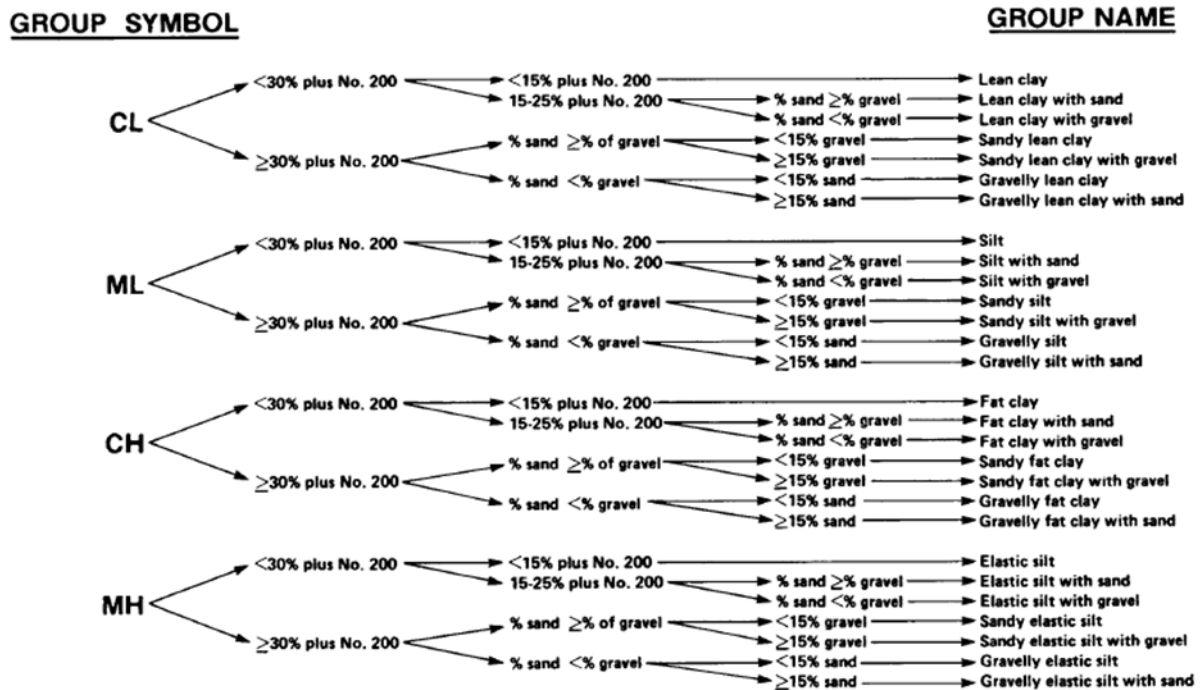


Figure 2:

Flow Chart for Identifying Inorganic Fine-Grained Soil (Source ASTM D2488-09)

If the soil contains enough organic particles to influence the soil properties the soil should be identified as an organic soil (OL/OH), expanding the group name description as detailed in **Figure 3** based on the percent sand or gravel that the organic material contains.

- It is not necessary to characterize organic soils using the full identification procedures for fine grained materials as detailed above in **Section 4.2.3**.
- Organic soils shall be identified as top soil or peat (PT).
- However, description of the other relevant observable properties of the organic soils should be given (color, odor, moisture content).

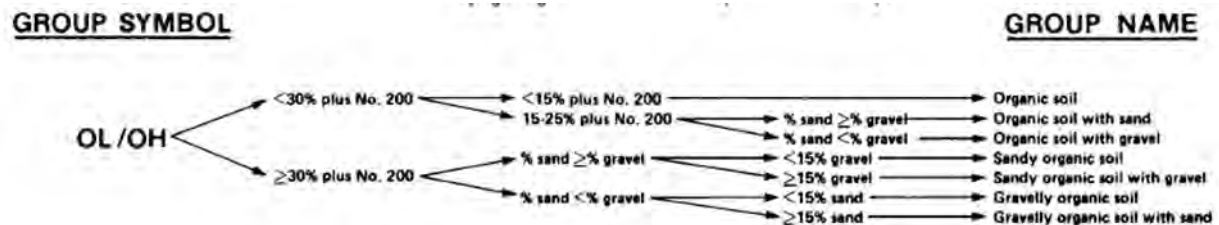


Figure 3:

Flow Chart for Identifying Organic Fine-Grained Soil (Source ASTM D2488-09)

In designating soil names and descriptions, it is customary to list the primary grain size first, followed by modifiers and secondary grain sizes. Common modifiers include:

- Trace: Particles are estimated to be less than 5% by volume.
- Few: 5 to 10% by volume.
- Little: 15 to 25% by volume.
- Some: 30 to 45% by volume.
- Mostly: 50 to 100% by volume.

4.3 Color

Color is probably the most obvious feature of soil and is an important soil property that should be included in its description. An experienced observer can often relate soil color to specific chemical, physical and/or biological properties of the soils in that area. Some broad generalizations are also possible. For example, inorganic soils typically have clean, bright colors (e.g., light gray, olive green, brown, red, yellow, white), whereas organic soils have dark or drab shades (e.g., dark gray, dark brown, black). Red colors may indicate the presence of free iron oxides common in well-oxidized soil and white or pinkish colors may be indicative of silica, calcium carbonate or aluminum compounds. Materials of similar geologic origin could also be identified based on color.

Mottling or spots or streaks of a particular color within a predominant background color is indicative of soil that has experienced a variety of conditions that affect the soil color. Thus, mottling in soil is a clue that should be evaluated in terms of depositional environments, groundwater fluctuations, or contaminant transport. Mottling is described in terms of three basic characteristics:

- Abundance (few, common, many),
- Contrast (faint, distinct, prominent), and
- Size (fine, medium, coarse).

In expressing color, it is customary to list the dominant color first, followed by a description of abundance, contrast, and size of the other colors in the mottled pattern. When describing the color of a soil:

- Color should be described as accurately as possible using the Geotechnical Gauge. For example, rather than "brown," consider gray-brown, brownish-orange, tan, dark brown, etc. If use of a Munsell color chart is required, both the code and associated color should be listed. Note, however, that it is generally not necessary to get overly-specific in naming a particular shade.
- Note whether the sample contains layers, patches or mottling of varying colors, and describe all of the representative colors.
- Indicate whether the color represents dry conditions.

It is customary to use the color description of the soil in lower case before the soil name and appropriate modifiers.

4.4 Moisture

Soil moisture is an important indicator of soil conditions and should be included in the description of a soil. For example, visible or free water from a soil sample can infer the proximity of the water table or perched water zones. Soil moisture conditions should be described using the criteria provided in **Table 12**.

Table 12: Criteria for Describing Soil Moisture

Description	Criteria	Granular Soil	Cohesive Soils
Dry	Absence of moisture, dusty, dry to the touch	Soil runs freely through hands	Hard, powdery or friable
Moist	Moisture present but no free water	Soil particles will begin to adhere	Soil has weakened structure but free water does not form when handling
Wet	Visible free water; usually soil is at or below water table	Color darkens, soil particles will adhere and free water is present	Color darkens, soil has weakened structure and/or free water forms when handling
Note: Adapted from ASTM D2488			

It is customary to describe the soil's moisture in lower case and within parenthesis following the soil name and appropriate modifiers.

4.5 Visual Indications of Potential Contamination

During environmental sampling, visual indications of potential contamination (e.g., discoloration) and/or the presence of anthropogenic materials (e.g., glass, wood, brick, plastic, slag, gravel fill, etc.) may be encountered. Record observations of any potential field evidence of environmental impacts and/or the presence of anthropogenic materials in the soil description. Anthropogenic materials are commonly used as fill and could indicate a non-native source of contamination. Notable observations of potentially contaminated soils include: staining, sheens, unusual discolorations, unusual crystals, and odors. When describing visual indications of contamination, describe how they are present, such as a sheen, staining along joints or root casts, residual or free-phase product seeping from the sample; however, do not attempt to infer what chemical may be present. For larger investigation projects with well-defined contaminants of concern and release mechanisms, it is advisable to prepare guidelines for screening and describing contaminated soils.

Soils having a significant amount of organic matter typically have a distinctive, pungent musty odor of decaying vegetation. In addition, soils impacted with organic contamination may exhibit unusual odors; some contaminants that may give a noticeable odor include petroleum hydrocarbons, solvents, ammonia, mineral spirits, turpentine, phenols and cresol, and organic pesticides. Odors may generally be described using the criteria provided in **Table 13** and descriptions of the odor characteristics (e.g., rotten egg odor, sweet chemical

odor); however, do not attempt to infer the specific chemical that may be present. If field activities are being conducted as part of a litigation project or potential litigation project, always check with the PIC/PM prior to including descriptors for odors as it may be preferable to simply note the presence of an odor without classifying it as strong, slight, etc.

Table 13: Criteria for Describing Odor

Description	Criteria
Strong	Distinct or sharp odor is noticed
Moderate to Slight	Less distinct to faint odor
None	No detectable odor is noted
Note: Adapted from USEPA EPA/600/4-91/029	

When inspecting soils for signs of contamination, adhere to the requirements of the HASP and, before monitoring soil odors, the sample should be screened with field screening equipment. Under no circumstance should odors be vigorously inhaled from any soils as they could contain potential biological or chemical hazards.

It is customary to describe the signs of potential contamination in lower case and within parenthesis following the soil name and appropriate modifiers.

4.6 Example Soil Descriptions

In summary, a soil is identified by assigning a group symbol and name with a description of the following key physical properties:

- USCS soil name (synonymous with ASTM D2488-09a Group Name) with appropriate modifiers,
- Color,
- Moisture content,
- Relative density or consistency, and
- Field evidence of potential contamination.

The above-noted naming convention generally follows the format described by the USCS classification system as described in ASTM D2488-09a. For reference purposes, examples of soil descriptions are provided in **Table 14**.

Table 14: Example Soil Classification

Detailed Field Observations	Basic Field Observations	Soil Classification
About 70% fine, hard round dark gray (N3) sand, 10% fine sub-angular, hard gray (N5) gravel, and 20% light gray (N7) silt low dry strength, slow dilatancy and no plasticity; trace of reddish brown silty clay; SPT-N = 8; wet, maximum size fine sand	70% fine gray sand, 10% fine gravel, and 20% light gray silt with trace of reddish brown silty clay (wet, loose)	Dark gray silty fine SAND (SM) with trace of reddish brown silty clay (wet, loose) Or Dark gray (N3) silty fine SAND (SM) with trace of reddish brown (10R3/6) silty clay (wet, loose)
About 65% fine to coarse, hard subangular reddish brown (10R3/6) sand, and 20% fine sub-angular, hard gray gravel with 15% coal fragments and cinders; SPT-N = 35; moist, maximum size 1- inch		Reddish brown well graded SAND (SW) with little sub-angular fine gravel and little fill (coal fragments, cinders) (moist, dense) Or Reddish brown (10R3/6) well graded SAND (SW) with little sub-angular fine gravel and little fill (coal fragments, cinders) (moist, dense)
Dark brown (10YR3/3) to dark gray (N3) spongy fibrous organic soil, many fine roots, trace of fine to coarse sand; SPT-N = 2; wet, very soft to soft, maximum size 5 mm; Discolored, moderate sweet chemical smell		Dark brown to dark gray peat (PT) with trace of fine to coarse sand (wet, very soft to soft) (discolored, moderate sweet chemical smell) Or Dark brown (10YR3/3) to dark gray (N3) peat (PT) with trace of fine to coarse sand (wet, soft) (discolored, moderate sweet chemical smell)
About 30% coarse, hard angular yellowish red (10YR6/8) sand with weak cementation, 5% fine sub-angular, hard brown (10YR5/3) gravel, and 65% greenish gray (5G6/1) silt, firm, medium dry strength, slow dilatancy and medium plasticity; SPT-N = 16; wet, maximum size ½-inch. Strong petroleum odor and black staining		Greenish gray elastic SILT with some yellowish red (10YR6/8) angular coarse sand a few sub-angular brown gravel (wet, firm) (stained, strong petroleum odor) Or Greenish gray (5G6/1) elastic SILT (MH) with some yellowish red (10YR6/8) angular coarse sand a few sub-angular brown (10YR5/3) gravel (wet, firm) (stained, strong petroleum odor)

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Accurate soil classification requires the collection of sufficiently detailed information throughout the logging process. Certain precautions should be taken to while recording the required information.

- Sunglasses should not be worn when describing soil colors.
- Note that samples from split-spoons and small-diameter core tools are not always representative of coarse-grained strata. Be sure to check driller's logs (when available) and soil cuttings for boulders, cobbles, gravels or other materials that may be encountered during advancement of the boring.
- Fill may be encountered during site characterization activities. Fill material can be determined from historical information or from the identification of man-made materials, such as concrete, brick, glass, plastic, cinders, and/or wood. If the soil boring being described is determined to be fill material, "fill" should be included in the soil description. Materials designated as "fill" should still be classified according to the USCS analysis methods provided above. Additional descriptors should be added if the materials making up the fill can be explicitly identified.
- If there are odor or color descriptors that are significant to a project (e.g., prussian blue at an MGP site or solvent-like odors at petroleum site), these should be discussed with the PIC/PM and understood prior to implementing field activities.

6. RECORDKEEPING

This FGD specifically pertains to recordkeeping during soil sampling projects. All information should be recorded in accordance with FGD 1.01 (Field Notes and Records) and FGD 5.09 (Soil Boring Field Log). In general, draft field forms should be scanned and saved electronically immediately following the completion of the soil sampling activities. Following review of draft documents by the PIC and/or PM, field forms should be finalized and final versions may be included in project reports, if necessary. Draft and final versions of the field form should be managed in accordance with Ramboll Environ's Document Retention Policy and project-specific requirements, and copies should be maintained in the project file.

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FIELD GUIDANCE DOCUMENT NO. 5.07
SUBSURFACE SOIL SAMPLING –
DIRECT PUSH TECHNOLOGY (DPT)

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SUBSURFACE SOIL SAMPLING – DIRECT PUSH TECHNOLOGY (DPT)

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ATTACHMENTS

Attachment A Direct Push Sampling Equipment

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines for use by Ramboll employees operating in the United States and Canada for collection of subsurface soil samples using direct push technologies (DPT). DPT is commonly used for soil sample collection at sites where there is an advantage to using a drill rig with a smaller footprint that can quickly penetrate soils while reducing the generation of investigation derived waste (IDW) (EPA, 2005). Subsurface soil sampling via DPT may be conducted as part of environmental investigations or remedial actions to:

- Collect soil samples for biological, chemical and/or geotechnical testing¹ and assess hydrogeological conditions including, but not limited to, sampling to support source identification, characterize nature and extent of contamination in soils, assess background conditions, and conduct confirmatory sampling; and
- Allow visual, odor, and volatile vapor screening of subsurface soils.

This FGD provides guidance for subsurface soil sampling using DPT associated with typical field activities and projects, however, it should be understood that for certain projects other sampling procedures or alternative methods may be required, including methods specified by state-specific or regulatory program-specific guidelines, requirements or procedures. Site-specific and state/regulatory requirements will be reviewed by the Ramboll Principal-in-Charge / Project Director (PIC / PD) and/or Project Manager (PM), and additional requirements will be defined in the project-specific Work Plan, Field Sampling Plan, Quality Assurance Project Plan (QAPP) and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a reference for developing project specific procedures.

This FGD does not supersede Ramboll health and safety procedures or site-specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. Ramboll employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP followed by approved site-specific procedures, which may include those in this FGD. The Ramboll PIC/PD and/or PM shall verify that project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information are maintained in the project file for the duration of the project or as established by applicable Ramboll document handling and retention policies. The signatures of the PIC/PD and/or PM indicate approval of the methods and precautions outlined in the site-specific HASP.

¹ Note that direct push sampling does not allow collection of undisturbed samples required for certain geotechnical testing (e.g., strength, consolidation, hydraulic conductivity).

2. EQUIPMENT AND MATERIALS

A general list of equipment that may be necessary for typical subsurface soil sampling using DPT is provided below. This list provides an overall summary of general equipment which may be required for soil sampling using DPT but should not be considered exhaustive. Additional equipment may be specified in the project-specific Work Plan and/or HASP.

- Site information (e.g., maps, contact numbers, keys or lock codes for gates or access points, previous field logs).
- The DPT rig, and other drilling equipment, such as rods, samplers, liners (e.g., PVC, polyethylene, acrylic, Lexan), and caps, which should be supplied by the drilling contractor (refer to **Attachment A** for brief descriptions of commonly used samplers).
- Appropriate tools for adjusting samplers and opening liners (dual longitudinal liner ripping blade, hacksaw (with clean blades), pliers, wrench, etc.), which should be supplied by the drilling contractor.
- Pin flags or wooden stakes, or in paved areas, spray paint or nails with flagging tape, to mark sample location(s). Care should be taken not to use materials that may interfere with sampling/analytical results. Refer to **FGD 1.04** (Documenting Sampling Locations).
- Plastic sheeting.
- Folding worktable, half-pipe, or half-sheet of corrugated roofing plastic to hold and keep the samplers organized.
- Soils classification guidance chart as outlined on **FGD 5.01** (Soil Classification).
- Color chart (e.g., Munsell) as outlined on **FGD 5.01** (Soil Classification).
- Measuring tape (both long-weighted cloth type and small measuring type, preferably marked in tenths and hundredths of a foot) for measuring sample recovery and subsample intervals.
- Spatula, knife or spoon (typically stainless steel) used for splitting soil cores and collecting soil samples.
- Mixing bowl/bucket and spoons (typically stainless steel unless metal analysis will be performed) for composite sample preparation.
- Laboratory supplied certified-clean sample containers (appropriate for various analyses to be performed), as may be required in the Work Plan.
 - If soil samples are to be analyzed for Volatile Organic Compounds (VOCs) refer to **FGD 5.05** (Soil Sampling for VOC Analysis) for additional equipment requirements.
 - If soil samples are to be analyzed or screened for Non-aqueous Phase Liquid (NAPL) refer to **FGD 5.11** (Soil Sampling - NAPL Dye Tests) and/or **FGD 5.12** (Soil Sampling - NAPL Ultraviolet Light Tests) for additional equipment requirements.
 - If soil samples are to be analyzed for Polychlorinated biphenyl (PCBs) refer to **FGD 5.16** (Soil Sampling for PCB Analysis) for additional equipment requirements.
 - If soil samples are to be analyzed for poly and perfluoralkyl substances (PFAS), refer to **FGD 1.07** (PFAS Sampling).

- Sample shipment containers, labels, chain of custody forms and packing materials for sampling containers as outlined in **FGD 1.02** (Sample Handling, Shipping, and Chain of Custody).
- Trash Bags - used to dispose of gloves and other non-hazardous waste generated during sampling (refer to **FGD 15.01**, Waste Handling).
- Decontamination supplies (refer to **FGD 14.01**, Sampling Equipment Decontamination).
- Appropriate waste container and labelling materials – used to dispose of IDW and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling).
- Field screening equipment (e.g., PID, XRF) as required by the site-specific Work Plan, Field Sampling Plan, QAPP and/or the site-specific HASP.
- Zip-loc® bags and/or glass jars and aluminum foil (used for field screening purposes).
- Personal Protective Equipment (PPE) in accordance with the site-specific HASP, including protective gloves which must always be worn when handling and using sample equipment.
- Field notebook and test boring and well construction field log forms (if required), and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records).
- Mobile phone and camera.
- For long-term drilling projects, setting up a field station is recommended. The field station might include portable chair(s), worktable, canopy, and a first aid station/kit.

3. PROCEDURES REFERENCED

In addition to the reference and guidance documents cited above, the following Safe Work Practices (SWPs) and FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **SWP** Subsurface Utility Clearance
- **FGD 1.01**, Field Notes and Records
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody
- **FGD 1.03**, Data Management
- **FGD 1.04**, Documenting Sampling Locations
- **FGD 1.05**, Field Quality Control Samples
- **FGD 1.07**, PFAS Sampling
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping
- **FGD 4.06**, Equipment Calibration
- **FGD 5.01**, Soil Classification
- **FGD 5.04**, Surface Soil Sampling
- **FGD 5.05**, Soil Sampling for VOC Analysis

- **FGD 5.06**, Field Analysis of Soils using Portable X-Ray Fluorescence
- **FGD 5.09**, Soil Boring Log Preparation
- **FGD 5.10**, Borehole Decommissioning
- **FGD 5.11**, Soil Sampling - NAPL Dye Tests
- **FGD 5.12**, Soil Sampling - NAPL Ultraviolet Light Tests
- **FGD 5.16**, Soil Sampling for PCB Analysis
- **FGD 5.19**, Incremental Composite Sampling (Soils/Sediments)
- **FGD 6.06**, Temporary Overburden Well Installation and Sampling
- **FGD 14.01**, Sampling Equipment Decontamination
- **FGD 14.02**, Heavy Equipment Decontamination
- **FGD 15.01**, Waste Handling

The list above is not intended to be all inclusive. Other SWPs and FGDs may need to be referenced based on the specific requirements of the site-specific Work Plan, Field Sampling Plan, and/or QAPP (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 Planning and Design Considerations

Strategic decisions including, but not limited to, the selection of the direct push drill rig (e.g., access limitations), and the potential need to adjust boring locations (e.g., subsurface utilities), will be approved by the PIC/PD and/or PM before the initiation of associated field activities and will be documented in the Work Plan, Field Sampling Plan, and/or QAPP. The Work Plan, Field Sampling Plan, and/or QAPP will be designed for the collection of quality data to meet the objectives of the sampling program and will include information such as the number of borings, depth, number of samples per boring, and the laboratory analyses to be performed on each sample as well as quality assurance/quality control (QA/QC) requirements. The Work Plan, Field Sampling Plan, and/or QAPP will generally provide for some discretion in the field, depending on encountered conditions; however, any significant departure from prescribed sampling activities should be discussed with and approved by the PIC/PD and/or PM.

When planning a DPT sampling event, the following should be considered:

- *Type of Direct Push Rig.* DPT uses hydraulically powered rigs that utilize both hydraulic force and percussion to advance soil sampling equipment into the subsurface. Some direct push rigs are also equipped with a rotational drive that will allow the use of augers. Direct push rigs can be mounted on pickup trucks, skid loaders, tracked carriers, skids or other vehicles. The type and size of the direct push rig and associated equipment will depend on project -specific needs such as the boring depth and access limitations. The type of direct push rig and associated equipment should be specified in the work plan and discussed with the drilling contractor prior to mobilization.

- *Sampling Locations.* Consideration for placement of sampling locations should be given to the objectives of the sampling effort. However, accessibility and potential hazards (e.g., subsurface utilities, overhead clearance [including utilities, ceilings or other obstructions] traffic, surface stability, soil strength), and need to pre-cut surfaces (e.g., asphalt or concrete) should be considered when selecting sampling locations as they could limit DPT equipment use and/or require additional controls (e.g., traffic control, clearing of vegetation, temporary mats for protection of landscaping, or delicate surfaces).
- *Sampler Type.* DPT samples can be collected using either single barrel or double tube configurations (refer to **Attachment A** for brief descriptions of commonly used DPT samplers). The dual tube system is preferable as it provides a casing that isolates the media to be sampled from the formation, thereby preventing potential cross-contamination or potential sloughing of the borehole walls. A single barrel sampler may be suitable for discrete shallow (i.e., less than 10 feet) sampling in the unsaturated zone provided that the barrel sampler is used in a sealed or closed configuration. The sampler barrel is typically five feet in length.
- *Subsurface Soils.* DPT is most suitable for sampling cohesive overburden soils that contain a low percentage of gravel and are not dense or highly compacted, or contain cobbles or weathered rock. In cases where soils to be sampled may lack cohesiveness and may fall out of the sampler, core catchers at the leading end of the sampler may help retain the sample until retrieval at the surface.
- *Liner Type.* DPT soil sampling uses a liner to facilitate sample retrieval from the barrel. Liner materials include brass, stainless steel, cellulose acetate butyrate, polyethylene terephthalate glycol, polyvinyl chloride, and Teflon. Potential interferences between the liner materials and the contaminants of concern must be evaluated when selecting the liner materials. When low reporting limits are required, use of the more inert liner materials (e.g., stainless steel) is recommended.
- *Liner Dimensions.* Liners vary in diameter (from about 1 to 3 inches) and length (from about 2 to 5 feet). Metal liners can also be obtained in shorter lengths (2-6 inches) to allow ready collection of discrete intervals. Selection of the liner dimensions should consider: (a) volume requirements for sample analyses; (b) quantity of samples and sampling intervals (ideally the sampler would be positioned at the top of the interval of interest); and (c) enhanced recovery (typically larger diameter borings will be less affected by presence of small subsurface obstructions like pebbles).
- *Borehole backfilling approach.* Factors to be considered in selecting the approach for backfilling the borehole include potential contamination of drill cuttings, local permit regulations and guidance, and client specific requirements. DPT boreholes can be backfilled using several methods, including retraction grouting with a tremie tube and a bentonite and/or Portland cement grout, gravity filling with bentonite and/or Portland cement grout, filling with hydrated bentonite pellets, or backfilling with drill cuttings.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02** (Site Preparation, Inspection and Housekeeping). In addition, to the extent that non-dedicated sampling equipment is to be used (e.g., spatula, knife or spoon, mixing bowls), such sampling equipment should be decontaminated before collection of each

sample to minimize potential cross-contamination between samples, as described in **FGD 14.01** (Sampling Equipment Decontamination), the project-specific Work Plan, Field Sampling Plan and/or QAPP. Used disposable sampling equipment should be considered IDW and should be managed in accordance with **FGD 15.01** (Waste Handling), following the sampling event.

At a minimum, the following tasks should be completed (as applicable) as field staff prepare for implementation of the work:

- Coordinate and obtain permission for site access;
- Review and sign the site-specific HASP;
- Review applicable permits and permit conditions that may affect site work including backfill requirements, air, dust or sound monitoring, agency notifications, and restricted operating hours;
- If work is being conducted under agency supervision, make appropriate advance notifications to advise of the start of work;
- Confirm soil boring/sampling locations;
- Complete subsurface clearance activities (refer to **SWP** Subsurface Utility Clearance);
- Review project-specific Work Plan, Field Sampling Plan, and/or QAPP, where applicable;
- Review and discuss with the PIC/PD and/or PM the proposed Work Plan, Field Sampling Plan or sampling strategy;
- Identify the type of sampler and drilling equipment required for project-specific tasks and review the standard instruction manual provided by the manufacturer of the specific sampling equipment being used for sampling;
- Contact the drilling contractor to verify scope and confirm sampling equipment is available and appropriately decontaminated prior to mobilization;
- Contact the laboratory to provide advance notice when sample delivery is anticipated; and
- Verify that all equipment/materials and sampleware required to complete the work have been packed prior to mobilization.

Prior to the commencement of the field effort, Ramboll oversight personnel should inspect, test, and/or calibrate equipment that will be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration). To increase productivity in the field, it is recommended that prior to mobilization the laboratory-provided sampleware quantities are checked, sample containers are pre-labeled (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody) and non-dedicated sampling equipment is decontaminated and packaged (refer to **FGD 14.01**, Sampling Equipment Decontamination).

4.3 Direct Push Sampling Guidelines

The following provides a recommended list of practices for soil sampling using DPT.

- Where applicable, contact the identified key site personnel upon arrival to the Site and visually assess proposed work areas and decide where containerized soil cuttings and other IDW should be staged and stored.
- Review the physical location of each soil boring with the driller before initiating subsurface work. Verify that the proposed locations have been cleared in accordance with **SWP** Subsurface Utility Clearance and that the drill rig can operate safely while maintaining minimum clearance from overhead power lines, or damaging other property (e.g., equipment, fences, etc.).
- Inspect the backfill material provided by the drillers to verify it complies with potential permit requirements.
- Discuss the following with the driller:
 - Expected depth and diameter of the borings;
 - Amount and depth of the soil samples to be collected;
 - Approximate anticipated depth of groundwater;
 - Borehole backfilling procedure and materials;
 - Staging locations for soil cuttings and other IDW;
 - Location for conducting equipment decontamination; and
 - Surface materials and the need to predrill or core prior to DPT. If the surface material is asphalt, the direct push drill rig tooling may be able to penetrate the asphalt (verify with driller prior to initiating field work). However, if the surface is covered with concrete, a concrete corer or saw may be required to provide access to the subsurface.
- Prior to start of the DPT sampling, set up the sample processing/field station area, which may include placing plastic sheeting on the ground surface to prevent potential contamination of underlying soil/asphalt/concrete, setting up a worktable, core cradle, or corrugated sheets to hold the samplers, and installing a canopy.
- Although equipment will be decontaminated between uses to further limit potential cross-contamination between sampling locations, sampling should progress from suspected areas of lowest to highest concentration.
- The driller will advance the DPT sampler to the target sampling depth (refer to **Attachment A** for brief descriptions of commonly used DPT samplers). The sampler will be advanced using hydraulic pressure and percussion hammering on the driving head of the sampling assembly at a constant rate. The sampler will be advanced to a depth that is equal to its length (typically 24-inch inner sampling barrel), or less if sampler refusal is encountered (i.e., limited or no advancement of the sampler, altering the robe alignment or bending of the rod). Refusal can result from tip resistance (i.e., distinct unconsolidated deposits overlying bedrock or presence of cobbles in the subsurface), sleeve friction (i.e., the interaction of the sampler with cohesive soils, which can “grab” the outside of the sampler and limit depth penetration), subsurface heterogeneity, or

operator error (e.g., advancing the probe off vertical, which will cause the probe to bend).

- During direct push sampling, Ramboll personnel should:
 - Maintain a safe distance from the drill rig and maintain eye contact with the operator if approaching the drill rig.
 - Monitor ambient air in the work area as required by the site-specific Work Plan or Field Sampling Plan and the site-specific HASP.
 - Communicate with the operator regarding observed changes in subsurface conditions during drilling (e.g., increased or decreased resistance to DPT, groundwater first encountered) and depths where these occur.
- Have the drilling contractor retrieve the sampler from the borehole, place the sampler on the sample processing work area, and remove the liner from the sample barrel.
- Upon delivery, Ramboll personnel will
 - Don a pair of new clean nitrile gloves immediately prior to handling each core.
 - If the liner will be used as a sample container, use a decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination) tool to cut the portion of the liner that will be used for the sample, and cover it with liner caps, which should be taped to the liner to prevent sample loss (Teflon or other tape without potential VOC-containing adhesives for VOC samples). Then cut the remainder of the liner as described below.
 - If the liner will not be used as the sample container, cut it lengthwise on either side with a decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination) tool to separate the halves and allow for sample screening and collection. If sampling for VOCs is being performed, do not cut the liner until immediately prior to field screen/sample to minimize VOC loss.
- Once the liner is open, Ramboll personnel should:
 - Place a measuring tape alongside the liner, photo-document the core, and measure and record the soil recovery in the core. If poor soil recovery is experienced or anticipated, then evaluate the possible causes for poor recovery. Consider (a) advancing the core to the top of the desired sample interval and then advancing the core to obtain the desired interval; (b) using a catcher; (c) extending the sampler to a cohesive layer, if present; (d) using a larger split spoon barrel; and/or (e) advancing a second adjacent soil boring to target the necessary interval. Alternatively, review and discuss with the PIC/PD and/or PM other sampling approaches.
 - When the sample recovery is less than 100%, the recorded retrieved interval corresponds to the top of the target sampling interval. For example, if recovering 18 inches from the 10 to 12 feet below ground surface (bgs) sampling interval, the sampling interval recorded is 10 to 11.5 feet bgs. Exceptions may include presence of slough in the top of the sampler, when sampling compressible soils (e.g., peat), or if a rock temporarily prevents sample collection. If any of these conditions are

observed during drilling, discuss appropriate recording of the sample recovery with the PIC/PD and/or PM.

- Use a decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination) spatula, knife or spoon to split the soil cores and to expose soil for sampling, field screening, and photo-documentation.
- Screen the soil with field instruments (e.g., PID, XRF) as required by the site-specific Work Plan, Field Sampling Plan, and/or QAPP and in accordance with instrument manufacturer recommendations and pertinent FGDs.
- Classify the soil in accordance with **FGD 5.01** (Soil and Rock Classification) and document related drilling activities in accordance with **FGD 5.09** (Field Soil Boring Log Preparation).
- If soil samples are to be field tested for the presence of NAPL refer to **FGD 5.11** (Soil Sampling - NAPL Dye Tests) and/or **FGD 5.12** (Soil Sampling - NAPL Ultraviolet Light Tests).
- Don a new pair of clean nitrile gloves immediately prior to collecting samples that will be sent for laboratory analyses.
- Collect samples as required by the site-specific Work Plan, Field Sampling Plan, and/or QAPP as follows:
 - If soil samples are to be analyzed for VOCs collect these samples first in accordance with **FGD 5.05** (Soil Sampling for VOC Analysis).
 - Homogenize sample in accordance with the homogenization procedures provided in **Section 4.4**.
 - If soil samples are to be analyzed for PCBs refer to **FGD 5.16** (Soil Sampling for PCB Analysis).
 - If soil samples are to be analyzed for PFAS, refer to **FGD 1.07** (PFAS Sampling).
 - If multiple samples are to be collected from a single liner, don a pair of new clean nitrile gloves and use a decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination) spatula, knife or spoon to collect and prepare each sample.
- Transfer the sample to appropriate sample container(s) provided by the analytical laboratory, label and seal the sample containers, and store in an ice-filled insulated cooler pending transport to the analytical laboratory, or the laboratory courier in accordance with sample container guidelines in **Section 4.5** and sample transport and storage guidelines in **Section 4.6** and **FGD 1.02** (Sample Handling, Shipping, and Chain of Custody).
- If multiple samples are to be collected, decontaminate non-dedicated, non-disposable sampling equipment between sampling locations as described in the **FGD 14.01** (Sampling Equipment Decontamination), the project-specific Work Plan, Field Sampling Plan and/or QAPP.
- If the Work Plan or Sampling Plan requires continuous sampling, have the driller advance the sampler to a depth equal to the base of the last sample interval. If sampling is

discontinuous, have the driller advance the sampler to just above the next sample target depth.

- Upon completion of the drilling and soil sampling activities:
 - The boring shall be backfilled as required in the project-specific Work Plan, Field Sampling Plan, and/or permit(s).
 - If surfaces are to be restored (e.g., pavement, concrete, vegetation), reconstruct the surface and match to adjoining grades in accordance with the project-specific Work Plan and/or Field Sampling Plan.
 - Document the sampling location in accordance with **FGD 1.04** (Documenting Sampling Locations) and place a stake or flag at the sampling location for future reference if these do not interfere with site activities (e.g., in a parking lot or driveway).
- If required by the project-specific Work Plan or Field Sampling Plan, decontaminate the drilling rig and equipment prior to demobilization from the Site in accordance with **FGD 14.02** (Heavy Equipment Decontamination).
- If dedicated, disposable sampling equipment was used during the sampling event, it should be considered IDW and should be managed in accordance with **FGD 15.01** (Waste Handling) following the collection sampling event.

4.4 Sample Homogenization Procedures

Homogenization refers to the complete mixing of materials to obtain uniform color and consistency throughout the sample prior to analyses. Homogenization is typically performed on discrete samples (e.g., several intervals within a sampling location or several sampling locations within a specific sampling interval) to create composite samples. Compositing may be performed either in the field or at the laboratory. Homogenization should not be performed for samples designated for VOC analysis (refer to **FGD 5.05**, Soil Sampling for VOC Analysis).

- Place samples to be homogenized into a large, decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination) or dedicated container constructed of inert material (e.g., glass, Teflon, or stainless steel) appropriate for the analyses requested.
- Prior to homogenization, remove large, unrepresentative materials such as twigs, leaves, stones, wood chips, and debris and document this encountered material in the field log.
- Mix materials as quickly and efficiently as possible using a decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination) glass, high density polyethylene, or stainless-steel spoon until textural, color, and moisture homogeneity are achieved.
- When mixing large amounts of materials, mechanical mixers can be used as long as they are made of stainless steel, and have been decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination).

4.5 Sample Containers

As outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody), equipment and sample containers that will come into contact with collected soil samples should be constructed of inert materials that will not affect the concentration of constituents in the sample (i.e., stainless steel or Lexan®). The level of care that needs to be taken with the materials used will depend on the level and types of constituents associated with the sample and the quality assurance needs and study goals. This should be outlined in the project-specific Work Plan, Field Sampling Plan and/or QAPP.

When the liners will not be used for sample collection, the laboratory will provide appropriate sample containers appropriate for each predetermined sample analysis. The sample volume is a function of the analytical requirements and will be specified in the Work Plan, Field Sampling Plan and/or QAPP. If possible, jars should be filled to capacity allowing no headspace (unless samples are to be stored frozen in which case some head space is required to allow for sample expansion). If samples are to be analyzed for VOCs, they should be collected in a manner that minimizes disturbance of the sample (refer to **FGD 5.05**, Soil Sampling for VOC Analysis).

4.6 Sample Transport and Storage

Sample containers shall be handled as outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody). Samples should be kept in an ice-filled transport container during fieldwork and covered to limit light penetration.

If the liners will be used for sample collection, they should be properly capped/sealed at both ends and stored to minimize sample disturbance.

4.7 QA/QC

Follow QA/QC procedures described in the project-specific Work Plan, Field Sampling Plan and/or QAPP throughout the sample collection, processing, handling, and analysis process. In their absence, the QA/QC guidelines of **FGD 1.05** (Field Quality Control Samples) should be reviewed.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Field activities require recording sufficiently detailed information throughout the implementation of field work. Certain precautions should be taken to work safely while collecting soil samples via DPT. Additionally, implementation of the work may face some difficulties, including the following:

- Direct push drilling is only suitable in unconsolidated shallow sediments. If the lithology at the site contains large amounts of gravel/cobbles, dense clay, caliche or bedrock, alternative drilling techniques may have to be considered.
- Only drillers licensed in the State where the work is being performed should be subcontracted to perform the work, if applicable. Most states have specific licensing requirements.

- In some States or local jurisdictions, drilling permits are to be procured by the driller and/or consultant prior to mobilization. In addition, boring logs and other documentation may need to be submitted to the permitting entity by the driller and/or consultant after completion of the drilling and sampling. Local Ramboll offices should be consulted to determine if specific reporting requirements apply. If the driller obtains the drilling permits, Ramboll should obtain copies of the required permits prior to mobilization. When applicable, Ramboll should also obtain copies of the driller's soil boring records after completion.
- Prior to mobilization, identify the location of soil borings and evaluate the need for security, barricading, and/or traffic control (e.g., when borings are located near the right of way).
- It is important to always remain alert and aware of your surroundings. Sampling using a direct push rig involves the use of heavy equipment, and is subject to hazards posed by equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and/or other physical, mechanical, and chemical hazards.
- Stand a safe distance away from the direct push rig when taking notes. Be aware that the operator may not be able to see you, equipment accidents can happen very quickly, and you need to be alert and ready to move. Be sure to wear a high-visibility vest or clothing.
- Keep direct push equipment out of high-traffic areas and properly stored when not in use to limit trip, spill and fall hazards onsite. Use marking tools when necessary to flag or mark off possibly dangerous areas.
- If the borehole cannot be completed by the end of the day, leave the drill rig over the borehole. Where not possible (e.g., public right of way), cover the borehole and secure the area to prevent accidents and unauthorized access.
- At sites with certain contaminants and/or subsurface conditions, potentially toxic and/or explosive gases may migrate from the borehole to the surface. Field staff should perform air monitoring and confirm that PPE is used in accordance with the site-specific HASP.
- When working out of sight of the general public or when site employees are in potentially hazardous areas (e.g., wooded habitats), field staff should use the "buddy system" and ensure that the project-specific HASP includes safety measures and procedures for work in isolated areas.
- When the liners are removed from the sampler tubes, it is important to track the proper orientation of the sample and to precisely and liberally mark the depths (e.g., top of run, labeled footage marks along the length of the sample, total depth of run) at which the sample was collected. Different liner cap colors can be used to distinguish the top from the bottom of the core or the orientation can be marked on the exterior of the liner with a permanent marker. When, say a six-inch sample is cut out of a sample run from a 5-foot sleeve, the remaining sleeve portions should be sufficiently labeled so that the boring can continue to be properly logged and to avoid confusion.
- If the Work Plan or Field Sampling Plan specifies analyses requiring field preservation, be sure to avoid direct contact with laboratory-provided preservative chemicals.

- The sample processing area should minimize exposure to ambient factors (e.g., atmospheric air, wind-blown dust, vehicular exhaust).
- Background soil samples should be kept isolated from samples collected from potentially contaminated soil samples and IDW. When possible, sampling should progress from areas of lowest to highest suspected concentrations.
- When possible, designated roles should be established so that the soil sampling and logging is performed by the same person and the recording and documentation is completed by the same person throughout the sampling process.
- When backfilling boreholes below the water table, bentonite pellets or coated bentonite chips are generally easier to place than standard bentonite chips because pellets do not hydrate as quickly, hence pellets or coated bentonite chips are the preferred method for small backfill jobs where significant confining zones have not been breached. Note, however, that some pellet coatings have been known to contain acetone, which may interfere with groundwater VOC analysis. If used, samples of the coated bentonite pellets may be collected and held for future analysis if acetone is detected in the groundwater sample.

6. RECORDKEEPING

Document sampling locations in accordance with **FGD 1.04** (Documenting Sampling Locations) and record information related to soil sampling in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management). In addition, for each soil boring a soil boring log with the recorded information should be prepared and saved in the project file (refer to **FGD 5.09** – Soil Boring Logs).

ATTACHMENT A

DIRECT PUSH SAMPLING EQUIPMENT

Direct push technology (DPT) sampling involves “pushing” a hollow lined barrel into the subsurface using a combination of equipment weight and high frequency percussive or hydraulic methods. Since DPT compresses and/or rearranges soil particles to allow the barrel to advance, there is no need to remove soil thereby minimizing soil cuttings requiring offsite disposal. The depths that can be achieved by DPT sampling are dependent on the soil type, the size of the sampler, and the weight and power of the DPT rig. DPT sampling is most suitable for sand, silt and clay with some gravel. DPT technology may have difficulty penetrating dense or hard soil, hard-packed saturated sand, and soil with cobbles or boulders.

DPT devices may be driven by manual, mechanical, or hydraulic methods, and may be truck-mounted or stand-alone. A DPT tool string includes the sample collection tool and extension rods for advancement and retrieval of the sample tool. There are three types of rod systems:

- A. The Large Bore DPT soil sampling system consists of a single string of rods that connect the sampling tool to the rig and is used as a discrete interval sampler. The large bore sampling system consists of a head assembly, a barrel, liner, a piston rod, a cutting shoe, and a piston tip. While it is being driven, the sampler remains closed by a piston tip that is held in place by a

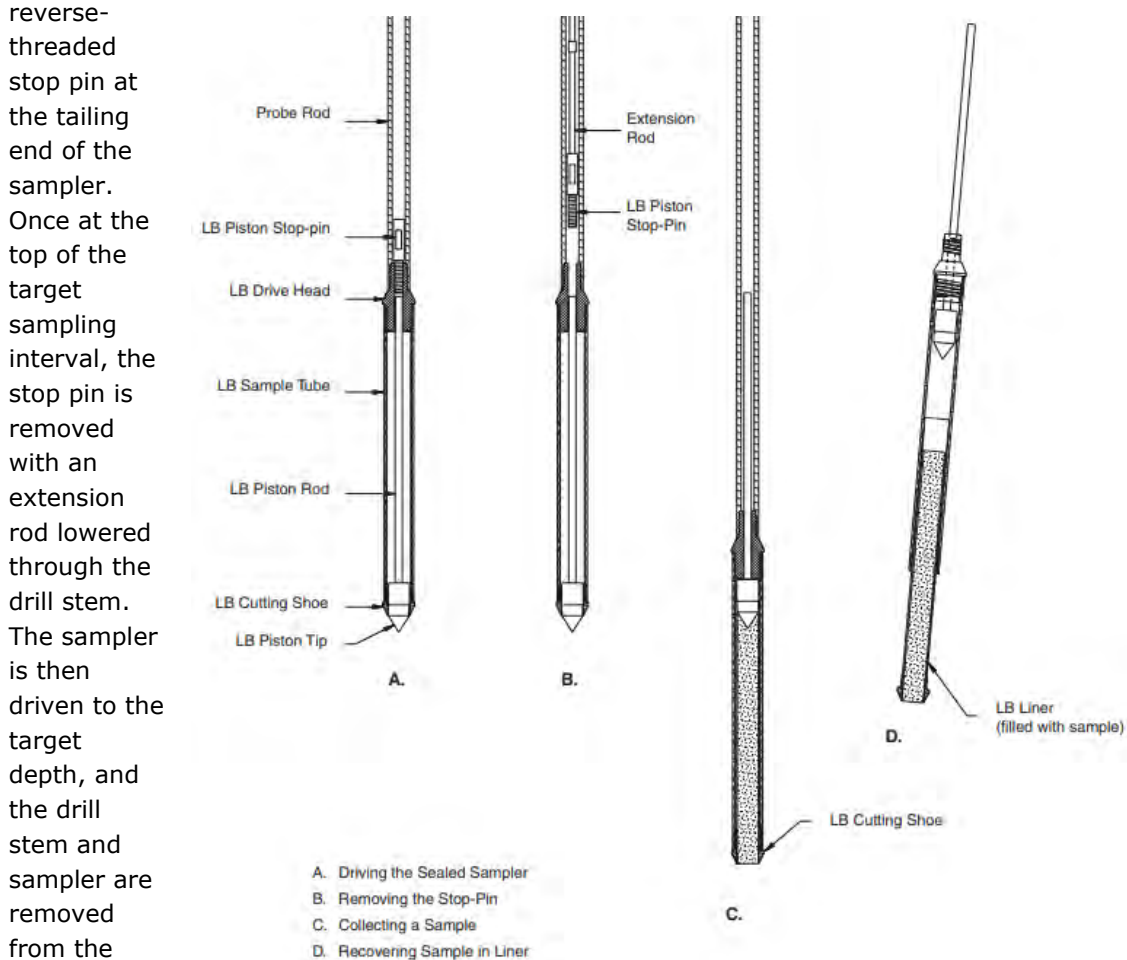


Figure 1: Large Bore DPT System (Source: Geoprobe)

- B. Single tube DPT soil sampling consists of a single string of rods that connect the sampling tool to the rig and can be used as an open tube sampler or closed point sampler assembly. The open tube sampling system consists of a head assembly, a barrel, liner and a cutting shoe. The cutting shoe is affixed to the liner, which is inserted and threaded into the barrel. The drive head is threaded the opposite end of the barrel. In this configuration, coring starts at the ground surface with a sampler that is open at the leading end. The sampler is driven to the target depth in the subsurface using the DPT rig, and when retrieved, the entire string is removed from the borehole. To collect samples from greater depths when soils are stable, a new sampler is reintroduced into the open borehole and the process repeated. In unstable soils that cause borehole wall collapse, the single tube sampler can be equipped with a closed point assembly. The closed point assembly also allows collection of targeted interval samples at depth.

A closed point assembly can be inserted into the single tube DPT soil sampler. This assembly fits firmly into the cutting shoe and is held in place by center rods that prevents soil from entering the sampler as it is advanced to the bottom of an existing hole, allowing collection of a representative sample at the target depth. The barrel and closed point string are driven to the target sampling depth, after which the closed point string is retrieved leaving the barrel and open tube sampling system in-place. The sampler is driven to the target depth in the subsurface using the DPT rig, after which the entire string is removed from the borehole to retrieve the sample.

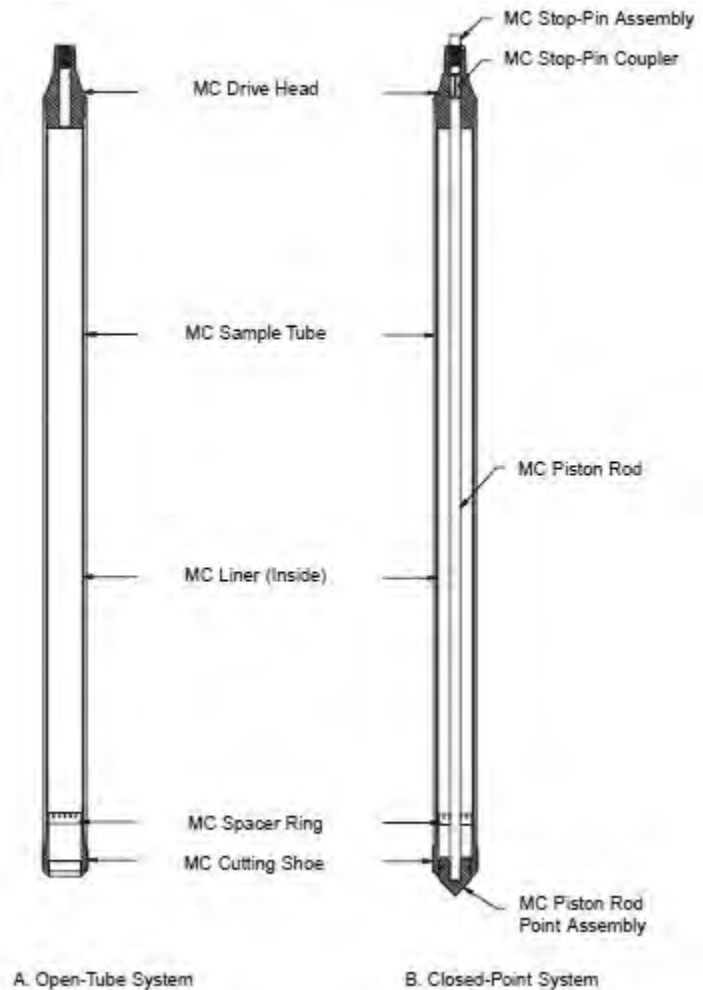


Figure 2: Single Tube DPT System (Source: Geoprobe)

- C. The dual tube DPT soil sampling system allows sampling of subsurface soils from within a sealed outer casing. It uses an outer casing that remains in place during sample retrieval and an inner rod and liner string for sample collection. A cutting shoe is installed at the leading end of the outer casing probe rod. The inner string assembly (i.e., inner rod and sample liner) is installed within the outer casing. If the first sampling interval is not the ground surface, a solid drive tip (discrete point) is used on the leading end of the inner rod string instead of a sample liner to seals the assembly as it is driven into the subsurface. The dual tube system with the discrete point is then driven to the top of the target sampling interval, at which point the inner string is retrieved, and the discrete point is removed from the drive head and replaced with a liner. The inner rod with the liner is then inserted into the outer casing, which is extended with an additional casing. A drive cushion is then placed on top of the inner rod and a drive cap placed over the entire assembly. The whole string is driven to the target sampling depth, after which the inner rods and liner with sample are retrieved from the outer casing.

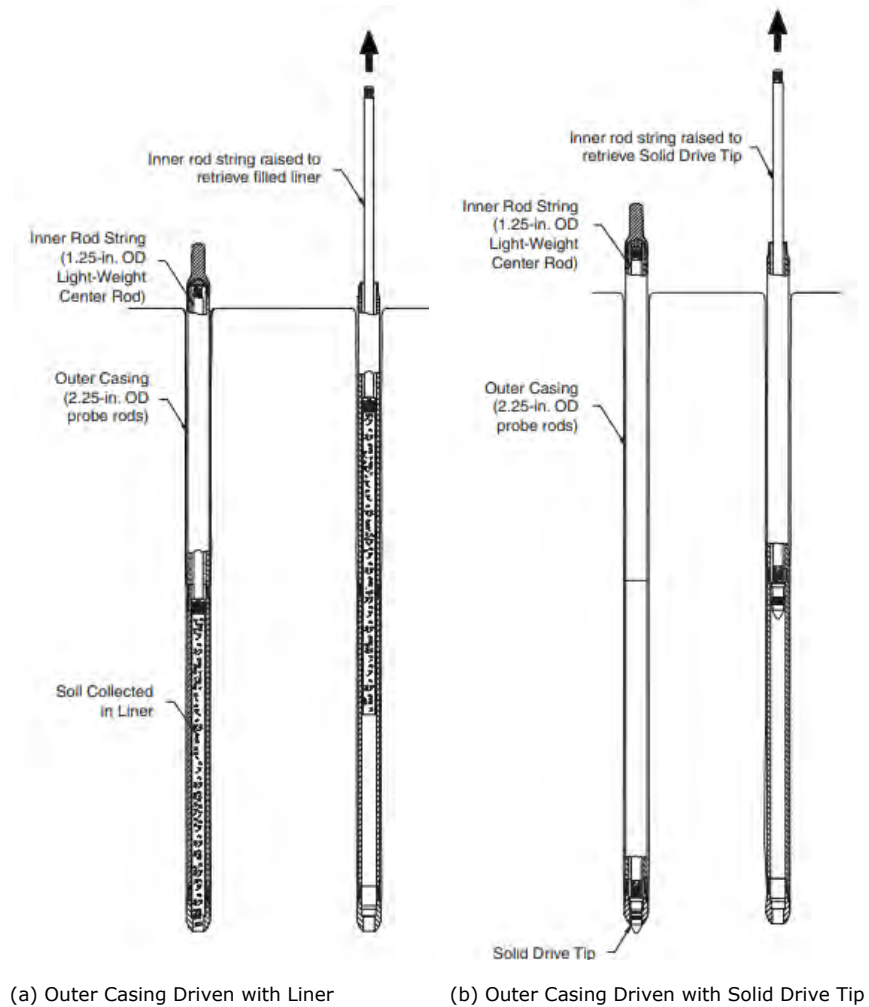


Figure 3: Dual Tube DPT System (Source: Geoprobe)

FIELD GUIDANCE DOCUMENT NO. 5.09

FIELD SOIL BORING LOG PREPARATION

FIELD GUIDANCE DOCUMENT NO. 5.09

FIELD SOIL BORING LOG PREPARATION

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Applicable To:	All North American offices
Effective Date:	November 16, 2015
Revision Notes:	1. Revised company name and format.
Documents Used as Reference During Preparation:	ASTM D1586 - 11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils; ASTM D 2487-00 Standard Practice for Classification of Soils for Engineering Purposes; ASTM D 2488-00 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure); New Jersey Department of Environmental Protection, 2005. Field Sampling Procedures Manual; Ontario Ministry of Environment and Energy Standards Development Branch. "Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario Version 1.1". December, 1996; and, Ontario Ministry of Environment Regulation 153/04 as amended by Ontario Regulation 511/09, 2011.

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ATTACHMENTS

Attachment A: Soil Boring Log Template

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for logging geologic information gathered from soil borings through unconsolidated materials¹; and completing field logs as part of environmental field investigations. Soil logs serve to document soil types, field instrument measurements, field observations and field test results. Soil types and properties may vary at a site and accurate soil(s) identification and geologic logging is essential to the successful completion of projects. Detailed soil boring logs are critical to developing accurate conceptual site models to support characterization of the nature and extent of contamination, performing hydrogeological modeling, conducting site specific risk evaluations, evaluating the feasibility of remedial alternatives, and/or preparing remedial design specifications.

This FGD provides guidelines for geologically logging soils associated with typical field activities and projects. It should be understood that, more specific soil boring records, including those defined in state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable for certain projects. Specific requirements for these types of records or activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, sampling plans and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements. In addition, PICs and PMs are encouraged to provide additional direction or training to junior scientists and engineers for the implementation of the procedures outlined in this FGD.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail.

2. EQUIPMENT / MATERIALS

A general checklist of equipment and materials that may be required for logging soil borings is provided below. This checklist includes an overall summary of general equipment typically required for documenting soil boreholes and should not be considered an exhaustive compilation. Additional equipment may be specified in the project-specific work plan, other referenced FGDs and/or the HASP.

- Field notebook and all-weather pens or permanent as outlined in **FGD 1.01** (Field Notes and Records).

¹ Unconsolidated materials refers to natural soils, fill, and unconsolidated deposits below the soil horizon. Throughout this FGD references to soils should be understood as any unconsolidated material encountered in the subsurface during boring activities.

- Field log forms (preferably produced on *Rite in the Rain*® water-resistant paper):
 - Blank Field Boring Log form (a comprehensive example is provided as **Attachment A**).
 - Blank Field Well Completion Log form (if required).
- Geotechnical Gauge (as manufactured by W. F. McCollough or equivalent) as outlined on **FGD 5.01** (Soil Classification) and **FGD 5.17** (Rock Classification).
- Color chart, as outlined on **FGD 5.01** (Soil and Rock Classification) and **FGD 5.17** (Rock Classification).
- Spatula or other instrument for splitting soil cores.
- Measuring tape or ruler.
- Plastic Sheetting to go under the cores while logging.
- Decontamination supplies.
- Digital Camera.
- Clipboard.

Based on the field activity and project, the following also may be needed:

- Field screening equipment (as required by Work Plan and/or HASP).
- Electronic water level indicator or interface probe.
- A portable table or other stable working surface.
- Duct tape to secure plastic sheeting to table.
- Stacking sieves (as required by Work Plan).
- Time keeping device.
- Water Spray bottle (to wet the soil if needed and/or wipe down surfaces).
- Paper towels.
- Corrugated roofing plastic sheet.
- Zip lock bags (used for PID readings).

3. REFERENCED GUIDANCE DOCUMENTS

The following FGDs are related to this FGD and should be referenced, as needed:

- **FGD 1.01**, Field Notes and Records.
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody.
- **FGD 1.03**, Data Management.
- **FGD 1.04**, Documenting Sampling Locations.
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping.

- **FGD 4.01**, Field Screening - Combustible Gas.
- **FGD 4.02**, Field Screening - Volatile Gas.
- **FGD 4.03**, Field Screening - Landfill Gas.
- **FGD 4.06**, Equipment Calibration.
- **FGD 5.01**, Soil Classification.
- **FGD 5.02**, Subsurface Soil Sampling - Test Pits and Excavations.
- **FGD 5.03**, Soil Screening.
- **FGD 5.04**, Surface Soil Sampling.
- **FGD 5.07**, Subsurface Soil Sampling – Geoprobe®.
- **FGD 5.08**, Subsurface Soil Sampling - Split Spoon and Shelby Tube.
- **FGD 5.14**, Subsurface Soil Sampling - Thin Wall Corer.
- **FGD 5.15**, Stockpile Sampling.
- **FGD 5.17**, Rock Classification.
- **FGD 6.01**, Permanent Overburden Well Installation.
- **FGD 6.05**, Permanent Bedrock Well Installation.
- **FGD 6.06**, Temporary Overburden Well Installation and Sampling.
- **FGD 6.15**, Well Construction Record.
- **FGD 8.01**, Sediment Sampling.
- **FGD 8.02**, Grain Size Determination for Sediment Samples in the Field.
- **FGD 9.02**, Installation of Subslab Sampling Points.
- **FGD 9.03**, Installation of Soil Gas Sampling Points.
- **FGD 14.01**, Sampling Equipment Decontamination.
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of the site-specific sampling plan (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 General Information

During borehole drilling, information regarding all activities related to the soil boring should be recorded in the Field Notebook or on a Field Boring Log form (refer to example provided as **Attachment A**). The Field Notes or Field Boring Log form should be populated concurrently with the soil borehole drilling activities, and the person completing the log should pay close attention to the drilling activities. The following guidelines should be considered when recording information:

- Pertinent information will be recorded in the field notebook or on the Field Boring Log form for each borehole and will include the information specified in **Section 4.2** of this FGD.
- Where applicable, field personnel should indicate in the field log book and on the Soil Boring Log form if the borehole is completed as a monitoring well, soil gas probe, or if it is backfilled and abandoned (refer to the corresponding FGD for additional information and construction details to be recorded).
- Borehole drilling activities may also require that additional forms, such as a Field Well Completion Log form (refer to **FGD 6.15**, Well Construction Record), or equipment calibration log forms (refer to field screening FGDs), also be completed. Alternatively, based on project-specific requirements, information may be recorded in the project-specific Field Logbook, as long as all information identified in the form(s) is recorded in the logbook (refer to **FGD 1.01**, Field Notes and Records).
- Any free forms or field sketches, such as Field Boring Log form, or borehole location sketches, should be appropriately referenced in the field notebook (refer to **FGD 1.01**, Field Notes and Records) and collectively, should present a complete record of the field activities observed. Thus, these records should be thorough enough to enable reviewers to reconstruct the field activities, rationales for decisions made, and observations.
- Records should be recorded in accordance with **FGD 1.01**, Field Notes and Records.
- Soil samples should be collected for field logging in accordance with the developed project-specific Work Plan and the following FGDs:
 - **FGD 5.02**, Subsurface Soil Sampling - Test Pits and Excavations.
 - **FGD 5.04**, Surface Soil Sampling.
 - **FGD 5.07**, Subsurface Soil Sampling - Geoprobe®.
 - **FGD 5.08**, Subsurface Soil Sampling - Split Spoon and Shelby Tube.
 - **FGD 5.14**, Subsurface Soil Sampling - Thin Wall Corer.
 - **FGD 5.15**, Stockpile Sampling.
 - **FGD 8.01**, Sediment Sampling.
 - **FGD 8.02**, Grain Size Determination for Sediment Samples in the Field.
 - **FGD 14.01**, Sampling Equipment Decontamination.
 - **FGD 15.01**, Waste Handling.

4.2 Requirements for Soil Boring Log Form

The Soil Boring Log summarizes and presents all data gathered during lithological sampling of soils and is a critical component of the overall record of an investigation. Field personnel should be aware of and record in the field log book or on the Soil Boring Log form (refer to example provided as **Attachment A**) the following general soil boring details:

- Soil boring unique identification number (ID).
- Name of Ramboll Environ oversight personnel completing the log.
- PIC or PM of the project.
- Project number.
- Drilling contractor and master/head driller's name.
- Date and the start and end time of drilling.
- A description of the boring location including a map depicting the boring location relative to fixed site features (e.g., building corners, utility poles, gates/fences, etc.).
- Drilling method used (e.g., hand auger, hollow stem auger, air rotary, mud rotary, direct-push [i.e., Geoprobe]) and nominal outside diameter(s) of drill string equipment.
- Drilling equipment (i.e., rig make and model).
- Borehole diameter. Note that some boreholes will have "telescoping" intervals of larger or smaller diameter (e.g., if installing a double-cased well to seal off specific water-bearing zones).
- Detailed description of ground surface conditions (e.g., 4 inches of concrete overlying 6 inches of $\frac{3}{4}$ inch stone).
- The type of soil sampling performed (e.g., split spoon, Shelby tube, direct-push) and the length of the sampler device.
- Intervals over which soil cores are being collected (e.g., continuous soil cores, one split spoon every 5 feet, etc.).
- Hammer weight and drop, if collecting split spoon samples.
- Total borehole depth (note the depth of the borehole before and after backfilling).
- Depth at which water is first encountered during drilling and any subsequent water-bearing zones.
- Depth and intervals of any drilling refusal or cavities.
- Description of fluids added during drilling and associated quantities.
- Depth of water at completion of soil boring.
- Depth of boring after cave-in (if applicable).
- Method and materials used to abandon, backfill or convert the boring to a well or monitoring probe.
- A description of any problems encountered during the drilling process and corrective actions, as applicable. For example, record if borings must be relocated during the site

inspection due to the presence of subsurface utilities or other obstructions, or if borings must be off-set to an alternative, pre-cleared location due to refusal. This information should also be recorded in the field notebook.

- A description of any notable features encountered during drilling, including depth or depth range encountered below ground surface. This information may include changes in characteristics indicated by the driller (e.g., drill chatter, softer drilling, more difficult drilling, loss of water).

For each sampling interval, field personnel should be aware of and record in the field log book or on the Soil Boring Log form the following details:

- Blow counts (when drilling and/or sampling methods allow). Record the number of blow counts per six-inch interval of the Standard Penetration Test (SPT) to provide an estimate of relative density of the penetrated material. Blow counts shall be recorded for each six-inch interval (i.e. four measurements for each 2-foot interval or three measurements for each 18-inch interval). The final log should include the N- value (the sum of the second and third blow counts over a 2-foot interval). If the blows do not represent SPT data (for example, if a 3-inch diameter split spoon is used in lieu of the standard 2-inch diameter split-spoon), this should be noted. Blow counts should only be collected in accordance with the methods set forth in ASTM D1586, which specifies a 30-inch drop of a 140 pound hammer using a 2-inch diameter sampler.
- Soil recovery, recorded as the portion of sample (in feet or inches) that is recovered out of the entire length of the coring tool utilized. The recovery must be recorded for each advanced interval and should be correlated to the size of the sample apparatus. For example, if a split-spoon sampler was driven 24 inches, but only 8 inches of material was found inside the sampler, the amount of recovery would be recorded as 8"/24".
- Sample designation and sampling depth interval in accordance with **FGD 1.02** (Sample Handling, Shipping and Chain of Custody).
- Description of the materials sampling in accordance with **FGD 5.01** (Soil Classification) and **FGD 5.17** (Rock Classification) if appropriate. The log should clearly indicate that "Unless otherwise noted, soil classifications are based on field observations and have not been confirmed by laboratory testing."
- Depth below ground surface corresponding to any changes in stratigraphy or notable features. When describing underlying samples, use the following where applicable:
 - (same) ... if underlying materials are identical to prior sampling interval.
 - (same with ____) ... when soil classification remains constant, but specific qualifiers (e.g., organics, no glass) are no longer applicable.
 - (grades to ____) when soil classification remains constant, but there is a change in color, moisture content, or relative density or consistency.
- Field screening results (e.g., photoionization detector screening), if performed. If the collection of vapor readings or other field parameters is required in the Work Plan, refer to the Work Plan for appropriate intervals over which measurements should be collected and the pertinent field screening FGDs.

- Field test results (e.g., portable chemical-specific test kits, pocket penetrometer or pocket torvane strength tests), if performed. If field testing is required in the Work Plan, refer to the pertinent field testing FGDs.
- Identification of samples submitted for laboratory analysis, as may be required in the Work Plan.
- Identification of samples sent for geotechnical testing or supplemental analysis of physical properties, as may be required in the Work Plan.
- Record of whether debris, or large particle sizes were encountered in collection of or excluded from any sample including description of those material.
- Difficulties encountered during the sample collection process, as applicable (e.g., caving of borehole, subsurface obstructions, equipment failure).

Where applicable, field personnel should record in the field notebook or on the Soil Boring Log form the following additional information:

- Whether the borehole is logged using soil cuttings descriptions rather than whole samples.
- Whether information from an adjacent boring log is used to identify depth intervals for sampling. In such case, reference should be made to the adjacent boring log.
- Whether a boring was logged based on a collocated boring. For example, if two borings are adjacent and one was formally logged and the other not formally logged (or logged in less detail) the name of the more detailed boring log should be referenced on the less detailed boring log (e.g. boring log B-1S may include the description: "Boring B-1S advanced without logging soils, adjacent boring B-1D logged").
- Whether the borehole remained open overnight and the precautions taken to secure the borehole and the overall area.
- Time, date, and type of materials used to backfill the borehole.

If appropriate and/or required by the project, data recorded in a field log book or field Soil Boring Log form should be transferred to a final Soil Boring Log form within two weeks after the boring was drilled. Where required, a Professional Geologist and/or Professional Engineer should review the soil boring log before its finalized.

4.3 Additional Soil Boring Documentation

Upon completion of the soil boring, its location relative to fixed and reproducible landmarks should be defined in the field book or site map. A detailed dimensioned sketch should be prepared in accordance with **FGD 1.04** (Documenting Sampling Locations).

In addition to documenting field activities in a logbook, photographs (if allowed) should be taken to document each soil sample, and details of each photograph (file name, date, time, direction, and subject) should be recorded in accordance with **FGD 1.01** (Field Notes and Records).

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Soil boring log preparation requires recording sufficiently detailed information throughout the borehole advancement process. Certain precautions should be taken to ensure safety while recording the required information.

- Proper personal protective equipment (PPE) must be worn and subsurface materials handled in accordance with the project HASP.
- If soil borings are discontinuous (e.g., two foot samples at five foot intervals) and differing materials are encountered in consecutive samples, approximate the transition from one layer to another by:
 - Discussing with the driller any noted changes in the advancement of the soil boring which would allow an approximation of the transition depth.
 - Estimating the transition point as the midpoint between sampling intervals.

In either case, the approximated transition depth/elevation should be shown with a dashed rather than a solid line in the boring log to convey uncertainty in the boundary between the strata.

- It is not uncommon for sample recoveries to represent a fraction of the sampling interval. In those instances there should be some consideration to the materials immediately above and below the sampling interval, the presence of coarse grained materials, potential sloughing within the borehole, and/or potential obstructions in the sampling device which may have contributed to the reduced recovery. If additional guidance is needed, discuss with the PM and/or PIC the specific procedures to be followed in logging the specific sampling interval.
- If samples for analysis are to be collected, the field soil log should be prepared after samples collection to minimize losses due to volatilization or cross-contamination due to excessive handling of the soil.

6. RECORDKEEPING

This FGD specifically pertains to recordkeeping for soil boring drilling projects. In addition to the soil boring log preparation guidelines provided above, all information should be recorded in accordance with **FGD 1.01** (Field Notes and Records). In general, draft field forms should be scanned and saved electronically immediately following the completion of the field activities. Following review of draft documents by the PIC and/or PM, field documentation forms should be finalized and final versions may be included in project reports, if necessary. Draft and final versions of the boring logs should be managed in accordance with Ramboll Environ's Document Retention Policy and project-specific requirements, and a copy should be maintained in the Project File.

ATTACHMENT A
SOIL BORING LOG TEMPLATE

FIELD SOIL BORING LOG enter ID

PROJECT NAME: _____

FIELD PERSON: _____

PROJECT NUMBER: _____

PROJECT MANAGER: _____

PROJECT LOCATION: _____

DATE: _____

BORING LOCATION MAP										DRILLING CONTRACTOR:	
										DRILLER:	
										RIG TYPE AND DRILLING METHOD :	
										OTHER EQUIPMENT:	
										SAMPLING METHODS:	
										TOTAL DEPTH:	BOREHOLE DIAMETER:
										START TIME:	STOP TIME: <i>(Date if Necessary)</i>
										WATER DEPTH:	SURFACE MATERIAL:
										BACKFILL DATE/TIME:	MATERIAL: BY:
										COMMENTS:	
SAMPLE DESCRIPTION:											
SAMPLE DEPTH	SAMPLER TYPE	BLOW COUNTS	RECOVERY (FEET/FEET)	PID/FID (PPM)	OTHER (Specify):	SAMPLE NAME	TIME	DEPTH IN FEET	USGS SYMBOL/ CONTACT	DEPTH IN FEET	
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								10			

**FIELD SOIL BORING LOG enter ID
(Continued)**

SAMPLE DEPTH	SAMPLER TYPE	BLOWS IN 6 INCHES	RECOVERY (FEET/FEET)	PID/FID (PPM))	OTHER (Specify):	SAMPLE NAME	TIME	DEPTH IN FEET	USGS SYMBOL/ CONTACT	DEPTH IN FEET	BORING ID:
										JOB NAME/NUMBER:	
										SAMPLE DESCRIPTION:	
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								0			
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								0			

Unless otherwise noted, soil classifications are based on field observations and have not been confirmed by laboratory testing

FIELD GUIDANCE DOCUMENT NO. 6.02

GROUNDWATER PURGING AND SAMPLING

FIELD GUIDANCE DOCUMENT NO. 6.02

GROUNDWATER PURGING AND SAMPLING

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Applicable To:	All North American offices
Effective Date:	May 23, 2016
Revision Notes:	
Documents Used as Reference During Preparation:	US EPA Region 4, Science and Ecosystem Support Division, March 6, 2013. <i>Groundwater Sampling</i> , SESDPROC-301-R3. US EPA Region 9 Laboratory, September 2004. <i>Field Sampling Guidance Document #1220 – Groundwater Well Sampling</i> . US EPA OSWER, <i>Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers</i> , EPA 542-S-02-001, May 2002. NJDEP, August 2005. <i>Field Sampling Procedures Manual</i> . USGS, 2006. <i>National Field Manual for the Collection of Water-Quality Data</i> , Chapter 4.

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ATTACHMENTS

Attachment A: Groundwater Purging and Sampling Equipment

Attachment B: Groundwater Purging Sheet

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for the collection of groundwater samples for laboratory analysis following well purging (other than low-flow sampling techniques which are described in **FGD 6.20**, Groundwater Sampling – Low Flow). Groundwater sampling is conducted to characterize the quality of groundwater as part of environmental investigations (e.g., investigation of potential contaminant sources, delineation of contamination, evaluation of migration pathways), remedial actions and/or monitoring programs. To ensure that groundwater samples collected are representative of the groundwater zone being investigated, samples should only be collected after appropriate purging and field parameter monitoring has been conducted. Groundwater purging and sample collection using bladder pumps is preferable (refer to **Attachment A**), as the use of bailers or vacuum systems can result in excessive disturbance to the water column in the well and potentially affect sample quality. Nonetheless, in certain cases (e.g., for collection of groundwater samples for VOC analysis when a peristaltic pump is used for groundwater sampling, when the water column is small, or when the saturated zone is very deep), groundwater purging and sampling could require the use of a bailer.

Although this FGD provides guidelines for collection of groundwater samples associated with typical sampling activities, it should be understood that for certain projects more specific sampling procedures, including site- or state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable. Specific requirements for these types of projects and activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and/or Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, Sampling Plan and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans, but rather a general reference for developing project-specific requirements.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP followed by procedures recommended in this FGD. The Ramboll Environ PIC and PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information are maintained in the project file for the duration of the project. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

A general checklist of equipment that may be required for typical groundwater well purging and sampling is provided below. Additional equipment may be specified in the project-specific HASP and/or Field Sampling Plan. This checklist includes an overall summary of general equipment typically required for groundwater sampling but should not be considered exhaustive. More specialized sampling equipment may be required depending on project-

specific preferences. Ramboll Environ oversight personnel should understand the equipment and materials that are required for groundwater sampling.

1. General Groundwater Sampling Equipment Checklist

- Pump and associated equipment (e.g., generator, batteries, control box, compressor, tubing, CO2 or nitrogen compressed gas cylinders);
- Bailers (if needed) constructed of material (e.g., fluorocarbon resin, Teflon®, stainless steel, HDPE, or PVC) which minimizes potential chemical alteration of groundwater or may cause a loss of analytes via sorption;
- Water quality meter with flow-through cell that, at a minimum, measures temperature, pH, dissolved oxygen (DO), oxygen reduction potential (ORP), and specific electric conductance, and associated manuals. Turbidity measurements can be made using a separate turbidity meter;
- Measuring container (e.g., one-gallon plastic water jug, graduated measuring cup or graduated cylinder);
- Plastic sheeting;
- 5-gallon buckets, preferably with graduations for accurate purge volume estimation;
- Dedicated suspension line or tether constructed of material which minimizes interactions or alterations when in contact with groundwater or which may cause loss of analytes via sorption (e.g., poly twine, nylon string, stainless-steel, Teflon-coated stainless-steel wire, etc.) - for lowering and raising pump/bailer (pump tubing does not constitute a dedicated suspension line and should not be used for lowering and raising pump/bailer);
- Electronic water level indicator (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements);
- Trash bags - for disposal of gloves, tubing and any other non-hazardous waste generated during sampling (refer to **FGD 15.01**, Waste Handling);
- 55-gallon steel drums, Department of Transportation-rated (for legal waste hauling), or other appropriate waste container – for disposal of any Investigation Derived Wastes (IDW) and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling);
- Labeling materials for IDW containers as outlined in **FGD 15.01** (Waste Handling);
- Personal Protective Equipment (PPE) and field screening equipment in accordance with the site-specific HASP;
- Site information (e.g., maps, contact numbers, previous field logs);
- Well construction specifications and diagrams; and
- Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records).

2. Project or Task Specific Groundwater Sampling Equipment Checklist

- Bucket, water, and Liquinox® (or Alconox) – used for the decontamination of sampling and monitoring equipment (refer to **FGD 14.01**, Sampling Equipment Decontamination);
- Cable ties;
- Well keys;
- Sample containers (appropriate for various analysis to be performed);
- Sample shipment containers and ancillary materials (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody);
- Sample labels and clear tape;
- Chain of custody forms (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody); and
- Field measurement equipment/kits for confirmation of parameters (temperature, dissolved oxygen, Fe 2+, etc.).

3. Additional Suggested Equipment

- Tool set: socket set, socket wrench, screw driver, multi-tool, tubing cutters, “turkey baster” and/or cup for water removal from flush mounted well vaults;
- Spare/replacement parts: gripper plug/well cap, well lid bolts;
- Road and site maps;
- Mobile phone; and
- Camera and extra batteries.

A description of groundwater purging and sampling equipment is provided in **Attachment A**.

3. REFERENCED GUIDANCE DOCUMENTS

The following FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **FGD 1.01**, Field Notes and Records.
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody.
- **FGD 1.03**, Analytical Data Management.
- **FGD 1.05**, Field Quality Control Samples.
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping.
- **FGD 4.04**, Field Screening - Water Quality.
- **FGD 4.06**, Equipment Calibration.
- **FGD 6.04**, Groundwater and Free Product Level Measurements.

- **FGD 6.20**, Groundwater Sampling - Low Flow Purge.
- **FGD 14.01**, Sampling Equipment Decontamination.
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPIs) may need to be referenced based on the specific requirements of the site-specific Work Plan/Field Sampling Plan (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 Planning and Design Considerations

All significant sampling strategy decisions will be approved by the PIC and/or PM before the initiation of associated field activities. The Work Plan/Field Sampling Plan will be designed for the collection of quality data to meet the goals of the study/monitoring program and will include the number of samples, locations, depths, number of sampling sites, analyses and analyte detection limits to be performed on each sample as well as quality control/quality assurance samples. The Work Plan/Field Sampling Plan will generally provide for some discretion in the field depending on conditions encountered; however, any significant departure from prescribed sampling activities should be approved by the PIC and/or PM.

When planning a groundwater sampling event for a well that will be purged, the following should be considered:

- *Purge Method.* Purging is the process of removing potentially stagnant water from a well immediately prior to sampling and allowing water from the surrounding formation that is representative of actual aquifer conditions to enter the well. This process involves the removal of several well/casing volumes of water by use of pumps or bailers. The specific purging/sampling approach to be used depends on site-specific conditions, project objectives, and/or regulatory requirements.
- *Bailer/Pump Choice.* The equipment needed for groundwater purging/sample collection can vary greatly depending on specific site conditions and project objectives. As such, bailer/pump selection should take into consideration a variety of well characteristics, including but not limited to: depth of well; diameter of well; depth to water; analytes of interest; expected recharge rate of well; and sampling objectives. For example, a peristaltic pump is not recommended for collection of groundwater samples for VOC analysis as it is a negative pressure pump. A detailed list of bailer/pump options and their advantages/limitations is provided on **Table 1** in **Attachment A**.
- *Sampling Interval.* Before conducting groundwater sampling, an appropriate well sample depth interval must be determined. Boring and well construction logs, along with historical sample collection depth and groundwater elevation data (if available), should be reviewed to determine the screen interval and relative water column status of each targeted well. For example, if the screen interval is fully submerged, the midpoint of the well screen would be considered the most representative sample depth. If the water elevation consistently falls below the top of the well screen, the midpoint between the

groundwater surface elevation and the bottom of the well screen should generally be targeted as the representative sample depth. This can also be calculated during the sampling event based on current groundwater elevations.

- *Other Considerations.* Additional requirements (e.g., targeted aquifer zones) may be defined in project-specific Work Plan, sampling plan and/or FGDs and, as such, may determine alternative sample depths from those provided by the guidelines set above.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02**, Site Preparation, Inspection and Housekeeping. To the extent that non-dedicated sampling equipment is to be used (e.g., submersible pumps, water level indicator, or bailer), such sampling equipment should be decontaminated between wells as described in **FGD 14.01** (Sampling Equipment Decontamination), the project-specific Work Plan/Field Sampling Plan and/or Quality Assurance Project Plan (QAPP) to minimize potential cross-contamination of samples among wells. Used dedicated sampling equipment is considered IDW and should be managed in accordance with **FGD 15.01**, Waste Handling following the sampling event.

At a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the site-specific HASP. Clean, chemical protective, dedicated gloves must always be worn when handling and using sample equipment;
- Coordinate and obtain permission for site access;
- Review project-specific Work Plan/ Field Sampling Plan/QAPP, where applicable;
- Review and discuss with the PIC and/or PM the proposed Work Plan/Field Sampling Plan or sampling strategy. Note that site geology and expected contaminants should be reviewed to determine if unpreserved bottles may be needed (e.g., anticipated effervescence due to high levels of dissolved calcium carbonate in groundwater reacting with acid preservatives);
- When contractors are used to perform the sampling or in states where sampling can only be performed by personnel licensed or certified by the State, discuss the Work Plan/Field Sampling Plan with the contractor;
- Review the standard instruction manual provided by the manufacturer of the specific equipment being used for groundwater sampling;
- Obtain the glassware/bottles in advance and check against sampling numbers to confirm that the appropriate containers and quantities are provided prior to mobilizing; and
- Ensure that all equipment/materials required to complete the work have been packed prior to travel.

In addition, prior to initiating the well sampling activities, Ramboll Environ oversight personnel should field-verify the well identity and construction against available documentation (Site Plans, Well Construction Logs, etc.). It is imperative that a positive well identification be made prior to sampling using measured total well depth, well labels, site

plans, and well construction records to ensure that the correct well is sampled (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements). If total well depth is measured, proper decontamination of the water level indicator tape must be conducted before deploying the water level indicator into another well (refer to **FGD 14.01**, Sampling Equipment Decontamination).

Further, prior to the commencement of the field effort, Ramboll Environ oversight personnel should inspect, test, and/or calibrate equipment that may be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration). Pre-measuring the pump suspension line and/or discharge tubing to the individualized targeted well depths and/or pre-labeling sample containers in advance of field efforts may increase productivity (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody). However, special care should be taken to ensure that the correct pre-labeled containers are used to collect each groundwater sample.

Unless otherwise required by the project-specific Work Plan/Field Sampling Plan, sampling should begin with monitoring wells with the lowest expected groundwater contamination and proceed systematically to monitoring wells with the highest expected groundwater contamination.

4.3 General Groundwater Purging and Sampling Guidelines

Groundwater samples are generally collected from monitoring wells, piezometers, or boreholes using pumps or bailers. A description of groundwater sampling equipment is provided in **Attachment A**. The following provides a general recommended list of practices for groundwater sampling activities:

- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.
- All wells to be sampled should be inspected for damage, access constraints, and/or vehicle traffic proximate to the well location.
- Although equipment should be decontaminated between uses, to further limit potential cross-contamination between wells, perform measurements from least to most contaminated locations.
- Lay polyethylene sheeting around the well for placement of monitoring and sampling equipment and contain any accidental groundwater spilled during purging or sampling.
- Remove the well cover or equivalent protective casing cover (refer to **FGD 6.04**, Groundwater and Free Product Measurements) and measure gas concentrations in accordance with the applicable manufacturer instructions and field screening FGDs (e.g., **FGD 4.01** - Field Screening - Combustible Gas, **FGD 4.02** - Field Screening - Volatile Gas, **FGD 4.03** - Field Screening - Landfill Gas). Record field screening readings in field book. The necessity and methodology to conduct field screening should be detailed in the site-specific HASP and sampling plan.
- As detailed in **FGD 6.04**, Groundwater and Free Product Measurements, record the condition of the well, noting any damage to the well, plug, and/or protective casing, and record any evidence of pressure (positive or negative).

- Complete all depth-to-water or free product measurements prior to any planned groundwater and/or product withdrawals, sampling or disturbance of groundwater activities unless otherwise specified in the Work Plan/Field Sampling Plan (refer to **FGD 6.04**, Groundwater and Free Product Measurements).
- If using a bailer for groundwater sampling:
 - Calculate the well volume in gallons (V_w) using the following equation:

$$V_w = 7.48(\pi \frac{d_w^2}{4} h_w)$$

Where:

d_w is the well diameter (feet)

h_w is the height of water in the well (feet)

In general, the volume of a 2-inch diameter well is 0.163 gallons per foot and the volume of a 4-inch diameter well is 0.653 gal/ft.

- To prepare the bailer suspension line, measure the correct amount needed such that the bailer intake is positioned at the target depth in the well. The measurements should account for the additional length needed at ground surface to appropriately anchor the suspension line. If the suspension line and tubing were premeasured in advance of field efforts, make any necessary alterations based on field observations (e.g., unanticipated groundwater elevations).
 - Secure the tether to the eye on the upper side of the bailer.
 - Lower the bailer slowly into the well to minimize sample agitation associated with degassing, aeration, and turbidity and to the extent possible, avoid hitting the sides or bottom of the well. The bailer will fill with water when lowered into the well and should only be submerged to the depth necessary for bailer intake to be positioned at target sampling depth.
 - When the bailer is filled, slowly raise the bailer, minimizing contact with the sides of the well to the extent possible. The bailer will self-seal when raised back out of the well.
 - When transferring the sample from a bailer to a container, use a bottom emptying device to allow the water to slowly drain from the bailer. The sample should be allowed to run down the sides of the container to avoid excessive agitation of the sample.
- If using a pump for groundwater sampling
 - In the case that a dedicated pump is not used for groundwater sampling:
 - Prepare the pump suspension line and discharge tubing, measure the correct amount needed such that the pump intake or bottom of discharge tubing rests at the target depth in the well. The measurements should account for the additional length needed at ground surface to appropriately anchor the suspension line and connect discharge tubing to water quality monitoring equipment. If the suspension line and tubing were premeasured or ordered to

premeasured lengths in advance of field efforts, make any necessary alterations based on field observations (e.g., unanticipated groundwater elevations). Assemble the pump, suspension line, and tubing. Inspect all sampling equipment prior to deployment, making certain that all connections are secure and equipment is in working condition. Troubleshooting is generally easier if the pump and tubing assembly are inspected prior to deployment. If not using dedicated sampling equipment, ensure all materials are properly decontaminated prior to conducting sampling (refer to **FGD 14.01**, Sampling Equipment Decontamination).

- Slowly lower the assembly into the well using the suspension line to achieve minimal water column disturbance until the location of the tubing or pump intake reaches the predetermined depth within the well. Anchor the assembly in place by securing the suspension line at the surface and/or clamping the tubing in place via spring clamp.
- Measure and record the depth to water following insertion of the pump and tubing assembly.
- Once the pump (whether a dedicated pump or not) is ready for use, allow the water level to return to its static level prior to initiating purging.
- Calculate the well volume in gallons (V_w) using the following equation:

$$V_w = 7.48 \left(\pi \frac{d_w^2}{4} h_w \right)$$

Where:

d_w is the well diameter (feet)

h_w is the height of water in the well (feet)

In general, the volume of a 2-inch diameter well is 0.16 gallons per foot and the volume of a 4-inch diameter well is 0.65 gal/ft.

- Assemble the water quality meter sensor probe and flow through cell in accordance with the manufacturer's specifications.
- Carefully connect the pump's discharge tubing to the influent of the flow-through cell of the water quality meter and connect a section of clean tubing to the effluent of the cell. The influent and effluent connections to the flow-through cell are unique and based on each meter's design; orientation of flow matters and influent/effluent ports should be marked on the flow cell.
- When water fills the cell, check for leaks and make the necessary adjustments. If water is particularly turbid at the beginning of the purge it can be helpful to disassemble the water quality meter sensor probe and flow through cell and rinse them with DI water to remove any residual particulates once the turbidity decreases.
- For the standard purging method, evacuate at least three well volumes and until the water quality parameters specified (e.g., pH, DO, ORP, temperature, specific conductance, and turbidity) in the project-specific Work Plan, Field Sampling Plan, QAPP and/or FGDs developed based on state-specific or regulatory program-specific guidelines,

requirements or procedures have stabilized. In the absence of specific stabilization guidance, the following parameters or any combination thereof established by USEPA should be monitored to determine when well stability has been achieved.

pH	± 0.1 unit
Specific Conductance	± 3%
Temperature	[See Note 1]
Dissolved Oxygen	± 0.3 mg/L
Turbidity	± 10% (when turbidity is greater than 10 NTUs)
ORP/Eh	± 10 millivolts

Note 1: Temperature generally tends to stabilize rapidly and is considered a relatively insensitive indicator of stability. Nonetheless, temperature stability can be defined as ± 3%.

- Collect measurements approximately once every 5 minutes or a period defined by the time it takes for purge water to adequately replace the water quality meter's flow-through cell.
 - If the purge rate decreases, the time required for purge water replacement will increase.
 - It is generally accepted that when the measurements of the monitored parameters fall within the stated range for three consecutive readings, chemical parameter stabilization has been achieved.
 - If the anticipated "third" reading of any individual parameter does not fall within the stated range, then the process to achieve three consecutive readings for that parameter must be restarted.
- In some situations, even with slow purge rates, a well may be pumped or bailed dry. In these situations, under certain regulatory programs this constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). In such cases, it is not necessary that the well be evacuated three times or that chemical parameters stabilize before it is sampled. Nonetheless, the pH, specific conductance, temperature, and turbidity should be measured and recorded during collection of the sample from the recovered volume. These data would serve as the field measurements of record for the sampling event.
- If flow rates are to be measured when using pump and a flowmeter is not available, the discharge from the effluent of the flow-through cell could be collected in a container of known volume (i.e. one gallon plastic water jug or a graduated cylinder) and the time to fill the container noted. When flow rate measurements are complete, redirect the discharge as detailed above and dispose the contents of the graduated cylinder into 5-gallon buckets or directly into 55-gallon drums.
- Containerize purge water in accordance with **FGD 15.01**, Waste Handling. The discharge tubing should be secured such that all purge water is collected in 5-gallon buckets or directly into labeled Department of Transportation (DOT)-rated 55-gallon drums, depending on site conditions and purge volumes.

- Upon purge completion, reduce the pumping rate and disconnect the water quality meter from the discharge tubing.
- Wells should be sampled as soon as possible after purging. Collect the groundwater sample from the primary discharge tubing connected directly to the pump with no remaining purging appurtenances (e.g., fittings, flow diverters, flow-through cell). Laboratory-supplied sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside wall of the container. Record the sample time on the sample bottle-ware and in the field notebook (refer to **FGD 1.01**, Field Records and Notes). Regarding sample collection note that:
 - The ideal order of sampling (from first to last) should be VOCs, SVOCs, TPH, pesticides/herbicides, PCBs, metals, general chemistry analytes (e.g., TDS, TSS, nitrate, etc.), and filtered metals, although this order may be modified based on pump characteristics and/or site-specific or well-specific considerations (see below).
 - When collecting VOC samples, the volatile organic analysis (VOA) vials should be filled slowly to minimize agitation. Upon filling, a meniscus should be present at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus.
 - Samples collected for dissolved gases or VOC analyses must ensure that the tubing is completely full of groundwater to prevent aeration. If groundwater contains air bubbles throughout the entire purge, consult pump manual to remedy pumping issues and discuss with PIC and/or PM.
 - Filtered (dissolved) samples should be collected after all other samples are collected using the pump.
 - If using a peristaltic pump, collect a groundwater sample for VOC analysis using a bailer as described above after groundwater sampling for all other parameters has been completed.
- Effervescence (e.g., high levels of dissolved calcium carbonate in groundwater reacting with acid preservatives) observed during filling of the laboratory supplied containers should be recorded in the field notebook. Discuss with the PIC and/or PM whether samples should be collected in unpreserved containers and include a notation in the chain-of-custody.
- If a field-filtered (dissolved) sample is to be collected, an inline filter is fitted at the end of the discharge tubing and the sample is collected after the filter. The inline filter must first be flushed in accordance with manufacturer's recommendations. If there are no recommendations for flushing, a minimum of 0.5 to 1.0 liter of groundwater from the monitoring well must pass through the filter prior to sampling.
 - Groundwater filter cartridges are dedicated sampling equipment and are thus considered IDW and should be managed accordingly. A new cartridge must be used at each sampling location.

- If the filter becomes clogged or groundwater flow is too slow, remove and replace with a new filter cartridge.
- Withdraw the sampling equipment from the well, replace the well cap, and re-secure the well. For non-dedicated equipment that has come in contact with groundwater, following sampling completion, remove the equipment from the monitoring well and decontaminate in accordance with **FGD 14.01**, Sampling Equipment Decontamination. For dedicated equipment that has come in contact with groundwater, disconnect from the non-dedicated equipment and manage as IDW.
- Record in the field book or appropriate field forms any abnormal conditions within the well (e.g., evidence of blockage, root growth into the well casing, separated casing sections, etc.). Inform the PIC or PM so necessary maintenance, redevelopment or repairs are conducted before the next planned water sampling event.

4.4 Sample Containers

As outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody), equipment and sample containers that will come into contact with collected groundwater should be constructed of inert materials that will not affect the concentration of constituents in the water sample (i.e., glass, stainless steel or Teflon). The level of care that needs to be taken with the materials used will depend on the level and types of constituents associated with the groundwater and the quality assurance needs and study goals. This should be outlined in the project-specific Work Plan/Field Sampling Plan or QAPP.

The laboratory will provide appropriate sample containers, prefilled with preservatives appropriate for each predetermined sample analysis. The sample volume is a function of the analytical requirements and will be specified in the Work Plan/Field Sampling Plan or QAPP. Sample VOCs first to prevent loss of volatiles due to disturbance of the water and be sure to fill VOA vials to zero headspace, as described above in Section 4.3.

4.5 Sample Transport and Storage

Samples shall be handled, transported and stored to maintain structural and chemical qualities of groundwater samples. Sampling bottles shall be handled as outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody). All samples should be kept in an ice-filled transport container during fieldwork and covered to limit light penetration. If the cooler size allows for space between sample bottles, bubble wrap should be used to fill annular space and prevent breakage during travel. Glass bottleware should be wrapped individually in bubble wrap for further protection. If provided, pack glass sample vials in laboratory issue foam packing cartons. If shipping groundwater samples with preservatives, confirm the sample shipments, packaging, and labeling are performed in accordance with applicable DOT-requirements.

4.6 QA/QC

Quality Assurance/Quality Control (QA/QC) procedures described in the project-specific Work Plan/ Field Sampling Plan and/or QAPP must be followed throughout the purging, sample collection, processing, handling, and analysis process. In their absence, the QA/QC guidelines of **FGD 1.05** (Field Quality Control Samples) should be reviewed.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while groundwater sampling. Additionally, implementation of the work may face some difficulties.

- Some states require that only personnel licensed or certified in the State where the work is being performed perform the sampling. Therefore, State regulations and guidance governing groundwater should be consulted prior to conducting the work. In addition, local Ramboll Environ staff should be contacted for any other regional or local requirements.
- It is important to always remain alert and aware of your surroundings. Groundwater sampling could involve the use of generators and associated equipment, and is subject to hazards posed by equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and/or other physical, mechanical, and chemical hazards.
- Prior to mobilization, determine the location of wells and evaluate the need for security, barricading, and/or traffic control (e.g., when wells are located on the right of way).
- At sites with certain contaminants and/or subsurface conditions, potentially toxic and/or explosive gases may accumulate at and around the well as it is being sampled. Stay upwind of the well and ensure that air monitoring is conducted and personal protective equipment is used in accordance in the site-specific HASP.
- Keep any sampler, tether, or suspension lines untangled. Use a plastic winder or spool winder to retrieve the sampler/pump to keep the line from tangling.
- When working out of sight of the general public or when site employees are in potentially hazardous areas (e.g., wooded habitats), all field staff should utilize the “buddy system” and should ensure that the project-specific HASP includes safety measures and procedures.
- Care should be taken when opening well protective covers for the presence of spiders and insects such as wasps or hornets.
- For some wells, well keys may not work with rusted/outdated well locks. Bolt cutters may be used to remove the lock, which should be replaced upon completion of well sampling. Do not use petroleum based solvent sprays to free seized locks as it may impact water quality in the well.
- Wells with a water-tight cap may experience a buildup of pressure. Keep your face and body away from the top of the well when loosening or removing the cap.
- Certain sampling equipment configurations have tubing without a pump at the sample intake depth (e.g., peristaltic pump or a bladder pump with drop-tubing). Without a weight on the end of the tubing, the tubing can easily get caught on the joints between sections of the PVC well casing or on the open borehole wall due to the natural curl in the tubing from being stored in rolls while lowering the tubing into the well. To remedy this, fasten a stainless steel rod as a splint against the bottom few feet of tubing or simply secure a stainless steel weight to the bottom of the tubing to straighten the curl in the tubing and keep it from getting stuck. Some sampling equipment will include a

weight for this purpose. Proper decontamination of the stainless steel rod or weight is required prior to deployment into a subsequent well (refer to **FGD 14.01**, Sampling Equipment Decontamination).

- It can be helpful to utilize Microsoft Excel to simplify purge stabilization calculations in the field and eliminate the need to transcribe purge notes into electronic form for reporting purposes. An Excel-based purge sheet can also reduce potential mistakes; however, a thorough understanding of the stabilization criteria calculations is necessary prior to use in the field. An example of a low-flow sampling purge sheet with auto-calculations is presented on **Figure 1**.

21	Well Evacuation Data										
22											
23	Stabilization Criteria			± 0.1 SU	± 3 %	± 10 %	± 3 %	± 10 mV	± 10 %	0.3 ft	
24	Time	Vol.	Rate	pH	Cond.	Turb.	Temp.	ORP	DO	DTW	Appearance or
25		L	mL/min	Std	ms/cm	NTU	C	mV	mg/L	ft	Comments
26											
27	9:54	—	350	9.86	0.240	78.9	10.18	16	11.89	23.50	Slightly silty
28	9:59	0.0	320	7.89	0.360	70.4	11.17	77	9.98	23.50	Slightly silty
29	10:04	1.6	250	7.71	0.364	58.2	11.14	93	9.84	23.30	Slightly silty
30	10:09	2.8	250	7.68	0.361	48.6	11.04	100	9.64	23.30	Clear
31	10:14	4.1	250	7.68	0.360	30.3	10.96	107	9.59	23.30	Clear
32	10:19	5.3	250	7.68	0.360	16.0	11.11	107	9.50	23.30	Clear
33	10:24	6.6	250	7.68	0.362	9.3	11.09	111	9.87	23.30	Clear
34	10:29	7.8	250	7.69	0.363	5.7	11.26	114	9.49	23.30	Clear
35	10:34	9.1	250	7.64	0.362	5.8	11.21	115	9.50	23.30	Clear
36	10:39	10.4	250	7.65	0.362	5.8	11.20	118	9.52	23.30	Clear
37	10:44	11.6	100	7.66	0.363	5.5	11.32	118	8.82	23.30	Clear

Figure 1: Groundwater Purge Sheet

As each parameter stabilizes for three readings within its specified criteria, cells activate green. Purge rate and depth to water cells help guide adjustments needed to comply with low flow guidance. To see a report-ready completed sheet, see **Attachment B**.

- Pumping issues, particularly for deep wells using low-flow or intermittent-flow pumps, can be difficult to troubleshoot. A small cup of deionized (DI) water can be used to test for flow. Place the end of the discharge tubing into the DI water cup during pumping to see if there is a discharge (i.e., bubbles occur). As purge water fills the tubing at depth, air is displaced and forced out the top, causing bubbles in the water. If bubbles are observed, the pump is operating and there is flow.
- Bladder pumps have several O-rings and check balls that are necessary for its operation. If bubbles are observed in the DI water during compressor discharge, but water is suctioned back into the tubing during the refill cycle, the pump check ball is not working properly or may be missing. Air bubbles in the discharge water that do not go away after purging for a few minutes are usually indicative of a failed O-ring.
- A small cup of DI water can be used to monitor the purge rate of intermittent-flowing bladder pumps before having water at the surface by observing the duration and/or speed of bubbles. Monitoring the duration and speed of bubbles at the beginning of the

purge will allow the operator to make adjustments and fine-tune the air controls (refill, discharge and pressure) to bring water to the surface.

- Stabilization of parameters when pumping at low flow rates can be difficult. Several adjustments can help make stabilization easier and enhance the rate of stabilization:
 - Minimizing the length of extra tubing at ground surface can help minimize the effect of atmospheric temperatures on purge water.
 - Insulating the tubing with tin foil and/or shading from direct sunlight can help minimize the effect of atmospheric temperatures on purge water.
 - Increasing the flow rate to the maximum allowable rate (based on drawdown and regulatory requirements) will help replace water in the flow-through cell more frequently, thus reducing the severity of parameter fluctuations.
- When purging with intermittently-flowing pumps (i.e., bladder pumps), collection of readings should occur during the same portion of the flow cycle (ideally at the end of a discharge cycle, so measurements are based on fresh water entering the flow-through cell) to minimize parameter fluctuations between cycles.
- For wells with slow recovery, attempts should be made to avoid purging them dry as it may affect the quality of the sample. For example, as water enters a well that has been purged dry, it may cascade down the sand pack and/or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column. A possible remedy to purging the well dry is to reduce the purge rate.
- If possible, sampling of wells which have a slow recovery should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered. These types of wells should, unless it is unavoidable, not be purged at the end of one day and sampled the following day.
- Sampling equipment (e.g., air compressors) are temperature sensitive and sampling in extremely cold temperatures can complicate even trivial tasks. When sampling in these conditions, keeping sampling equipment and discharge tubing from freezing is critical. Insulating the compressor from freezing temperatures and keeping it warm between use (within a vehicle, field trailer, etc.) will help keep it functioning properly. Any interruption of flow could cause purge water in the discharge tubing to freeze; insulating the tubing and maintaining higher flow rates (within regulatory guidelines) will help keep purge water from freezing.
- Adequate preparation prior to sampling each well will save time in the long run. Make sure the generator/air compressor has fuel or that spare batteries/air canisters are available in the event that stabilization takes longer than anticipated. Stopping mid-purge to refuel or acquire additional air canisters will disrupt stabilization, increasing the time required to sample a well.
- Each sampling effort should minimize exposure to ambient factors (e.g., atmospheric air, wind-blown dust, vehicular or generator exhaust). Ensure equipment and vehicles release exhaust downwind from the sampling location, especially if sampling for VOCs.
- While purging, the time between water quality measurements can be used to organize bottle-ware and confirm well-specific information (e.g., sample analyses, bottles appropriately labeled, duplicate collection, field filtering).

- If the Work Plan/Field Sampling Plan involves analyses requiring field preservation, be sure to avoid direct contact with laboratory-provided preservative chemicals.

6. RECORDKEEPING

Document all sampling locations in accordance with **FGD 1.04** (Documenting Sampling Locations) and record all information related to groundwater sampling in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management).

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ATTACHMENT A
GROUNDWATER PURGING AND
SAMPLING EQUIPMENT

Several styles of well evacuation equipment exist for the collection of groundwater samples. Equipment choice will depend on a variety of factors including but not limited to cost, well specifications, and sampling parameters. The following are brief descriptions of the more commonly used groundwater purging and/or sampling equipment.

Bailer

The bailer is one of the oldest and simplest methods of sampling and consists of a rigid cylindrical length of polyethylene, PTFE or stainless steel with a check valve or other sealing mechanism at one or both ends. It is available in numerous dimensions to accommodate a wide variety of well diameters. Double check valve bottom-draining bailers are recommended as they allow for lessened sample disturbance during transfer to the container.



Figure 1 Disposable Bailers

Source: <http://www.geotechenv.com/>



Peristaltic Pump

A suction lift pump (negative air pressure) consisting of a rotor and ball bearing rollers. Liquid moves totally within the tubing dedicated for sampling so no part of the pump contacts the liquid. Medical-grade silastic tubing is recommended for the section in contact with the rollers. Geopump and Solinst are popular manufacturers of this pump type.

Figure 2 Peristaltic Pump

Source: <http://www.geotechenv.com/>

Submersible Pump

Consists of an electric motor in a stainless steel and Teflon housing that drives two or more impellers at high rates of rotation, bringing water to the surface at a continuous rate. It can be operated with a generator or a 12V battery. Grundfos is a popular manufacturer of this pump type.



Figure 3 Submersible Pump

Source: <http://www.geotechenv.com/>



Gear Pump

A small and lightweight pump that is similar to the submersible pump. It functions through the use of two or more internal gears that create positive displacement. As the gears rotate they separate on the intake side of the pump, creating a void and suction which is filled by fluid. The fluid is carried by the gears to the discharge side of the pump, where the meshing of the gears displaces the fluid. Fultz is a popular manufacturer of these pumps.

Figure 4 Gear Pump

Source: <http://www.nj.gov>

Inertial Pump

Working on the principal of inertia, this pump consists of tubing with a check valve at one end of it. The pump operates simply by lifting the pump up and dropping it back down. The check valve allows water to enter when the pump is dropped, but not escape when lifting the pump back up. Continued up and down movement advances water upward due to inertia. Waterra is a common manufacturer of this type of pump

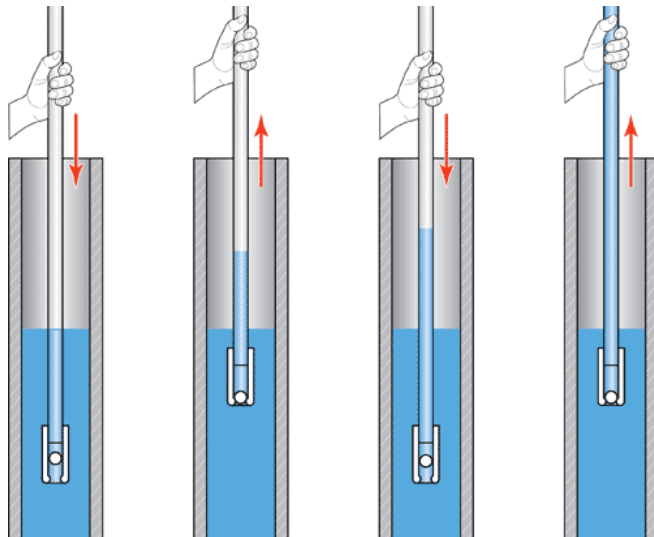


Figure 7 Inertial Pump

Source: <http://www.fao.org>

A comparison of the various pump options and their advantages/limitations is provided on **Table 1**.

Table 1 - Groundwater Sampling Pumps				
Pump Type	Advantages	Disadvantages	Sampling Capability	Approximate Lift Capacity
Bailers	- Simple - Low cost - No power source needed - Portable and readily available	- Disturbance of sample generally unavoidable - Cannot be relied upon for air sensitive parameters including DO, pH, CO and Fe - VOC may be biased low (due to aeration)	VOC results may be biased low due to aeration of the sample and thus this is not the preferred method for VOC sampling.	Not Applicable
Peristaltic Pump	- Speed of operation is variably controlled - No decontamination of the pump necessary - Easy to operate	- Limited to a depth of about 25 ft - Not reliable for air sensitive parameters including DO, pH, CO₂ or Fe - Not reliable for VOCs and SVOCs - Needs external power source - Some devices require priming - Some devices difficult to sample through due to surges in flow	Restricted from sampling for VOCs and SVOCs due to the negative pressure imparted upon the sample.	Up to 25 feet
Bladder Pump	- Acceptable for sampling for all parameters - Simple design and operation - Minimal disturbance of sample	- Large gas volumes may be needed - Only pumps with disposable bladders may be field cleaned for portable use when approved decontamination methods are employed - Depth	Acceptable for sampling for all parameters.	Up to 500 feet

Table 1 - Groundwater Sampling Pumps				
Pump Type	Advantages	Disadvantages	Sampling Capability	Approximate Lift Capacity
Submersible Centrifugal Pump	- Versatile and light weight - Variable speed control for fine tuning of flow rate - Acceptable for low-flow purging and sampling - Able to be thoroughly decontaminated due to ability of complete disassembly	- Sample temperature may be biased high during low-flow sampling due to high rotation rate of impellers - Motor stall possible at low pumping rates - Requires external power source - Impellers easily damaged by silty/sandy water - Difficult to clean and maintain in the field	May not be acceptable for sampling for trace contaminants, but useful for all other parameters.	Up to 525 feet
Gear Pump	- Good variable speed control especially at low rates - Acceptable for low flow purging and sampling - Light weight	- Difficult to decontaminate when in the field - Turbid purge water wears on the gears - Cannot properly handle suspended solids - Gears may be damaged in silty/sandy water - Gears may bind in water exceeding 85 degrees F	Acceptable for sampling for all parameters.	Up to 150 feet
Inertial Pump	- Inexpensive and easy to operate - Rapid method for sampling shallow wells - Simple decontamination of valves	- Labor intensive and time consuming - Unavoidable agitation caused by pumping resulting in agitation and aeration - Uneven sample delivery. Some models are only useful in 2-inch diameter wells	May not be acceptable for sampling VOCs due to potential loss through agitation.	Between 75 to 300 feet, depending on type of pump and well

ATTACHMENT B
GROUNDWATER PURGING SHEET



Low Flow Groundwater Sampling Field Log

Monitoring Well - **MW-103B**

Client or Site Name
Princeton, NJ

Sampling Information

Date - March 5, 2015

Personnel - W. Lamison & T. Correll

Weather - Mostly Sunny, 28°F

Sampling Device - 2-Inch Bladder Pump

Water Quality Meter - Horiba U-52

Monitoring Equipment - MiniRAE PID 3000

Well Information

Well Vault PID - 0.0 ppm

Well Casing PID - 0.4 ppm

Measured Depth to Bottom - 75.00 ft BTOC

Well Screened Zone - 65 - 75 ft BTOC

Well Diameter - 2.0 inch

Depth to Pump Intake - 70.0 ft BTOC

Static Depth to Water - 23.14 ft BTOC

Post-Pump Depth to Water - 23.10 ft BTOC

Well Volume - 8.46 gallons

Well Evacuation Data

Time	Vol. L	Rate mL/min	pH	Cond. mS/cm	Turb. NTU	Temp. °C	ORP mV	DO mg/L	DTW ft	Appearance or Comments
9:54	—	550	9.86	0.240	78.9	10.18	16	11.89	23.80	Slightly silty
9:59	0.0	320	7.89	0.360	70.4	11.17	77	9.98	23.60	Slightly silty
10:04	1.6	250	7.71	0.364	58.2	11.14	93	9.84	23.30	Slightly silty
10:09	2.8	250	7.68	0.361	48.6	11.04	100	9.64	23.30	Clear
10:14	4.1	250	7.68	0.360	30.3	10.96	107	9.59	23.30	Clear
10:19	5.3	250	7.66	0.360	16.0	11.11	107	9.50	23.30	Clear
10:24	6.8	250	7.68	0.362	9.3	11.09	111	9.87	23.30	Clear
10:29	7.8	250	7.69	0.363	5.7	11.26	114	9.49	23.30	Clear
10:34	9.1	250	7.64	0.362	5.8	11.21	115	9.50	23.30	Clear
10:39	10.4	250	7.65	0.362	5.6	11.20	118	9.52	23.30	Clear
10:44	SAMPLE	100	7.66	0.363	5.5	11.32	118	8.82	23.30	Clear

Notes / Sample Information

Appearance at Start - Slightly silty

Appearance After Purging - Clear

Total Volume Purged - 12.1 liters

Purge Rate - 100-550 mL/min

Analyses - TCL VOCs (8260B);
TCL SVOCs (8270C/8270C + SIM);
Dissolved Organic Carbon (SM5310);
Dissolved Mn, Mg, Ca, Na, K (200.8);

Notes

Sample ID - MW-103B-150305

Sample Time - 10:44

Additional Sample - None

Additional Sample ID - N/A

DTW After Purging - 23.30 ft bTOC

DTW at Time of Sampling - 23.30 ft bTOC

Figure 2:

Completed Groundwater Purge Sheet, finalized for printing.

FIELD GUIDANCE DOCUMENT NO. 6.04
GROUNDWATER AND FREE PRODUCT
LEVEL MEASUREMENTS

FIELD GUIDANCE DOCUMENT NO. 6.04

GROUNDWATER AND FREE PRODUCT LEVEL MEASUREMENTS

Prepared By:	Doug Burge Josh Myers
Peer Reviewed By:	Nick Zurweller Jason Schwankert Justine Petras Christopher Ritchie John Noble Luke Chmielecki Carol Serlin Jose Sananes Nestor Soler
Approved By:	J. Mark Nielsen
Applicable To:	All North American offices
Effective Date:	February 21, 2014
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Revision Notes:	1. Revised company name and format.
Documents Used as Reference During Preparation:	

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1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for groundwater level measurements (depth to water) and free product level measurements (depth of free product) in groundwater monitoring wells or piezometers. These guidelines may also be applicable for measuring the depth to water or free product in other types of wells (potable and non-potable) or boreholes as applicable.

Groundwater level measurements are collected to determine the depth to groundwater within a well relative to ground surface, top of the well casing, and/or an established elevation datum. Similarly, free product measurements are collected to determine the depth to non-aqueous phase liquid (NAPL) accumulated within a well relative to an established elevation datum. The accumulated thickness of NAPL within a well can be determined if the bottom of the free product can be additionally measured. Properly collected and recorded measurements can be utilized for generation of potentiometric surface maps to establish groundwater flow direction, define horizontal and vertical hydraulic gradients, evaluate variations in groundwater elevations over time, evaluate NAPL mobility or recovery, and other project specific tasks.

Although this FGD provides guidelines for groundwater and free product level measurements, it should be understood that for certain projects more specific sampling procedures, including state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable. Specific requirements for these types of projects and activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, sampling plan and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements.

This FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by procedures recommended in this FGD. The Ramboll Environ PIC and PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information are maintained in the project file for the duration of the project. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

Below is a general checklist of equipment that may be required for typical groundwater level measurement efforts. This checklist only suggests general equipment that may be necessary for a project or task and should not be considered exhaustive.

2.1 General Water and Free Product Level Measurement Equipment Checklist

- Electronic water level indicator;
- Electronic oil/water interface probe for wells containing known or suspected NAPL;
- GPS or other locating device;
- Site map showing locations of wells; and
- Well construction records and previous water level measurements.

2.2 Project- or Task-Specific Water and Free Product Level Measurement Equipment Checklist

- Well lock keys;
- Steel tape measure or submersible water level meter for use in measuring total well depth;
- Decontamination supplies /equipment (non-ionic detergent, tub, brushes, etc.);
- Wash bottles/bucket;
- Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during sampling;
- Appropriate waste container – used to dispose of any Investigation Derived Wastes (IDW) and/or decontamination wastes;
- Socket wrench (manhole bolt sizes vary; most commonly require a 9/16" socket);
- Water valve gate box key (for older style flush-mounted wells);
- Pry bar (or other equivalent tool to assist in the removal of the flush mounted well cover or handhole);
- Syringe (or other equivalent tool such as a turkey baster to assist in removing standing water in flush mounted wells); and
- Extra batteries for the water level meter (usually 9-volt).

2.3 Miscellaneous Additional Suggested Equipment

- Extra vehicle keys;
- Metal locator (to find buried/obstructed flush mounted wells);
- First aid kit;
- Mobile phone;
- Credit card for gas and emergencies;
- Road and site maps;
- Chemical protective gloves and other personal protective equipment (PPE) as required by the HASP;
- Field notebook and field data sheets;
- Waterproof pens;

- Bolt cutters (to remove rusted padlocks);
- Replacement padlocks; and
- Camera and extra batteries.

3. REFERENCED GUIDANCE DOCUMENTS

The following FGDs are related to this FGD and should be referenced, as needed:

- **FGD 1.01**, Field Notes and Records;
- **FGD 1.03**, Data Management;
- **FGD 1.06**, Field Surveying and Monitoring Well Elevation Surveying;
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping;
- **FGD 4.06**, Equipment Calibration;
- **FGD 6.15**, Well Construction Record; and
- **FGD 14.01**, Sampling Equipment Decontamination.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of the site-specific Work Plans/sampling plan (e.g., field screening FGDs, FGDs for sampling of media, etc.).

4. PROCEDURES

4.1 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02**, Site Preparation, Inspection and Housekeeping. At a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the site-specific HASP;
- Coordinate and obtain permission for site access;
- Review project-specific Work Plan/sampling plan;
- Review project-specific Quality Assurance Project Plan (QAPP), where applicable;
- Review and discuss with PIC and/or PM the proposed activities or Work Plan/sampling plan;
- Review the standard instruction manual provided by the manufacturer of the specific equipment being used for water level monitoring and field screening;
- Inspect the water level meter(s) for any signs of damage and test for proper operation;
- Identify well locations and any specific order in which they are to be collected (refer to Section 4.2 and Section 5.0), and confirm the measurement datum on each well casing;

- Obtain copies of recent or historic (i.e., same season) water or free product level data to be able to anticipate the approximate depth of water or free product minimizing unnecessary wetting of the tape and as a check of the measured levels;
- Obtain copies of well construction records (refer to **FGD 6.15**, Well Construction Record), as these can be used to confirm the well identification if not clearly identifiable; and
- Identify wells that are known or suspected to contain NAPL or other free product. An electronic oil/water interface meter must be used in these wells in lieu of an electronic water level indicator.

All significant field activity decisions will be approved by the PIC and/or PM before the initiation of field activities. The sampling plan should be designed for the collection of quality data that meet the goals of the study/monitoring program. The work plan/sampling plan should generally provide for some discretion in the field depending on encountered conditions; however, any significant departure from prescribed field activities shall be approved by the PIC and/or PM.

Prior to the commencement of the field effort, inspect, test, and/or calibrate equipment that will be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration).

4.2 General Water Level Measurement Guidelines

Water level measurements are generally taken in monitoring wells, piezometers, or boreholes using electronic water level indicators. There are different manufacturers of electronic water level indicators including Solinst, Keck, and Heron. Electronic water level indicators consist of a reel of dual conductor wire embedded within a pre-marked tape, a probe with an insulating gap between the wire attached to the end of the tape, and an indicator on the reel. Generally, tapes are marked every 1/100th of a foot and/or millimeter. When the probe comes into contact with water, the circuit is closed and the indicator signals this contact with an audible buzzer and/or an optical light. The meters typically run on 9-volt batteries located within the reel as a power source. Many water level meters include a sensitivity adjustment on the indicator. The sensitivity adjustment diminishes potential short circuiting of the probe in moist environments such as those encountered in a well.

The following provides a recommended list of practices for water and/or free product level measurement activities:

- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.
- All wells to be gauged should be inspected for damage, access constraints, and/or vehicle traffic proximate to the well location.
- Because groundwater or free product depth can vary due to natural fluctuations in ambient conditions (e.g., barometric pressure), all measurements for a specific sampling event should be collected within as short of a time frame as possible.

- Although equipment should be decontaminated between uses, to further limit potential cross-contamination between wells, perform measurements from least to most contaminated locations.
- All depth to water or free product measurements should be completed prior to any planned groundwater and/or product withdrawals, sampling or disturbance of groundwater unless otherwise specified in the work plan/sampling plan.
- All water or free product level measurements should be made relative to an established reference datum and should be recorded in the field notes. The reference datum is usually marked, notched or etched on the well or casing at the time of installation on the north side of the inner casing. In the absence of a marked, notched or etched reference datum take water level and depth measurements from the north side of the inner casing and mark or etch it for future reference. In the case of a casing notched or etched at a distinct angle, the measurements should be made from the highest point in the casing. Note this procedure in the field book.
- Record in the field book the model name, number, and serial number of the electronic water level meter or interface probe being used.
- Identify the well to be measured and confirm by checking for proper identification markings on the well, comparing to a site map, and if needed historical water and/or product level measurements and well construction records. If the well cannot be positively identified, contact the PIC or PM before proceeding. It may be possible to identify the well by comparison of the total well depth with the well construction records; however, such measurement should be discussed with the PIC or PM before proceeding in cases where the well is to be sampled after water level/free product measurements are collected.
- Decontaminate the water level meter probe, interface probe, and/or tape (if total well depth measurements are being conducted with a tape) prior to each use.
- Remove well cover or equivalent protective casing cover. Inspect the interior of the well box for insects, etc., that could present a biological hazard. If there is water in the well box, remove all water (at least to a level below the top of the inner well casing) prior to removing the well cap or plug. Indicate that water was removed from the well box and identify possible causes (e.g., missing bolts, damaged well cover, etc.).
- Remove the well cap or plug, noting well identification, time of day, and date in field book. Also note any abnormal conditions in the well (e.g., damaged inner casing, limited clearance between the bottom of the well box and the top of the inner well casing, absence of reference datum, etc.) If the top of the well casing has been damaged, the reference datum may no longer be accurate.
- If the wells are outfitted with expansion caps, these should be removed and the wells allowed to equilibrate for an appropriate period of time prior to the collection of water level measurements. This is especially critical for wells screened below the water table or in confined units. There are no set guidelines and appropriate equilibration times can range from minutes to hours depending on well recharge, local geology and topography, and project objectives.
- Record observance of positive or negative pressure in the well upon removal of the well cap. The presence of pressure/vacuum in the well could be qualitatively assessed during

loosening and removal of an expansion cap (resulting in air either being audibly pushed out or drawn in to the well casing) or using a piece of paper or other light object (i.e., easily moved or displaced by light air flow) placed immediately above the inner well casing and observing its movement (i.e., if it adheres to well casing, there is a negative pressure in the well; if it moves from the well casing, there is a positive pressure in the well). If pressure was observed, the water level should be measured multiple times over a 5 to 10 minute period to allow time for equilibration and confirm that the water level has reached static conditions.

- Monitor the headspace of well with a field screening device in accordance with the applicable manufacturer instructions and FGD. Record field screening readings in field book. The necessity and methodology to conduct field screening should be detailed in the site-specific HASP and sampling plan.
- Check that the indicator on the water level probe is working properly by pushing the test button on the reel. Replace batteries in the electronic water level meter or product interface probe if testing or operation of indicates the battery is not providing sufficient power. If the battery is replaced during a field measurement event this must be recorded in a field log book.
- Lower the probe slowly into the well taking care to minimize contact with the well casing. If significant kinks are observed in the tape, attempt to straighten manually and record observations in project field book or log.
- When a strong and steady signal from the indicator signals water or free product has been encountered slowly pull the tape up until the signal ceases.
- Manually lower and raise the probe to exactly locate the water or free product interface.
- At the point where the signal indicates free water surface or free product has been encountered, measure and record the depth of the probe using the marked tape.
- If free product is encountered, continue to manually lower the probe into the well until a strong and steady signal from the indicator signals that water has been encountered. Lower and raise the probe to exactly locate the water or free product interface. Measure and record the depth of the probe using the marked tape.
- Measurements should be referenced to the established reference datum.
- Repeat the measurement to verify accuracy. Measurement should be recorded to the nearest 1/100th of a foot or to the nearest millimeter.
- If total well depth measurements are required, these should be made in reference to the top of casing as well as the ground surface. These measurements should be performed after sampling.
- Withdraw the probe from the well, replace the well cap, and re-secure the well.
- Record in the field book any abnormal conditions within the well (e.g., evidence of blockage, root growth into the well casing, separated casing sections, etc.). Inform the PIC or PM so necessary maintenance, redevelopment or repairs are conducted before the next planned water level measurement event.

To minimize potential cross-contamination across wells, decontaminate the probe and portions of the tape that made contact with water and/or product as described in the

FGD 14.01 (Sampling Equipment Decontamination), project-specific sampling plan and/or QAPP.

4.3 QA/QC

Quality Assurance/Quality Control (QA/QC) procedures described in the project-specific Work Plan/sampling plan and/or QAPP must be followed throughout the water level measurement process.

5. PRECAUTIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. Additionally, implementation of the work may be faced some difficulties. However, certain precautions should be taken to ensure safety while conducting water level measurements.

- Operate electronic water level meters and product interface probes in accordance with the manufacturer's instructions and recommendations.
- The protective casing of flush-mount wells often fills with run-off surface water. If upon removing the well cover, the top of inner well casing is submerged, utilize a syringe, turkey baster, or equivalent tool to remove the excess water before removing the well cap in order to avoid surface water flow into the well.
- Well keys may not work with rusted/outdated well locks; bolt cutters may be used to remove the lock, which should be replaced upon completion of water level measurement. Do not use petroleum based solvent sprays to free seized locks as this may impact water quality in the well.
- Wells with a water-tight cap may experience a buildup of pressure, especially if they are screened below the static water level. Keep your face and body away from the top of the well when loosening or removing the cap.
- Ensure that the water level has reached the static level prior to recording the depth to water. Should the water level be in a state of flux due to pressure buildup, allow ample time for the water level to stabilize to static conditions before recording measurement (refer to Section 4.2).
- Water level probe indicator response may be indicative of potential faults that could be corrected in the field:
 - If the signal from the indicator is intermittent or weak it may be necessary to decrease the sensitivity since it may be short circuiting prior to encountering free water.
 - If there is no signal it may be necessary to increase the sensitivity since some groundwater is less conductive and may not complete the circuit.
 - If the signal is still intermittent, weak, or absent then replace the battery and reattempt the measurement.
- Cascading water may interfere with the measurement of free water; particularly in open boreholes or rock wells.

- Some well casings have sharp edges; care should be taken when lowering or withdrawing the tape to avoid damaging the tape and water level probe.
- Oil or other product floating on the water column may insulate the contacts of the probe resulting in a misleading indication of the depth to free water. A separate oil/water level indicator should be used if there is known or suspected product in a well (refer to Section 4.2).
- It should be noted that some water level indicators will have a 2 to 3 inch weight on the tip of the probe which can displace water in a well before the water indicator detects it. These models also make it difficult to detect small amounts of water in wells, i.e. less than 3 inches. If this is expected to be a potential issue, then request a model with the water indicator located on the tip of the probe.
- Meters should be inspected periodically to ensure accurate readings. Electronic water level meters and interface probes may not function properly if the electric wire is broken, cut, or if insulation is removed exposing the wire (resulting in short circuiting). Repaired meters may have had sections of the tape removed and/or spliced and may not meet data quality objectives. Damaged tapes or tapes suspected of being damaged should be repaired by the manufacturer or replaced.
- If using the water level meter for total depth measurements, confirm that the probe is designed for total immersion and the maximum acceptable depth of immersion.
- Tape lengths can be confirmed using a calibrated steel tape as necessary to adhere to data quality objectives. Discrepancies in tape length must be noted in the field log book and/or field sheet.
- For high conductivity groundwater (brine) decreasing the sensitivity control prevents bridging so a moist probe is not detected as being in water.

6. RECORDKEEPING

Document all water level measurement locations in accordance with **FGD 1.04** (Documenting Sampling Locations) and record all information in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management).

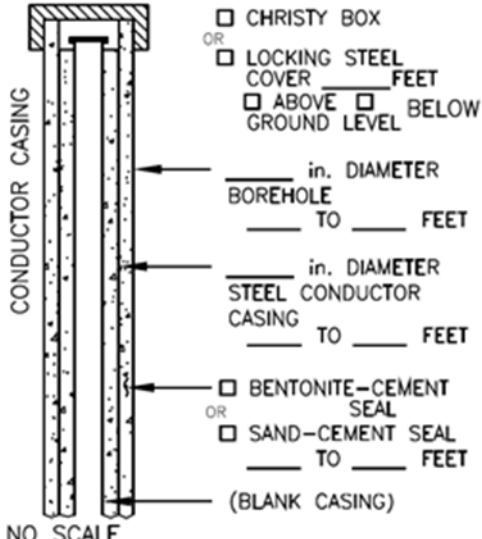
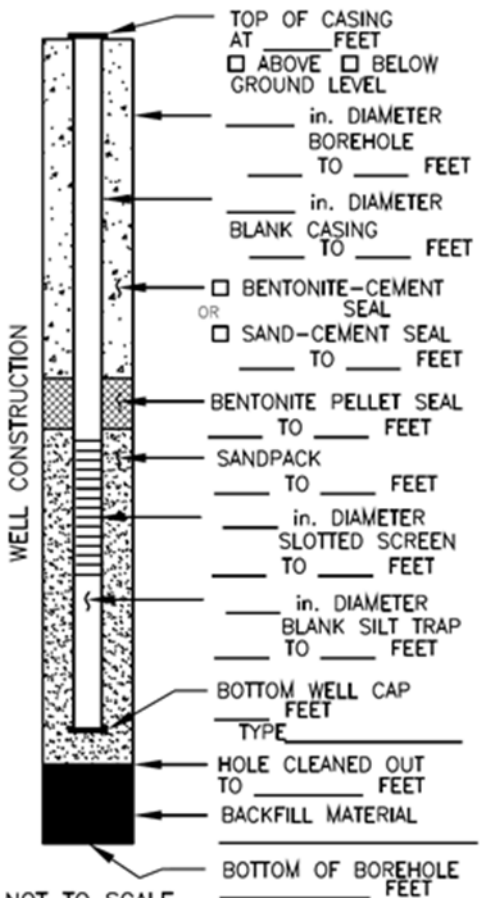
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FIELD GUIDANCE DOCUMENT NO. 6.05

WELL COMPLETION LOG

WELL COMPLETION LOG

PROJECT NAME: _____ FIELD PERSON: _____
 PROJECT NUMBER: _____ PROJECT MANAGER: _____
 PROJECT LOCATION: _____ DATE: _____

 CONDUCTOR CASING ☐ CHRISTY BOX OR ☐ LOCKING STEEL COVER _____ FEET ☐ ABOVE ☐ BELOW GROUND LEVEL _____ in. DIAMETER BOREHOLE _____ TO _____ FEET _____ in. DIAMETER STEEL CONDUCTOR CASING _____ TO _____ FEET ☐ BENTONITE-CEMENT SEAL OR ☐ SAND-CEMENT SEAL _____ TO _____ FEET (BLANK CASING) NO SCALE	Well Number: _____ Well Location: _____ Drilling Company: _____ Driller: _____ Drilling Method: _____ Method of Decontamination: _____ WATER CONTAINMENT: ☐ Ground Surface ☐ Storm Sewer ☐ Drum ☐ Tank Truck ☐ Storage Tank ☐ Other _____ BEFORE DEVELOPMENT: Depth to Water: _____ Feet BGS Date: _____ Time: _____
 WELL CONSTRUCTION TOP OF CASING AT _____ FEET ☐ ABOVE ☐ BELOW GROUND LEVEL _____ in. DIAMETER BOREHOLE _____ TO _____ FEET _____ in. DIAMETER BLANK CASING _____ TO _____ FEET ☐ BENTONITE-CEMENT SEAL OR ☐ SAND-CEMENT SEAL _____ TO _____ FEET BENTONITE PELLET SEAL _____ TO _____ FEET SANDPACK _____ TO _____ FEET _____ in. DIAMETER SLOTTED SCREEN _____ TO _____ FEET _____ in. DIAMETER BLANK SILT TRAP _____ TO _____ FEET BOTTOM WELL CAP _____ FEET TYPE _____ HOLE CLEANED OUT TO _____ FEET BACKFILL MATERIAL BOTTOM OF BOREHOLE _____ FEET NOT TO SCALE	MATERIALS USED: Length of: _____ Inch Conductor Casing: _____ Feet Length of: _____ Inch Slotted Screen: _____ Feet Material: _____ Slot Size: _____ Length of: _____ Inch Blank Casing: _____ Feet Material: _____ Number of: _____ LB Stacks of Sand: _____ Sand Name/Number: _____ Pound of Bentonite Pellets: _____ Pellet Size: _____ Number of: _____ LB Sacks of Cement: _____ Number of: _____ LB Sacks of Powdered Bentonite: _____ Amount of Grout: _____ LBS Amount of Redimix Cement Sand Ordered: _____ YD³ Amount of Redimix Cement Sand Used: _____ YD³ Number of: _____ LB Sacks of Redimix Used: _____ Concrete Pump Used: _____

FIELD SOIL COMPLETION LOG (CONTINUED)

[illegible]

Prepared by (name/signature):		Date:	
Reviewed by (name/signature):		Date:	

FIELD GUIDANCE DOCUMENT NO. 6.07

WELL DEVELOPMENT

FIELD GUIDANCE DOCUMENT NO. 6.07

WELL DEVELOPMENT

Prepared By:	Chris Buzgo Taryn Correll Melanie Charles
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Applicable To:	All North American offices
Effective Date:	September 19, 2014
Revision Date:	June 8, 2016
Revision Notes:	1. Revised company name and format.
Documents Used as Reference During Preparation:	USEPA, 1991. <i>Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells</i> . USEPA Office of Solid Waste, 1992. <i>RCRA Ground Water Monitoring: Draft Technical Guidance</i> . ASTM D5521 / D5521M-13. <i>Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers</i> .

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1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for the development of newly constructed groundwater wells and existing wells being rehabilitated. Well development is a critical step in the construction of a well and is necessary before the well can be used in environmental and hydrogeologic investigations (e.g., groundwater sampling, water level monitoring, withdrawal tests, and injection tests). Well development is also used in the rehabilitation of wells which may have been in disuse over long periods of time and/or have accumulated silt.

Well development refers to the process of clearing the well and formation around the screen of fine-grained materials such as fine sands, silts, and clays, produced during drilling or naturally occurring in the formation. Well development is conducted to create an effective filter pack, allowing for establishment of a good hydraulic connection between the well and the formation so as to allow water to flow more freely to the well.

Typical well development methods include bailing, overpumping, mechanical surging, air-lift surging, and water jetting. The appropriate well development method is selected on the basis of well design, well depths, lithology, and other project requirements. The simplest method of removing fines from water-bearing formations is by a process of overpumping during which water is removed from the well at a higher rate than used for normal service of the well (e.g., purging prior to sampling). Effective development should cause reversals of flow through the well screen so as to agitate the sediment, remove the finer fraction from the well pack, and to rearrange the well pack. This FGD focuses on the most common well development method- mechanical surging with bailing and pumping to force water into and out of the well screen interval by operating a plunger up and down in the casing, similar to a piston in a cylinder.

Although this FGD provides guidelines for well development using mechanical surging with bailing and pumping, other well development methods may be more appropriate for specific site conditions or types of wells (e.g., bedrock wells, multiple nested wells installed within a single borehole, artesian wells, deep water production wells with more than one screened interval, and wells with the potential presence of a Non-Aqueous Phase Liquid (NAPL)) or may be specified by state-specific or regulatory program-specific guidelines, requirements or procedures. In general, well development procedures that include adding water or other fluids to the well and have the potential to impact groundwater quality are not recommended. Sometimes, depending upon well type depth and lithology, a combination of different methods may be needed.

Site-specific and state/regulatory requirements, for well development should be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements defined in a project-specific Work Plan, and/or sampling plan. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather a general reference for developing project specific requirements.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP

shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by procedures recommended in this FGD. The Ramboll Environ PIC and PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information is maintained in the project file for the duration of the project. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

Below is a general checklist of equipment that may be required for well development efforts. This checklist only suggests general equipment that may be necessary for a project or task and should not be considered exhaustive. Where licensed drillers are required to develop wells, the drilling contractor will generally supply the equipment and materials necessary for well development. Additional equipment may be specified in the project-specific HASP.

1. Well Development Equipment Checklist

- Either a surge block and cable, bailer or Waterra® inertial lift development valve and tubing (or similar). A surge block consists of a plunger made of PVC or rubber attached to a rod or pipe and connected to a cable of sufficient length to reach the bottom of the screen. Bailer (generally, can be supplied by the drilling contractor). Bailers are typically non-dedicated, bottom suction bailers constructed of stainless steel and attached to the cable in the same manner as the surge block;
- Appropriate pump and associated polyethylene tubing and power source, such as a marine battery or portable generator;
- Electronic water level indicator or interface probe (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements);
- Turbidimeter, multi-probe water quality meter, and flow-through cell;
- Decontamination equipment (refer to **FGD 14.02**, Equipment Decontamination);
- Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during well development (refer to **FGD 15.01**, Waste Handling);
- 55-gallon steel drums or other appropriate waste containers supplied by drilling contractor unless specialized containers are required) - used to dispose of any Investigation Derived Wastes (IDW) including well development water and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling);
- Equipment (i.e., disposable bailer, cooler) and sample containers for collecting IDW characterization sample(s);
- Plastic sheeting;
- Well keys;
- Personal Protective Equipment and field screening equipment in accordance with the site-specific HASP;
- Site information (maps, contact numbers, previous field logs, etc.);

- Well design and construction information such as well logs, construction specifications, and diagrams.
- Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records);
- Labels for Investigation Derived Waste (IDW) containers as outlined in **FGD 15.01** (Waste Handling); and
- General hand tools for opening and closing protective well covers and 55-gallon drums.

2. Additional Suggested Equipment

- Road and site maps;
- Camera and extra batteries;
- Weighted, calibrated measuring tape;
- Clipboard/field case; and
- Calculator.

3. PROCEDURES REFERENCED

The following FGDs are related to this FGD and should be referenced, as needed:

- **FGD 1.01**, Field Notes and Records;
- **FGD 1.03**, Data Management;
- **FGD 4.06**, Equipment Calibration;
- **FGD 6.01**, Permanent Overburden Well Installation;
- **FGD 6.04**, Groundwater and Free Product Level Measurements;
- **FGD 6.05**, Permanent Bedrock Well Installation;
- **FGD 6.06**, Temporary Overburden Well Installation and Sampling;
- **FGD 6.15**, Well Construction Record;
- **FGD 14.01**, Sampling Equipment Decontamination; and
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of the site-specific Work Plans/sampling plan (e.g., field screening FGDs, FGDs for sampling of media, etc.).

4. PROCEDURES

4.1 Well Development Methods and Planning Considerations

Well development is a critical step in the installation of a well (refer to well installation FGDs) and is also used in the rehabilitation of wells. In certain States, the development or rehabilitation of a well is to be performed by contractors licensed as a water or environmental well driller (as appropriate) in the State where the work is being performed. Therefore, State regulations and guidance governing well development should be consulted prior to conducting the work. In addition, local Ramboll Environ staff should be contacted for any other regional or local requirements.

The method used to develop wells is dependent upon site-specific subsurface conditions, equipment availability, well design and well accessibility. Similarly, the volume of water to be removed for well development can depend on the radius or zone of influence of the well and how the well was constructed (e.g., duration and drilling method). Thus, prior to well development, available well construction details and information on the local geology and hydrogeology should be compiled and reviewed. The complexity of the well construction, the local geology, and the presence and the risk of aquifer contamination are also factors to consider in planning the development of a well. If water or other fluids were added to the well during construction (e.g. rock coring or fluid rotary), at least the amount of water lost to the borehole during drilling shall be removed from the well during development. If the well was installed via mud-rotary drilling methods, well development should occur immediately following well installation if possible, otherwise removal of a mudcake filter pack may be problematic. For other drilling methods, well development should occur at least 48 hours after well installation to allow the grout sufficient time to cure. However, if grout is not used to seal the well (e.g., hydrated bentonite chips), well development could occur within several hours of well installation.

Generally, pumping a well until the water runs clear is not an effective or proper well development method, since the one-directional high-stress flow may cause bridging of formation soils and filter pack materials. Appropriate well development methods include mechanical surging with bailing or pumping, over pumping, air lift pumping, and jetting. Following are general guidelines for the most common well development method, mechanical surging with bailing and pumping.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02** (Site Preparation, Inspection and Housekeeping). At a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the a site-specific HASP;
- Coordinate and obtain necessary access agreements and permits;
- Review project-specific work plan/sampling plan, where applicable;
- Review project-specific Quality Assurance Project Plan (QAPP), where applicable; and

- Review and discuss with the PIC and/or PM the proposed Work Plan/sampling plan or sampling strategy.
- Prior to initiating the well development activities, Ramboll Environ personnel should review the well construction records (refer to **FGD 6.15**, Well Construction Record) and confirm the location and construction details (materials, diameter, depth, etc.).
- Confirm that all non-dedicated (i.e. reusable) equipment and instruments that will come in contact with the well have been decontaminated (refer to **FGD 14.01**, Sampling Equipment Decontamination).
- Prior to opening the well, field screening equipment (refer to field screening equipment FGDs) should be calibrated (refer to **FGD 4.06**, Equipment Calibration) and background levels recorded in the field notebook in accordance with **FGD 1.01** (Field Notes and Records).

4.3 Well Development Using Mechanical Surging with Bailing and Pumping

- During the well development process Ramboll Environ personnel should record all equipment and materials used including times and quantities. Observations and field data should be recorded in the field notebook in accordance with **FGD 1.01** (Field Notes and Records). Ramboll Environ personnel should record any problems encountered and communicate with the PM or PIC. Initial records should include:
 - Well designation;
 - Date of well installation;
 - Well diameter, well depth, screen depth and length, and height of well casing above or below ground surface;
 - Date of development and start and end times of development;
 - Calculation of the well volume (see equation below), including source of well construction information (e.g., well record, field measurement);
 - Details in the equipment used for well development (i.e., type and size/capacity of pump, description of surge equipment, such as surge block, bailer, Waterra® or pump); and
 - Name of well developer and drilling company (if applicable).
- Verify the correct well has been located based on well tag/identifier on the outer casing.
- Unlock and open the protective steel casing or well box.
- Unlock and remove the inner casing cap (or water-tight locking cap on the well casing in the case of a flush mounted well) and, when required, use the field screening equipment (refer to field screening equipment FGDs) to measure organic vapor/gas concentrations in the well box. Record all field measurements in the field notebook in accordance with **FGD 1.01** (Field Notes and Records).
- If appropriate based on surface conditions, polyethylene plastic sheeting should be placed around the well casing.
- Measure and record in the field notebook the depth to water and total well depth before development using an electronic water level indicator or interface probe (if NAPL is

expected to be present) (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements) and calculate the well volume in gallons (V_w) using the following equation:

$$V_w = 7.48(\pi \frac{d_w^2}{4} h_w)$$

Where:

d_w is the well diameter (feet)

h_w is the height of water in the well (feet)

In general, the volume of a 2-inch diameter well is 0.16 gallons per foot and the volume of a 4-inch diameter well is 0.65 gal/ft.

- Well development should begin by assembling the equipment for well development and withdrawing at least two well volumes of water from the well and storing it into 55-gallon steel drums or other appropriate waste containers (refer to **FGD 15.01**, Waste Handling). During the initial water withdrawal, water level drawdown in the well and purge/water removal rate should be measured and recorded in the project field book. However, if the well runs dry during the initial well volume removal, if initial water level monitoring indicates that the well will run dry, or existing nearby wells in the same formation have been identified as running dry during development or purging, the well development activities should be temporarily halted and the Ramboll Environ oversight personnel should contact the PIC and/or PM to discuss alternate well development procedures.
- The entire screened interval should be developed from the top of the well screen down, dividing the screened interval into sections (typically 3 to 5 feet) as necessary. This will prevent the buildup of fines grained materials on the surge block, which in turn could bind the surge block to the well casing.
- Following initial water withdrawal, the well should then be surged by lowering the surge block or other surge device (Waterra®) to the top of the well screen and manually pumping the surge block with a stroke of less than 3 feet. The pulling and pushing action on the surge block will force water into and out of the well screen, thereby removing any drilling or formation fine grained materials from the well screen and suspending them in the development water. After surging, the surge block should be removed and development water removed using the pump and tubing. A bailer may be used prior to pumping to remove water with high turbidity in order to avoid damage to pumping equipment. Turbidity and other water quality parameters (e.g., conductivity, temperature, and pH) should be measured during removal of the development water to evaluate the geochemical characteristics of the purge water. Alternatively, if allowed by the well configuration, a low-capacity pump can be installed above the surge block to simultaneously surge and discharge, thereby ensuring a gradient is maintained towards the well.
- The above surging and removal action is performed at depths corresponding to the entire screened interval until drilling or formation fine grained materials are no longer produced or until turbidity has decreased and other water quality parameters (e.g., conductivity, temperature, and pH) have stabilized. Typically, well development should proceed until

monitored parameters (especially turbidity) have stabilized or a total of five well volumes of water have been removed. The stabilization metrics should be defined in the Work Plan/sampling plan. The surging and removal action sequence may be repeated at higher extraction rates to achieve the desired well development. Some wells may be incapable of achieving non-turbid water quality and well development should be suspended after a reasonable well development effort has been undertaken and results have been communicated to the PIC and/or PM.

- Ramboll Environ personnel should describe in the field notebook the details of the well surging process (e.g., equipment used, depths surged, surge depth increments, and speed, length and frequency rates.) Ramboll Environ personnel should record the drawdown in the well, the purge rate during each pumping cycle, and the water quality parameters per well volume removed. In addition, Ramboll Environ personnel should provide descriptions of the physical character of removed water, including changes in clarity, color, particulate matter, and odor.
- The following guidelines improve the effectiveness of well surging:
 - The manual surging rate should initially be gentle, with gradual increases during the development process (i.e., increases in rate with depth of surging). The manual surging rate is controlled by the speed, length and frequency of the pushing and pulling action.
 - The energy of surging is gradually increased at each depth of surging until drilling or formation fine grained materials are no longer produced from surging at that depth.
 - The depth of surging is incrementally increased from top to bottom of the well screen.
- Measure and record in the field notebook the depth to water, drawdown and total well depth after each removal of development water and at the completion of development using an electronic water level indicator (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements).
- Measure the purge rates during each cycle and record in the field notebook.
- If the well runs dry during development or if it is suspected that the well will run dry, the well development activities should be temporarily halted and Ramboll Environ oversight personnel should contact the PIC and/or PM to discuss alternate well development procedures. In some cases, well recharge may span from hours to more than a day.
- Record in the field notebook the total amount of water removed during well development and the rationale for terminating the development of the well (e.g., water quality parameters stabilized, five well volumes removed, well ran dry).
- All equipment shall be decontaminated upon completion of well development (refer to **FGD 14.01**, Sampling Equipment Decontamination) and dedicated equipment (e.g., non-reusable tubing) should be removed and managed as investigation-derived waste (refer to **FGD 15.01**, Waste Handling).

4.4 Management of Investigation-Derived Waste

All IDW, including well development and decontamination fluids, generated during well development will be containerized pending analytical results and determination of disposal options as outlined in **FGD 15.01** (Waste Handling), unless project-specific requirements specify otherwise.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Certain precautions should be taken to ensure safety while conducting well development activities. Additionally, implementation of the work may face some difficulties and may require compliance with state-specific or regulatory program-specific requirements.

- Some States may have specific licensing requirements for installing monitoring wells. Where required, only drillers licensed in the State where the work is being performed should be subcontracted to perform the work.
- If the State requires that the well be developed by the drilling contractor, the drilling contractor should be informed of the well construction design as part of the contracting process so they can ensure that the appropriate equipment, personnel and materials are mobilized. The driller should define the specific equipment that will be used for well development, so field personnel can prepare accordingly.
- It is important to always remain alert and aware of your surroundings. Sites may be subject to hazards posed by heavy equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and other physical, mechanical, and chemical hazards.
- Prior to mobilization, determine the location of wells and evaluate the need for security, barricading, and/or traffic control (e.g., when wells are located on the right of way).
- At sites with certain contaminants and/or subsurface conditions, potentially toxic and/or explosive gases may accumulate at and around the well as it is being developed. Stay upwind of well development activities and ensure that air monitoring is conducted and personal protective equipment is used in accordance in the site-specific HASP.
- Water shall not be added to the well to aid in development, unless previously approved by the PIC and PM and/or regulatory agency.
- For existing wells being rehabilitated through development, well keys may not work with rusted/outdated well locks. Bolt cutters may be used to remove the lock, which should be replaced upon completion of well rehabilitation. Do not use petroleum based solvent sprays to free seized locks as it may impact water quality in the well.
- Wells with a water-tight cap may experience a buildup of pressure. Keep your face and body away from the top of the well when loosening or removing the cap.

6. RECORDKEEPING

Record all information related to well development in accordance with **FGD 1.01**, Field Notes and Records and **FGD 1.03**, Data Management.

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FIELD GUIDANCE DOCUMENT NO. 6.15

WELL CONSTRUCTION RECORD

FIELD GUIDANCE DOCUMENT NO. 6.15

WELL CONSTRUCTION RECORD

Prepared By:	Dan Clark
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Approved By:	J. Mark Nielsen
Applicable To:	All North American offices
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Documents Used as Reference During Preparation:	ASTM D 5092. <i>Standard Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers.</i> USEPA, 1991. <i>Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells.</i> USEPA Office of Solid Waste, 1992. <i>RCRA Ground Water Monitoring: Draft Technical Guidance.</i>

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ATTACHMENTS

Attachment A: Sample Well Completion Log Form

Attachment B: Sample Well Reporting Requirements

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ for documenting groundwater well construction activities. These records provide critical information gathered in the field with respect to the installation of wells used as part of environmental and hydrogeological investigations.

Although this FGD provides guidelines for producing well construction records, it should be understood that for certain projects, more specific well construction records, including state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable. Specific requirements for these types of records or activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM), and any additional requirements will be defined in a project-specific Work Plan, sampling plan, and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans, but rather a general reference for developing project specific requirements.

It should be noted that this FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail.

2. EQUIPMENT / MATERIALS

Below is a general checklist of equipment that may be required for documenting the construction of groundwater wells. This checklist includes an overall summary of general equipment typically required for documenting well installation efforts and should not be considered exhaustive. Additional equipment may be specified in the project-specific work plan and/or HASP.

- Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records);
- Field log forms (preferably produced on *Rite in the Rain*® water-resistant paper);
 - Blank Field Well Completion Log form (a comprehensive example is provided as **Attachment A**).
 - Blank Field Boring Log form (if required).
- All-weather pens or (weather permitting) other indelible ballpoint pens with black or blue ink;
- Calculator; and
- Digital Camera.

Based on the field activity and project, the following also may be needed:

- Tape measure and/or weighted, calibrated measuring tape;
- Electronic water level indicator or interface probe;
- State-specific monitoring well report form(s), as necessary;
- Field monitoring equipment such as a photoionization detector;
- Tables for well volume calculation; and
- Clipboard/field case.

3. PROCEDURES REFERENCED

The following FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **FGD 1.01**, Field Notes and Records.
- **FGD 1.04**, Documenting Sampling Locations.
- **FGD 1.06**, Field Surveying and Monitoring Well Elevation Surveying.
- **FGD 5.01**, Soil and Rock Classification.
- **FGD 5.09**, Soil Boring Logs.
- **FGD 6.01**, Permanent Overburden Well Installation.
- **FGD 6.04**, Groundwater and Free Product Level Measurements.
- **FGD 6.05**, Permanent Bedrock Well Installation.
- **FGD 6.06**, Temporary Overburden Well Installation and Sampling.
- **FGD 6.07**, Well Development.
- **FGD 6.11**, Monitoring Well Decommissioning.
- **FGD 6.12**, Monitoring Well Inventories and Management.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of the site-specific work plans/sampling plan (e.g., field screening FGDs, FGDs for sampling of media, etc.).

4. PROCEDURES

4.1 General Information

During well construction, information regarding all activities related to the installation of wells should be recorded in the Field Notebook or on a Field Well Completion Log form (a comprehensive example is provided as **Attachment A**) during each day of field activities. The Field Notes or Field Well Completion Log form should be populated concurrently with well installation activities, and the person completing the log should pay close attention to the type and quantity of every component that is used by the driller when constructing the well. The following guidelines should be considered when recording information:

- Pertinent information will be recorded in the field notebook or on the Field Well Completion Log form (a comprehensive example is provided as **Attachment A** for each well and will include the information specified in **Section 4.2** of this FGD):
- Well construction activities may also require that additional forms, such as a Soil Boring Log form (refer to **FGD 5.09**, Soil Boring Logs), Well Development Log form (refer to **FGD 6.07**, Well Development), or equipment calibration log forms (refer to field screening FGDs), also be completed. Alternatively, based on project-specific requirements, information may be recorded in the project-specific Field Logbook, as long as all information identified in the form(s) is recorded in the logbook (refer to **FGD 1.01**, Field Notes and Records).
- Any free forms or field sketches, such as Field Well Completion Log forms, or well construction diagrams, should be appropriately referenced in the field notebook (refer to **FGD 1.01**, Field Notes and Records) and collectively, should present a complete record of the field activities observed. Thus, these records should be thorough enough to enable reviewers to reconstruct the field activities, rationales for decisions made, and observations.
- Records should be made with writing implements (pens, markers) that use permanent, archival-grade ink (waterproof ink, when necessary). Black or blue ink should be used. Erasable ink and pencil are unacceptable being neither permanent nor archival.
- If using Field Well Completion Log forms:
 - The forms should be signed by the author (or authors).
 - Information intentionally left blank should be marked with an "X" or labeled "intentionally left blank."
 - Data entries should be recorded in the Field Well Completion Log form immediately upon obtaining the data. Avoid making temporary notes in other locations for later transfer to the Field Well Completion Log form, as this increases the potential for transcription errors and/or loss of information or data.
 - Note in the field book which forms are being used and the number of forms. All pages of forms should be numbered sequentially and cross-referenced in the field book. Each page of the forms should be signed and dated. Finally, ensure that forms are securely filed in the project file upon return to the office each day in accordance with **FGD 1.01** (Field Notes and Records).

- Explain any deviations or omissions from the work specified in the work plan, especially when such deviations result in measurements not being collected, or additional measurements being collected.

4.2 Requirements for Field Well Completion Log Form

The information recorded on the Field Well Completion Log form (provided as **Attachment A**) is a critical component of the overall record of a well installation. As-built well dimensions (e.g., total borehole depth at start of well construction; depth intervals of sand pack, well seal, and annular fill material/grout; height of casing stick-up, etc.) should be measured and recorded on the Field Well Completion Log form as the installation progresses. This serves to verify that the construction adheres to the well design and that any field modifications to the design are properly justified and documented.

The following information should be recorded during well installation in the field notebook or on the Field Well Completion Log form.

- Monitoring well's unique identification number (ID);
- Name of Ramboll Environ oversight personnel completing the log;
- Drilling company and driller name;
- Date and time of installation;
- Drilling method and nominal outside diameter(s) of drilling equipment;
- Borehole depth (note the depth of the borehole before and after backfilling, if backfilling is performed to bring the base of the borehole to the desired depth);
- Borehole diameter(s): Note that some boreholes will have "telescoping" intervals of larger or smaller diameter (e.g., if installing a double-cased well to seal off specific water-bearing zones);
- Bottom cap type;
- Well sump dimensions and depth to top and bottom of well sump (if used);
- Casing type(s) and diameter(s), identifying the type of material (e.g., Schedule 40 or Schedule 80 PVC, PTFE/Teflon®, steel, etc.) and the inside diameter (ID) of all casing materials installed in the well;
- Screen type (e.g., PVC, stainless steel, etc.), diameter, slot type (e.g., milled, louvered, wire-wrapped, etc.), and slot size (e.g., 0.010-inch, 0.020-inch, etc.);
- Dimensions of the screen and depth to top and bottom of the screened interval;
- Dimensions of the casing and depth to top and bottom of the casing interval. If the casing extends above the ground surface, height of casing above ground surface;
- Depth to top and bottom of the filter pack interval. Well surging should be considered prior to making these measurements as it enhances filter pack quality by inducing particle settlement;
- Filter pack manufacturer, grain size, and material (e.g., Lapis Lustre® No. 3 Monterey silica sand);

- Filter pack placement method (e.g., free-fall, tremie pipe, etc.);
- Quantity of filter pack material used (number of sacks and pounds per sack);
- Dimensions of the annular seal and depth to top and bottom of the seal interval;
- Annular seal placement method (e.g., free-fall, tremie pipe, etc.);
- Type and manufacturer of annular seal material (e.g., CETCO® 3/8-inch bentonite chips, etc.);
- Quantity or volume of annular seal material (i.e., number of 5-gallon pails [e.g., pellets] or sacks and pounds per sack);
- Volume of water for hydrating annular seal (must be potable water);
- Well seal hydration time;
- Depth to top and bottom of the annular seal/fill (e.g., grout) interval;
- Grout manufacturer and type (e.g., Lehigh Portland Type I/II Cement, CETCO® Powder Bentonite);
- Quantity and/or volume of grout material (i.e., number of sacks and pounds per sack);
- Grout mixture ratio (i.e., quantity of powdered bentonite [if any] and cement per gallon of water);
- Water source for annular seal hydration and grout mixing (must be potable water);
- Grout placement method (e.g., tremie pipe);
- Surface completion type and design (e.g., diameter and height of above-grade protective casing, diameter of flush-mount well box, diameter and below-grade depth of protective pipe, dimensions of concrete pad, number and type of protective bollards, etc.);
- Type, manufacturer, depth, and quantity of surface completion sealant (i.e., concrete);
- Type of well seal/cap;
- Well lock type(s) and key blank or combination number(s);
- Depth to water after well construction (before well development);
- Date and time of depth to water measurement;
- The reference datum marked, notched or etched on the well or casing, which will be surveyed and used for depth to water or free product measurements; and
- A description of any problems encountered during installation and corrective actions.

Note that unless specified elsewhere, well construction as-built dimensions should be measured to the nearest 0.1 ft., and depths to groundwater are measured to the nearest 0.01 ft. If a Field Well Completion Log form is not used, a detailed drawing of the well with the information listed above should be included in the field notebook.

4.3 Additional Well Construction Documentation

Upon completion of the well, its location relative to fixed and reproducible landmarks should be defined in the field book or site map. A detailed dimensioned sketch should be prepared in accordance with **FGD 1.04** (Documenting Sampling Locations).

In addition to documenting field activities in a logbook, photographs (if allowed) should be taken to document each step of the well installation process, and details of each photograph (file name, date, time, direction, and subject) should be recorded in accordance with **FGD 1.01** (Field Notes and Records). Further, all materials used should be clearly and completely described as appropriate including, but not limited to, type, manufacturer, size, and quantity.

4.4 Well Construction Reporting

After well installation, the as-built location and elevation of the constructed well shall be surveyed and documented in accordance with **FGD 1.04** (Documenting Sampling Locations), **FGD 1.06** (Field Surveying and Monitoring Well Elevation Surveying), and **FGD 6.12** (Monitoring Well Inventories and Management). In addition, as required by state and local law and/or the well construction permit, well completion report(s) will be completed and filed with the appropriate agency (well reporting requirements for some States are provided in **Attachment B**. Although the filing of well construction reports may be the responsibility of the licensed well driller in certain states, Ramboll Environ has a responsibility to ensure our subcontractors are submitting the appropriate permits, forms, and documentation to State agencies. Record keeping requirements are discussed in **Section 6**.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Well construction activities require recording sufficiently detailed information throughout the installation process. Certain precautions should be taken to ensure safety while recording the required information.

- It is important to always remain alert and aware of your surroundings. Well installation involves the use of drilling rigs and associated equipment, and well sites may be subject to hazards posed by heavy equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and other physical, mechanical, and chemical hazards.
- Avoid walking while recording information. Sites may have excavations, equipment, debris, and other obstacles that pose slip, trip or fall hazards.
- Step away from roadways and high traffic areas before commencing note-taking. Do not assume that drivers can see you standing on the shoulder of a road, especially in bad weather. Many workplace traffic accidents involve distracted drivers hitting a worker standing/working on the shoulder of a roadway. Wear a safety vest or brightly colored (yellow or orange) clothing and remain alert at all times.
- Stand a safe distance away from the drill rig when taking notes.

6. RECORDKEEPING

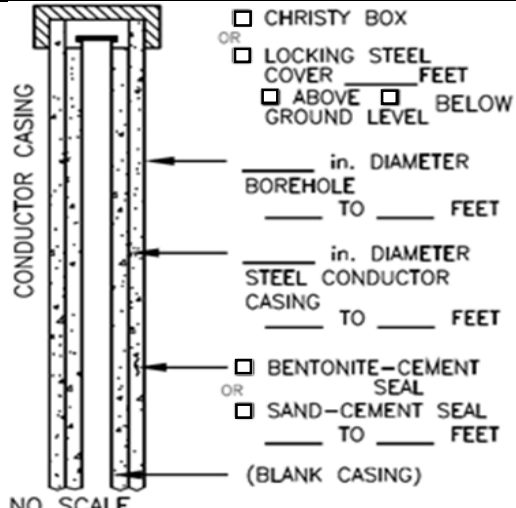
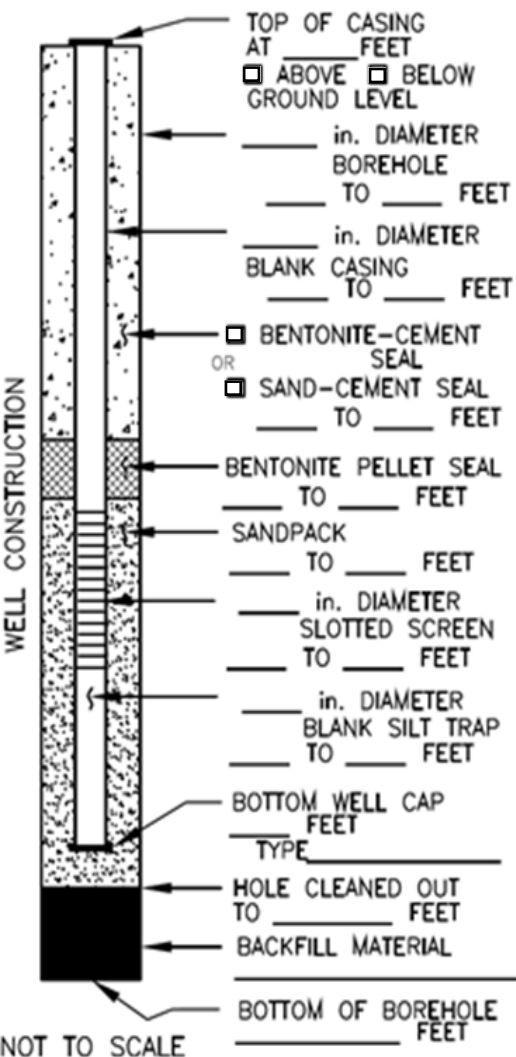
This FGD specifically pertains to recordkeeping during well installation projects. In addition to the well construction record guidelines provided above, all information should be recorded in accordance with **FGD 1.01** (Field Notes and Records). In general, draft field forms should be scanned and saved electronically immediately following the completion of the well installation activities. Following review of draft documents by the PIC and/or PM, field documentation forms should be finalized and final versions may be included in project reports, if necessary. Draft and final versions of the well construction record should be managed in accordance with Ramboll Environ's Document Retention Policy and project-specific requirements, and a copy should be maintained in the Project File.

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ATTACHMENT A
SAMPLE WELL COMPLETION LOG FORM

FIELD WELL COMPLETION LOG

PROJECT NAME: _____ FIELD PERSON: _____
 PROJECT NUMBER: _____ PROJECT MANAGER: _____
 PROJECT LOCATION: _____ DATE: _____

 CONDUCTOR CASING ☐ CHRISTY BOX OR ☐ LOCKING STEEL COVER _____ FEET ☐ ABOVE ☐ BELOW GROUND LEVEL _____ in. DIAMETER BOREHOLE _____ TO _____ FEET _____ in. DIAMETER STEEL CONDUCTOR CASING _____ TO _____ FEET ☐ BENTONITE-CEMENT SEAL OR ☐ SAND-CEMENT SEAL _____ TO _____ FEET (BLANK CASING) NO SCALE	Well Number: _____ Well Location: _____ Drilling Company: _____ Driller: _____ Drilling Method: _____ Method of Decontamination: _____ WATER CONTAINMENT: ☐ Ground Surface ☐ Storm Sewer ☐ Drum ☐ Tank Truck ☐ Storage Tank ☐ Other _____ BEFORE DEVELOPMENT: Depth to Water: _____ Feet BGS Date: _____ Time: _____
 WELL CONSTRUCTION TOP OF CASING AT _____ FEET ☐ ABOVE ☐ BELOW GROUND LEVEL _____ in. DIAMETER BOREHOLE _____ TO _____ FEET _____ in. DIAMETER BLANK CASING _____ TO _____ FEET ☐ BENTONITE-CEMENT SEAL OR ☐ SAND-CEMENT SEAL _____ TO _____ FEET BENTONITE PELLET SEAL _____ TO _____ FEET SANDPACK _____ TO _____ FEET _____ in. DIAMETER SLOTTED SCREEN _____ TO _____ FEET _____ in. DIAMETER BLANK SILT TRAP _____ TO _____ FEET BOTTOM WELL CAP _____ FEET TYPE _____ HOLE CLEANED OUT TO _____ FEET BACKFILL MATERIAL BOTTOM OF BOREHOLE _____ FEET NOT TO SCALE	MATERIALS USED: Length of: _____ Inch Conductor Casing: _____ Feet Length of: _____ Inch Slotted Screen: _____ Feet Material: _____ Slot Size: _____ Length of: _____ Inch Blank Casing: _____ Feet Material: _____ Number of: _____ LB Stacks of Sand: _____ Sand Name/Number: _____ Pound of Bentonite Pellets: _____ Pellet Size: _____ Number of: _____ LB Sacks of Cement: _____ Number of: _____ LB Sacks of Powdered Bentonite: _____ Amount of Grout: _____ LBS Amount of Redimix Cement Sand Ordered: _____ YD³ Amount of Redimix Cement Sand Used: _____ YD³ Number of: _____ LB Sacks of Redimix Used: _____ Concrete Pump Used: _____ NOTES: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

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ATTACHMENT B

SAMPLE WELL REPORTING REQUIREMENTS

Sample Well Reporting Requirements	
State	Well Construction Reporting Requirements
California	Department of Water Resources (DWR) Well Completion Report (DWR Form 188)
New Jersey	Wells must be installed by a NJ licensed well driller and a Form A (As-Built Construction Certification) and Form B (Location Certification) need be submitted to NJDEP upon completion of a well
Massachusetts	The licensed well installation contractor must submit Well Completion Reports to the MassDEP within 30 days following completion of a well
New Hampshire	The licensed well installation contractor must submit Well Completion Reports to the NH Water Well Board within 90 days following completion of a well (RSA 482-B:10).
North Carolina	Wells must be installed by a NC licensed well driller, must be registered with NC DENR and must have a permanent well identification tag affixed to the well.

FIELD GUIDANCE DOCUMENT NO. 6.20
GROUNDWATER SAMPLING - LOW FLOW

FIELD GUIDANCE DOCUMENT NO. 6.20

GROUNDWATER SAMPLING - LOW FLOW

Prepared By:	Michael Wilson
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Applicable To:	All North American offices
Effective Date:	August 29, 2016
Revision Date:	--
Revision Notes:	--
Documents Used as Reference During Preparation:	ASTM D 6771 – 02 Standard Practice for Low-Flow purging and Sampling for Wells and Devices Used for Groundwater Quality Investigations. U.S. Environmental Protection Agency Region 1, Low Stress (low flow) purging and Sampling Procedure for The Collection Of Groundwater Samples From Monitoring Wells, EQASOP-GW 001, Revised January 19, 2010. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, EPA Ground Water Issue, EPA/540/S-95/504 April 1996. Low Flow Purging and Sampling Guidance, New Jersey Department of Environmental Protection (NJDEP), December 2003 (with 3/05 corrections). Attachment 3, Example Standard Operating Procedures for Low Stress (Low Flow) Minimal Drawdown Ground-Water Sample Collection, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, Groundwater Forum Issue Paper, EPA 542-S-02-001, May 2002 Aiken B.S., and LaPat-Polasko, L. Recommendations for Improved Dissolved Oxygen Sampling, Methods for Assessing Natural Attenuation.

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ATTACHMENTS

Attachment A: Groundwater Sampling Equipment

Attachment B: Groundwater Purging Sheets

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines developed by Ramboll Environ US Corporation (Ramboll Environ) for the collection of groundwater samples for laboratory analysis using low-flow purging and sampling techniques. . The purpose of Low-Flow Purging and Sampling (LFPS) is to collect groundwater samples that are representative of ambient groundwater conditions in the aquifer. This is accomplished by adjusting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well. LFPS has several benefits over conventional purging:

- It minimizes disturbance of sediment in the bottom of the well, thereby producing a less turbid sample.
- It minimizes turbulence and aeration of the groundwater sample during sample collection.
- The amount of groundwater purged from the well is usually reduced as compared to conventional groundwater purging and sampling methods, thereby reducing water management requirements.
- Groundwater samples tend to be more representative of actual aquifer conditions with respect to mobile contaminants and turbidity as LFPS causes minimal disturbance of the formation adjacent to the screened interval.
- It is generally less prone to sampling variability, increases sample consistency, and reproducibility of data.

Although this FGD provides guidelines for collection of groundwater samples using LFPS, it should be understood that for certain projects more specific sampling procedures, including site- or state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable. Specific requirements for each project will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, Sampling Plan and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans, but rather serve as a general reference for developing project-specific requirements.

It should be noted that this FGD does not supersede Ramboll Environ health and safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP followed by approved site-specific procedures, which may include those in this FGD. The Ramboll Environ PIC and PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information are maintained in the project file for the duration of the project or as established by applicable Ramboll Environ's document handling and retention policies. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

A general checklist of equipment that may be required for typical LFPS is provided below. Additional equipment may be specified in the project-specific HASP and/or Field Sampling Plan (FSP). This checklist includes an overall summary of general equipment typically required for LFPS and should not be considered exhaustive. More specialized sampling equipment may be required depending on project-specific needs. Ramboll Environ oversight personnel should understand and be familiar with the operation of the equipment and materials that are required for low-flow groundwater sampling.

1. General Groundwater Sampling Equipment Checklist:

- Site information (e.g., maps, contact numbers, keys or lock codes for gates or access points);
- Well construction specifications and diagrams;
- Groundwater sampling logs and field forms from the previous sampling event;
- Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records).
- Plastic sheeting;
- Cable ties;
- Keys for wells;
- Measuring tape;
- Electronic water level indicator (refer to **FGD 6.04**, Groundwater and Free-Product Level Measurements);
- Sample containers (appropriate for various analysis to be performed);
- Sample shipment containers and ancillary materials (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody);
- Sample labels, indelible pen or sharpie, and clear tape;
- Chain of custody forms (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody);
- Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during sampling (refer to **FGD 15.01**, Waste Handling);
- 55- gallon steel drums, Department of Transportation-rated (for legal waste hauling), or other appropriate waste container – for disposal of any Investigation Derived Wastes (IDW) and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling);
- Labeling materials for Investigation Derived Waste (IDW) containers as outlined in **FGD 15.01** (Waste Handling);
- Bucket, spray bottle, distilled/deionized water, and Liquinox (or Alconox) – used for the decontamination of sampling and monitoring equipment (refer to **FGD 14.01**, Sampling Equipment Decontamination); and

- Personal Protective Equipment (PPE) and field screening equipment in accordance with the site-specific HASP, including sterile gloves which must always be worn when handling and utilizing sample equipment.
2. Project- or Task-Specific LFPS Equipment Checklist:
- Pump and associated equipment (e.g., generator, extension cords, batteries, control box, compressor, CO2 or nitrogen compressed gas cylinders);
 - Tubing – Used to discharge water from pump, material based on sampling parameters (poly, Teflon®, etc.). The tubing must be either Teflon® or Teflon®-lined polyethylene. However, when sampling for metals analysis only, the tubing may be constructed of flexible polypropylene or polyethylene;
 - Water quality meter with flow-through cell that, at a minimum, measures temperature, pH, dissolved oxygen (DO), oxygen reduction potential (ORP), and specific electric conductance, and associated manuals. Turbidity measurements can be made using a separate turbidity meter. Total capacity of the cell must be small (i.e., less than 300 mL);
 - Measuring container (e.g., one-gallon plastic water jug, graduated measuring cup, or graduated cylinder);
 - Plumbing fittings – check valves, barbed “T” or “Y” fittings, stainless-steel needle valves or stainless-steel/Teflon ball valves; and
 - Dedicated suspension line or tether constructed of material that minimizes interactions or alterations when in contact with groundwater or that may cause loss of analytes via sorption (e.g., poly twine, nylon string, stainless-steel, Teflon-coated stainless-steel wire, etc.) for lowering and raising pump (pump tubing does not constitute a dedicated suspension line and should not be used for lowering and raising pump).
3. Miscellaneous Additional Suggested Equipment:
- Tool set: socket set, socket wrench, screw driver, multi-tool, tubing cutters, “turkey baster” and/or cup for water removal from flush-mounted well vaults;
 - Spare/replacement parts: gripper plugs/well caps, well lid bolts;
 - Road and site maps;
 - Folding work table;
 - Mobile phone; and
 - Camera and extra batteries.

A description of the types of LFPS pumps is provided in **Attachment A**.

3. REFERENCED GUIDANCE DOCUMENTS

The following FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **FGD 1.01**, Field Notes and Records;
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody;
- **FGD 1.03**, Data Management;
- **FGD 1.05**, Field Quality Control Samples;
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping;
- **FGD 4.04**, Field Screening - Water Quality;
- **FGD 4.06**, Equipment Calibration;
- **FGD 6.02**, Groundwater Sampling;
- **FGD 6.04**, Groundwater and Free Product Measurements;
- **FGD 14.01**, Sampling Equipment Decontamination; and
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of the site-specific Work Plan/Sampling Plan (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 Planning and Design Considerations

All significant sampling strategy decisions will be approved by the PIC and/or PM before the initiation of associated field activities and documented in the Work Plan/Field Sampling Plan. The Work Plan/Field Sampling Plan will be designed for the collection of quality data to meet the objectives of the study/monitoring program and will include the number of samples, locations, depths, number of sampling sites, analytical parameters, methods, and analytical detection/reporting limits, as well as quality assurance/quality control sample requirements. The Work Plan/Field Sampling Plan will generally provide some discretion in the field depending on the conditions encountered; however, any significant departure from prescribed sampling activities should be discussed with and approved by the PIC and/or PM.

When planning a low-flow sampling event, the following should be considered:

- *Pump Selection* - The equipment needed for groundwater LFPS purging/sample collection can vary greatly depending on specific site conditions and project objectives. LFPS is generally conducted at flow rates of 500 mL/minute or less. Pumps used for LFPS must be submersible, positive-displacement pumps. In specific cases, peristaltic pumps may be appropriate and could be used for LFPS when previously approved by the PIC and/or

PM or defined in project-specific work plans. The more commonly used positive-displacement pumps include bladder, variable-speed submersible-centrifugal, and gear pumps. As such, pump selection should take into consideration a variety of well characteristics, including but not limited to: depth to water; analytes of interest; chemical incompatibilities; suspended solids concentrations; ease of decontamination; and availability of a power source. A description of common LFPS equipment is provided in **Attachment A** and a list of their advantages/limitations is provided on **Table 1** in **Attachment A**.

- *Tubing* - The preferred inside diameter (ID) of tubing is one quarter inch (1/4-in), and should be no greater than three-eighths of an inch (3/8-in). Larger tubing diameters reduce flow velocity resulting in a corresponding increase of pump speeds to maintain flow. Increased pump speed will, in turn, elevate the potential for turbulent flow across the screened interval and this may affect the quality of the water being sampled. Conversely, any reduction in flow velocity may allow air to become trapped in the tubing, which may ultimately affect air-sensitive parameters or allow particulates to settle, which may affect turbidity values.
- *Flow-through Cell (flow cell)* - Typical flow-through cell design is not complicated and almost all on the market today share common features. Cells should be transparent in order to "see" the physical condition of the purge water or air bubbles passing through the system. For example, highly turbid or iron bacteria-laden water can be visually monitored for change as the purge progresses. The cell must also be sealed against unwanted exposure to the atmosphere, thus ensuring accurate measurement of air-sensitive parameters (dissolved oxygen, pH, etc.). The total capacity of the cell must be small (i.e., less than 300 mL) in order to maintain a desirable turnover rate of water coming into the cell to ensure real-time data integrity. The in-line design of the cell must also allow for purge water to enter the flow cell from a bottom port and exit at the top. The discharge of the flow cell may be fitted with a check valve.
- *Pump Intake Location* - When LFPS is performed correctly, the data being collected should be reflective of water quality within a narrow zone along a length of well screen or fracture in an open borehole. For these reasons, it is important to place the pump intake in the zone of highest contaminant concentration or contaminant flux along the screened/open-hole interval. This is particularly important in wells constructed with more than five feet of well screen.

Information to be considered when selecting the pump intake depth should include:

- (a) evidence of soil contamination from boring logs and field screening techniques;
- (b) soil sampling analytical results; (c) vertical groundwater quality profiles; and
- (d) areas of high permeability as identified from drilling operations (i.e., water or drilling fluid injection/discharge rate changes, observation of fractures or staining on rock cores, etc.) or by borehole geophysical methods (refer to **FGD 3.08**, Downhole Gamma Ray Logging, **FGD 3.09**, Downhole Caliper Logging, and/or **FGD 3.10**, Downhole Geophysical, Acoustic, and Video Logging), hydrogeological field tests (refer to **FGD 6.03**, Determination of Hydraulic Properties - Slug Test and/or **FGD 6.08**, Determination of Hydraulic Properties - Pump Test) or geotechnical laboratory testing results.

- *Other Considerations* - Additional sampling objectives (e.g., targeted aquifer zones) may be defined in the project-specific Work Plan, Field Sampling Plan and/or FGDs and may determine different sample depths than those that would be defined based on the pump intake considerations above.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02**, Site Preparation, Inspection and Housekeeping. In addition, because samples will be collected from existing groundwater monitoring wells, field staff should review and complete pertinent tasks identified in **FGD 6.02**, Groundwater Sampling. Further, to the extent that non-dedicated sampling equipment is to be used (e.g., water level indicator, purge pump, water quality instrumentation), to minimize potential cross-contamination of samples among wells, such sampling equipment should be decontaminated between wells as described in **FGD 14.01** (Sampling Equipment Decontamination), project-specific Work Plan/Field Sampling Plan, and/or Quality Assurance Project Plan (QAPP). Used dedicated sampling equipment that is considered IDW should be managed in accordance with **FGD 15.01**, Waste Handling, following the sampling event.

At a minimum, the following tasks should be completed to prepare field staff for implementation of the work:

- Review and sign the site-specific HASP.
- Coordinate and obtain permission for site access.
- Review project-specific Work Plan/Field Sampling Plan/QAPP, where applicable.
- Review and discuss with the PIC and/or PM the proposed Work Plan/Field Sampling Plan or sampling strategy. Note that site geology and expected contaminants should be reviewed to determine if unpreserved bottles may be needed (e.g., anticipated effervescence due to high levels of dissolved calcium carbonate in groundwater reacting with acid preservatives);
- When contractors are used to perform the sampling or in states where sampling can only be performed by personnel licensed or certified by the State, discuss the Work Plan/Field Sampling Plan with the contractor.
- Review the standard instruction manual(s) provided by the manufacturer of the specific equipment being used for groundwater sampling.
- Obtain the glassware/bottles in advance and check against sampling numbers to confirm that the appropriate containers and quantities are provided prior to mobilizing.
- Ensure that all equipment/materials required to complete the work have been secured and packed prior to travel.

Prior to initiating the well sampling activities, Ramboll Environ oversight personnel should field-verify the well identity and construction against available documentation (Site Plans, Well Construction Logs, etc.). Prior to sampling, it is imperative that a positive well identification be made using measured total well depth, well labels, Site Plans, and well construction records to ensure that the correct well is sampled (refer to **FGD 6.04**, Groundwater and Free Product Level Measurements). If total well depth is measured, proper

decontamination of the water level indicator tape must be conducted before deploying the water level indicator into another well (refer to **FGD 14.01**, Sampling Equipment Decontamination).

Further, prior to the commencement of the field effort, Ramboll Environ oversight personnel should inspect, test, and/or calibrate equipment that may be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration). Pre-measuring the pump suspension line and/or discharge tubing to the individualized targeted well depths, and pre-labeling sample containers in advance of field efforts will increase productivity (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody). However, special care should be taken to ensure that the correct pre-labelled containers are used to collect each groundwater sample.

Unless otherwise required by the project-specific Work Plan/Field Sampling Plan, sampling should begin with monitoring wells with the lowest expected groundwater contaminant concentrations and proceed systematically to monitoring wells with the highest expected groundwater contaminant concentrations.

4.3 General LFPS Guidelines

The purpose of LFPS is to collect groundwater samples that are representative of ambient groundwater conditions in the aquifer by adjusting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well. The following provides a general recommended list of practices for LFPS activities:

- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.
- All wells to be sampled should be inspected for damage, access constraints, and/or vehicle traffic proximate to the well location.
- Although equipment should be decontaminated between uses, to further limit potential cross-contamination between wells, perform measurements from least to most contaminated locations.
- Place polyethylene sheeting (or garbage bags) around the well for placement of monitoring and sampling equipment and to contain any accidental spillage during purging or sampling.
- Remove the well cover or equivalent protective casing cover (refer to **FGD 6.04**, Groundwater and Free Product Measurements) and measure head space concentrations in accordance with the applicable manufacturer instructions and field screening FGDs (e.g., **FGD 4.01**, Field Screening - Combustible Gas; **FGD 4.02**, Field Screening - Volatile Gas; **FGD 4.03**, Field Screening - Landfill Gas). Record field screening readings in the field book. The necessity and methodology to conduct field screening should be detailed in the site-specific HASP and sampling plan.
- As detailed in **FGD 6.04**, Groundwater and Free Product Measurements, record the condition of the well, noting any damage to the well, plug, and/or protective casing, and record any evidence of air pressure (positive or negative) when removing the well cap;

- Complete all depth-to-water or free product measurements prior to any planned groundwater and/or product withdrawals, sampling or disturbance of groundwater activities unless otherwise specified in the Work Plan/ Field Sampling Plan (refer to **FGD 6.04**, Groundwater and Free Product Measurements).
- To prepare the pump suspension line and discharge tubing, measure the correct length needed so that the pump intake or bottom of discharge tubing rests at the target depth in the well. The measurements should account for the additional length needed at ground surface to appropriately anchor the suspension line and connect discharge tubing to water quality monitoring equipment. The length of tubing, from the top of the well casing to the flow-through chamber, should be the shortest length manageable to minimize: (a) exposure to ambient temperature, direct sunlight, and air bubble formation; and (b) the likelihood of deposited solids or air bubbles being trapped in tubing bends and re-mobilized. If the suspension line and tubing were premeasured or ordered to premeasured lengths in advance of field efforts, make any necessary alterations based on field observations (e.g., unanticipated groundwater elevations).
- Assemble the pump, suspension line, and tubing. Inspect all sampling equipment prior to deployment, making certain that all connections are secure and equipment is in working condition. Troubleshooting pump issues is generally easier if the pump and tubing assembly are inspected prior to deployment. If not using dedicated sampling equipment, ensure all materials are properly decontaminated prior to conducting sampling (refer to **FGD 14.01**, Sampling Equipment Decontamination).
- Slowly lower the assembly into the well using the suspension line to achieve minimal water column disturbance until the location of the tubing or pump intake reaches the predetermined depth within the well. Anchor the assembly in place by securing the suspension line at the surface and/or clamping the tubing in place via spring clamp.
- Measure and record depth to water following insertion of the pump and tubing assembly. Allow the water level to return to its static level prior to initiating purging.
- Prior to groundwater sampling, the well should be purged. Assemble the water quality meter sensor probe and flow through cell in accordance with the manufacturer's specifications.
- During initial pump startup, do not connect the pump discharge line to the flow-through cell. Monitor drawdown and adjust the flowrate as necessary to stabilize it and prevent fouling of probes by bacteria, sediment, or NAPL.
- Once drawdown measurements indicate a relatively constant flow rate has been achieved, continue to run the pump for a few minutes to clear any unwanted material before connecting the pump discharge line to the flow cell.
- Carefully connect the pump discharge tubing to the influent port of the flow-through cell of the water quality meter and connect a section of clean tubing to the effluent port of the cell. The influent and effluent connections to the flow-through cell are unique and based on each meter's design; orientation of flow matters and influent/effluent ports should be marked on the flow cell.
- When water fills the cell, ensure the tubing is completely full of water, check for leaks and make any necessary adjustments. If water is particularly turbid at the beginning of the purge, once the turbidity decreases it can be helpful to disassemble the water quality

meter sensor probe and flow through cell and rinse them with DI water to remove any residual particulates.

- For low-flow purging, evacuate groundwater at a flow rate of 100 to 500 mL/min and until the water quality parameters (e.g., pH, DO, ORP, temperature, specific conductance, and turbidity) specified in the Work Plan, Field Sampling Plan, QAPP and/or FGDs developed based on state-specific or regulatory program-specific guidelines, requirements or procedures have stabilized. In the absence of specific stabilization guidance, the following parameters or any combination thereof established by USEPA should be monitored to determine when parameter stability has been achieved.

pH	± 0.1 unit
Specific Conductance	± 3%
Temperature	± 3% [See Note 1]
Dissolved Oxygen	± 0.3 mg/L [See Notes 2 and 3]
Turbidity	± 10% (when turbidity is greater than 10 NTUs)
ORP/Eh	± 10 millivolts
Water Level Drawdown	< 0.3 ft from static [See Note 4]

Note 1: Temperature generally tends to stabilize rapidly and is considered a relatively insensitive indicator of stability.

Note 2: Under some regulatory programs, the DO stability is defined in terms of percent change (e.g., in New Jersey, less than ± 10% change in DO indicates parameter stability).

Note 3: If there is a significant discrepancy between the DO and the ORP results, for example, if the DO result is greater than 2 mg/L and the ORP measurement is negative millivolts (<-100 millivolts), then either the DO and/or the ORP meter may not be appropriately calibrated or operating correctly. Recalibrate both meters and check the DO and ORP measurements again. If the issues with the DO measurements continue, consider using an in situ probe (e.g. YSI) or Chemetrics sampler approach.

Note 4: During pump start-up, drawdown may exceed the 0.3-ft target and then recover as flow-rate adjustments are made.

- Collect measurements approximately once every five minutes or periodically as defined by the time it takes for purge water to adequately replace the water quality meter's flow-through cell.
 - If the purge rate decreases, the time required for purge water replacement will increase.
 - It is generally accepted that when the measurements of the monitored parameters fall within the stated range for three consecutive readings, chemical parameter stabilization has been achieved.
 - If the anticipated "third" reading of any individual parameter does not fall within the stated range, then the process to achieve three consecutive readings for that parameter must be restarted.

- In some situations, even with slow purge rates, a well may not recharge and be pumped dry. In these situations, under certain regulatory programs this constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). In such cases, it is not necessary that the well be evacuated three times or that chemical parameters stabilize before it is sampled. Nonetheless, the pH, specific conductance, temperature, and turbidity should be measured and recorded during collection of the sample from the recovered volume. These data would serve as the field measurements of record for the sampling event.
- If flow rates are to be measured and a flowmeter is not available, the discharge from the effluent of the flow-through cell can be collected in a container of known volume (i.e., one-gallon plastic water jug or a graduated cylinder) and the time to fill the container noted. When flow-rate measurements are complete, redirect the discharge as detailed above and dispose the contents of the jug or graduated cylinder into five-gallon buckets or directly into 55-gallon drums.
- Containerize purge water in accordance with **FGD 15.01**, Waste Handling. The discharge tubing should be secured such that all purged groundwater is collected in five-gallon buckets or directly into labeled Department of Transportation (DOT)-rated 55-gallon drums, depending on site conditions and purge volumes.
- Upon completion of well purging, reduce the pumping rate to less than or equal to 100 mL/min and disconnect the water quality meter from the discharge tubing;
- Wells should be sampled as soon as possible after purging. Refer to **FGD 6.02**, Groundwater Sampling, for guidance on groundwater sample collection procedures. If sampling for volatile organics, collect the sample for VOCs first to prevent loss of volatiles due to disturbance of the water, and be sure to fill VOA vials to zero headspace, as described in **FGD 6.02**, Groundwater Sampling.
- Withdraw the sampling equipment from the well, replace the well cap, and re-secure the well. For non-dedicated equipment that has come in contact with groundwater, remove the equipment from the monitoring well and decontaminate in accordance with **FGD 14.01**, Sampling Equipment Decontamination. For dedicated equipment that has come in contact with groundwater, disconnect from the non-dedicated equipment and manage as IDW.
- Record in the field book or appropriate field forms any deviations from standard procedures (i.e., sample collection prior to stabilization), the rationale for those modifications, and any abnormal conditions within the well (e.g., evidence of blockage, root growth into the well casing, separated casing sections, etc.). Inform the PIC or PM so necessary maintenance, redevelopment or repairs are conducted before the next planned water sampling event.

4.4 Sample Containers

As outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody), equipment and sample containers that will come into contact with collected groundwater should be constructed of inert materials that will not affect the concentration of constituents in the water sample (i.e., glass, stainless steel or Teflon). The sample container requirements and the quality assurance needs should be outlined in the project-specific Work Plan/Field Sampling Plan or QAPP.

The laboratory will provide appropriate sample containers, prefilled with preservatives appropriate for each predetermined sample analysis. The sample volume is a function of the analytical requirements and will be specified in the Work Plan/Field Sampling Plan or QAPP.

4.5 Sample Transport and Storage

Samples shall be handled, transported and stored in an attempt to maintain structural and chemical qualities of the groundwater samples. Sampling bottles shall be handled as outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody). All samples should be kept in an ice-filled transport container during field work and covered to limit light penetration. If the cooler size allows for space between sample bottles, bubble wrap should be used to fill annular space and prevent breakage during travel. Glass bottle ware should be wrapped individually in bubble wrap for further protection. If provided, pack glass sample vials in laboratory-issue foam packing cartons. If shipping groundwater samples with preservatives, confirm the sample shipments, packaging, and labelling are performed in accordance with applicable DOT-requirements.

4.6 QA/QC

Quality Assurance/Quality Control (QA/QC) procedures described in the project-specific Work Plan/Field Sampling Plan and/or QAPP must be followed throughout the sample collection, processing, handling, and analysis process. In their absence, the QA/QC guidelines of **FGD 1.05** (Field Quality Control Samples) should be followed.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while groundwater sampling. Additionally, implementation of the work may face some difficulties, including the following:

- Some states require that only personnel licensed or certified in the State where the work is being performed perform the sampling. Therefore, State regulations and guidance governing groundwater should be consulted prior to conducting the work. In addition, local Ramboll Environ staff should be contacted for any other regional or local requirements.
- It is important to always remain alert and aware of your surroundings. Groundwater sampling could involve the use of generators and associated equipment, and is subject to hazards posed by equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and/or other physical, mechanical, and chemical hazards.
- Prior to mobilization, determine the location of wells and evaluate the need for security, barricading, and/or traffic control (e.g., when wells are located in driveways or on the right of way).
- At sites with certain contaminants and/or subsurface conditions, potentially toxic and/or explosive gases may accumulate at and around the well as it is being sampled. Stay upwind of the well and ensure that air monitoring is conducted and personal protective equipment is used in accordance in the site-specific HASP.

- Keep any sampler, tether, or suspension lines untangled. Use a plastic winder or spool winder to retrieve the sampler/pump to keep the line from tangling.
- When working out of sight of the general public or when site employees are in potentially hazardous areas (e.g., wooded habitats), all field staff should utilize the “buddy system” and should ensure that the project-specific HASP includes safety measures and procedures.
- Care should be taken when opening well protective covers and removing well caps for the presence of insect nests such as wasps or hornets.
- For some wells, well keys may not work with rusted/outdated well locks. Bolt cutters may be used to remove the lock, which should be replaced upon completion of well sampling. Do not use petroleum based solvent sprays to free seized locks as it may impact water quality in the well. Replace any damaged locks.
- Wells with a water-tight cap may experience a buildup of pressure. Keep your face and body away from the top of the well when loosening or removing the cap.
- Certain sampling equipment configurations have tubing without a pump at the sample intake depth (e.g., a bladder pump with drop-tubing). Without a weight on the end of the tubing, while lowering the tubing into the well it can easily get caught on the joints between sections of the PVC well casing or on the open borehole wall due to the natural curl in the tubing from being stored in rolls. To remedy this, a stainless steel rod can be fastened as a splint along the bottom few feet of tubing or a stainless steel weight can be secured to the end of the tubing to remove the curl and keep the tubing from getting stuck. Some sampling equipment will include a weight for this purpose. Proper decontamination of the stainless steel rod or weight is required prior to deployment into a subsequent well (refer to **FGD 14.01**, Sampling Equipment Decontamination).
- It can be helpful to utilize electronic worksheet to simplify purge stabilization calculations in the field and eliminate the need to transcribe purge notes into electronic form for reporting purposes. An MSExcel®-based purge sheet can also reduce potential mistakes; however, a thorough understanding of the stabilization criteria calculations is necessary prior to use in the field. An example of a low-flow sampling purge sheet with auto-calculations is presented on **Figure 1**.

21	Well Evacuation Data																			
23	Stabilization Criteria				± 0.1 SU	± 3 %	± 10 %	± 3 %	± 10 mV	± 10 %	0.3 ft									
24	Time	Vol.		pH	Cond.	Turb.	Temp.	ORP	DO	DTW	Appearance or									
25		L	Rate	Std	ms/cm	NTU	C	mV	mg/L	ft	Comments									
27	9:54	—	350	9.86	0.240	78.9	10.18	16	11.89	23.60	Slightly silty									
28	9:59	0.0	320	7.89	0.360	70.4	11.17	77	9.98	23.50	Slightly silty									
29	10:04	1.6	250	7.71	0.364	58.2	11.14	93	9.84	23.30	Slightly silty									
30	10:09	2.8	250	7.68	0.361	48.6	11.04	100	9.64	23.30	Clear									
31	10:14	4.1	250	7.68	0.360	30.3	10.98	107	9.58	23.30	Clear									
32	10:19	5.3	250	7.66	0.360	16.0	11.11	107	9.50	23.30	Clear									
33	10:24	6.6	250	7.63	0.362	9.3	11.09	111	9.87	23.30	Clear									
34	10:29	7.8	250	7.69	0.363	5.7	11.26	114	9.49	23.30	Clear									
35	10:34	9.1	250	7.64	0.362	5.8	11.21	115	9.50	23.30	Clear									
36	10:39	10.4	250	7.65	0.362	5.6	11.20	116	9.52	23.30	Clear									
37	10:44	11.6	100	7.66	0.363	5.5	11.32	118	8.82	23.30	Clear									

Figure 1: Groundwater Purge Sheet

As each parameter stabilizes for a minimum of three consecutive readings within its specified criteria, cells activate green. Purge rate and depth to water cells help guide adjustments needed to comply with low-flow guidance. To see a report-ready completed sheet, see **Attachment B**.

- Pumping issues, particularly at deep wells using low-flow or intermittent-flow pumps, can be difficult to troubleshoot. A small cup of deionized (DI) water can be used to test for flow. Place the end of the discharge tubing into the DI water cup during pumping to see if there is a discharge (i.e., bubbles occur). As purge water fills the tubing at depth, air is displaced and forced out the top, causing bubbles in the water. If bubbles are observed, the pump is operating and there is flow.
- Bladder pumps have several O-rings and check balls that are necessary for proper operation. If bubbles are observed in the DI water during compressor discharge, but water is suctioned back into the tubing during the refill cycle, the pump check ball is not working properly or may be missing. Air bubbles in the discharge water that do not disappear after purging for a few minutes are usually indicative of a failed O-ring.
- A small cup of DI water can be used to monitor the purge rate of intermittent-flowing bladder pumps before water arrives at the surface by observing the duration and/or speed of bubbles. Monitoring the duration and speed of bubbles at the beginning of the purge will allow the operator to make adjustments and fine tune the air controls (refill, discharge and pressure) to bring water to the surface.
- Stabilization of parameters when pumping at low flow rates can be difficult. Several adjustments can help make stabilization easier and enhance the rate of stabilization:
 - Minimizing the length of extra tubing at ground surface can help minimize the effect of atmospheric temperature on purge water;
 - Insulating the tubing with tin foil and/or shading from direct sunlight can help minimize the effect of atmospheric temperature on purge water; and
 - Increasing the flow rate to the maximum allowable rate (based on drawdown and regulatory requirements) will help replace water in the flow-through cell more frequently, thus reducing the severity of parameter fluctuations.
- Various injected chemicals, such as in situ chemical oxidation (ISCO) or in situ chemical reduction (ISCR) products will significantly impact the DO and ORP measurements and may lead to inconsistencies in the DO and ORP data, likewise, dissolved hydrogen concentrations are significantly affected by ISCO and ISCR.
- When purging with intermittently-flowing pumps (i.e., bladder pumps), collection of readings should occur during the same portion of the flow cycle (ideally at the end of a discharge cycle, so measurements are based on fresh water entering the flow-through cell) to minimize parameter fluctuations between cycles.
- For wells with slow recovery, attempts should be made to avoid purging them dry as it may affect the quality of the sample. For example, as water enters a well that has been purged dry, it may cascade down the sand pack and/or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column. A possible remedy to purging the well dry is to reduce the purge rate.
- If possible, sampling of wells that have a slow recovery should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered. Unless it is unavoidable, these types of wells should not be purged at the end of one day and sampled the following day.

- Sampling equipment (e.g., air compressors) are temperature sensitive and sampling in extremely cold temperatures can complicate even trivial tasks. When sampling in these conditions, keeping sampling equipment and discharge tubing from freezing is critical. Insulating the compressor and keeping it warm between use (within a vehicle, field trailer, etc.) will help keep it functioning properly. Any interruption of flow could cause purge water in the discharge tubing to freeze; insulating the tubing and maintaining higher flow rates (within regulatory guidelines) will help keep purge water from freezing.
- Adequate preparation prior to sampling each well will save time in the long run. Make sure the generator/air compressor has fuel or that spare batteries/air canisters are available in the event that stabilization takes longer than anticipated. Stopping mid-purge to refuel or acquire additional air canisters will disrupt stabilization, greatly increasing the time required to sample a well.
- Each sampling effort should attempt to minimize exposure to ambient factors (e.g., atmospheric air, wind-blown dust, vehicular exhaust).
- While purging, the time between water quality measurements can be used to organize bottle-ware and confirm well-specific information (e.g., sample analyses, bottles appropriately labeled, duplicate collection, field filtering).
- If the Work Plan/ Field Sampling Plan involves analyses requiring field preservation, be sure to avoid direct contact with laboratory-provided preservative chemicals.

6. RECORDKEEPING

Document all sampling locations in accordance with **FGD 1.04** (Documenting Sampling Locations) and record all information related to groundwater sampling in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management).

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ATTACHMENT A

GROUNDWATER SAMPLING EQUIPMENT

ATTACHMENT A - GROUNDWATER SAMPLING EQUIPMENT

Several types of well water evacuation equipment exist for the collection of groundwater samples using LFPS techniques. Equipment choice will depend on a variety of factors including but not limited to cost, well specifications, and sampling parameters. Two basic collection scenarios have a bearing on pump selection:

- **Dedicated System** (a permanently installed pump system in a well) – A dedicated pump system consists of a single pump and tubing set up in each permanent monitoring well. This allows consistent sampling from a targeted monitor zone without the need to install/remove the pump during each monitoring event. Typically used for long-term monitoring at sites, a dedicated system usually consists of the pump and the associated tubing, with the controller mobilized for each sampling event.
- **Portable System** (transferable from well to well) – A portable LFPS system allows low-flow sampling from many monitoring wells using the same pump. Commonly available portable systems are easy to disassemble, without any tools, and simple to clean to eliminate any potential cross contamination.

Bladder pumps can be used for either system, however, only those with disposable bladders and easily cleaned parts are suitable when sampling on a well-to-well basis. Variable-speed submersible-centrifugal pumps, gear or progressive-cavity pumps can be used for either operating system as long as they are constructed of easy to clean stainless steel/Teflon® parts. Pumps constructed with impellers, helicoils, or gears, which are difficult to clean or are constructed of unacceptable plastic parts, are not suitable for sampling.

Following are brief descriptions of more commonly used pumps for low-flow groundwater purging and/or sampling. A comparison of these pumps is provided in **Table 1**.

Bladder Pumps

Bladder pumps use pneumatic pressure, a liner or bladder and a series of check valves that allow the bladder to fill with liquid then pneumatic pressure pushes on the bladder forcing fluid from the pump. The assembly typically includes a pump, a controller, an air compressor or compressed air, and tubing. Pneumatic bladder pumps operate with a unique, gentle action ideal for low-flow sampling. Timed on/off cycles of compressed air alternately squeeze the flexible bladder to displace water out of the pump, and release it to allow the pump to refill by submergence. Following the fill cycle, compressed air or nitrogen from a cylinder or compressor at the wellhead is driven down to the pump through tubing to compress the bladder, thus driving the water sample up to the surface through a second tubing line. The pumping sequence consists of repeated fill-compress cycles, using a pneumatic controller positioned at the wellhead. The controller is used to vary the duration and frequency of the fill-compress cycles in order to deliver the desired sample flow rate at the wellhead.



Figure 1: Bladder Pump Setup (left) and Pump (right)

Source: www.soilinst.com

The bladder design offers the advantage of minimizing sample turbulence, which can result in loss of VOCs in the sample, as well as eliminating contact of the water sample with the compressed air or nitrogen used to lift the sample to the surface. Bladder pumps run easily at low rates for extended times without overheating (like high-speed electric pump motors) which can alter samples and ruin the pumps, and without creating any disturbance that could affect sample chemistry. Some manufacturers of bladder pumps include QED, Geotech and Solinst.

Submersible Pumps

Submersible pumps consist of an electric motor in a stainless steel and Teflon housing that drives two or more impellers at high rates of rotation, bringing water to the surface at an uninterrupted flow during sampling. The assembly typically includes a pump, a controller, a power source, and tubing.

These pumps are light weight and versatile. To overcome potential overheating that could affect sample quality, the pumps can be provided with a cooling shroud. To avoid potential issues backflow, the pump should be provided with a check valve. In addition, to provide greater pump speed control (e.g., to account for changes in pressure and torque at the impellers) and minimize potential pump flow loss, the pump controller should be equipped with a "ten turn pot" frequency adjustment knob. Some manufacturers of submersible pumps include Geotech, and Waterra.



Figure 2: Submersible Pump

Source: <http://www.geotechenv.com/>



Figure 3: Gear Pump

(Source: <http://www.fultzpumps.com>)

Gear Pump

The gear pump is a small and lightweight pump that is constructed of stainless steel and Teflon® and operates on positive displacement. The assembly typically includes a pump, a controller, a battery, and tubing. It functions through the use of two or more internal Teflon® gears within a stainless steel cavity that displaces water up the hose in a steady stream. As the gears rotate they separate on the intake side of the pump, creating a void and suction which is filled by fluid. The fluid is carried by the gears to the discharge side of the pump, where the meshing of the gears displaces the fluid.

The pump's low rpm electric motor will not disturb the sample as it generates little heat. Compared to the submersible pumps, which have impellers, the gear pumps require less flow rate adjustments and provide more consistent flow. Fultz is a manufacturer of gear pumps.

Table 1: Groundwater Sampling Pumps				
Pump Type	Advantages	Disadvantages	Sampling Capability	Approximate Lift Capacity
Bladder Pump	- Acceptable for sampling for all parameters. - Simple design and operation - Minimal disturbance of sample.	- Large gas volumes may be needed. - Only pumps with disposable bladders may be field cleaned for portable use when approved decontamination methods are employed.	Acceptable for sampling for all parameters.	Up to 1000 feet
Submersible Centrifugal Pump	- Versatile and light weight. - Variable speed control for fine tuning of flow rate. - Able to be thoroughly decontaminated due to ability of complete disassembly.	- Sample temperature may be biased high during low-flow sampling due to high rotation rate of impellers. - Motor stall possible at low pumping rates. - Requires external power source. - Impellers easily damaged by silty/sandy water. - Difficult to clean and maintain in the field.	May not be acceptable for sampling for trace contaminants, but useful for all other parameters.	Up to 280 feet
Gear Pump	- Good variable speed control especially at low rates. - Light weight. - Does not have temperature issue as gears do not create excess heat like electric impeller pumps.	- Difficult to decontaminate when in the field. - Turbid purge water wears on the gears. - Cannot properly handle suspended solids. - Gears may be damaged in silty/sandy water. - Gears may bind in water exceeding 85 degrees F.	Acceptable for sampling for all parameters.	Up to 150 feet

ATTACHMENT B
GROUNDWATER PURGING SHEET



Low Flow Groundwater Sampling Field Log

Monitoring Well - MW-103B

Client or Site Name
Princeton, NJ

Sampling Information

Date - March 5, 2015
Personnel - W. Larrison & T. Correll
Weather - Mostly Sunny, 28°F

Sampling Device - 2-Inch Bladder Pump
Water Quality Meter - Horiba U-52
Monitoring Equipment - MiniRAE PID 3000

Well Information

Well Vault PID - 0.0 ppm
Well Casing PID - 0.4 ppm
Measured Depth to Bottom - 75.00 ft BTOC
Well Screened Zone - 65 - 75 ft BTOC

Well Diameter - 2.0 inch
Depth to Pump Intake - 70.0 ft BTOC
Static Depth to Water - 23.14 ft BTOC
Post-Pump Depth to Water - 23.10 ft BTOC
Well Volume - 8.46 gallons

Well Evacuation Data

Stabilization Criteria										
		± 0.1 SU	± 3 %	± 10 %	± 3 %	± 10 mV	± 10 %	0.3 ft		
Time	Vol. L	Rate mL/min	pH Std	Cond. ms/cm	Turb. NTU	Temp. C	ORP mV	DO mg/L	DTW ft	Appearance or Comments
9:54	--	550	9.86	0.24	78.9	10.18	16	11.89	23.8	Slightly silty
9:59	0.0	320	7.89	0.36	70.4	11.17	77	9.98	23.5	Slightly silty
10:04	1.6	250	7.71	0.364	58.2	11.14	93	9.84	23.3	Slightly silty
10:09	2.8	250	7.68	0.361	48.6	11.04	100	9.64	23.3	Clear
10:14	4.1	250	7.68	0.36	30.3	10.96	107	9.59	23.3	Clear
10:19	5.3	250	7.66	0.36	16	11.11	107	9.5	23.3	Clear
10:24	6.6	250	7.68	0.362	9.3	11.09	111	9.87	23.3	Clear
10:29	7.8	250	7.69	0.363	5.7	11.26	114	9.49	23.3	Clear
10:34	9.1	250	7.64	0.362	5.8	11.21	115	9.5	23.3	Clear
10:39	10.4	250	7.65	0.362	5.6	11.2	118	9.52	23.3	Clear
10:44	SAMPLE	100	7.66	0.363	5.5	11.32	118	8.82	23.30	Clear

Notes / Sample Information

Appearance at Start - Slightly silty
Appearance After Purging - Clear
Total Volume Purged - 12.1 liters
Purge Rate - 100-550 mL/min

Analyses - TCL VOCs (8260B);
TCL SVOCs (8270C/8270C + SIM);
Dissolved Organic Carbon (SM5310);
Dissolved Mn, Mg, Ca, Na, K (200.8);

Sample ID - MW-103B-150305
Sample Time - 10:44

Additional Sample - None
Additional Sample ID - N/A
DTW After Purging - 23.30 ft BTOC
DTW at Time of Sampling - 23.30 ft BTOC

Notes

Figure 2: Complete Groundwater Purge Sheet

Completed groundwater purge sheet, finalized for printing.

FIELD GUIDANCE DOCUMENT NO. 9.01
SOIL GAS AND SUB-SLAB SOIL GAS SAMPLING

FIELD GUIDANCE DOCUMENT NO. 9.01

SOIL GAS AND SUB-SLAB SOIL GAS SAMPLING

Prepared By:	Wayne Weber Nick Zurweller Micky Shetty
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Applicable To:	
Effective Date:	January 30, 2017
Revision Date:	
Revision Notes:	
Documents Used as Reference During Preparation:	Department of Toxic Substances Control and California Environmental Protection Agency (DTSC/CalEPA). <i>Vapor Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion To Indoor Air (Vapor Intrusion Guidance)</i>. Dated October 2011. California Environmental Protection Agency and Department of Toxic Substances Control (CalEPA/DTSC), Los Angeles Regional Water Quality Control Board, San Francisco Regional Water Control Board, <i>Advisory Active Soil Gas Investigations</i>. Dated April 2015 Dominic DiGiulio. U.S. Environmental Protection Agency. <i>Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA Method TO-15 to Support Vapor Intrusion Investigations</i>. Ada, Oklahoma. Missouri Department of Natural Resources. <i>Missouri Risk-Based Corrective Action (MRBCA) Technical Guidance, Appendix H: Measurement of Soil Vapor Levels</i>. Dated April 2006 New Jersey Department of Environmental Protection. <i>Vapor Intrusion Technical Guidance, v. 3.1</i>. Dated March 2013 New Jersey Department of Environmental Protection. <i>Field Sampling Procedures Manual</i>. Dated August 2005.

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ATTACHMENTS

Attachment A: Commonly Used Soil Gas and Subslab Gas Sampling Containers

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ US Corporation (Ramboll Environ) for the collection of representative samples of gas contained in the interstitial spaces of materials immediately beneath the concrete floor slab of residential, commercial, and/or industrial structures (i.e., sub-slab) or within the vadose zone soil outside building footprints or in undeveloped areas (soil gas). Soil gas and sub-slab gas sampling¹ and analysis techniques include methods used to collect subsurface vapor phase data at sites potentially affected by volatile organic compounds (VOCs, which can include chlorinated solvents and petroleum hydrocarbons), methane, hydrogen sulfide and semi-volatile organic compounds (SVOCs). Data obtained from soil gas or sub-slab gas investigations can be used to (a) identify the source and spatial distribution of vapor phase subsurface contamination; (b) delineate impact and define locations warranting further investigation; (c) evaluate the potential for vapor intrusion (VI) into a structure; (d) determine whether detected gas measured near property boundaries trigger active remedial action (e.g., landfill gas); (e) define whether and what type of remedial action may be warranted; and/or (f) monitor the performance of remedial actions, including vapor mitigation or gas extraction systems.

Although this FGD provides guidance for soil gas and sub-slab gas sampling, it should be understood that for many projects, sampling procedures, including state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable. Moreover, it should also be understood that sampling guidelines have changed significantly in recent years and may continue to change in the future. Therefore, current local, state, and/or federal guidance should be consulted as part of developing project-specific Sampling Plans. Specific requirements for projects and activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM), and any additional requirements will be defined in the project-specific Work Plan, Sampling Plans and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans but rather provide a general reference for developing project specific plans. In addition, PICs and PMs are encouraged to provide additional direction or training to junior scientists and engineers for the implementation of the procedures outlined in this FGD.

This FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by approved site-specific procedures, which may include procedures recommended in this FGD. The Ramboll Environ PIC and PM must ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information is maintained in the project file for the duration of the project. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

¹ "Soil gas" commonly refers to both vapor and gas in the vadose and are used interchangeably throughout this FGD.

2. EQUIPMENT / MATERIALS

A general checklist of equipment that may be necessary for typical soil gas and sub-slab gas sampling efforts is provided below. Additional equipment may be specified in the project-specific Work Plan and/or HASP. This checklist includes an overall summary of general equipment typically required for surface soil sampling and provides an overall summary of general equipment which may be required to conduct soil gas or sub-slab gas sampling and should not be considered exhaustive.

1. General Soil Gas and Sub-Slab Gas General Sampling Equipment Checklist:

- 9/16-inch or other appropriate sized open end wrench and medium adjustable wrench or 3/4-inch open end wrench to access sampling points;
- Stainless steel compression fittings, hose barb connectors or other appropriate connectors for 1/4-inch OD tubing, hose barb;
- 1/4-inch OD Teflon, Nyla flow or PEEK tubing (i.e., flexible tubing or flexible hose);
- 1/4-inch by 1/4-inch by 1/4-inch three-way valve(s) made of stainless steel, low-density polyethylene (LDPE) or equivalent;
- Tubing/Pipe cutter;
- Vacuum pump(s) equipped with a flow meter, flow regulator, and in-line vacuum gauge(s);
- Vacuum gauge(s);
- Flow regulator(s);
- Modeling clay (non-volatile) or weather stripping (e.g., Mortite or equivalent);
- Helium canister and regulator;
- Helium meter;
- Plastic shroud (e.g., clear household storage container) with four holes sized to fit tubing from helium meter, helium canister and sampling train;
- Oxygen, carbon dioxide, methane or other field measurement meter(s);
- Sample containers (appropriate for various analysis to be performed);
- Sample labels;
- Alternating current (AC) extension cord (best with multiple sockets);
- Ground fault circuit interrupter;
- Decontamination equipment and supplies (refer to **FGD 14.01**, Sampling Equipment Decontamination);
- Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during sampling (refer to **FGD 15.01**, Waste Handling);
- Appropriate waste container – used to dispose of any Investigation Derived Wastes (IDW) and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling);

- Labels for Investigation Derived Waste (IDW) containers as outlined in **FGD 15.01** (Waste Handling);
 - Personal Protective Equipment (PPE) and field screening equipment in accordance with the site-specific HASP, including sterile gloves which must always be worn when handling and utilizing sample equipment;
 - Site information (maps, contact numbers, access information, previous field logs, etc.);
 - Sampling point construction specifications, and diagrams; and
 - Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records).
2. Project or Task Specific Soil Gas and Sub-Slab Gas Sampling Equipment Checklist (refer to **Attachment A** for brief descriptions of the more commonly used containers for soil gas and sub-slab gas sampling):
- Passivated Stainless Steel Canisters / SUMMA® Canisters.
 - Polymer (Tedlar®) Gas Sampling Bags.
 - Gas Sampling bags with Evacuation Chamber.
 - Glass Bulbs.
 - Glass Syringes.
 - Sorbent Tubes.
3. Miscellaneous Additional Suggested Equipment:
- Extra vehicle keys.
 - Credit card for gas and emergencies.
 - Road and site maps.
 - Camera and extra batteries.
 - Mobile phone.

3. REFERENCED GUIDANCE DOCUMENTS

In addition to the reference and guidance documents cited above, the following Standard Practice Instruction (SPIs) and FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **SPI 27**, Subsurface Clearance.
- **FGD 1.01**, Field Notes and Records.
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody.

- **FGD 1.03**, Data Management.
- **FGD 1.04**, Documenting Sampling Locations.
- **FGD 1.05**, Field Quality Control Samples.
- **FGD 2.02**, Site Preparation, Inspection, and Housekeeping.
- **FGD 4.01**, Field Screening - Combustible Gas.
- **FGD 4.02**, Field Screening - Volatile Gas.
- **FGD 4.03**, Field Screening - Landfill Gas.
- **FGD 4.06**, Equipment Calibration.
- **FGD 9.02**, Sub Slab Sampling Probe Installation.
- **FGD 9.03**, Soil Gas Sampling Points Installation.
- **FGD 9.05**, Passive Soil Vapor Sampling.
- **FGD 14.01**, Sampling Equipment Decontamination.
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other SPIs and FGDs may need to be referenced based on the specific requirements of the site-specific Work Plan/Sampling Plan (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 Planning Considerations

All significant sampling strategy decisions will be approved by the PIC and/or PM before the initiation of associated field activities. The Work Plan/Sampling Plan will be designed for the collection of data of sufficient and consistent quality to meet the objectives of the investigation or monitoring program. The Work Plan/Sampling Plan should clearly specify the number of samples, locations, depths, number of sampling sites, and analyses to be performed on each sample. The Work Plan/Sampling Plan will generally provide for some discretion in the field depending on encountered conditions; however, any significant departure from prescribed sampling activities should be approved by the PIC and/or PM and documented in subsequent data submittals.

When planning a soil or sub-slab gas sampling event, the following should be considered:

- *Sampling Containers.* Various types of gas sampling containers are available for soil gas and sub-slab gas sampling. Brief descriptions of the more commonly used containers for soil gas and sub-slab gas sampling are provided in **Attachment A**. Selection of the sampling containers should consider the purpose of the data, potential for contaminant loss, the levels of detection required, and holding times. Unless otherwise specified in the project-specific Work Plan/ Field Sampling Plan and/or Quality Assurance Project Plan (QAPP), Summa canisters are the preferred sample container for soil gas and subslab gas sampling. Note that when using Summa canisters, the pressure of the canister should be measured and recorded upon receipt from the laboratory, once on-site, prior

to and post sampling, and prior to shipment to the laboratory. The laboratory should also measure and record the pressure of the canister prior to shipment and upon receipt of the canisters.

- *Sampling Point Purging.* Prior to sampling, locations are purged to ensure that representative soil gas is sampled. The volume to be purged is calculated based on the sampling point construction details (i.e., sand pack volume, sampling point volume) and the sampling train configuration (i.e., volume of sample tubing). At a minimum, three purge volumes should be evacuated from the sampling point prior to sampling and the rate of purging should be less than 200 mL/min. Note that some regulatory programs (e.g., California Environmental Protection Agency) also require that the vacuum applied during purging and sampling be measured and recorded to ensure it does not exceed 100 inches water.
- *Purge Volume Test.* A site-specific purge volume test may be required to demonstrate that samples collected are representative of subsurface conditions. The purge volume test should be conducted near the confirmed contaminant source by collecting and analyzing gas samples for the target compounds after removing three purge volumes.
- *Sampling Point Curing Time.* If installation of the sampling point required the use of sealants or cement, sampling should not take place until these materials have fully cured. Refer to **FGD 9.02** (Installation of Sub-Slab Sampling Points) and **FGD 9.03** (Installation of Soil Gas Sampling Points) for recommended lapse times between installation and sampling and discuss appropriate durations with the PIC and/or PM prior to soil gas and sub-slab gas sampling.
- *Equilibration Time.* Following soil gas or sub-slab point installation, sufficient time should be allowed for subsurface conditions to re-equilibrate prior to sample collection. Equilibration times vary depending on installation method (e.g., the 2015 California Environmental Protection Agency, Department of Toxic Substances Control Advisory for Active Soil Gas Investigations recommends an equilibration time of 2 hours if installed using direct push versus 48 hours when installed using hand augering and/or rotary drilling) as well as soil texture. Users of this FGD should consult local, state, and/or federal guidance as appropriate.

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02**, Site Preparation, Inspection and Housekeeping. Further, to the extent that non-dedicated sampling equipment may be used (e.g., tubing), such sampling equipment should be decontaminated between sampling points as described in **FGD 14.01** (Sampling Equipment Decontamination), project-specific Work Plan/Sampling Plan and/or QAPP to minimize potential cross-contamination between sampling points. Dedicated sampling equipment should be considered IDW following the sampling event and should be managed in accordance with **FGD 15.01**, Waste Handling.

At a minimum, the following tasks should be completed (as applicable) as field staff prepare for implementation of the work:

- Review and sign the site-specific HASP;
- Coordinate and obtain permission for site access;

- Review project-specific Work plan/Sampling Plan, where applicable;
- Review project-specific QAPP, where applicable;
- Review and discuss with the PIC and/or PM the proposed Work Plan/Sampling Plan or sampling strategy; and
- Ensure that all equipment/materials required to complete the work have been ordered, packed, or otherwise acquired prior to mobilization. This includes field sampling equipment (including laboratory containers) and expendables.

In addition, prior to initiating the soil or sub-slab gas sampling activities, Ramboll Environ field staff should verify the identity and construction of all sampling points against available site-specific documentation (scaled site maps, soil boring logs, construction logs, site photographs, etc.). It is imperative that a positive identification be made of each and every point prior to sampling to ensure correct locations are sampled and provided with the correct sample identification. Prior to the commencement of the field effort, Ramboll Environ field personnel should inspect, test, and/or calibrate equipment that will be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration). Pre-labeling sample containers in advance of field efforts may increase productivity (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody).

4.3 General Soil Gas and Sub-Slab Gas Sampling Guidelines

Soil gas and sub-slab gas samples are collected from temporary or permanent soil gas or sub-slab sampling points by negative pressure using pre-evacuated sampling containers or vacuum pumps. Brief descriptions of the more commonly used containers for soil gas and sub-slab gas sampling are provided in **Attachment A**. The following provides a general list of practices for soil gas and sub-slab gas sampling activities (refer to **Section 5** for modifications to this procedure for sampling points with no or low gas flow conditions):

- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas;
- All locations to be sampled should be inspected for damage, access constraints, and/or vehicle traffic proximate to the well location;
- Although equipment should be decontaminated between uses, to further limit potential cross-contamination between sampling locations, measurements and sampling activities should be conducted from least to most contaminated locations;
- Remove the sampling point cover or equivalent protective casing cover (refer to **FGD 9.02**, Installation of Sub-Slab Sampling Points and **FGD 9.03**, Installation of Soil Gas Sampling Points) and measure gas concentrations in accordance with the applicable equipment manufacturer instructions and field screening FGDs (e.g., **FGD 4.01** - Field Screening - Combustible Gas, **FGD 4.02** - Field Screening - Volatile Gas, **FGD 4.03** - Field Screening - Landfill Gas). Record field screening measurements in the site-specific field book and/or other field data sheets. The necessity and methodology to conduct field screening should be detailed in the site-specific HASP and Work Plan/Sampling Plan;

- Assemble purging and sampling train, which will vary based on the type of container to be utilized for collection of gas samples (see **Figures 1** through **4** below). In all cases, at least one three-way valve and tubing should be used to connect the sampling point to the sampling container. The third line will be used during the purging of the sampling point. All fittings should be tightened in accordance with the manufacture's recommendations with care not to overtighten:
 - Ensure that the valve associated with the sampling container is closed (or, if using a glass syringe, that the plunger is down and sealed) until all connections have been made and the shut-in and leak tests described below have been completed.
 - Ensure all valves in the three-way valve are in the closed position before assembly of the purging and sampling train.
 - Connect the sampling point to a three-way valve using flexible hose.
 - Place a shroud over the sampling probe, keeping the three-way valve inside the shroud².
 - Connect flexible hose to the two other valves of the three-way valve. Ensure that the valve is fully accessible from the access door or glove box on the shroud.
 - Pass the tubing through two holes on the shroud and seal the annulus with modeling clay as necessary (placing modeling clay at the interface of the shroud and the concrete slab or ground surface improves the seal between the surfaces).
 - Attach the helium regulator and tubing to the helium canister.
 - Insert the flexible hose connected to the regulator on the helium supply canister (which should remain closed) into the shroud through a third hole on the shroud and seal the annulus with modeling clay as necessary.
 - Insert the tubing connected to the helium meter (which should remain off) into the shroud through a fourth hole in the shroud and seal the annulus with modeling clay as necessary.
 - If using passivated stainless steel canisters or Summa Canisters (refer to **Figure 1** below),
 - Connect the vacuum side of the pump to the three-way valve and a hose to the pump discharge. This second line will be the pump discharge line used during the purging of the sampling point.
 - Use flexible hose to connect the Summa Canister to the three-way valve.

² If a shut-in test is conducted to appropriately demonstrate that the valve is not leaking, it may not be necessary to place the 3-way valve within the shroud.

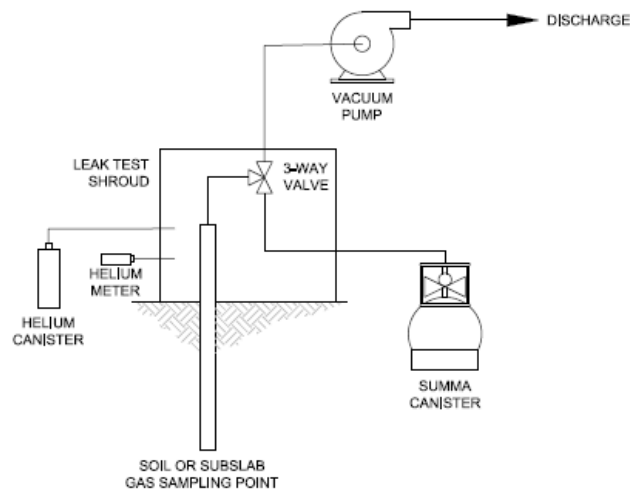


Figure 1:

Sampling Train Configuration for Summa Canister

- If using gas sampling bags with evacuation chamber (refer to **Figure 2** below),
 - Connect the vacuum side of the pump to a second three-way valve using a flexible hose. The second three-way valve should be connected using flexible hose to the first three-way valve (i.e., connected to the sampling point) and to the fitting on the evacuation chamber used to create a vacuum in the chamber. Connect a hose to the pressure side the pump; this line will be the pump discharge line used during the purging of the sampling point.
 - Place the gas sampling bag in the evacuation chamber and connect the bag to the pass-through fitting on the evacuation chamber. Use flexible hose to this fitting to the first three-way valve (i.e., connected to sampling point and pump).

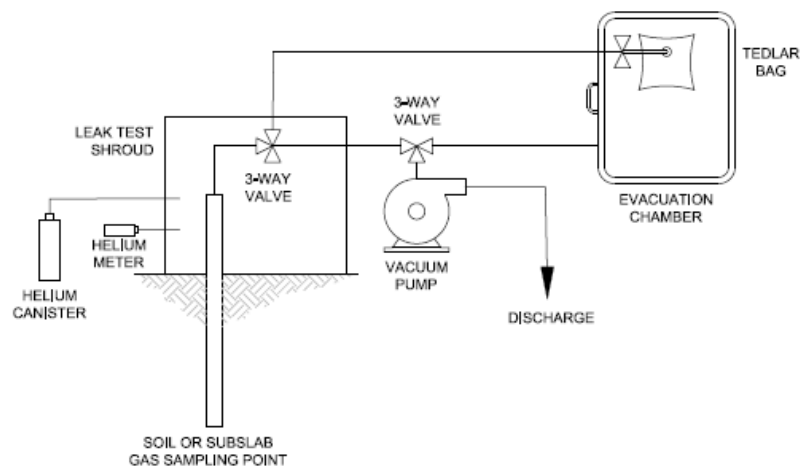


Figure 2:

Sampling Train Configuration for Gas Sampling Bag with Evacuation Chamber

- If using glass bulbs or sorbent tubes (refer to **Figure 3** below),
 - Connect the vacuum side of the pump to a second three-way valve using a flexible hose. Connect both three-way valves using flexible hose. Connect the pressure side the pump to the second three-way valve using a hose; this line will be the pump discharge line during the purging of the sampling point.
 - Use flexible hose to connect the glass bulb or sorbent tube to the first three-way valve (i.e., connected to sampling point and pump).

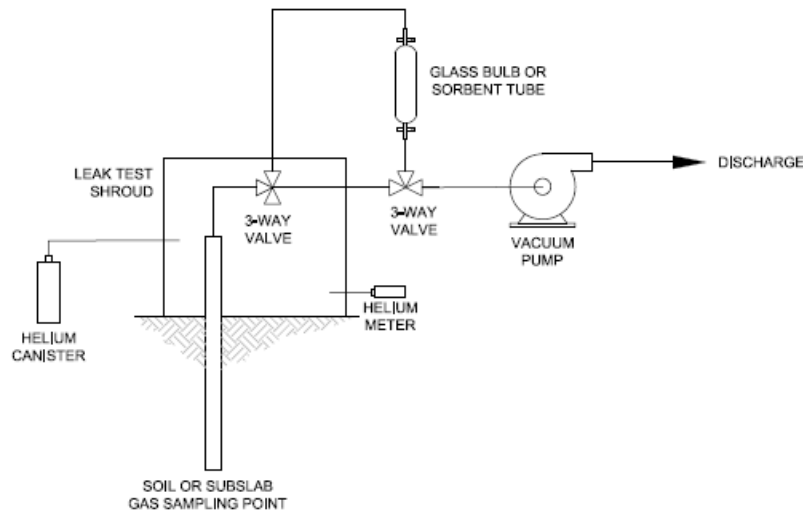


Figure 3:

Sampling Train Configuration for Glass Bulb or Sorbent Tube

- If using glass syringes (refer to **Figure 4** below),
 - Connect the vacuum side of the pump to the three-way valve using flexible hose.
 - Connect a hose to the pressure side the pump; this line will be used for the pump discharge line during the purging of the sampling point.
 - Connect the glass syringe to the three-way valve (i.e., connected to sampling point and pump), using flexible hose if needed.

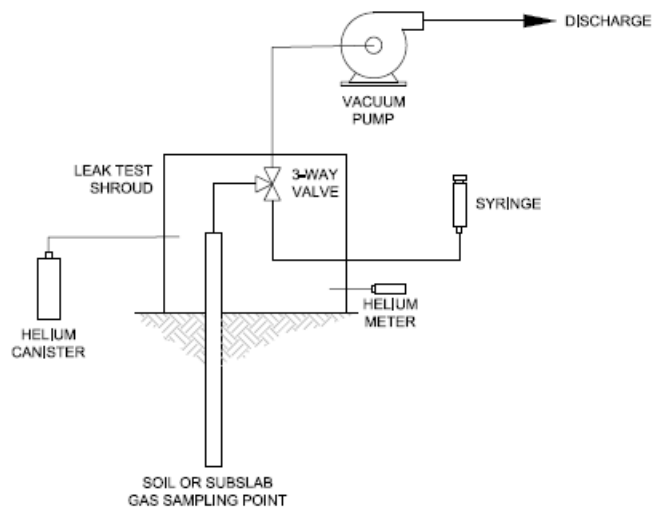


Figure 4:

Sampling Train Configuration for Gas Sampling Bag with Evacuation Chamber

- Conduct shut-in test on the sampling train to check for leaks in the above ground fittings. To conduct a shut-in test,
 - Open each of the three-way valves except the valve connected to the sampling point. Note that the valve associated with the sampling container should remain closed (or, if using a glass syringe, that the plunger is down and sealed) during the shut-in test.
 - Begin evacuating the sample train of air by applying vacuum with the pump or purge canister to a minimum measured vacuum of 100 inches of water.
 - Turn-off vacuum source and observe the vacuum measured using an in-line vacuum gauge. If pressure on the gauge does not dissipate then all above ground connections are considered air tight. If the vacuum dissipates, the shut-in test has failed, and all connections should be inspected for leaks. Repeat the procedure after inspecting and adjusting all connections.
 - If the shut-in test passes, close each of the three-way valves and proceed with the leak testing.
- Leak testing should not occur until the shut-in test passes.
- Conduct leak test on the sampling point to check its integrity. To conduct a leak test:
 - Zero the helium detector to ambient air.
 - If purging using a pump, connect the pump discharge line to a Tedlar® bag (i.e., not the sampling container) which will be used to measure helium concentrations within the sampling train.
 - Open the three-way valves except the valve(s) connected to the sampling container. Note that the valve associated with the sampling container should also remain closed (or, if using a glass syringe, that the plunger is down and sealed) during leak test.
 - Close and seal the shroud.

- Connect the compressed helium gas cylinder to tubing connected to the shroud and open the regulated valve to allow helium to flow into the shroud.
- Measure the concentration of helium within the shroud (target concentration between 10 and 20%).
- Purge the sampling point as follows:
 - Draw air through the probe and associated tubing using the pump, purge canister, or a syringe at a rate no less than 200 mL/min and maintaining a vacuum pressure of less than 100 inches of water.
 - When using a pump or purge canister, flow meters and in-line vacuum gauges can be used to monitor flow rates and vacuum pressure. If using a syringe to purge or for sample collection, flow rates can be monitored by timing the interval at which the plunger is drawn. Similarly, Tedlar® bags can be used to estimate the volume and rate of removal.
 - Remove at least three pore volumes unless otherwise indicated in the project-specific Work Plan/ Field Sampling Plan and/or QAPP.
 - After the required purge volume has been extracted, close the valve on the Tedlar® bag connected to the pump discharge line and the regulator on the helium canister.
 - Remove the tubing connected to the helium meter from the shroud and seal the hole with modeling clay.
 - If purging was performed using a syringe, connect the syringe directly into the helium meter and measure the helium concentration of the purged sub-slab gas. If purging was performed using a pump, connect the Tedlar® bag into the helium meter, open the Tedlar® bag valve, and measure the helium concentration of the purged sub-slab gas. If required by the project-specific Work Plan/Sampling Plan or QAPP, analyze or screen the purge sample with a portable field instrument. If collecting a subslab gas sample, this measurement should be performed outdoors to avoid release of subslab gas into indoor air.
- If helium detections in the purge are non-detect or less than 10 percent of the chamber concentration, the sampling probe integrity is acceptable. Otherwise, the integrity of either the sampling train or the sub-slab sampling probe is considered compromised and requires retesting, repair or reinstallation.
 - If helium is detected at concentrations greater than 10 percent of the chamber concentration, the fittings in the sampling train should be tightened and/or the sub-slab sampling probe should be resealed and the sampling train resampled.
 - If elevated levels of helium are repeatedly detected, abandonment and reinstallation should be considered (refer to **FGD 9.02** - Installation of Subslab Sampling Points, and **FGD 9.03** - Installation of Soil Gas Sampling Points).

- Sample collection should not occur until the leak test passes. Sampling should proceed as follows:
 - If using Polymer (Tedlar®) Gas Sampling Bags
 - Close the valve connected to the pump discharge line and open the valve connected to the sample container.
 - Once the bag is full, close all valves and turn-off the pump.
 - If using Summa Canisters,
 - Measure and record the pressure of the canister upon prior to sampling.
 - Open the canister valve to allow collection of the time-composited sample over the specified time period. Note the flowrate/vacuum on the Summa canister needs to be defined based on the total duration of the sample collection effort (e.g., 8-hour, 12-hour or 24-hour time composite).
 - Close the valve(s) connected to the vacuum source (e.g., purge canister, or vacuum side of the pump) and turn-off the pump (if used).
 - The vacuum in the sampling device will draw the sample from the sampling point.
 - Measure and record the pressure of the canister at the end of sampling. Note that the canisters should be returned to the laboratory with a slight vacuum (two to four inches of mercury).
 - If using gas sampling bags with evacuation chambers,
 - Close the valve(s) connected to the pump (e.g., discharge line and/or vacuum side of the pump) and turn-off the pump.
 - The vacuum in the sampling device will draw the sample from the sampling point.
 - If using glass bulbs or sorbent tubes,
 - Close the valve connected to the second triple-valve (i.e., connected to the vacuum side of the pump) and open the valve connected to the sample container.
 - The duration of the sampling will be defined in the project-specific Work Plan/ Field Sampling Plan and/or QAPP. When using sorbent tubes, the duration will depend on the sorbent and the contaminants being sampled.
 - If using glass syringes
 - Close the valve connected to the vacuum side of the pump and turn-off the pump.
 - Draw the plunger on the syringe at a constant rate to extract the sample.
- Upon completion of the sampling, close all valves and disassemble purge and sampling train.

4.4 Sample Containers

As outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody), equipment and sample containers that will come into contact with collected confirmatory should be constructed of materials that will not affect the concentration of constituents in the sample. Soil gas samples should be collected in gas-tight containers and handled in a manner that will prevent photodegradation of target analytes or otherwise compromise the integrity of the samples. The level of care that needs to be taken with the materials used will depend on the level and types of constituents associated with the sample and the quality assurance needs and study goals. This should be outlined in the project-specific Work Plan/Sampling Plan or QAPP. Brief descriptions of the more commonly used containers for soil gas and subslab gas sampling are provided in **Attachment A**.

The laboratory will provide appropriate sample containers that fulfil volume requirements to perform necessary testing and achieve data quality objectives. The sampling containers and sample volume are a function of the analytical requirements and will be specified in the Work Plan/Sampling Plan or QAPP.

4.5 Sample Transport and Storage

Samples shall be handled, transported and stored to maintain structural and chemical qualities of the samples. Sample containers shall be handled as outlined in **FGD 1.02** (Sample Handling, Shipping and Chain of Custody). All sample containers should be kept in the foam-packed transport container provided by the laboratory during fieldwork. In the absence of a padded transport container, bubble wrap should be used to wrap the sample containers individually to prevent damage during travel.

4.6 QA/QC

Quality Assurance/Quality Control (QA/QC) procedures described in the project-specific Work Plan/Sampling Plan and/or QAPP must be followed throughout the sample collection, processing, handling, and analysis process. In their absence, the QA/QC guidelines of **FGD 1.05** (Field Quality Control Samples) should be reviewed. In general, QA/QC procedures should follow the Work Plan (See **Section 4.1**).

5. PRECAUTIONS AND OTHER CONSIDERATIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while soil gas and sub-slab soil gas sampling. Additionally, implementation of the work may include potential issues to consider as follows:

- It is important to always remain alert and aware of your surroundings. Soil gas and subslab gas sampling is subject to hazards posed by equipment used to install the sampling points, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and/or other physical, mechanical, and chemical hazards;

- Prior to mobilization, determine the location of sampling points and evaluate the need for security, barricading, traffic control (e.g., when sampling points are located on the right of way) and/or clearing access (e.g., when sampling points are located in areas that may be used by vehicles or moveable equipment);
- At sites with certain contaminants and/or subsurface conditions, potentially toxic and/or explosive gases may accumulate at and around the sampling point as it is being sampled. Stay upwind of the sampling point and ensure that air monitoring is conducted and personal protective equipment is used in accordance in the site-specific HASP;
- When working out of sight of the general public or when site employees are in potentially hazardous areas (e.g., wooded habitats), all field staff should utilize the “buddy system” and should ensure that the project-specific HASP includes safety measures and procedures for work in isolated areas;
- Care should be taken when opening sampling point protective covers for the presence of insect nests such as wasps or hornets;
- For some sampling points, keys may not work with rusted/outdated well locks or bolts may be rusted. Bolt cutters may be used to remove the lock, which should be replaced upon completion of sampling. Do not use petroleum based solvent sprays to free seized locks or bolts as it may impact sample quality;
- Sampling points with an air-tight cap may experience a build-up of pressure. Keep your face and body away from the top of the sampling point when loosening or removing the cap;
- Keep any hoses associated with the purging and sampling train untangled;
- For sampling points with no or low gas flow conditions (e.g., low permeability soils), the purge and sampling procedures may need to be modified as follows:
 - If the applied vacuum cannot be maintained below 100 inches of water and a flow rate of 100 mL/min is unattainable, record the threshold vacuum and close the sampling point valve to allow the sampling point to equilibrate.
 - Once the vacuum has completely dissipated (as determined by monitoring with the in-line vacuum gauge), reopen the sampling point valve until the vacuum threshold is met again.
 - Repeat this procedure until the sampling point has been purged at least three times. Note that this method may not be appropriate for larger sampling containers such as Summa canisters.

Sampling of these points should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered. These types of sampling points should, unless it is unavoidable, not be purged at the end of one day and sampled the following day.

- For large diameter sampling points, the standard purge and sampling flow rate of less than 200 mL/min may be impractical and may be increased when approved by the PIC and/or PM, as additional monitoring requirements may be imposed (e.g., pressure, flowrate, nitrogen or other indicators of atmospheric air intrusion, etc.);

- Continuous monitoring for nitrogen or other indicators of atmospheric air intrusion (e.g., oxygen, carbon dioxide, methane and balance gases with a landfill gas meter) during purging can be used to establish whether the applied vacuum should be reduced to prevent ambient air leaks or intrusion;
- Care should be taken to avoid the over tightening of compression fittings as threads may be stripped and the fitting damaged, which could compromise sample integrity;
- When using Summa canisters for sample collection, canister-dedicated gauges should only be relied upon if the gauges have been reported by the laboratory as calibrated and working properly since these gauges tend to be inaccurate due to overuse; and
- Generally, soil gas sampling should not be conducted within 48 hours of significant precipitation. However, whether sampling should be conducted depends on the depth to which the soil is wetted relative to the planned depth of sample collection. Sampling should not be conducted if soils are wetted at a depth equal to or greater than the planned sampling depth.

Changes in barometric pressure can affect the discharge rates of soil venting and soil gas probes that provide a conduit to the subsurface. During barometric lows, flow of soil vapors out of the vadose zone is possible and during barometric highs, flow of atmospheric air into the vadose is possible.

6. RECORDKEEPING

Document all sampling locations in accordance with **FGD 1.04** (Documenting Sampling Locations) and record all information in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management).

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ATTACHMENT A
COMMONLY USED SOIL GAS AND SUBSLAB
GAS SAMPLING CONTAINERS

Following are brief descriptions of the more commonly used containers for soil gas and subslab gas sampling.

Passivated Stainless Steel Canisters / Summa Canisters



Figure A-1:

Summa Canister
(Source: EMSL Analytical, Inc.)

Passivated Stainless Steel Canisters, also called Summa Canisters, are pre-evacuated gas sampling containers that draw air samples by vacuum. They are typically equipped with a flow regulator and vacuum gauge; however, if the canister is not fitted with a permanent vacuum gauge, a field vacuum gauge should be attached between the flow regulator and the canister inlet prior to sampling. The flow regulator allows for the collection of time-composite samples as is required under certain laboratory methods. Prior to use, (a) all connections should be initially hand-tightened to prevent stripping, (b) the integrity of the seal on the canisters should be monitored by measuring and recording the pressure of the unit when the canisters leave the laboratory, during transit from the field to the lab, at the start and end of the sampling, and upon receipt of the canisters; and (c) the sample lines must be purged with sample air prior to opening the canister for sampling to prevent sample dilution. Typically, canisters are returned to the laboratory with a slight vacuum (two to four inches of mercury) and holding times are of less than 14 days.

Polymer (Tedlar®) Gas Sampling Bags

Polymer gas sampling bags (Tedlar®, Teflon®, metal-coated Tedlar®) are sealed bags with one or two septum ports and hose valves (e.g., stainless steel, polypropylene) that allow connection to the discharge hose of a pump. The bag is directly filled from the sampling point using a pump and are considered suitable for sampling of gas contained VOCs, sulfur compounds, carbon monoxide, carbon dioxide, methane, and sulfur hexafluoride. However, some agencies do not allow use of polymer bags for VOC sampling. Check site-specific requirements before using polymer bags for VOC sampling.

The fittings on the valves can be a major source of leakage and must be checked for tightness and integrity. These tests, as well as cleaning or purging of the bags, should be performed with clean air or nitrogen. Given the potential for sorption of contaminants to the bag, the holding times for samples in the gas bag will vary. In general, Tedlar® bags are best suited for short holding times (less than 3 hours). Aluminized bags are the best suited for longer holding times.



Figure A-2:

Tedlar Gas Sampling Bag
(Source: Fisher Scientific)

Surrogates do not need to be added to the samples when using polymer gas sampling bags because surrogate recovery levels cannot be precisely calculated. This is because the volume of the soil gas sample collected in a polymer bag cannot be measured precisely.

Polymer Gas Sampling Bags with an Evacuation Chamber



Figure A-3:

Tedlar bag in Evacuation Chamber
(Source: SKC, Inc.)

Gas sampling bags can be used with an evacuation chamber, which is an air-tight container which allows the sample to be collected without the sample passing through a pump. The evacuation chamber has two fittings to allow: (a) connection from the sampling point directly to the gas sample bag; and (b) removal of air around the gas sample bag in the chamber. By removing the air in the chamber a vacuum is created which in turn causes the bag to fill.

The limitations and recommendations for gas sampling bags listed above also apply to this gas sampling container.

Glass Bulbs

Glass bulbs are glass cylinders with openings at each end and with a septum port that allows sample withdrawal with a syringe (see below). The air sample is collected by connecting one end of the bulb to the probe and the other end to the pump, which draws the sample through the bulb. While glass bulbs are easy to use and are made of inert material, they are easily breakable and can leak contaminants through the valves. In general, samples in glass bulbs are best suited for holding times of less than 24 hours. If needed, soil gas samples collected in glass bulbs should have surrogates added within 15 minutes of collection.



Figure A-4:

Gas Sampling Bulb (Source: Sigma-Aldrich)

Glass Syringes



Figure A-5:

Glass Syringe (Source: Fisher Scientific)

Syringes are used to withdraw a soil gas sample from a probe and inject it directly to an analytical instrument for on-site analysis. They come in varying sizes and materials of construction, although the preferred is the gas-tight glass syringe with Teflon® seals. They are easy to use and replace. When using glass syringes, they should be checked for leaks before each use (i.e., seal of the plunger, wear on the barrel). Syringes should also be leak tested periodically to verify integrity. Plastic syringes should not be used for soil gas sampling due to potential for interaction with some target analytes.

Sorbent Tubes

Sorbent tubes are glass tubes with sealed ends that are filled with a sorbent layer (e.g., charcoal, tenax, carbotrap, polyurethane foam, carbon molecular sieve) specific to the contaminants of interest. Sorbent tubes allow for collection of a wider range of target analyses and for detection of low level concentrations, not detectable by other methods. The sorbent tube is attached to the sampling point and the sample is pumped through the tube, where the sorbent material strips the contaminants from the air. Measurements of the flow rate and volume of soil vapor drawn through the sorbent tube need to be measured accurately. The tube is then analyzed by thermal or solvent extraction. In general, samples in sorbent tubes are best suited for holding times of less than 14 days.



Figure A-6:

Sorbent tubes (Source: Sigma-Aldrich)

FIELD GUIDANCE DOCUMENT NO. 9.02
INSTALLATION OF SUB-SLAB SAMPLING PROBES

FIELD GUIDANCE DOCUMENT NO. 9.02

INSTALLATION OF SUB-SLAB SAMPLING PROBES

Prepared By:	Doug Burge Nick Zurweller
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Applicable To:	
Effective Date:	January 30, 2017
Revision Date:	February 24, 2017
Revision Notes:	1. Added vapor pins®
Documents Used as Reference During Preparation:	Scientific Engineering Response and Analytical Services. <i>Standard Operating Procedures Construction and Installation of Permanent Sub-Slab Soil Gas Wells</i>. 2007. Dominic DiGiulio. U.S. Environmental Protection Agency. <i>Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA Method TO-15 to Support Vapor Intrusion Investigations</i>. Ada, Oklahoma. Department of Toxic Substances Control and California Environmental Protection Agency (DTSC/CalEPA). <i>Vapor Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)</i>. Dated October 2011. New Jersey Department of Environmental Protection. <i>Vapor Intrusion Technical Guidance, v. 3.1</i>. Dated March 2013. Cox-Calvin & Associates, Inc. <i>Standard Operating Procedure Installation and Extraction of the Vapor Pin</i>. Dated September 9, 2016. Cox-Calvin & Associates, Inc. <i>Standard Operating Procedure Leak Testing the Vapor Pin® via Water Dam</i>. Dated March 28, 2016.

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1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll Environ US Corporation (Ramboll Environ) for the installation of permanent sub-slab sampling probes intended for use in collecting soil gas samples contained in the interstitial spaces beneath the concrete floor slab of residential, commercial, and industrial structures. Installation of sub-slab sampling probes provides a means for the collection of representative soil gas or vapor samples to measure the concentration of Volatile Organic Compounds (VOCs) that may have accumulated beneath the floor slab of a structure. Sub-slab gas data is used to evaluate the potential for Vapor Intrusion (VI) into a structure, determine whether contaminants collecting under a building represent a threat to human health via VI, and define whether remedial action is warranted.

Although this FGD provides guidance for sub-slab sampling probe installation associated with typical field activities and projects, it should be understood that for certain projects, more specific sampling procedures or alternative methods, including state-specific or regulatory program-specific guidelines, requirements or procedures, may be applicable. Specific requirements for these types of projects and activities will be reviewed by the Ramboll Environ Principal-in-Charge / Project Director (PIC) and Project Manager (PM) and will be defined in a project-specific Work Plan, Sampling Plan and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans, but rather a general reference for developing project specific requirements. In addition, PICs and PMs are encouraged to provide additional direction or training to junior scientists and engineers for the implementation of the procedures outlined in this FGD.

This FGD does not supersede Ramboll Environ Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll Environ employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by approved site-specific procedures, which may include those recommended in this FGD. The Ramboll Environ PIC and PM must ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information is maintained in the project file for the duration of the project. The signatures of the PIC and PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

A general checklist of equipment that may be required for typical sub-slab sampling efforts is provided below. Additional equipment may be specified in the project-specific Work Plan, Sampling Plan, and/or HASP. This checklist includes an overall summary of general equipment typically required for surface soil sampling and should not be considered exhaustive. More specialized sampling equipment may be required depending on project specific needs or the particular type of sampling to be performed (refer to **Sections 4.3 and 4.4** of this FGD).

1. General Sub-Slab Sampling Equipment Checklist:

- Diagram of structure;

- Building utility diagrams;
- Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during sampling (refer to **FGD 15.01**, Waste Handling);
- Decontamination supplies (refer to **FGD 14.01**, Sampling Equipment Decontamination);
- Appropriate waste container – used to dispose of any Investigation Derived Wastes (IDW) and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling);
- Alternating current (AC) extension cord (best with multiple sockets);
- Ground fault circuit interrupter;
- Portable vacuum cleaner and extensions nozzles;
- Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records); and
- Labels for Investigation Derived Waste (IDW) containers as outlined in **FGD 15.01** (Waste Handling).

2. Project or Task Specific Sub-Slab Sampling Equipment Checklist:

- Hammer Drill or Rotary Hammer.
- Hammer Drill or Rotary Hammer drill bits, 3/8-inch and 1-inch or 1.25-inch diameter. Note that drill bit diameters may vary according to the sizes of the parts used in assembling sampling probe and any project specific requirements.
- 9/16-inch open end wrench and medium adjustable wrench or 3/4-inch open end wrench.
- Plastic disposable cups or small painting tub for mixing cement and/or bentonite.
- Disposable mixing device (i.e., Popsicle stick, tongue depressor, etc.).
- Stainless steel female compression fitting for 1/4" stainless steel tubing with threaded female 3/4" hex size on opposite end. Note that the hex size is the distance from the flat outer edge of one side to the flat outer edge of the exact opposite side, not the distance from opposite corners of the hex.
- Stainless steel threaded hex head plug, 9/16" hex size.
- 1/4" OD stainless steel, Teflon, Nylaflow or PEEK tubing.
- Tubing/Pipe cutter suitable for cutting stainless steel pipe or tubing.
- Teflon tape.
- Permeable stainless steel probe tip.
- Deionized water.
- Anchoring cement (i.e., hydraulic cement or similar).
- Modeling clay (non-volatile) or weather stripping (e.g., Mortite or equivalent).
- Helium canister and regulator.

- Helium meter.
 - Plastic shroud (e.g., clear household storage container) with three holes sized to fit tubing from helium meter, helium canister and sub-slab sampling probe.
 - For California EPA-Lead Sub-Slab Sampling:
 - Sand;
 - Dry and hydrated bentonite; and
 - Teflon Sealing disk.
3. Additional Equipment for Vapor Pin Installation:
- Vapor Pins®, a re-usable, sub-slab sampling device which can reduce installation time (photograph of the Vapor Pin® provided in **Attachment A**).
 - Silicone sleeves.
 - Hammer drill and rotary hammer drill bits, 5/8-inch and 1.5-inch diameter.
 - Vapor Pin® installation/extraction tool.
 - Hammer.
 - Vapor Pin® flush mount cover, if permanent sampling point to be installed.
 - Vapor Pin® drilling guide, if necessary.
 - Vapor Pin® protective cap.
 - Vapor Pin® water dam, if necessary.
 - Distilled water (if water dam is being utilized).
4. Additional Suggested Miscellaneous Equipment:
- Extra vehicle keys.
 - Credit card for gas and emergencies.
 - Road and site maps.
 - Camera and extra batteries.
 - Sample containers (appropriate for various analysis to be performed).
 - Sample labels.
 - Larger or smaller diameter drill bits.

3. PROCEDURES REFERENCED

In addition to the United States Environmental Protection Agency (USEPA) guidance document, the following Standard Practice Instruction (SPIs) and FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **SPI 27**, Subsurface Clearance.

- **FGD 1.01**, Field Notes and Records.
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody.
- **FGD 1.03**, Data Management.
- **FGD 1.04**, Documenting Sampling Locations.
- **FGD 1.05**, Field Quality Control Samples.
- **FGD 2.02**, Site Inspections.
- **FGD 4.01**, Field Screening - Combustible Gas.
- **FGD 4.02**, Field Screening - Volatile Gas.
- **FGD 4.03**, Field Screening - Landfill Gas.
- **FGD 4.06**, Equipment Calibration.
- **FGD 5.03**, Soil Screening.
- **FGD 9.01**, Soil and Sub-Slab Soil Gas Sampling.
- **FGD 9.05**, Passive Soil Vapor Sampling.
- **FGD 14.01**, Sampling Equipment Decontamination.
- **FGD 15.01**, Waste Handling.

The list above is not intended to be all inclusive. Other SPIs and FGDs may need to be referenced based on the specific requirements of the site-specific Work Plan/Sampling Plan (e.g., field screening FGDs, FGDs for sampling of other media, etc.).

4. PROCEDURES

4.1 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02**, Site Inspections. At a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the site-specific HASP;
- Coordinate and obtain permission for site access;
- Complete a subsurface clearance (refer to SPI-27);
- Review project-specific Work plan/Sampling Plan, where applicable;
- Review project-specific Quality Assurance Project Plan (QAPP), where applicable;
- Review and discuss with the PIC and/or PM the proposed Work Plan/Sampling Plan or sampling strategy; and
- Review the standard instruction manual provided by the manufacturer of the specific equipment being used for the installation and sampling of sub-slab sampling probes.

All significant sampling strategy decisions will be approved by the PIC and/or PM before the initiation of associated field activities. The Work Plan/Sampling Plan will be designed for the collection of quality data that will best answer the questions and meet the goals of the study/monitoring program and will include the number of samples, locations, depths, number of sampling sites, and analyses to be performed on each sample. The Work Plan/Sampling Plan will generally provide for some discretion in the field depending on encountered conditions; however, any significant departure from prescribed sampling activities should be approved by the PIC and/or PM.

Prior to the commencement of the field effort, inspect, test, and/or calibrate equipment that will be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration). Pre-labeling sample containers in advance of field efforts may increase productivity (refer to **FGD 1.02**, Sample Handling, Shipping and Chain of Custody).

4.2 General Sub-Slab Sampling Probe Installation Guidelines

The following provides a recommended practice for installation of sub-slab sampling probes in a concrete slab without coverings (tiles, carpet, linoleum, asbestos containing materials, etc.) that is at least 4-inches thick. The thickness of the concrete slab and coverings (tiles, carpet, linoleum, asbestos containing materials, etc.) should be confirmed with site personnel and/or review of building foundation as-built documentation prior to any field work. Installation of sub-slab sampling probes in thinner concrete slabs or where coverings may be present should be defined in the project-specific Work Plans, Sampling Plans, and/or FGDs and should be discussed with the Ramboll Environ PIC and PM.

- Ensure that all equipment/materials required to complete the work have been packed and that they have been inspected to ensure their suitability.
- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.
- If the concrete slab is too hard to drill with a 1-inch bit, drill a 3/8-inch pilot hole. Drill the 3/8-inch diameter inner hole to a depth of approximately 2 inches taking care not to penetrate completely through concrete slab into interstitial space above sub-slab material.
- Drill a 1-inch diameter outer hole to a depth of less than 2 inches at the same location as the inner hole (use the 3/8-inch diameter inner hole as the center of the outer hole). The depth of the 1-inch outer hole should not exceed the depth of the 3/8-inch inner hole.
- Use the vacuum to remove any cuttings/dust that was generated during drilling from within and around the holes.
- Use the drill to extend the 3/8-inch inner hole through the slab and a few inches into sub-slab material. Take care to observe and record the total slab depth when breakthrough occurs, as it can be difficult to determine after over-drilling into the sub-slab material.
- If necessary, temporarily plug the inner hole and use the vacuum to remove any cuttings/dust that was generated during drilling from within and around the outer hole. The fully penetrated 3/8-inch inner hole through the slab should not be vacuumed.

- Construct the sampling probe as follows:
 - Using a tubing/pipe cutter, cut a length of ¼-inch stainless steel tubing equal to the distance from the bottom of the outer hole to the bottom of the slab (i.e., through the slab). Note that in some jurisdictions the stainless steel tube is to extend to the bottom of the cavity while in others it should remain within the concrete slab. Do not allow stainless steel tubing to become obstructed with sub-slab material or drill cuttings/dust.
 - Attach the cut length of ¼-inch stainless steel tubing to the stainless steel female connector for ¼-inch pipe and tube. Tighten the nut so that compression fitting seals this connection as per compression fitting manufacturer's specifications (generally, tighten one-quarter turn beyond hand tight).
 - Insert the 9/16-inch stainless steel threaded hex plug into the threaded female ¾" hex size on opposite end of stainless steel female connector. Hand-tighten the plug. Alternatively, temporarily insert a male fitting and cover it with Teflon tape. After, the probe is completed and cemented in place, replace the male fitting with the hex plug as noted above.
 - Place a small amount of modeling clay around the stainless steel tubing adjacent to the nut that connects the stainless steel tubing to the female connector. If applied in sufficient volume, the modeling clay will seal the annulus between the outer hole and the inner hole when the sampling probe is set and will allow the sampling probe to be flush and centered with the exposed surface of the floor slab. Placement of the modeling clay will also prevent any anchoring cement from flowing into the inner hole during the final step of installation.
- Place the completed probe into the outer hole. The probe stainless steel tubing should not contact the sub-slab material and the top of the female connector with the hex plug should be flush with the surface of the slab and centered in the outer hole.
- Mix a small amount of anchoring cement and fill the annulus between the probe and the outer hole. Allow cement to cure according to manufacturer's instructions or at least two hours after installation of the probe (whichever is greater) before integrity testing or collection of soil gas samples.
- Record the location and installation details (e.g., diameter and length of probe, thickness of concrete), including sketches, of the sub-slab sampling probes should in field notes following installation.

4.3 Vapor Pin® Installation/Extraction Procedure

The following provides an alternative method of installing sub-slab sampling probes using Vapor Pin® technology. The applicability of these procedures should be defined in the project-specific Work Plans, Sampling Plans, and/or FGDs and should be discussed with the Ramboll Environ PIC and PM.

- Ensure that all equipment/materials required to complete the work have been packed and that they have been inspected to ensure their suitability.
- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.

- Confirm with site personnel the thickness of the concrete slab prior to installation (a minimum 4-inch thickness is recommended).
- For flush mount installation, drill a 1.5-inch diameter hole at least 1.75-inches into the slab.
 - Drill a 5/8-inch diameter hole in the center of the larger hole using drilling guide (or into the surface for a temporary point) through the slab and a few inches into the sub-slab material.
 - Temporarily plug the inner hole and use the vacuum to remove any dust that was generated during drilling from within and around the outer hole. The fully penetrated 5/8-inch inner hole through the slab should not be vacuumed.
 - Place the lower end of the Vapor Pin® with a silicon sleeve into the drilled hole. Place the Vapor Pin® installation/extraction tool over the vapor pin and strike the vapor pin into place using the hammer. The silicon sleeve may slightly bulge between the slab and Vapor Pin®. Following installation, place a protective cap on the Vapor Pin® to prevent vapor loss. Wait at least 20 minutes (or as required by state-specific sampling guidance and defined in the project-specific Work Plan or Sampling Plan) after installation of the probe for sub-slab conditions to re-equilibrate before integrity testing or collecting soil gas samples for sub-slab conditions to re-equilibrate.
 - Cover the Vapor Pin® with a flush mount cover.
- Use a short piece of Tygon™ tubing to connect to the sample tubing to the Vapor Pin®. Place the Nylaflow (or appropriate tubing) as close to the Vapor Pin® as possible to minimize contact between the soil gas and Tygon™ tubing.
- Record the location and installation details (e.g., diameter and length of probe, thickness of concrete), including sketches, of the sub-slab sampling probes should in field notes following installation.
- For temporary installations, the probe can be removed following sampling as follows:
 - Place the threaded side of the installation/extraction tool onto the barrel of the Vapor Pin®.
 - Rock the Vapor Pin® back and forth, similar to removing a cork from a wine bottle. Do not pull the Vapor Pin® straight up.
 - After the Vapor Pin® has been removed, fill the void with hydraulic cement.

4.4 Sub-Slab Sampling Probe Installation Procedures for California EPA-Lead Projects

The following describes the sub-slab sampling probe installation procedures prescribed by the California EPA (CalEPA, 2011). The applicability of these procedures should be defined in the project-specific Work Plans, Sampling Plans, and/or FGDs and should be discussed with the Ramboll Environ PIC and PM.

- Ensure that all equipment/materials required to complete the work have been packed.
- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.

- Confirm with site personnel the thickness of the concrete slab prior to installation.
- Drill a 1- to 1.25-inch diameter hole through the slab and remove cuttings and dust generated during drilling was from around the hole using the vacuum cleaner as you progress through the slab.
- Using the drill, extend the hole 3 to 4 inches into the engineered fill or sub slab soil and remove cleaner cuttings and dust generated during drilling from around the hole using the vacuum.
- Measure the total depth of hole and the slab thickness after cleaning.
- Assemble the sub-slab soil vapor kit by connecting the permeable probe tip to the end of the 1/8-inch or 1/4-inch tubing and the sealing cap on the opposite end of the tubing. Alternatively, construct the sampling probe as follows:
 - Using a tubing/pipe cutter, cut a length of 1/8-inch or 1/4-inch stainless steel tubing equal to the distance from the bottom of the outer hole to the bottom cavity below the slab (i.e., through the slab). Do not allow stainless steel tubing to become obstructed with sub-slab material or drill cuttings/dust.
 - Attach a permeable probe tip to the bottom of the cut length of 1/8-inch or 1/4-inch stainless steel tubing.
 - Attach a sealing cap to the top of the cut length of 1/8-inch or 1/4-inch stainless steel tubing.
- Place the sub-slab sampling probe assembly into the hole with the probe tip touching the bottom of the hole.
- Add sufficient sand to the annulus between the hole and the sub-slab sampling probe assembly to cover the top of the probe tip with at least one inch of sand (approximately two inches).
- When required, slide a Teflon™ sealing disk over the probe to prevent the downward migration of wet bentonite into the sand pack.
- Add dry granulated bentonite to the annulus between the hole and the sub-slab sampling probe assembly to above the base of the concrete slab (approximately 1 inch).
- Place hydrated bentonite above the dry granular bentonite (approximately 1 inch). The bentonite for this portion of probe construction should be hydrated at the surface to ensure proper sealing.
- The remainder of the hole should be filled with bentonite grout if the probe is permanent or with hydrated bentonite if the probe is semi-permanent. Prior to the introduction of this material, the concrete surfaces in the borehole should be cleaned with a damp towel to increase the potential of a good seal.
- If required, the probe should be constructed with a gas-tight fitting and flush-mounted well box so that the probe completion is not a tripping hazard.
- Wait at least two hours after installation of the probe before integrity testing or collection of soil gas samples.

- Record the location and installation details (e.g., diameter and length of probe, thickness of concrete), including sketches, of the sub-slab sampling probes should in field notes following installation.

Schematics or photos of the three types of sub-slab sampling probes are provided in **Attachment A**.

4.5 Integrity Testing

The following details two methods to evaluate the integrity of the probe and surface seal prior to sampling: helium tracer testing and water dam testing. Helium tracer testing can be used for integrity testing of all sub-slab sampling probes while water dam testing is specific to sampling using Vapor Pins®. Under some regulatory programs, water dam testing may not be acceptable. Therefore, Federal and/or State regulations and guidance governing subslab sampling probe installation should be reviewed prior to conducting the work. In addition, local Ramboll Environ staff should be consulted on any other regional or local requirements related to water dam integrity testing.

4.5.1 Helium Tracer

The following provides a recommended practice for evaluating the integrity of the probe and surface seal prior to sampling using a helium tracer.

- Zero the helium detector.
- Attach the helium regulator and tubing to the helium canister.
- Place shroud over sub-slab sampling probe and tubing. Modeling clay can be placed at the interface of the shroud and the concrete slab to improve the seal and preserve helium within the shroud.
- Insert the tubing connected to the helium regulator into the shroud through a hole on the shroud and seal the annulus with modeling clay.
- Insert the tubing connected to the sub-slab sampling probe into the shroud through a second hole on the shroud and seal the annulus with modeling clay.
- Insert the tubing connected to the helium meter into the shroud through a third hole on the shroud and seal the annulus with modeling clay.
- Connect the tubing of the sub-slab sampling probe to the syringe or low flow pump. If using a pump, the discharge point should be connected to a tedlar bag.
- Pump helium into the shroud.
- Measure the concentration of helium within the shroud (typically around 10%).
- Purge the sub-slab probe by drawing air through the probe and associated tubing using a syringe or low flow pump at a rate no greater than 200 mL/min. Extract at least 3 pore volumes of air from the sub-slab probe. The purge volume is calculated as follows:

$$\text{Purge Volume} = 3\pi r^2 h$$

Where r is the inner radius of the probe tubing, and h is the length of the probe and connecting tubing.

- After the purge volume has been extracted, close the valve on the tedlar bag and the regulator on the helium canister.
- Remove the tubing connected to the helium meter from the shroud and seal the hole with modeling clay.
- If purging was performed using a syringe, connect the syringe directly into the helium meter and measure the helium concentration of the purged sub-slab gas.
- If purging was performed using a pump, connect the tedlar bag into the helium meter, open the tedlar bad valve, and measure the helium concentration of the purged sub-slab gas.

If helium detections in the purge are non-detect or less than 10 percent of the chamber concentration, the sampling probe integrity is acceptable. Otherwise, the integrity of either the sampling train or the sub-slab sampling probe is considered compromised and requires retesting, repair or reinstallation.

- If helium is detected at concentrations greater than 10 percent of the chamber concentration, the fittings in the sampling train should be tightened and/or the sub-slab sampling probe should be resealed and the sampling train resampled.
- If elevated levels of helium are repeatedly detected, abandonment and reinstallation should be considered.

An illustration of the helium test on sub-slab sampling probes is provided in **Attachment B**.

4.5.2 Water Dam

The following details the water dam procedure used to evaluate the integrity of the probe and surface seal, which is only appropriate when using Vapor Pins®. Note that not all foundations lend themselves to this method. If the foundation material is uneven, damaged or the surface is covered with carpet or other materials not conducive to standing water, the helium test may be more appropriate.

- Clean the slab within a 2-inch radius of the Vapor Pin®.
- Roll modeling clay to form a thin roll and place it around the bottom of the Vapor Pin® water dam. Push the water dam over the Vapor Pin® and against the concrete surface.
- Attach sample tubing to the top of the Vapor Pin® and pour distilled water into the water dam to cover the base of the Vapor Pin® and the tubing connection. Wait for two minutes as concrete will absorb some of the water, which is normal.
- Purge the sub-slab probe by drawing air through the probe and associated tubing using a syringe or low flow pump at a rate no greater than 200 mL/min. Extract at least 3 pore volumes of air from the sub-slab probe. The purge volume is calculated as follows:

$$\text{Purge Volume} = 3\pi r^2 h$$

Where r is the inner radius of the probe tubing, and h is the length of the probe and connecting tubing.

- If water is lost to the sub-slab during purging, remove the water from the water dam, and reposition the Vapor Pin® to stop the leakage. Reseat the leak test equipment if needed and repeat the water dam test. If the water dam test fails twice, consider abandonment and reinstallation. If a significant volume of water is lost to the sub-slab due to leakage, consider abandonment and reinstallation.

4.6 QA/QC

Quality Assurance/Quality Control (QA/QC) procedures described in the project-specific Work Plan/Sampling Plan and/or QAPP must be followed throughout the sample collection, processing, handling, and analysis process. In their absence, the QA/QC guidelines of **FGD 1.05** (Field Quality Control Samples) should be reviewed.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

These are some problems that may occur during sub-slab soil gas sampling probe installation:

- The design and construction of the concrete slab should be known before installation of sub-slab probes is commenced. If a building is determined to have a moisture/vapor barrier and/or a tension slab, special care should be given when hand-drilling through the concrete slab. The effects on the moisture/vapor barrier should be considered and discussed with the building representatives.
- For tension foundation slabs, the tension cables within the slab should be located prior to drilling either through visual observation or through remote-sensing with either a metal detector or ground penetrating radar. The cutting of a tension cable within a slab during drilling could compromise the integrity of the slab.
- Often there are coverings over the concrete slab, including, but not limited to tiles, carpet, linoleum, asbestos containing materials. These coverings may require mitigation, special handling or specific restoration. If lead based paint or asbestos containing materials could be encountered during installation of the sub-slab sampling probes, pertinent health and safety measures should be clearly defined in the site-specific HASP and implemented prior to installation. If restoration of surfaces is required, these should be clearly defined proposed Work Plan/Sampling Plan or sampling strategy and discussed with the PIC and/or PM and the site representative.
- If needed, parts and equipment used for the installation of sampling probes can be decontaminated using Alconox and deionized water. In addition, heating stainless steel parts in an oven to a specified temperature to drive off potential VOC contamination may also be used as a decontamination method. Depending on the data quality objectives of the project, stainless steel tubing and fittings can be purchased as "certified-clean" in original equipment manufacture's packaging.
- Tubing could become obstructed during installation. To avoid obstruction, ensure that the end opening does not contact the sub-slab material, modeling clay, and anchoring cement. If contact occurs with any of these materials, the end opening of tubing should be inspected for obstructions.

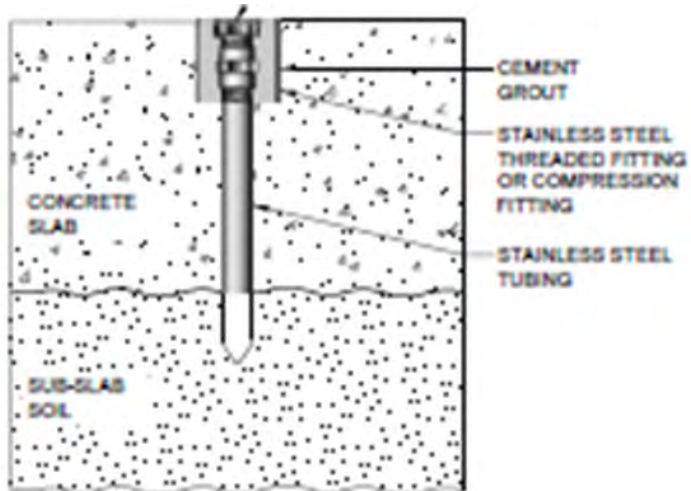
- The top of the female connector with the hex plug might not be flush with surface of the slab and centered in the hole. Drilling the outer hole at an angle and too shallow may cause this issue. To prevent this issue from occurring, both inner and outer holes should be drilled as straight as possible and the outer hole should not be drilled too deep or too shallow prior to installation of the sampling probe.
- Concrete cuttings may accumulate on top of sub-slab material within the interstitial space below the concrete slab. To minimize accumulation of concrete cuttings during installation, the inner and outer holes should be vacuumed before drilling entirely through concrete slab.
- When vacuuming cuttings/dust that was generated during drilling, care should be exercised to prevent vacuuming sub-slab materials.
- The probe could potentially break loose from the anchoring cement while removing hex head plug or the male connector used during sampling. If this occurs, reapply anchoring cement and allow curing before sampling. If unable to create an effective seal when reapplying anchoring cement, re-installation of sampling probe at an adjacent location may be necessary.
- For the installation of sub-slab sampling probe using California EPA guidelines, care should be used in placement of the bentonite to prevent post-emplacement expansion which might compromise both the probe and cement seal.

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ATTACHMENT A
SUB-SLAB SAMPLING PROBE SCHEMATICS

ATTACHMENT A – SUB-SLAB SAMPLING PROBE SCHEMATICS

Figure A-1: General Sub-Slab Sampling Probe Schematic



SOURCE:
STANDARD OPERATING PROCEDURES FOR INSTALLATION OF
SUB-SLAB VAPOR PROBES AND SAMPLING USING EPA METHOD
TO-15 TO SUPPORT VAPOR INTRUSION INVESTIGATIONS.
DOMINIC DI GIULIO, USEPA.

Figure A-1:

General Sub-Slab Sampling Probe Schematic

Figure A-2: Photograph of a Vapor Pin® (Flush Completion)



Figure A-2:

Photograph of a Vapor Pin®

Figure A-3: CalEPA Sub-Slab Sampling Probe Schematic

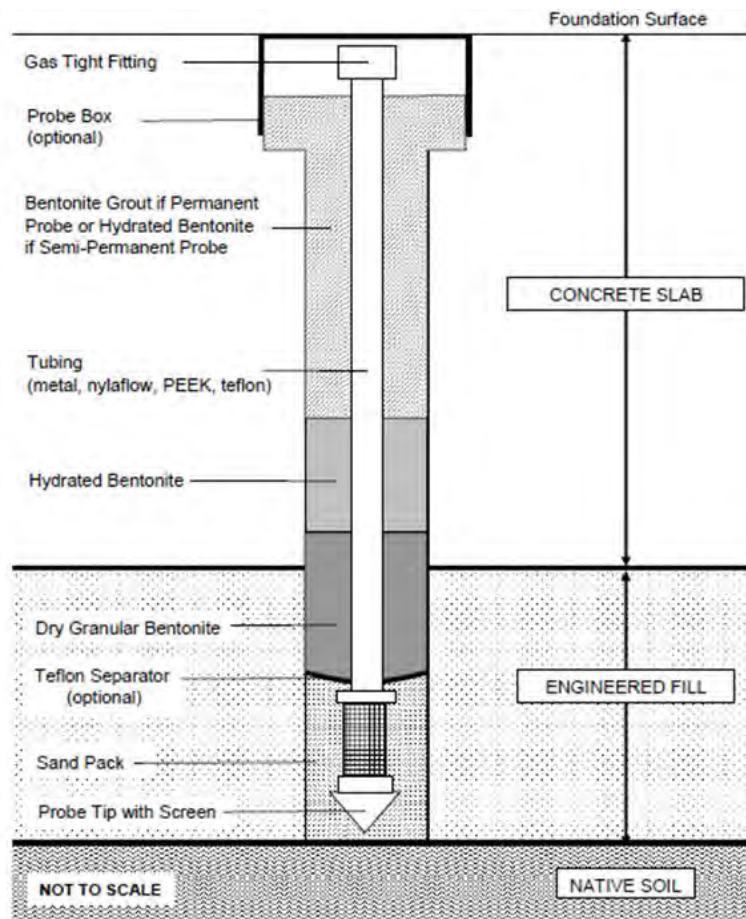


Figure A-3:

CalEPA Sub-Slab Sampling Probe Schematic

ATTACHMENT B
HELIUM TEST SETUP FOR
SUB-SLAB SAMPLING PROBE

ATTACHMENT B - HELIUM TEST SETUP FOR SUB-SLAB SAMPLING PROBE

Figure B-1: Helium Test Setup for Sub-Slab Sampling Probe



Figure B-1:

Helium Test Setup for Sub-Slab Sampling Probe

FIELD GUIDANCE DOCUMENT NO. 14.01
SAMPLING EQUIPMENT DECONTAMINATION

FIELD GUIDANCE DOCUMENT NO. 14.01

SAMPLING EQUIPMENT DECONTAMINATION

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1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll US Corporation (Ramboll) for the decontamination of non-dedicated sampling equipment used for environmental sampling. Decontamination procedures for heavy equipment (e.g., drill rigs, excavators, or other machinery that may be used as part of site investigations or remedial action implementation) are discussed in **FGD 14.02** (Heavy Equipment Decontamination) and decontamination procedures for biological sampling equipment are detailed in **FGD 14.03** (Biological Sampling Equipment Decontamination). The main purposes of non-dedicated sampling equipment decontamination are to (a) prevent cross-contamination of samples resulting from the reuse of the sampling equipment, thereby improving data quality and usability; (b) minimize the transfer of contaminants between sites where the sampling equipment are used; and (c) ensure that sampling equipment can be effectively reused multiple times. Thus, decontamination activities should be viewed as an integral component of the field program.

Sampling equipment decontamination generally is required prior to use, between successive uses, and upon completion of sampling activities (e.g., prior to storing owned equipment or returning rented equipment). Decontamination is performed to ensure that sampling equipment that contacts environmental media (e.g., soil, groundwater, sediment, and surface water) is free from chemical contaminants after each use; and is verified through collection and laboratory analysis of equipment blank samples.

Although this FGD provides guidelines for decontamination procedures associated with typical field activities and projects, it should be understood that for certain projects, more specific decontamination procedures or alternative methods, including state-specific or regulatory program-specific guidelines, requirements or procedures or compound-specific sampling techniques and/or protocols, may be applicable. In addition, compound-specific decontamination procedures may also be applicable. Specific requirements for these types of projects and activities will be reviewed by the Ramboll Principal-in-Charge (PIC) / Project Director and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, Sampling Plan and/or FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans, but rather a general reference for developing project specific requirements.

This FGD does not supersede Ramboll health and safety procedures or Site-Specific Health and Safety Plan (HASP) requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP, followed by approved site-specific procedures, which may include those recommended in this FGD. The Ramboll PIC and/or PM shall ensure that all project personnel review and sign the applicable HASP, and that the signed HASP and relevant project information are maintained in the project file for the duration of the project or as established by applicable Ramboll's document handling and retention policies. The signatures of the PIC and/or PM indicate approval of the methods and precautions outlined in the HASP.

2. EQUIPMENT / MATERIALS

A general checklist of equipment that may be required for typical non-dedicated field equipment decontamination procedures is provided below. This checklist includes an overall summary of general equipment typically required for this equipment decontamination and should not be considered exhaustive. More specialized materials, rinses, or reagents may be required depending on the field sampling equipment and project specific needs.

2.1 General Equipment Checklist

- Site information (e.g., maps, contact numbers, keys or lock codes for gates or access points).
- Field notebook and all-weather or permanent pens as outlined in **FGD 1.01** (Field Notes and Records).
- Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during sampling (refer to **FGD 15.01**, Waste Handling).
- Appropriate waste container – used to dispose of any Investigation Derived Wastes (IDW) and/or decontamination wastes (refer to **FGD 15.01**, Waste Handling).
- Labels for IDW containers as outlined in **FGD 15.01** (Waste Handling).

2.2 Equipment Decontamination Equipment Checklist

- ASTM Type II Distilled and distilled- deionized water (DI water).
- Low-sudsing, non-phosphate containing, laboratory grade detergent (e.g., Alconox or Liquinox, detergent 8).
- Potable water (e.g., tap water).
- Solvent rinse (i.e. high purity acetone or methanol).
- Brushes and other scrubbing devices with non-metallic bristles, such as polypropylene, polyethylene or other plastic.
- Brush with metal bristles or scraper for dry decontamination prior to wet decontamination.
- Spray bottles (at least one filled with potable or distilled water and one filled with DI water).
- 10% nitric acid solution if using carbon steel sampling equipment (e.g., split spoon samplers).
- Organic surfactants (e.g., Simple Green).
- Steam cleaner or pressure washer.
- Racks, stands, standpipes, or other equipment that may be needed for ultra-clean decontamination (e.g., submersible pumps).
- Aluminum foil, Parafilm, or other inert wrapping material.
- At least three 5-gallon buckets and/or larger tubs (for containing larger equipment or when using pressure washers).

- Plastic sheeting or other materials to protect the ground surface.

3. PROCEDURES REFERENCED

The following FGDs are related to this FGD and should be reviewed prior to mobilization, as needed:

- **FGD 1.01**, Field Notes and Records.
- **FGD 1.02**, Sample Handling, Shipping and Chain of Custody.
- **FGD 1.03**, Data Management.
- **FGD 1.05**, Field Quality Control Samples.
- **FGD 5.02**, Subsurface Soil Sampling - Test Pits and Excavations.
- **FGD 5.04**, Surface Soil Sampling.
- **FGD 5.05**, Soil Sampling for VOC Analysis.
- **FGD 5.07**, Subsurface Soil Sampling - Direct Push.
- **FGD 5.08**, Subsurface Soil Sampling - Split Spoon and Shelby Tube.
- **FGD 5.15**, Stockpile Sampling.
- **FGD 5.16**, Soil Sampling for PCB Analysis.
- **FGD 6.02**, Groundwater Sampling.
- **FGD 6.03**, Determination of Hydraulic Properties - Slug Test.
- **FGD 6.04**, Groundwater and Free Product Level Measurements.
- **FGD 6.07**, Well Development.
- **FGD 6.08**, Determination of Hydraulic Properties - Pump Test.
- **FGD 6.09**, Groundwater Sampling - Private and Domestic Wells.
- **FGD 6.10**, Groundwater Sampling for Low Level Mercury.
- **FGD 6.13**, Groundwater Sampling - Vertical Profiling.
- **FGD 6.14**, Determination of Hydraulic Properties - Packer Pressure Test.
- **FGD 6.16**, Groundwater Sampling - Free Product/NAPL.
- **FGD 6.20**, Groundwater Sampling - Low Flow.
- **FGD 7.01**, Surface Water Sampling.
- **FGD 8.01**, Sediment Sampling.
- **FGD 15.01**, Waste Handling.
- **FGD 15.02**, Waste Sampling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPI) may need to be referenced based on the specific requirements of the site-specific Work Plan/Sampling Plan (e.g., field screening FGDs, and FGDs for sampling).

4. PROCEDURES

4.1 Planning and Design Considerations

All significant equipment decontamination decisions shall be approved by the PIC and/or PM before the initiation of field activities. The Work Plan/Sampling Plan should be designed to facilitate the collection of representative data that will meet the goals and data quality objectives of the study/monitoring program and should include specific requirements for non-dedicated field equipment decontamination. The Work Plan/Sampling Plan will generally provide some discretion for modifications in the field depending on encountered conditions; however, any significant departure from prescribed decontamination procedures should be discussed with and approved by the PIC and/or PM prior to implementation.

Prior to conducting the field investigation, consideration should be given to the equipment decontamination requirements, including:

- Contaminants of concern and type of sampling equipment, including material (e.g., stainless steel, HDPE, Teflon);
- Identification of where decontamination activities will take place, considering such factors as traffic patterns, the location of storm water inlets, surface water bodies, wetlands and other potentially sensitive areas;
- Design of the decontamination pad in consideration of the size of equipment being cleaned, measures to capture overspray or spills, the placement of liners, and other site-specific factors;
- Appropriate procedures and schedules for the collection and disposal of decontamination fluids;
- Appropriate procedures and schedules for the replacement of decontamination fluids; and
- Contingency measures and procedures in the event of a spill resulting from the decontamination activities.

For most decontamination activities, decontamination solutions should be prepared with concentrations of approximately 0.5% to 2% detergent by volume using distilled or potable water, depending on State-specific or regulatory program-specific requirements. In cases where detergent cleansing is not sufficient, cleaning solutions should be selected, or the decontamination train modified such that the cleaning agents are neither contaminants of concern at the site nor used in the specified analytical methods, as described below and in Table 1¹:

¹ ASTM-D5088: Standard Practice for Decontamination of Field Equipment Used at Waste Sites.

- Solvent rinses (e.g., acetone, methanol) or an organic surfactant solution (e.g., Simple Green) may need to be incorporated as the first step of the decontamination train to remove organic compounds with poor water solubility, such as oil, grease, or tar.
- To neutralize acidic or basic contaminants on equipment, a sodium bicarbonate solution (5% to 15% by volume) or sodium carbonate (10% to 20% aqueous solution).
- A rinsing solution consisting of trisodium phosphate (10% aqueous solution) to remove organic compounds (such as toluene, chloroform, trichloroethene, or polychlorinated biphenyls). Acid rinses (e.g., nitric, hydrochloric) may need to be incorporated into the decontamination train if metals analyses are to be performed. In such cases, additional health and safety as well as waste management measures will be required.

Table 1: Applications of Various Solutions for Decontamination of Field Equipment and Materials ^{A B C}		
Solution	Concentrations	Remarks
Portable Water	Tap water	Used under high pressure or steam to remove heavy mud and dirt, or to rinse off other solutions.
Laboratory-grade water	Distilled Deionized Reagent grade distilled and deionized water	
Low sudsing non-phosphate detergents (Liquinox, Detergent 8)	Typical concentrations are 0.5 to 2% solution by volume	General all-purpose cleaner. Detergent 8 is recommended for spray cleaning.
Sodium bicarbonate (baking soda)	5 to 15% aqueous solution	Used to neutralize either acidic or strongly basic contaminants.
Sodium carbonate (washing soda)	10 to 20% aqueous solution	Effective for neutralizing inorganic acids, organic acids, heavy metals, metal processing wastes.
Trisodium phosphate (TSP Oakite)	10% aqueous solution	Similar to sodium carbonate. Good rinsing solution for organic compounds (such as toluene, chloroform, TCE, PBBs, and PCBs).
Calcium hypochlorite (HTH)	10% aqueous solution	Disinfectant, bleaching, and oxidizing agent for pesticides, fungicides, chlorinated phenols, dioxins, cyanides, ammonia and other non-acidic inorganic wastes.
Hydrochloric acid, nitric acid	10% nitric 10% to 20% hydrochloric	Used for inorganic bases, alkali and caustic wastes. This material is hazardous and its use should be limited. Care should be taken in both use and disposal of these materials.

Table 1: Applications of Various Solutions for Decontamination of Field Equipment and Materials ^{A B C}		
Solution	Concentrations	Remarks
Citric, tartaric, oxalic acids or their respective salts	5% solution	Used to clean heavy-metal contaminants.
Organic solvents	Neat, undiluted	Used to remove organic compounds that have poor solubility in water, such as oil, grease, and tars. Do not use a solvent that is one of the analytes of interest or interferes with analyses. Porous materials such as polymers can absorb these solvents. These materials are hazardous and their use should be limited. Care should be taken in both use and disposal of these materials.
Notes: ^A Examples of commonly recommended cleaning solvents include pesticide-grade" isopropanol, acetone, methanol, hexane, heptane, and ethanol. Note that these materials are hazardous themselves and their will generate hazardous wastes that must be properly contained, handled, shipped and disposed of. ^B Adapted for Mickam et al. (1989), Moberly (1985), and Richter and Collentine (1983). ^C Many of the solvents listed are themselves hazardous materials. Care should be taken in both use and disposal of these materials. The Safety Data Sheets should be consulted for the selection of the appropriate PPE, handling, and disposal.		

4.2 Pre-Field Work Preparation Guidelines

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02** (Site Preparation, Inspection and Housekeeping). In addition, since samples will be collected from various media, field staff should review and complete pertinent tasks identified in relevant FGDs (e.g., **FGD 6.02**, Groundwater Sampling; **FGD 5.04**, Surface Soil Sampling; **FGD 6.04**, Groundwater and Free Product Level Measurements, etc.).

In addition, at a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the site-specific HASP;
- Coordinate and obtain permission for site access;
- Review project-specific Work Plan/Sampling Plan, where applicable;
- Review project-specific Quality Assurance Project Plan (QAPP), where applicable;
- Review and discuss with the PIC and/or PM the proposed Work Plan/sampling plan outlining decontamination procedures;

- Review and complete pertinent tasks identified in the applicable sampling FGDs (e.g., **FGD 6.02**, Groundwater Sampling; **FGD 5.04**, Surface Soil Sampling; **FGD 6.04**, Groundwater and Free Product Level Measurements); and
- Review **FGD 15.01** (Waste Handling) for management of decontamination fluids and other IDW.

4.3 General Equipment Decontamination Procedures

Decontamination requirements and procedures for sampling/monitoring equipment will vary depending on (a) whether equipment is used for aqueous or non-aqueous media; (b) the analytical method detection levels; and (c) the contaminants of concern (COCs). Commonly used decontamination processes for various equipment and materials are summarized in Table 2 below.²

Table 2: Commonly Recommended Decontamination Procedures for Different Equipment and Different Materials of Construction ^{A B}									
	Soapy Water Wash	Tap Water Rinse	10 % Nitric Acid Rinse ^C	Organic-Free Water Rinse	Rinse with Solvent	Air Dry for 24h	Oven Dry	Store in Aluminum Foil or Polyethylene	Discard After Use
Glass	•	•	•	•	• ^D	•		•	
Teflon	•	•	•	•	• ^E	•		•	
Metals and Stainless Steel	•	•	Do not use	•	• ^D	•		•	
Teflon Tubing	•	•	•		• ^E		• ^F	•	
PVC Tubing				Use Only New PVC Tubing					•
Stainless Tubing	•	•	Do not use	•	• ^D	•		•	
Glass Tubing	•	•	•	•	• ^D	•		•	
Well Sounders	•	•		•					
Submersible Pumps	•	•		•					

² ASTM-D5088: Standard Practice for Decontamination of Field Equipment Used at Waste Sites.

Table 2: Commonly Recommended Decontamination Procedures for Different Equipment and Different Materials of Construction ^{A B}									
	Soapy Water Wash	Tap Water Rinse	10 % Nitric Acid Rinse ^c	Organic-Free Water Rinse	Rinse with Solvent	Air Dry for 24h	Oven Dry	Store in Aluminum Foil or Polyethylene	Discard After Use
Notes: ^A These procedures are based on commonly recommended practices. It should be noted that there is not a lot of experimental data to support some of these practices. Additional Information can be found in studies by Mickam et al., 1989, Parker 1995, Parker and Ranney 1997a, 1997b in press. ^B Sampling equipment that employs a process whereby potentially contaminated material passes through internal mechanical workings (pump, housing, impellers, etc.) can be very difficult to decontaminate. This should be considered when identifying an appropriate decontamination process for equipment with internal sample contacting parts. ^C This step is used in removing inorganic contaminants and can be eliminated if they are not of concern. It is typically not necessary for non-porous surfaces such as glass or stainless steel. ^D Data by Parker and Ranney 1997a, 1997b should show that solvent rinsing may not be needed. ^E Data by Parker and Ranney 1997a, 1997b, show that oven drying may be more effective than an organic solvent rinse for removing sorbed organic contaminants. ^F Excessive heat that could damage the polymer should not be used. Check manufacturer's recommendations for heat tolerance.									

The following provides a recommended list of practices for non-dedicated field sampling equipment decontamination:

- Construct the decontamination area in the predetermined location as follows:
 - Cover the surface of the decontamination area with plastic sheeting in a flat or lightly sloped or depressed area to ensure that the decontamination fluids and any spills from the decontamination activities are captured and can be easily removed. If needed, use 2" x 4" timber or hay bales to create a frame and overlay the plastic sheeting over it.
 - Place appropriate waste containers within the decontamination area to contain any investigation decontamination wastes and IDW and label the containers as outlined in **FGD 15.01** (Waste Handling) pending disposal.
- Don appropriate PPE prior to conducting decontamination (gloves, safety goggles, face shields, Tyvek suits, etc., as appropriate) and change PPE (particularly gloves) as needed during the process to avoid re-contaminating equipment.
- If sampling equipment is laden with soil or sediment or other residuals, dry decontaminate it by scrubbing with a brush or scraper over the appropriate IDW container before proceeding with the wet decontamination. In some cases, residuals will need to be removed using a steam cleaner or pressure washer. Special considerations/precautions should be employed to ensure decontamination fluids applied under high-pressure and the associated residuals are adequately contained.

- Information regarding the decontamination methodology, date, time and personnel should be recorded in the field note book (refer to Section 6).

4.3.1 Wet Decontamination, Non-Aqueous Sampling Equipment (Three-Step Decontamination)

Unless otherwise indicated in site-specific work plans or FGDs, at a minimum, non-aqueous sampling equipment should follow the following three step wet-decontamination process (see Section 4.3.2 for the Seven-Step Decontamination Process description):

- Set up three five-gallon buckets as follows:
 - Detergent wash bucket – fill two thirds of the bucket with a solution of detergent and potable or distilled water.
 - Potable water rinse bucket – fill one third of the bucket with potable water.
 - Distilled-deionized (DI) water rinse bucket – fill one third of the bucket with DI water. Fill a spray bottle with DI water.
- Place sampling equipment in the detergent wash bucket and remove all visible particulate matter and residual oil and grease using a brush with plastic bristles.
- Once all visible particulate matter has been removed, rinse the equipment in the potable water rinse bucket using copious amounts of potable water and the spray bottle filled with potable water.
- Once all detergent been removed from the sampling equipment, rinse the equipment in the DI water rinse bucket using the spray bottle filled with DI water.
- Inspect the decontaminated equipment before use. If contamination persists or is suspected, perform the decontamination procedures for aqueous sampling equipment described below. Otherwise, the sampling equipment is ready for use or storage after it has been allowed to air dry.

4.3.2 Wet Decontamination, Aqueous Sampling Equipment (Seven-Step Decontamination)

Unless otherwise indicated in site-specific work plans or FGDs, at a minimum, aqueous non-dedicated field sampling equipment (or non-aqueous non-dedicated field sampling equipment requiring additional decontamination) should follow the following seven step wet-decontamination process:

- Set up seven five-gallon buckets as follows (note that some may not be needed depending on the COCs and analyses to be performed):
 - Detergent wash bucket – fill two thirds of the bucket with a solution of detergent and potable or distilled water.
 - Potable water rinse bucket – fill one third of the bucket with potable water.
 - DI water rinse bucket – fill one third of the bucket DI water. Fill a spray bottle with DI water.

- Nitric acid rinse (only if metals analysis is to be performed) – this bucket will initially be empty. Fill a spray bottle with a solution consisting of 10% nitric acid diluted with DI water.
- DI water rinse bucket (only if metals analysis is to be performed) – fill one third of the bucket DI water. Fill a spray bottle with DI water.
- Solvent rinse (only if organics analysis is to be performed) – this bucket will initially be empty. Fill a spray bottle with high purity acetone or methanol. Note that if acetone is known or suspected to be a COC or a Target Compound List analysis is to be performed, methanol should be used. However, methanol cannot be used when sampling media are impacted by gasoline or its by-products.
- DI water rinse bucket (only if organics analyses is to be performed) – fill one third of the bucket DI water. Fill a spray bottle with DI water.
- Place sampling equipment in the detergent wash bucket and remove all visible particulate matter and residual oil and grease using a brush with plastic bristles. Sampling equipment may need to be opened or taken apart to ensure all components that contact samples are adequately decontaminated.
- Once all visible particulate matter has been removed, rinse the equipment in the potable water rinse bucket using copious amounts of potable water and the spray bottle filled with potable water.
- Once all detergent has been removed from the sampling equipment, rinse the equipment in the first DI water rinse bucket using the spray bottle filled with DI water.
- If metals analysis is to be performed, rinse the equipment in the nitric acid rinse bucket using the spray bottle filled with the nitric acid solution. Follow-up with a rinse in the second DI water rinse bucket using the spray bottle filled with DI water.
- If organics analysis is to be performed, rinse the equipment in the solvent rinse bucket using the spray bottle filled with solvent. After the solvent has been allowed to evaporate, follow-up with a rinse in the third DI water rinse bucket using the spray bottle filled with DI water.
- Inspect the decontaminated equipment before use. If contamination persists or is suspected, repeat the decontamination procedures.

4.3.3 Wet Decontamination, Aqueous Sampling Equipment (Field Ultra-Clean Decontamination)

In certain situations (e.g., contaminant or general chemistry parameters are being measured at very low detection limits), equipment such as sampling pumps, tubing, and/or stainless steel bailers that come into direct contact with groundwater (or surface water) may require additional cleaning to ensure removal of trace amounts of contaminants.^{3 4} These procedures should be detailed in the project-specific Work Plan.

³ New Jersey Department of Environmental Protection Field Sampling Procedures Manual, August 2005.

⁴ U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A3, April 2004, accessed June 5, 2017, at <http://pubs.water.usgs.gov/twri9A3/>.

To effectively achieve decontamination of such equipment or where inorganic indicators or ambient sensitive constituents are being analyzed, the following ultra-clean decontamination procedures should be followed as specified in the project-specific Work Plan:

- Set up five sufficiently sized containers containing the following:
 - Detergent wash container – fill two thirds of the container with a solution of detergent and potable water.
 - Potable water rinse container – fill one third of the container with potable water.
 - DI water rinse container – fill one third of the container DI water. Fill a spray bottle with DI water.
 - Methanol rinse container – solvent-resistant container to be filled with approximately 2 liters of solvent (methanol), if organic constituents are being tested and project needs require additional decontamination. Fill a spray bottle with methanol.
 - Blank water – laboratory-provided DI water that is free of known constituents (target analytes). Fill a spray bottle with DI water.
 - Blank water rinse container - this bucket will initially be empty. Fill a spray bottle with organic-grade blank water (i.e., pesticide-grade or volatile-grade), prepared and/or quality assured by the analyzing laboratory.
- Place pump and other sampling equipment in the detergent wash bucket and remove all visible particulate matter and residual oil and grease using a brush with plastic bristles. State specific guidelines may require additional steps, such as soaking prior to removal of particulate matter.
- Once all visible particulate matter has been removed, rinse the equipment in the potable water rinse bucket using copious amounts of potable water and the spray bottle filled with potable water.
- Discard the initial detergent solution (containing particulate matter and residue from initial scrubbing) and replace with new detergent solution. Place the pump and other sampling equipment into the container such that the equipment is immersed.
 - Agitate equipment to effectively rinse.
 - For pumps, ensure that the intake is below the detergent solution level) and operate to achieve at least 3 recirculation cycles of the pump/tubing volume. If possible, adjust the flow rates (alternate high and low speeds) and/or introduce air periodically to increase cleaning efficiency.
 - When completed, pump approximately two pump/tubing volumes into a waste container (adding additional detergent solution to container, as needed for pump to operate).
- Remove equipment from container, and then rinse the inside of the container using potable water (until all sudsing stops).
- Rinse exterior of equipment/pump with potable water, and place into DI water rinse container (for pumps, water should be above the pump intake). Agitate equipment to rinse. For pumps, continue agitating within the DI water rinse container, and begin pumping but do not recirculate water – discharge to a waste container. Recirculate for

five or more equipment volumes (adding potable water/DI water as needed to maintain flow). To confirm adequate rinsing of pumps, capture a small aliquot of discharged water in a container, and shake to observe sudsing. Repeat until no suds appear.

- If the equipment is being used for inorganic constituent sampling only, change gloves, and rinse equipment in the DI water container. For pumps, use similar procedure as above (discharging water, not recirculating) and test for suds using a small bottle.
- If required, collect a field blank for Quality Assurance purposes in accordance with the project-specific Work Plan/Sampling Plan, or Quality Assurance Project Plan (QAPP) and **FGD 1.05** (Field Quality Control Samples).
- If the pump/equipment is being used for organic constituent sampling, place in the methanol rinse container. Make sure that the pump/equipment and nearby electrically powered equipment is grounded, and potential sources of sparks are eliminated before operating pumps. Don appropriate personal protective equipment (e.g., safety glasses, face shield, apron, nitrile/latex gloves, Tyvek suit, etc.) and work in a well-ventilated area downwind of the sampling locations, in accordance with the Site-Specific HASP.
- Immerse pump/equipment in the methanol rinse container (for pumps, to above the intake level). Agitate equipment, or for pumps, operate to discharge approximately 2 liters of solvent into a waste container (adding solvent to container as needed, to maintain flow). Stand back from pumps during operation as a safety precaution. Place any unused methanol into an appropriate waste container and let residual methanol in methanol rinse container evaporate to dryness.
- Change gloves, and then rinse pump/equipment exterior with organic-grade blank water and place into an air-dried container. Add organic-grade blank water to immerse equipment/pump to force residual methanol out of components, and capture in waste methanol container. If pump/equipment includes reusable tubing, rinse with an additional approximately 0.5 liter of organic-grade blank water per 10-feet of attached tubing.
- If equipment blanks are required, repeat this procedure using laboratory-provided blank water, and collect a field blank in accordance with the project-specific Work Plan/Sampling Plan, or Quality Assurance Project Plan (QAPP) and **FGD 1.05** (Field Quality Control Samples).

4.3.4 Storage of Decontaminated Sampling Equipment

To store the decontaminated sampling equipment, wrap the equipment in an inert wrapping material (e.g., aluminum foil, plastic wrap, Parafilm) and place in a sealed container that has been similarly decontaminated. Prior to storage equipment should be air dried to avoid bacterial growth. In some cases, inert gas or filtered air may need to be blown through equipment. Alternatively, the equipment can be chilled to avoid bacterial growth. If bacterial growth is observed, decontaminate again prior to use.

4.4 Quality Assurance / Quality Control

The effectiveness of the sampling equipment decontamination procedures is evaluated through collection of field blank samples. Guidance on the collection of field blanks is provided in **FGD 1.05** (Field Quality Control Samples). Details on the number of field blanks and the analyses to be performed on each sample, along with other Quality

Assurance/Quality Control (QA/QC) procedures should be outlined in the project-specific Work Plan/Sampling Plan, or Quality Assurance Project Plan (QAPP). In their absence, the QA/QC guidelines of **FGD 1.05** (Field Quality Control Samples) should be reviewed. However, it is generally recommended that field blanks be collected at a rate of 5% (1 per 20) of the total number of samples collected throughout the sampling event or one per sampling day if the total number of samples is less than 20. State-specific or regulatory program-specific guidelines may require that field blanks be collected more frequently.

5. PRECAUTIONS AND OTHER CONSIDERATIONS

All field activities require recording sufficiently detailed information throughout the implementation of field work. However, certain precautions should be taken to ensure safety while performing equipment decontamination activities.

- It is important to always remain alert and aware of your surroundings. Decontamination activities may be conducted in proximity to drill rigs or other heavy equipment and can be subject to hazards posed by nearby equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and/or other physical, mechanical, and chemical hazards.
- Prior to mobilization, determine the proposed location of the decontamination areas and evaluate the need for security, barricading, and/or traffic control.
- When working out of sight of the general public or site employees are in potentially hazardous areas (e.g., wooded habitats), all field staff should utilize the “buddy system” and should ensure that the project-specific HASP includes safety measures and procedures
- Decontamination procedures may involve the use of hazardous materials including acids, and organic solvents, which can pose chemical hazards during transportation, storage, and handling. Prior to use of any such reagents, discuss the health and safety procedures with the PIC and/or PM, and consult the project-specific HASP, as appropriate.
- Decontamination procedures may involve the use of high-pressure applications such as pressure washers and special considerations should be given to containing those fluids and the associated residuals.
- Decontamination wastes are considered IDW and shall be containerized, labelled and managed as outlined in **FGD 15.01** (Waste Handling).
- A nitric acid rinse is generally only required if metals analyses is to be performed and/or if visual contamination persists or gross contamination is suspected following the three-step decontamination procedure. When an acid rinse is required additional health and safety as well as waste management measures will be required.
- A solvent rinse is generally only required if organics analyses is to be performed and/or if visual contamination persists or gross contamination is suspected following the three-step decontamination procedure. Note that if acetone is known or suspected to be a COC or a Target Compound List analysis is to be performed, methanol should be used.

However, methanol cannot be used when sampling media impacted by gasoline or its by-products.

6. RECORDKEEPING

Document all decontamination activities in accordance with **FGD 1.01** (Field Notes and Records). At a minimum, the following information should be recorded for each decontamination activity:

- Date and time.
- The decontamination methodology, including details on the source water and rinsates.
- Location (i.e., boring, well, sample number) where the equipment was used before and after decontamination.
- Location and description of the decontamination area.
- Details on the IDW generated and managed (i.e., stored, characterized, disposed).
- Identification of any field blank samples collected.

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FIELD GUIDANCE DOCUMENT NO. 15.01
WASTE HANDLING AND MANAGEMENT
PROCEDURES

FIELD GUIDANCE DOCUMENT NO. 15.01

WASTE HANDLING AND MANAGEMENT PROCEDURES

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ATTACHMENTS

Attachment A: Hazardous Waste Storage Area Inspection Checklist

Attachment B: Waste Tracking Form

1. INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by Ramboll for the handling and management of waste materials generated during implementation of site investigation or remedial action activities. Waste materials may include:

- Solids (e.g., soil cuttings, excavated soils or sediments, demolition¹ materials, remediation waste²);
- Liquids (e.g., well development water, decontamination fluids, waste water, recovered groundwater, recovered dense non-aqueous phase liquids, remediation waste²);
- Personal protective equipment (PPE; such as used gloves, Tyvek/chemical-resistant coveralls, spent respirator cartridges); and
- Miscellaneous municipal solid waste (office waste, food waste, plastic bags, discarded paper products).

Generally, waste generated during implementation of site investigations or remedial activities is classified as either (1) hazardous, or (2) non-hazardous waste. Hazardous wastes are regulated by the Resource Conservation and Recovery Act (RCRA) or individual states (as non-RCRA hazardous waste [e.g., used oil in California]). Non-hazardous waste can be non-regulated, or it can be regulated by other regulatory programs such as the Toxic Substances Control Act (TSCA).

1. RCRA regulates the control of the generation, transportation, treatment, storage, and disposal of solid³ waste. A solid waste is considered hazardous, if not excluded from regulation as hazardous waste (40 CFR 261.4) and if it (a) exhibits hazardous waste characteristics as defined in 40 CFR 261 Subpart C (i.e., ignitability, corrosivity, reactivity or toxicity), (b) is listed in 40 CFR Subpart D, or (c) is a mixture of solid waste and one or more hazardous wastes not specifically excluded under 40 CFR 260.20 and 260.22. These materials will require management as hazardous waste at permitted facilities conforming to RCRA Subtitle C and may be subject to the land disposal restrictions of 40 CFR 268.

Note that in some states, some wastes are classified as non-RCRA hazardous waste because they are considered hazardous on a state level but are not listed as hazardous under RCRA. State requirements and definitions regarding classification of hazardous wastes should be reviewed.

2. TSCA regulated wastes that may be encountered during site investigations or remedial activities include polychlorinated biphenyls (PCBs), lead, and asbestos⁴. Generally, these pollutants are not defined as hazardous waste. PCB wastes are subject to the disposal

¹ In this document, demolition materials refer to separated concrete, concrete rubble, concrete slabs, block, brick and concrete fines.

² In this document, remediation waste refers to unsuitable or contaminated excess solid reagents (e.g., ZVI) or liquid (e.g., oxidants) that cannot be used as originally intended.

³ It is important to note that the RCRA definition of solid waste refers to any discarded materials, including those that are physically solid, liquid, semi-solid, or contained gaseous material.

⁴ In the context of this FGD, TSCA waste refers to PCB waste, managed under the TSCA program.

requirements of 40 CFR 761 Subpart D. PCB remediation waste refers to PCB-containing waste generated as a result of a spill, release, or other unauthorized disposal, at the following concentrations: (a) materials disposed of prior to April 18, 1978, that are currently at concentrations ≥ 50 parts per million (ppm) PCBs, regardless of the concentration of the original spill; (b) materials that are currently at any volume or concentration where the original source was ≥ 500 ppm PCBs beginning on April 18, 1978; (c) materials that are currently at any volume or concentration where the original source was ≥ 50 ppm PCBs beginning on July 2, 1979; and d) materials that are currently at any concentration if the PCBs are spilled or released from a source not authorized for use under 40 CFR 761. PCB remediation waste includes soil, debris generated as a result of a PCB spill cleanup, sewage sludge, aqueous decantate, buildings and other man-made structures (such as concrete floors, wood floors, or walls), porous surfaces, and non-porous surfaces. These materials will require management as TSCA-regulated waste at permitted facilities.

3. Non-hazardous waste refers to solid waste that does not meet the RCRA definition of hazardous waste. These materials will require management as non-hazardous waste at permitted facilities conforming to RCRA Subtitle D.

In some cases, comingled waste, which is a waste that meets the definition of both hazardous waste and TSCA regulated waste, may be generated from investigation or remedial activities. Such waste will require management in conformance to both RCRA Subtitle C and 40 CFR 761 Subpart D and may be subject to the land disposal restrictions of 40 CFR 268.

Although this FGD provides guidelines for waste handling and management associated with typical field activities and projects, it should be understood that some projects may generate certain wastes requiring special handling and characterization (e.g., radiological waste, biological waste, asbestos containing materials, lead-based paint). Further, for certain projects, more specific waste management procedures may be applicable, including state-specific or regulatory program-specific guidelines, requirements or procedures. Specific requirements for waste management in these types of projects and activities will be reviewed by the Ramboll Principal-in-Charge/Project Director (PIC) and Project Manager (PM) and any additional requirements will be defined in a project-specific Work Plan, Sampling Plan, Site-Specific Health and Safety Plan (HASP) and/or other FGDs. It should be emphasized that these guidelines are not meant to be project-specific work plans, but rather a general reference for developing project specific requirements.

It should be noted that Ramboll PIC and PM should make sure that the project Client has signed Ramboll's specific terms and conditions in reference to RCRA compliance. Similarly, Ramboll waste management subcontractors should adhere to Ramboll standard terms. It should be understood, that Ramboll's role is only to oversee/coordinate the waste handling activities; Ramboll personnel shall not transport or dispose of any waste.

This FGD does not supersede Ramboll Health and Safety procedures or HASP requirements; in the event of conflict between this FGD and the site-specific HASP, the procedures outlined in the HASP shall prevail. All Ramboll employees shall follow the guidelines, rules, and procedures contained in the site-specific HASP followed by procedures recommended in this FGD. The Ramboll PIC and PM shall ensure that all project personnel review and sign the

applicable HASP, and that the signed HASP and relevant project information are maintained in the project file and are available to all site personnel for the duration of the project.

2. EQUIPMENT / MATERIALS

A general checklist of equipment that may be required for typical waste handling and management is provided below. This checklist includes equipment and supplies typically required; however, it should not be considered exhaustive. Additional equipment may be specified in the project-specific Work Plan and/or HASP.

2.1 General Waste Handling Equipment

- Site information (maps, contact numbers, previous field logs, etc.).
- Garbage bags, plastic bags, rolls of plastic sheeting
- Tool kit with appropriate tools for opening/closing containers and securing covers (socket wrench set, pry bar, drum wrench, duct tape, bungee cords, rope).
- Containers for waste (e.g. Department of Transportation (DOT)-rated 55-gallon open and closed top drums, covered roll-off bins, baker tanks, poly tanks, 5-gallon buckets with lids)
- Equipment for moving containers (e.g. drum dolly, truck with a lift gate, forklift⁵)
- Hazardous/Non-hazardous/Analysis pending drum labels (weatherproof)
- Field screening equipment as required by the site-specific Work Plan or Sampling Plan and the site-specific HASP.
- PPE in accordance with the site-specific HASP, including sterile gloves, which must always be worn when handling waste. Note that Level B or C PPE may be required.
- Fire extinguisher and spill containment equipment
- Field book or pertinent field logs/forms, chain of custody forms, and all-weather or permanent pens as outlined in **FGD 1.01** - Field Notes and Records.

2.2 Miscellaneous Additional Suggested Equipment

- Extra vehicle keys.
- First aid kit.
- Mobile phone and camera.
- Credit card for gas and emergencies.
- Road and site maps.

⁵ Note that forklifts should not be operated by Ramboll employees.

3. PROCEDURES REFERENCED

The following Standard Practice Instruction (SPIs) and FGDs are related to this FGD and should be reviewed prior to fieldwork, as needed:

- **FGD 1.01**, Field Notes and Records.
- **FGD 1.03**, Data Management.
- **FGD 2.02**, Site Preparation, Inspection and Housekeeping.
- **FGD 14.02**, Heavy Equipment Decontamination.
- **FGD 15.02**, Waste Sampling.

The list above is not intended to be all inclusive. Other FGDs and Standard Practice Instruction (SPIs) may need to be referenced based on the specific requirements of the site-specific Work Plan/Sampling Plan/HASP (e.g., field screening FGDs).

4. PROCEDURES

4.1 Planning and Design Considerations

Waste generated during site investigations and remedial activities typically includes solid waste (including contaminated soil or sediment, waste or non-spec remediation materials, and demolition materials), liquid waste (including contaminated groundwater, waste water, Non-aqueous phase liquids (NAPLs), and decontamination water), used PPE, and/or municipal solid waste. Management and handling of waste materials will depend, among other considerations, on:

- The waste characterization results (refer to **FGD 15.02**, Waste Sampling). Waste materials are typically segregated and stored separately based on characterization results or suspected levels of contamination, such that RCRA hazardous waste, non-RCRA state-specific hazardous waste, TSCA regulated waste, comingled RCRA hazardous and TSCA regulated waste, non-hazardous waste, and municipal solid waste are managed independently;
- How waste is stored. Solid waste materials are typically stored in stockpiles, drums, or roll-off bins or could be directly loaded onto trucks. Similarly, liquid wastes are typically containerized in drums or tanks, and could be extracted by vacuum trucks. Municipal solid waste is typically stored in plastic bags. PPE is typically stored in drums and managed as solid waste, and in some cases, in plastic bags and managed as municipal solid waste;
- The condition of the storage device. In cases where waste materials are stored in drums or other containers that are damaged, corroded, dented or bulging, such containers may need to be overpacked to allow safe handling and transport; contact and discuss with PIC and/or PM and waste disposal subcontractor on how to proceed;
- The quantity of waste and the location of the disposal or treatment facility. These could define the most cost-effective waste management (e.g., transport via truck, rail or barge); and

- The location of the waste materials. This could define what equipment may be required to load and transport the wastes and whether any site improvements (e.g., temporary access roads or ramps) will be necessary.

All significant waste management and handling strategy decisions shall be approved by the PIC and/or PM before the initiation of field activities, including, but not limited to, the selection of the waste disposal or treatment facility and the mode of transport. As part of this process, the licensing (e.g., State permit or license) and regulatory status (e.g., if subjected to significant fines or violations) of the treatment or disposal facility(ies) should be evaluated. The Work Plan/Sampling Plan/HASP should clearly establish procedures for waste material storage, loading, and transport and meet applicable waste transport disposal requirements. The Work Plan/Sampling Plan/HASP should generally provide for some discretion for modifications in the field depending on encountered conditions; however, any significant departure from prescribed sampling activities should be approved by the PIC and/or PM.

4.2 Pre-Field Work Preparation Procedures

Before initiating field activities, field staff should review and complete pertinent tasks identified in **FGD 2.02**, Site Preparation, Inspection and Housekeeping. In addition, to the extent that non-dedicated equipment is to be used (e.g., excavator bucket for loading of waste material), to minimize potential cross-contamination of materials, such equipment should be decontaminated as described in **FGD 14.02** (Heavy Equipment Decontamination), the project-specific Work Plan/sampling plan and/or the Quality Assurance Project Plan (QAPP).

At a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the site-specific HASP;
- Review any permits and permit conditions that may be required for the planned site work including air, dust, sound monitoring, and restricted operating hours;
- If work is being conducted under agency supervision, make appropriate advance notifications to advise commencement of the field effort;
- Coordinate and obtain permission for site access and define, with the Site Owner, where waste containers should be staged. The location should be secured and, ideally, should be easily accessible to waste haulers;
- Complete a subsurface clearance (refer to **SPI 27**), if excavating and direct loading solid waste materials;
- Review project-specific Work Plan/Sampling Plan, where applicable;
- Review project-specific QAPP, where/if applicable;
- Review and discuss with PIC and/or PM the proposed waste management and handling strategy, including which wastes should be segregated (if any) based on characterization results;

- Review the standard instruction manual provided by the manufacturer of the specific field monitoring and/or sampling equipment being used for the waste management activity; and
- Ensure that all equipment/materials required to complete the work have been packed prior to mobilization.

4.3 General Waste Management Guidelines

The waste management procedures outlined in this FGD are for solid waste⁶ (e.g., soil cuttings, excavated materials or sediment), demolition materials, liquid waste (e.g., well development water, decontamination fluids, contaminated groundwater, waste water), NAPL, and used PPE. The following provides a recommended list of practices for waste management and handling activities.

Prior to the commencement of the field effort, Ramboll oversight personnel should inspect, test, and/or calibrate equipment that will be used to take field measurements (refer to **FGD 4.06**, Equipment Calibration). In addition, prior to their use all waste containers should be inspected for the following:

- Bulging/dimples;
- Crystals around the drum opening;
- Leaks, holes, stains;
- Existing Labels, markings, hazard warnings;
- Rust; and
- Damaged wall, bottom, lid/hatch or cover.

Containers showing any of the signs listed above or containing liquid or solid residue of unknown origin should not be used for waste containerization and should be removed from the site by an appropriate contractor under Ramboll supervision and discarded.

4.3.1 Solid Waste

Excess soil or sediment generated during field investigations may include soil cuttings and/or drilling muds from boreholes. In addition, soil waste is generated from remedial implementation (such as installation of injection wells or excavation of contaminated soils or sediment). The following provides a recommended list of practices for the handling and management of solid waste generated from soil borings:

- If allowed by State regulations, soil cuttings can be returned to the borehole in the reverse order that they were collected, such that cuttings from the last interval sampled are inserted into the borehole first. This will result in the placement of excess soil cuttings from the approximate intervals that they were collected from.

⁶ Common trash (office waste, food waste, etc.) may be disposed of as municipal solid waste provided it has not been in contact with solid or liquid waste.

- If the cuttings from soil borings need to be disposed off-site, excess soil cuttings should be containerized. Generally, 55-gallon, DOT-rated steel drums are utilized for this purpose.
- In instances where small quantities of soil cuttings are generated, a 5-gallon plastic or steel bucket with a lid can be utilized to containerize the soil cuttings. In instances where large quantities of soil cuttings are generated or where soil cuttings are generated concurrent with a remedial action that includes excavation of soil, the soil cuttings can be containerized in roll-off bins or stockpiles in the same manner as the excavated soils.
- Drum lids, bucket lids and roll-off bin covers should be open only when solid waste materials are being added to the containers and the lids/covers should be secured at the end of each workday and/or once the container(s) is full. The containers should be labeled in accordance with **Section 4.4** and disposed off-site in accordance with **Section 4.5**.

Remedial activity-related solid waste such as excavated soil can either be containerized in roll-off bins fitted with covers, stockpiled or directly loaded onto trucks for off-site disposal. Stockpiling and placement in roll-off bins is typically used when waste characterization results are not available or when site conditions or the rate of solid waste generation does not allow direct loading. Direct loading is allowable when waste characterization has been completed and the required approvals of the waste disposal facility(ies) have been procured. The following provides a recommended list of practices for the handling and management of solid waste generated from removal activities:

- If solid waste is to be stockpiled prior to loading for off-site disposal:
 - Construct a berm around each proposed stockpile (a separate stockpile should be created for each solid waste classification) with site soils, imported fill or hay bales and place a layer of plastic sheeting or a geomembrane under/at the base of the proposed stockpile area and over the berm. This system will prevent direct contact between the stockpiled material and the underlying soils and prevent water (e.g. rainwater) from emanating to/from the stockpile area.
 - Place hay bales or silt fence around the proposed stockpile area as a soil erosion and sediment control measure.
 - Once solid waste placement in the stockpile area commences, the stockpile should be covered with plastic sheeting at the end of each work day and when precipitation is forecasted. The plastic sheeting layer should be secured with sand bags and ropes to ensure no portion of the solid waste stockpile is exposed to the elements.
- If solid waste is to be placed in roll-off bins:
 - Place a layer of plastic sheeting along the side of the roll-off bin where material loading will take place. This will allow collection of any spilled materials and prevent direct contact between materials requiring off-site disposal and the underlying soils. Note, a layer of plastic sheeting may also be placed inside the roll-off bin by the waste transport subcontractor.

- Once solid waste placement in the roll-off bin commences, the roll-off bin should be covered and secured with the lid or a tarp at the end of each work day and when precipitation is forecasted.
- If solid waste is to be directly loaded onto trucks:
 - Prepare the loading area in accordance with the Remedial Action Work Plan.
 - Prior to loading trucks, ensure that waste materials cannot be spilled out of the vehicle during transport. If need be, the truck bed may need to be lined with plastic sheeting to prevent loss of waste during transport.
 - When loading trucks, ensure the load is evenly distributed on the truck bed and that the load does not exceed the truck capacity. If weights are exceeded, the truck may not be allowed on the road, subject to fines, and/or may be denied access to the disposal facility.
 - Upon completion of the truck loading, the load should be covered with a secured tarp to prevent material loss during transport.

4.3.2 Demolition Materials

Demolition materials are sometimes generated during a site investigation/remediation. Remedial activity-related demolition waste such as separated concrete, concrete rubble, concrete slabs, block, brick and concrete fines can either be containerized in roll-off bins fitted with covers, stockpiled, or directly loaded onto trucks for off-site disposal. Like solid wastes, stockpiling and placement in roll-off bins is typically used when waste characterization results are not available or when site conditions or the rate of demolition waste generation does not allow direct loading. As with solid wastes, direct loading is only allowable when waste characterization has been completed and the required approvals of the waste disposal facility(ies) have been procured. The following provides a recommended list of practices for the handling and management of demolition waste generated from removal activities:

- If demolition waste is to be stockpiled and has not been impacted by site contaminants:
 - Place hay bales or silt fence around the proposed stockpile area as a soil erosion and sediment control measure.
- If demolition waste is to be stockpiled and has been impacted by site contaminants:
 - Construct a berm around each proposed stockpile (a separate stockpile should be created for each demolition waste classification) with site soils, imported fill or hay bales and place a layer of plastic sheeting or a geomembrane under/at the base of the proposed stockpile area and over the berm. This system will prevent direct contact between the stockpiled material and the underlying soils and prevent water (e.g. rainwater) from emanating to/from the stockpile area.
 - Place hay bales or silt fence around the proposed stockpile area as a soil erosion and sediment control measure.
 - Once demolition waste placement in the stockpile area commences, the stockpile should be covered with plastic sheeting at the end of each work day and when precipitation is forecasted. The plastic sheeting layer should be secured with sand

bags and ropes to ensure no portion of the solid waste stockpile is exposed to the elements.

- If demolition waste is to be placed in roll-off bins and has not been impacted by site contaminants:
 - Once demolition waste placement in the roll-off bin commences, the roll-off bin should be covered and secured with the lid or a tarp at the end of each work day and when precipitation is forecasted.
- If demolition waste is to be placed in roll-off bins and has been impacted by site contaminants:
 - Place a layer of plastic sheeting along the side of the roll-off box where material loading will take place. This will allow collection of any spilled materials and prevent direct contact between materials requiring off-site disposal and the underlying soils.
 - Once solid waste placement in the roll-off bin commences, the roll-off bin should be covered and secured with a tarp at the end of each work day and when precipitation is forecasted.
- If demolition waste is to be directly loaded onto trucks:
 - Prepare the loading area in accordance with the Remedial Action Work Plan.
 - Prior to loading trucks, ensure that waste materials cannot be spilled out of the vehicle during transport. If need be, the truck bed may need to be lined with plastic sheeting to prevent loss of waste during transport.
 - When loading trucks, ensure the load is evenly distributed on the truck bed and that the load does not exceed the truck capacity. If weights are exceeded, the truck may not be allowed on the road, subject to fines, and/or may be denied access to the disposal facility.
 - Upon completion of the truck loading, the load should be covered with a secured tarp to prevent material loss during transport.

4.3.3 Liquid Waste

Liquid wastes produced during field investigations may include groundwater generated during well development, purging, sampling and decontamination fluids. In addition, liquid waste can be generated from remedy implementation (such as extracted groundwater from recovery wells or from dewatering activities, decontamination fluids, and remediation liquid wastes). Until waste characterization results are available, all liquid wastes shall be containerized. The following provides a recommended list of practices for the handling and management of liquid waste generated during field investigations and remedy implementation.

- All liquid wastes should be containerized pending the results of analytical testing. Generally, 55-gallon, DOT-rated steel, closed top drums are utilized for this purpose. In instances where there is little liquid waste generated, a 5-gallon plastic or steel bucket with a lid can be utilized to containerize generated liquids. In instances where large quantities of liquid waste are generated, liquids can be containerized in bulk containers such as frac tanks or poly tanks.

- Container lids (i.e., drum lids, bucket lids or frac tank hatches) should be open only during filling activities and the lids should be secured at the end of each workday, during rainfall events and once the container(s) is full. The containers should be labeled in accordance with **Section 4.4** and disposed off-site in accordance with **Section 4.5**.

If explicitly allowed by Federal and/or State regulations, containerized liquid waste (specifically, well development water and purge water) may be discharged to the ground in the immediate vicinity of the well the waste originated from provided that: (a) pertinent authorities have been notified or the activity is otherwise permitted; (b) liquid wastes only consist of well development and purge water (e.g., no decontamination water); and (c) chemical analysis of the contents of the container indicate that analytes are not above regulatory levels. If allowed by applicable Federal, State and/or local permits, remedial activity-related liquid wastes may be discharged to groundwater, surface water or a publicly owned treatment works (POTW) provided that: (a) pertinent permits have been procured; (b) the liquid waste is pretreated, as needed, to meet discharge requirements; and (c) a discharge monitoring program is implemented in accordance with permit requirements.

4.3.4 NAPL

NAPL may be generated during field investigations or as part of the remedy implementation (e.g., NAPL recovery, decanted oil from an oil/water separator). The following provides a recommended list of practices for the handling and management of NAPL waste.

- All NAPL should be containerized for off-site disposal. Generally, 55-gallon, DOT-rated steel, closed top drums are utilized for this purpose. In the event small or larger quantities of NAPL are generated, adequately sized containers with lids made of compatible material can be utilized.
- Drum and container lids should be open only during filling activities and the lids should be secured at the end of each workday, during rainfall events, and once the container(s) is full. The containers should be labeled in accordance with **Section 4.4** and disposed off-site in accordance with **Section 4.5**.

4.3.5 PPE and Expendable Sampling Equipment

PPE and expendable sampling equipment (e.g. disposable bailers, plastic dipper cups) generated during most investigation and remedial activities should be containerized in plastic garbage bags. In some instances where there are known hazardous materials being handled, the PPE should be containerized in drums until waste characterization sampling can be completed (refer to **FGD 15.02**). If there is uncertainty regarding the hazard classification of the site media, the materials should be containerized in drums and sampled for waste characterization and disposal purposes.

4.3.6 Containers with Unknown Contents

During field investigations or remedial actions, containers (e.g., 55-gallon drums, 5-gallon buckets) with unknown contents are sometimes encountered. Under no circumstance, should containers with unknown contents be handled or managed; contact and discuss with PIC and/or PM how to proceed.

4.4 Labeling

All waste containers must be properly labeled. All wastes must be characterized as either hazardous (RCRA or State), TSCA-regulated (PCBs), or non-hazardous/non-regulated. Waste labels should be weatherproof and completed legibly with a permanent marker to prevent being washed out, smeared, or faded. Another alternative to printed labels is to mark the container directly with paint pens. Label or markings on the container should be on the side of the container to minimize weathering effects.

In general, waste characteristics are not known during site investigations and generated wastes must be sampled to determine appropriate disposal options. Waste containers for these types of wastes will include a notification label stating that "*Waste Characterization Pending Analysis*" and the following information should be included on the label:

- Description of the waste (e.g. purge water, soil cuttings);
- Waste generation location (e.g. MW4 thru MW5, SBs-5, 6, 7 & 8) and depth, if applicable;
- Waste generation address;
- Date(s) waste was generated; and
- Client Contact Information (e.g. Name and phone number of someone familiar with the waste – can be the Site contact).

Once the waste has been characterized, the label should be changed as appropriate to non-hazardous, hazardous, or TSCA-regulated waste.

Waste characterization for materials to be generated during remedial activities has typically been completed prior to implementation of these activities. For these wastes the following information should be included on the appropriate label.

For non-hazardous wastes, a pre-printed label with the words "Non-Hazardous Waste" can be used and the following information shall be included on the label:

- Description of the waste (e.g. purge water, soil cuttings);
- Waste generation location (e.g. MW4 thru MW5, SBs-5, 6, 7 & 8) and depth, if applicable;
- Waste generation address;
- Date(s) waste was generated; and
- Client Contact Information (e.g. Name and phone number of someone familiar with the waste – can be the Site contact).

For hazardous wastes, a pre-printed label with the words "Hazardous Waste" can be used and the following information shall be included on the label:

- Description of the waste (e.g. purge water, soil cuttings);

- Waste generation location (e.g. MW4 thru MW5, SBs-5, 6, 7 & 8) and depth, if applicable;
- Date(s) waste was generated;
- Generator Information (e.g. Name, address, and telephone number of the Site Owner/Site Environmental Manager);
- EPA identification number – supplied by the Site Owner/Site Environmental Manager; and
- Client Contact Information (e.g. Name and phone number of someone familiar with the waste – can be the Site contact).

4.5 Waste Management

4.5.1 Waste Characterization

All waste generated during the course of site investigations or remedial actions shall be characterized for disposal in accordance with **FGD 15.02**, Waste Sampling.

4.5.2 Waste Storage

All waste should be transported off-site to an approved disposal or treatment facility as soon as possible. For waste that is temporarily stored on-site, inspections must be performed and documented regularly to ensure that waste containers have not been damaged, vandalized or otherwise compromised and that the waste is secure and contained. For all RCRA hazardous waste storage areas, these inspections shall be performed weekly (typically by the Client representative or other site personnel). Special attention should be given to RCRA hazardous wastes, TSCA regulated wastes, and mixed RCRA and TSCA wastes. The following summarizes waste storage requirements for these special wastes.

1. RCRA Hazardous Waste cannot accumulate on-site for longer than 90 days for large quantity generators and 180 days for small quantity generators (per 40 CFR 262). A hazardous waste storage area inspection checklist is provided in **Attachment A**. The following requirements for hazardous waste storage must be implemented:
 - Hazardous waste signs shall be posted as required by federal or state statutes;
 - The storage area must be separate and secured;
 - Secondary containment must be in place to contain any spills;
 - A spill kit must be available;
 - A fire extinguisher must be available; and
 - Adequate aisle space must be maintained between containers.
2. TSCA regulated remediation wastes (specifically PCB) cannot accumulate on-site for longer than 180 days.

4.5.3 Waste Loading and Transport

Following waste characterization, required approvals shall be procured from the disposal facility(ies) and, where applicable, state or federal agencies. Solid and liquid wastes can be transported for off-site disposal via truck, rail or barge.

Prior to waste loading, measures shall be taken to prevent the accidental release of contaminated materials to unimpacted areas. These may include placement of tarps in loading areas to prevent accidental spills during loading, and construction of a tracking pad/stabilized construction entrance or a wash station to prevent the off-site tracking of waste materials. Before the vehicle transporting waste materials leaves the loading area, it should be inspected to ensure it is free of soils that may have spilled during loading or have adhered to the vehicle.

All waste shall be transported and disposed of in accordance with applicable State, Federal, and local regulations. Wastes that are classified as hazardous shall be shipped/transported by state-certified waste haulers and shall be accompanied by a hazardous waste manifest (EPA Form 8700-22). PCB wastes shall be shipped/transported by state-certified waste haulers and shall be accompanied by a manifest (EPA Form 8700-22). Although PCB wastes are not regulated under RCRA, some States track PCB wastes as State-Regulated hazardous wastes – consult State regulations and guidance or contact your local Ramboll staff for any regional or local requirements before conducting the work. Non-hazardous wastes may be shipped using other types of shipping documents such as non-hazardous waste manifests or bills of lading. All shipping documents shall be signed by the generator (i.e., the site owner or their authorized representative), the hauler and the disposal facility (upon receipt of the waste).

5. PRECAUTIONS AND OTHER CONSIDERATIONS

Certain precautions should be taken to ensure safety while conducting waste handling.

- It is important to always remain alert and aware of your surroundings. Waste handling and management can involve the use of field trucks and associated equipment, and is subject to hazards posed by equipment, vehicle traffic, industrial machinery, hazardous chemicals and contaminants, and/or other physical, mechanical, and chemical hazards.
- Prior to mobilization, determine the waste storage means and locations and the need for security, barricading, and/or traffic control (e.g., when waste haulers enter or leave the site).
- To the extent practicable and as allowed by the Work Plan, wastes should be segregated such that different waste types (solid waste, demolition waste, NAPL and liquid waste) and waste classifications (hazardous, TSCA regulated, comingled hazardous-TSCA waste, and non-regulated waste) are handled, stored and managed separately. While additional storage will be required, it will typically result in more cost-efficient waste management and disposal.
- Prior to loading waste materials onto trucks, ensure that trucks are in good condition such that waste materials cannot be spilled out of the vehicle during transport.
- Prior to placement of waste into containers, ensure that the containers are empty, intact and in good condition, and compatible with the waste to be stored. Containers that are deteriorating (e.g., cracked, rusted) or leaking must not be used. Waste stored in defective containers must be transferred to containers in good condition.

- When trucks are being loaded, ensure the load is evenly distributed on the truck bed and that the load does not exceed the truck capacity. If weights are exceeded, the truck may not be allowed on the road, subject to fines, and/or may be denied access to the disposal facility.
- Before leaving the loading area, vehicles transporting waste materials should be inspected to ensure they are free of soils that may have spilled during loading or have adhered to the vehicle.
- Although PCB wastes are not regulated under RCRA, some States track PCB wastes as State-Regulated hazardous wastes. Therefore, State regulations and guidance governing PCB wastes should be consulted prior to conducting the work. In addition, local Ramboll staff should be contacted for any other regional or local requirements.

6. RECORDKEEPING

All waste generated during site activities should be inventoried in either the field log book or on waste inventory/disposal log forms and photographs. A sample waste inventory/disposal log form is provided in **Attachment B**. Each container should be tracked by the following:

- Waste generation date(s);
- Waste generation location;
- Waste characterization type (e.g. pending analysis, non-hazardous, hazardous);
- Container size/approximate waste quantity; and
- Media type (e.g. liquid, solid).

For waste that is temporarily stored on-site, inspections must be documented. Once the waste has been shipped off-site, the field log book or waste inventory/disposal log form should be updated with the following:

- Disposal shipment date;
- Transporter information;
- Disposal facility information; and
- Certificate of disposal information (e.g., manifest or record from the receiving waste disposal or treatment facility indicating the quantity and type of waste and the date of receipts at the facility).

Document all information collected in accordance with **FGD 1.01** (Field Notes and Records) and **FGD 1.03** (Data Management). Note that Federal and State regulation may require separate reporting requirements, specifically for hazardous wastes (e.g., State Hazardous Waste Annual Reports, USEPA Biennial Certification Forms - EPA Form 8700-13 A/B).

ATTACHMENT A
HAZARDOUS WASTE STORAGE AREA
INSPECTION CHECKLIST

HAZARDOUS WASTE STORAGE AREA INSPECTION CHECKLIST

Project Site: _____

Year: _____

Project Number: _____

Project Location: _____

Month: _____

	Weekly Hazardous Waste Container Inspection					Comments
	Date / /	Date / /	Date / /	Date / /	Date / /	
Containers marked properly name/address						
Containers marked properly contents/composition						
Containers marked properly physical state/hazard properties						
Containers marked properly hazard properties						
Containers marked properly start date						
Stored 90/180/365 days or less						
No leaks/staining						
Closed tops/bungs						
No dents/corrosion						
Incompatible wastes and materials stored separately						
Aisle space maintained						
Secondary containment liquid free						
Storage area secured						
Hazardous waste signs posted						
Spill Kit available/fully stocked						
Fire Extinguisher available						
Inspector's Initials						
Overall Comments:						

In General:

- Acids must be segregated from ignitables.
- Acids must be segregated from caustics.
- Corrosives should be segregated from flammables.
- Oxidizers should be segregated from EVERYTHING.
- Many corrosives are water-reactive.
- Most organic reactives must be segregated from inorganic reactives (metals).

INCOMPATIBLE WASTES - Some Deadly Combinations -

Acids + Oil or Grease = FIRE
 Acids + Caustics = HEAT/SPATTERING
 Caustics + Epoxies = EXTREME HEAT
 Chlorine Gas + Acetylene = EXPLOSION
 Flammable Liquids + Hydrogen Peroxide = FIRE/EXPLOSION
 Aluminum Powder + Ammonium Nitrate = EXPLOSION
 Sodium Cyanide + Sulfuric Acid = LETHAL GAS
 Ammonia + Bleach = LETHAL GAS

ATTACHMENT B
WASTE TRACKING FORM

Waste Tracking Form

Project Name: _____

Project Number: _____

Generator Name: _____

Generator ID:

Generator Address:

[illegible]

Footnotes:

USDOT - United States Department of Transportation

COD - Certificate of Disposal

USEPA - United States Environmental Protection Agency

1 - This is the USDOT Proper Shipping Name, Hazard Class or Division, Identification Number (UN/NA) and Packing Group - See 49 CFR 172

2 - Most frequently used Types of Container Abbreviations: CF (fiber or plastic boxes, cartons, cases); CM (metal boxes, cartons, cases); CY (cylinders); DF (fiberboard or plastic drums); DM (metal drums); DT (dump truck); TP (portable tanks); TC (tank cars)

3 - Volume is based on the container type - most frequently used units of measure abbreviations: G (gallons); K (kilograms); T (tons); Y (cubic yards); P (pounds); N (cubic meters); M (metric tons)

4 - This is a unique tracking number that must be pre-printed on the manifest by the forms printer - should be provided to you by the disposal facility.

DRAFT

APPENDIX D

Ramboll Safe Work Practices

PREPARED BY

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APPROVED BY

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DATE

July 2021

VERSION

1.0

SAFE WORK PRACTICE

FIRST AID & MEDICAL

SERVICES

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First Aid & Medical Services

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APPENDICES

Appendix A: US-specific requirements

1. PURPOSE

The purpose of this Safe Work Practice (SWP) is to define Ramboll work practices for providing first aid and other medical services, including maintaining first aid kits, making safety showers and eyewash stations available where required, and use of cardiopulmonary resuscitation (CPR) and/or automated external defibrillators (AEDs) in the event of a workplace medical emergency.

2. SCOPE

This SWP applies to first aid and other medical services that may be provided at Ramboll offices and industrial facilities, client offices and facilities, and any other sites where Ramboll employees are working. This SWP does not cover baseline, annual, or other medical examinations and follow-up activities performed by licensed healthcare facilities or providers under Ramboll's medical surveillance program and/or as required by local regulatory requirements. For those requirements refer to Ramboll's HSSP, [Medical Surveillance and Fitness for Duty](#). This SWP also describes but does not fully address emergency preparedness and response planning and related activities. Refer to Ramboll's SWP, [Emergency Preparedness and Response Planning](#). In the event of a conflict between this SWP and locally applicable regulatory requirements (or project-specific requirements), the more stringent set of requirements will be followed.

3. OVERVIEW

This SWP outlines Ramboll work practices for providing first aid and other medical services including maintaining first aid kits, making safety showers and eyewash stations available where required, and use of cardiopulmonary resuscitation (CPR) and/or automated external defibrillators (AEDs).

- **Readily available medical services** – Ramboll offices, industrial facilities and laboratories rely on local response agencies, designated or volunteer first aid responders, first aid kits, AEDs and safety showers/eyewash (where applicable). Ramboll project sites rely on effective means of communication, onsite or local response departments or agencies, designated first aid responders, first aid kits.
- **Third-party occupational medical provider** – Supports and coordinates non-emergency medical evaluation and treatment
- **Designated first aid providers** – First aid, CPR and AED training requirements; responsibilities as related to offices, facilities and project site work environments
- **First aid supplies** – Types of supplies, minimum requirements, inspections, replacement of expired items
- **First aid kit location** – Readily available and near proximity to work areas, signage and access, first aid kit types and distribution based on work environments and hazard types
- **AEDs** – Availability for Ramboll locations, inspection and service considerations (typically provided by an outside vendor), training, accessibility and signage
- **Emergency showers and eyewash** – Placement, use, water temperature, inspections and maintenance

4. RESPONSIBILITIES

4.1 Project Manager (PM) / Project Owner (PO)

- Request first aid and medical service information from the facility owner and consider the adequacy of the information provided. This information should be included in the project safety plan.
- Allocate adequate resources including people, budget and schedule to comply with requirements outlined in this SWP.
- Verify project staff are trained and certified in first aid, CPR and AEDs, in accordance with this SWP and applicable regulatory requirements.
- Support employee use of Stop Work Authority related to first aid and medical surveillance or any other perceived hazard until such hazards are evaluated and controlled to the satisfaction of the project team and HSS department.

4.2 Site Safety Representative (SSR)

- Verify that the first aid and medical service information, including the location of medical supplies and eyewashes/safety showers is reviewed with individuals involved in the work as part of their project safety orientation.
- Verify there is an adequate supply of first aid supplies available at the project site.
- If there is a project office, verify that emergency phone numbers and medical service information is posted. If there is no project office, verify that this information is readily available.
- Verify that clear access to emergency showers and eyewash stations is maintained.
- Verify that the emergency showers and eyewash stations are inspected and tested weekly. Maintain documentation of the inspection and testing.
- Assist or direct employees to Ramboll's third-party occupational medical provider call number or medical advice line, where available, to support non-emergency medical evaluation and treatment and scheduling of occupational clinic visits if necessary. Country-specific resources are described in [Section 9](#).
- Assist with reporting of incidents and safety observations in accordance with the HSSP, [Event Reporting and Investigation](#).

4.3 Ramboll Health, Safety and Security (HSS) department

- Support project safety plan development (when requested by the PM) including first aid and medical surveillance information and appropriate safety controls based on this SWP and site-specific concerns.
- Review and update this SWP on a biennial basis or more frequently if required.

4.4 Health, Safety and Security Coordinator (HSSC) / Safety Ambassador

- Promote awareness, understanding and use of this SWP by project team members.
- Facilitate application of this SWP in the context of local regulatory requirements and integration of this SWP into project safety plans.

- Maintain adequate stocks of first aid supplies at Ramboll office and industrial facilities.
- Assist or direct employees to Ramboll's third-party occupational medical provider call number or medical advice line, where available, to support non-emergency medical evaluation and treatment and scheduling of occupational clinic visits if necessary. Country-specific resources are described in [Section 9](#).
- For locations that obtain an AED, verify the AED undergoes regular inspections and maintenance by a qualified individual (typically an external vendor), in coordination with the Office Lead or Facility Manager and the FM&RE department (for Ramboll offices and facilities).
- Inform the HSS department if this SWP does not adequately address local regulatory requirements.

4.5 Facilities Management & Real Estate (FM&RE)

- Support external vendor agreements and/or recommend external vendors for AED inspections and maintenance (see [Section 6.5](#)) as needed, in coordination with the Office Lead or Facility Manager (for Ramboll offices and facilities).

4.6 Employees, subcontractors and visitors

- Review, understand and comply with project safety plans.
- Do not undertake any first aid activities unless properly trained to do so.
- Follow first aid and medical services safety practices defined in this SWP and other practices as defined by the site owner or occupant or as required by local regulations. In the event of a conflict, the more stringent requirements will be followed.
- Utilise Ramboll's third-party occupational medical provider call number or medical advice line, where available, to support non-emergency medical evaluation and treatment and scheduling of occupational clinic visits if necessary. Country-specific resources are described in [Section 9](#).
- Report safety events, issues or concerns to the SSR and in accordance with Ramboll's HSSP, [Event Reporting and Investigation](#).
- Exercise Stop Work Authority if any task is perceived to be unsafe or if more information is needed to proceed safely.

5. KEY DEFINITIONS

Automated external defibrillator (AED) – An AED is a portable electronic device that automatically diagnoses the life-threatening cardiac arrhythmias of ventricular fibrillation and ventricular tachycardia in a patient. These units are applied in order to treat the patient through defibrillation, which is the application of electrical therapy that stops the arrhythmia, allowing the heart to re-establish an effective rhythm. Additional discussion is provided in [Section 6.5](#). Personnel must be trained to use AEDs in accordance with [Section 7](#) of this SWP.

Cardiopulmonary resuscitation (CPR) – CPR is an emergency lifesaving procedure that is employed when someone's breathing or heartbeat has stopped. This may happen after an electric shock, heart attack, drowning or other condition. CPR combines rescue breathing and chest compressions. Employees must be trained to apply CPR in accordance with [Section 7](#) of this SWP.

Designated first aid provider – A designated first aid provider is a person who has been designated by their supervisor or manager to provide first aid support at project sites, including treating minor injuries. The designated first aid provider must have a valid first aid and CPR

certification. Designated first aid providers provide initial treatment for medical emergencies until emergency responders arrive.

First aid – First aid is the assistance given to any person suffering a sudden illness or injury, with care provided to preserve life, prevent the condition from worsening, and/or promote recovery. It includes initial intervention in a serious condition prior to professional medical help being available, such as performing CPR while waiting for emergency medical responders to arrive, as well as the complete treatment of minor conditions. Employees must be trained to administer first aid in accordance with [Section 7](#) of this SWP.

Personal eyewash or drench hose – Emergency eyewash and drench hose equipment that does not meet regulatory flow requirements. This includes small hand-held bottles as well as pressurised units. This equipment is usually staged in the immediate area of work to provide initial flushing before moving to a regulatory compliant station.

Plumbed eyewash or shower – Emergency eyewash or shower that is connected to a potable water source capable of meeting regulatory flow requirements.

Self-contained eyewash – Emergency eyewash units that are not plumbed to a potable water supply but contain sufficient water reservoir to meet regulatory flow requirements. Manufacturers require adding preservative to the water reservoir along with periodic water changes.

Unit first aid kits – First aid kits where supplies and materials are contained in uniform sized packages containing one or more applications of first aid products in accordance with local regulations or requirements.

6. WORK PRACTICES

Injuries and medical emergencies can occur anywhere, at any time. Therefore, the need for first aid supplies and medical services are required in all work environments regardless of risk level. Ramboll office leads, facility managers and project teams are expected to be familiar with the content of this SWP, locally applicable regulatory requirements and any project-specific requirements. In the event of conflicting requirements for work practices, the more stringent set of requirements will be followed and must be outlined in the project safety plan.

6.1 Readily available medical services

6.1.1 Ramboll offices, industrial facilities and laboratories

Ramboll offices, industrial facilities (manufacturing shops, warehouses, etc.) and laboratories are generally located in or nearby metropolitan areas with ready access to hospitals and clinics. Similarly, prompt emergency medical response is typically available through community emergency services. Minor injuries can often be treated at occupational clinics located near Ramboll offices. The locations of occupational clinics are provided in site-specific emergency response plans.

6.1.2 Project sites

Unlike offices, projects may be located anywhere, including areas where medical services and emergency response are not readily available. If medical services are not readily available at the project site, at least one designated first aid provider with a valid first aid and CPR training certificate must be provided (see [Section 6.2.2](#)).

6.2 Designated first aid providers

6.2.1 Ramboll offices, facilities and laboratories

Unless required by regulation, designated first aid providers are not required in these locations unless the location is a high risk work environment or is in a location without access to local emergency response providers (see [Section 6.2.2](#)). Ramboll periodically offers first aid and CPR training in offices for employees who choose to participate (but are not otherwise designated).

For locations that receive an AED, at least one person who regularly works at the location should receive AED training, which is typically covered as part of first aid, CPR and AED certification or may be provided as part of an external vendor's AED service package. However, these persons are considered volunteers and are not required to respond to office medical emergencies. Additional information about AEDs is provided in [Section 6.5](#).

6.2.2 Project sites

Project sites that involve high-risk work environments, project sites without onsite medical clinics, or sites in remote locations with extended emergency response times must have at least one designated and trained first aid provider on the site while fieldwork is being performed. The designated first aid provider may be a Ramboll employee or subcontractor employee. It is recommended that a second trained first aid provider also be present as a backup, particularly if the designated first aid provider also performs high risk work activities. Where project work involves exclusion zones where workers are exposed to hazardous chemicals, atmospheres or other hazards, at least one of the individuals working in the exclusion zone at any given time must be a designated first aid provider. In such cases it is also recommended that a second first aid provider be present as a backup, either in the exclusion zone or in the support zone.

Designated first aid providers also support treatment of minor injuries and may assist the injured person with contacting Ramboll's occupational medical provider for assistance with scheduling of non-emergency medical evaluation or treatment at an occupational medical clinic.

6.3 First aid supplies

Well-stocked first aid kits should be maintained in Ramboll work areas. These kits should be located to allow easy and quick access. Site-specific emergency response plans should indicate the location(s) of first aid supplies on a map or floorplan.

First aid kits must meet local regulatory requirements, which are referenced [Section 9](#) of this SWP. First aid kits must be sized according to the maximum number of people anticipated to be at the site. In general, kit contents should be adequate to treat first aid incidents for scenarios considered likely based on work types, and adequate for the number of people typically present.

First aid kits must be inspected prior to being deployed to offices, facilities or project sites, and should be inspected regularly thereafter (typically on a monthly basis). Inspections must confirm that kits are adequately stocked, and the contents have not expired.

6.4 First aid kit location

First aid kits must be readily available and in near proximity to work areas. While local requirements may vary, typically there is no required density of kits per person or per square foot of area. First aid kits should be marked with a sign for greater visibility. If kits are inside a cabinet, a label indicating a first aid kit must be on the outside of the cabinet.

In general, first aid kits are considered readily available if their location meets the following requirements:

- Easily accessible and not stored in locked cabinets or offices
- At least one per floor in multifloor offices

In evaluating whether a first aid kit is in near proximity to the work area, employers are generally expected to consider the type of work conducted and work area. While local regulations may vary, Ramboll considers first aid kits to be in near proximity to the work area if their location meets the following:

- Within four minutes for work environments with a potential for serious injury. For Ramboll, this generally means facilities or project sites that involve manufacturing, construction, remediation, demolition, operations and maintenance, or other high risk work environments.
- Within 15 minutes for work areas where the possibility of serious injury is relatively remote. For Ramboll, this generally means office areas, compliance services, field engineering activities, and other low- and medium-risk work environments.

Many offices, facilities and project sites have onsite or nearby offsite occupational medical providers or first response teams that meet the requirement for services in near proximity to the work area. When these services are relied upon, contact information or other response procedure should be detailed in the office or facility emergency response plan, or for project sites, in the project safety plan.

6.5 Automatic external defibrillator (AED)

The following outlines Ramboll requirements for installation of AEDs in facilities.

- AEDs may be obtained by Ramboll offices or facilities at the discretion of the Office Lead, Facility Manager, and in consultation with Ramboll's FM&RE department.
- AEDs must be inspected and serviced by a qualified individual (typically an external vendor) in accordance with manufacturer recommendations and regulatory requirements.
- AED use is optional. Trained employees are not obligated to use AEDs during a medical emergency.
- AEDs must be wall-mounted inside a protective case. Landlord permission may be necessary to install.
- AED locations must be marked by a sign that is readily visible to facility occupants.
 - Ramboll-owned/leased AEDs are not intended for public use. Signs notifying the location of a Ramboll-owned/leased AED on the exterior of facility will not be installed unless required by local, state or federal regulations.
 - The location of AEDs will be marked on maps included in the emergency response plan (ERP). Refer to the SWP, [Emergency Preparedness and Response](#).
- Some Ramboll offices or facilities may be located within a building or complex that provides an AED for use within the complex. For such locations, AED availability will be described in the office or facility ERP.

6.6 Emergency showers and eyewashes

Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. A recommended guideline is an emergency shower/eyewash

station should be located within 10 seconds of unimpeded travel from the corrosive material hazard.

The need for emergency showers or eyewash stations is based on the properties of the chemicals that workers use and the tasks that they perform in the workplace. A risk assessment provides an evaluation of the potential hazards of the job and the work areas. The selection of emergency shower, eyewash or both should match the hazard.

In some jobs or work areas, the effect of a hazard may be limited to the worker's face and eyes. Therefore, an eyewash station may be the appropriate device for worker protection. In other situations, the worker may risk part or full body contact with dangerous substances. In these areas, an emergency shower may be more appropriate.

A combination unit has the ability to flush any part of the body or all of the body. It is the most protective device and should be used wherever possible. This unit is also appropriate in work areas where detailed information about the hazards is lacking, or where complex, hazardous operations involve many chemicals with different properties. A combination unit is useful in situations where a worker may not be able to follow signage or procedures because of the effects of the exposure or injury.

6.6.1 Placement

Emergency showers and eyewashes must be accessible within 10 seconds of unimpeded travel from the hazard, which is generally equivalent to 55 ft/16 m. The travel path must be free from obstructions. Stairs and doors are considered obstructions. However, a single step up into an enclosure where equipment can be accessed is not defined as an obstruction. Although line-of-sight is preferred, the equipment does not need to be in line-of-sight (unless required by regulation), but signage must clearly indicate the location of the equipment or direction of travel and must be visible from all locations within the work area.

The number of eyewashes or showers needed for each hazard is based on the number of workers in that area and the probability that more than one person may be exposed at the same time.

Certain tasks are highly hazardous and should have emergency showers and eyewashes in the immediately area. These areas include bulk chemical unloading areas, battery maintenance and charging areas, bulk chemical storage area (corrosives). Emergency showers and eyewashes are also considered standard equipment for laboratory settings.

The placement of floor drains and the presence of electrical equipment and similar hazards should also be considered when identifying appropriate locations for emergency showers and eyewashes, as they generate a lot of water during an emergency and require weekly flushing.

NOTE – The absence of readily available potable water on more remote project sites where workers are exposed to corrosives does not eliminate the need to provide suitable emergency showers and eyewash stations in accordance with Ramboll safe work practices and applicable regulations.

6.6.2 Use

Persons working with (or near) corrosives should be aware of the location of the nearest emergency shower and eyewash unit. As a best practice it is recommended to verify that an emergency shower and eyewash has been flushed on a weekly basis, or for self-contained units,

that water changes are documented and current. Work that may result in contact with corrosives may not proceed until emergency shower and eyewash maintenance is current.

During an emergency, users must flush the affected area for a full 15 minutes. Modesty should not prevent removing outer garments that have come in contact with corrosives.

6.6.3 Water temperature

Water temperature should be tepid (i.e., similar to room temperature), and temperatures will be in accordance with applicable regulatory requirements where specifically defined. The use of the word "should" in regulatory language typically indicates the statement is optional but should be implemented wherever feasible. Water temperatures outside the tepid range may discourage users from flushing for the full 15 minutes and could contribute to other medical conditions such as hypothermia or shock.

6.6.4 Inspections and maintenance

Plumbed emergency showers and eyewash units must be activated weekly to flush the line and remove sediment, and to verify proper operation. An inspection tag that is signed and dated to document weekly flushing must be attached to each unit.

Plumbed emergency showers and eyewash units must be tested annually. The annual test includes a full 15 minute flush to verify that pressure/flow rate and flow pattern are maintained for 15 minutes. Annual testing must be documented on annual maintenance checklist or form that is recommended by the manufacturer.

Self-contained showers and emergency eyewash units must be inspected weekly and fluid changed as specified by the manufacturer of the unit. An inspection tag that is signed and dated to document inspections must be attached to each unit. Fluid change-out frequency will vary depending on the following setups:

- If potable water is used without a preservative, replace weekly.
- If a preservative is used, replace on a frequency of one to four months, depending upon conditions and in accordance with the manufacturer's recommendations.
- If a factory prepared concentrate with an additive is used, follow the manufacturer's instructions.
- If factory-sealed cartridges are used, replacement on a frequency of up to two years may be acceptable as these units do not require flushing or flow testing. Follow the manufacturer's recommendations.
- Personal eyewash bottles will be tested, refilled, disposed and maintained in accordance with the manufacturer's recommendations.

7. TRAINING & COMPETENCY

Ramboll's HSS training programme includes new employee induction training, supervised on-the-job training and annual completion of online modules or classroom instruction related to safety requirements and work practices. Training assignments vary based on employee roles and training classification. Completion of assigned training will be documented by a training completion certificate, which will be stored in the employee's electronic training record.

7.1 First aid, CPR and/or AED training

First aid, CPR and/or AED training will be provided to employees who may be responsible for providing these services. Training programmes will be approved by Ramboll's HSS department. Approval will require confirmation that the training programme meets country-specific requirements for duration, frequency and training subject matter.

Unless provided by a Ramboll qualified trainer, first aid, CPR and AED training programmes should be offered by, or developed in partnership with a nationally recognised medical organisation. When possible and when required by regulations, first aid courses should include an in-person training component. Trainings are recommended to be delivered in a group or classroom setting as appropriate for the office, facility or site.

Appropriate first aid, CPR and/or AED training shall be provided to each affected employee:

- Before the employee is first assigned duties that require him/her to serve as a first aid responder.
- Before there is a change in assigned duties.
- Whenever there is a change in first aid, CPR or AED procedures or operations.
- Whenever Ramboll has reason to believe that there are deviations from the first aid response procedures required by this instruction, or inadequacies in the employee's knowledge or use of these procedures.
- The training shall establish employee proficiency in the duties required by this instruction and shall introduce new or revised procedures, as necessary, for compliance with this instruction or when future revisions occur.
- The Ramboll qualified trainer or external training provider will certify that the training required by this section has been accomplished. The certification shall contain the employee's name, the signature(s) or initials of the trainers and the date(s) of training. The certification shall be available for inspection by employees and their authorised representatives. Ramboll will retain a copy of all employees that receive certification.

8. DOCUMENTATION

The following documentation specific to first aid and medical services is required.

8.1 Inspection records

Inspection records for Ramboll offices, facilities or project sites will be maintained digitally or in hard copy in a location determined by the office lead, facility manager or PO respectively.

8.1.1 First aid kits

Regular first aid kit inspections, where required, and replacement of expired components, should be documented. This is traditionally documented by writing inspection details on a tag fixed directly to the unit. Frequency of inspection will be based on the type of first aid supplies or kit, and on country or regional regulatory requirements as applicable to the type of facility.

8.1.2 Emergency eyewash and showers

Regular emergency shower and eyewash inspections, where required, must be documented. This is traditionally documented by writing inspection details on a tag fixed directly to the unit.

Frequency of inspection will be based on country or regional regulatory requirements as applicable to the type of facility.

8.1.3 AEDs

Regular AED inspections and maintenance are required for locations that obtain an AED, and must be documented. Inspection details are typically written on a tag fixed directly to the unit, and additional documentation is generated by the qualified inspector (typically an external vendor) for each inspection or maintenance event. Frequency of inspection and maintenance will be based on manufacturer recommendations and country or regional regulatory requirements.

8.2 First aid, CPR and AED training certificate(s)

A digital or hard copy certificate must be presented to the employee upon completion of first aid, CPR and/or AED training, whether conducted by a Ramboll qualified trainer, or by an approved vendor. Training records may be separate or may be combined where training includes more than one of these topics. Certificates will be stored on Ramboll Academy as described above. Trained employees should also carry a valid first aid, CPR and/or AED training certification card or digital proof of training.

9. INTERNATIONAL TILTS

9.1 Asia / Pacific

9.2 Brazil

9.3 Canada

9.4 European Union (EU)

9.5 Mexico

9.6 United Kingdom (UK)

9.7 United States (US)

Occupational Safety and Health Administration (OSHA) 29 CFR 1910.151: Medical Services and First Aid. <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.151>

9.7.1 First aid kits

First aid kits must meet American National Standards Institute (ANSI) Z308.1 requirements. The requirements of ANSI Z308.1 are described in Attachment A.

9.7.2 Emergency showers and eyewashes

OSHA defers to ANSI Z358.1 to outline emergency shower and eyewash requirements. The requirements of ANSI Z358.1 are described in Attachment A.

9.7.3 Third-party occupational medical provider

[WorkCare Incident Intervention programme](#) for non-emergency medical support

9.7.4 Training resources

The following are training resources for FA, CPR and AED training in the US. This training is also available internally from the Americas HSS department certified trainer.

- American Red Cross - <https://www.redcross.org/>

- National Safety Council - <https://www.nsc.org/>
- American Heart Association - <https://cpr.heart.org>

9.8 Other regions

10. ADDITIONAL INFORMATION

11. REVISION SUMMARY

Safe Work Practice

First Aid & Medical Services

APPENDIX A

US-SPECIFIC FIRST AID REQUIREMENTS

US-SPECIFIC REQUIREMENTS FOR FIRST AID KITS, AED, EYEWASH & SAFETY SHOWERS

Classification of first aid kits

ANSI Z308.1 divides kits into two classes and four types. Class A kits are general purpose and intended to meet the needs of a variety of work environments. Class B kits include a broader range and increased quantity of supplies to deal with injuries associated with higher-risk work environments. Each class of FA kit is available in four types, which are summarised below.

- Type I - Intended for use in stationary, indoor applications where kit contents have minimal potential for damage. These kits are not intended to be portable and should have a means for mounting in a fixed position. Some applications for Type I first aid kits are: general indoor use, office use or in a light manufacturing facility. First aid cabinets would fall into this classification.
- Type II - Intended for use in portable indoor applications. Kit contents should have minimal potential for damage. These kits should be equipped with carrying handle(s) and be subjected to a drop test. Refer to ANSI Z308.1-2015 for drop test information. Some applications for Type II first aid kits are: general indoor use, office or manufacturing environments.
- Type III - Intended for portable use in mobile industries and/or outdoor applications. Kits should be moisture resistant, equipped with a carrying handle, have the means for being mounted in a fixed position, and should also be corrosion resistant. Refer to Section 5.4.4 of ANSI Z308.1-2015 for Type III testing requirements. Typical applications for Type III first aid kits would be the transportation industry or construction jobsites.
- Type IV - All kit types that need to be waterproof indoors or outdoors. This would include marine applications, permanent outside locations and for use in automotive vehicles. Refer to Section 5.2.5 of ANSI Z308.1-2015 for testing requirements. Typical applications include the transportation industry, utility industry and the construction industry.

First Aid Kit Contents

The following items are the minimum recommended for a FA kit to comply with the ANSI Z308.1 standard but does not mean that the supplies will be sufficient for every work area. Quantities can (and in some cases should) be adjusted above the minimum for larger work areas. Also note that for unitised FA kits, each "unit" may contain multiple items. Unless specified otherwise, quantities refer to "each" and not "units."

Item & minimum size or volume	Class A minimum quantity	Class B minimum quantity
Adhesive bandages, 1 x 3 in	16	50
Adhesive tape, 3/8 in. x 2.5 yd total	1	2
Antibiotic, 0.14 fl. oz. application	10	25
Antiseptic, 0.14 fl. oz. application	10	50
Breathing barrier	1	1
Burn dressing (gel-soaked and 4"x4")	1	2
Burn treatment, 1/32 oz. application	10	25
Cold pack, 4"x5"	1	2

Item & minimum size or volume	Class A minimum quantity	Class B minimum quantity
Eye covering with means of attachment	2	2
Eye /skin wash	1 oz total	4 oz total
First aid guide	1	1
Hand sanitizer 1 / 32 oz.	6	10
Medical exam gloves	2 pair	4 pair
Roller bandage, 2"x4 yards	1	2
Roller bandage, 4"x4 yards	0	1
Scissors	1	1
Sterile pad, 3 x 3 in.	2	4
Tourniquet	0	1
Trauma pad, 5"x9"	2	4
Triangular bandage, 40 x 40 x 56 in.	1	2

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DATE

October 2021

VERSION

1.0

SAFE WORK PRACTICE

HAZARDOUS MATERIAL SHIPPING & TRANSPORT

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1. PURPOSE

The purpose of this Safe Work Practice (SWP) is to define safe practices for hazardous material shipping and transport, including requirements for safe transportation of hazardous materials and wastes over public roads or when using other shipping methods. The SWP is also intended to facilitate compliance with applicable regulatory requirements of the country or region.

2. SCOPE

This SWP is applicable to transportation (over public roads) of hazardous materials and wastes in amounts that require placarding, specific packaging or documentation. The SWP outlines the process by which hazardous materials and wastes are identified, packaged, labelled, placarded and manifested for transportation over public roads, as well as non-placarded vehicles transporting hazardous materials under regulatory exemptions or exceptions. This SWP also applies to the shipping of hazardous materials by rail car, ground or air, including when using standard commercial overnight shipping services (e.g., FedEx). Waste transportation is typically provided by subcontractors. Ramboll is not insured as a commercial transporter of waste, and any waste transport by Ramboll must be in quantities that are exempt from regulation (see [Section 6.2](#)).

While shipping information presented in this SWP is generally based on international requirements established by the United Nations (UN), the hazardous waste and transportation-related information is generally based on US requirements, including US Department of Transportation (US DOT) for hazardous materials and Materials of Trade (MOT) exceptions, and United States Environmental Protection Agency (USEPA) Resource Conservation and Recovery Act (RCRA) regulations applicable to hazardous waste.

Other countries or regions may provide similar requirements, and regulatory references are included in [Section 9](#), where available. In the event of a conflict between the SWP and locally applicable regulatory requirements, requirements of the shipping agency, or project-specific requirements, the more stringent set of requirements will be followed.

3. OVERVIEW

This SWP provides roles and responsibilities, key definitions, work practices, training and documentation requirements for hazardous materials shipping and transportation, including hazardous waste. Shipping information is based on international requirements. Hazardous waste and transportation information is based on US regulations. All transport and shipping must be performed in accordance with local regulations. The following work practice topics are addressed:

- **Hazardous material or waste determination** – Determination is made based on applicable regulations of the country or region.
- **Materials of Trade (MOT) determination** – Aggregate gross weight, packaging and package size limits, hazard communication, MOT exception and related information, training specific to MOT.
- **Waste generator category determination** – Based on type, frequency and amount of hazardous waste generated.

Hazardous Material Shipping & Transport

- **Obtain USEPA identification number** – Generally required for companies that generate, transport, treat, store or dispose hazardous waste.
- **Prepare hazardous materials and wastes for shipment** – USEPA requirements for hazardous waste; US DOT requirements for hazardous materials.
- **Prepare shipping documentation or hazardous waste manifest** – Shippers and transporters must prepare appropriate documents as required in the country or region.
- **Transportation of uncharacterised waste across public roads** – May be allowable if using appropriate safety controls and crossings are approved by local agency or authority with jurisdiction.
- **Recordkeeping and reporting** – Retention and reporting of shipping documentation and manifests.
- **Shipping of hazardous materials** – Small or excepted quantity exemptions, packing unpreserved environmental samples, safety and security measures.

4. RESPONSIBILITIES

4.1 Project Manager (PM) / Project Owner (PO)

- Request hazardous material transportation information from the facility owner and consider the adequacy of the information provided. This information should be included in the project safety plan.
- Provide appropriate resources, including people, budget and schedule to comply with requirements outlined in this SWP.
- Assign persons who have received training specific to country or regional requirements (e.g., US DOT Hazardous Material Transportation training) to package, mark, label and placard packages and vehicles, and to prepare manifests or shipping papers.
- Prepare a Waste Manifest Signature Authorization form (see [Section 8.2](#)) for hazardous waste manifests if a Ramboll employee will function as a client's authorised agent to sign hazardous waste manifests on behalf of the client.
- Use properly licensed transporters to deliver hazardous materials or wastes to treatment, storage, or disposal facilities that are properly permitted to accept the waste.
- Assign only employees who are qualified in accordance with the SWP, [Driving, Transportation and Journey Management](#) to drive regulated vehicles of 10,001 lb/4500 kg or more or other commercial vehicle as regulated in the country or region.
- Request assistance or technical support from the Health, Safety and Security (HSS) department if needed.
- Support use of stop work authority by employees or subcontractors related to hazardous materials transport or any other perceived hazard. Work is to be stopped until the identified hazards are evaluated and controlled to the satisfaction of the project team and Health, Safety and Security (HSS) department and in accordance with safe work practices.

- Discuss stop work situations with the local Health, Safety and Security Coordinator (HSSC), Safety Ambassador or a representative of the HSS department, including reporting of incidents and safety observations in accordance with the HSS Process (HSSP), [Event Reporting and Investigation](#).

4.2 Site Safety Representative (SSR)

- Be present at the site to oversee the project or appoint another on-site employee as a backup SSR (with approval from the PM).
- Ensure the project safety plan containing hazardous material transport information is reviewed with site employees and subcontractors as part of the project safety orientation and during toolbox safety meetings.
- Implement requirements of this SWP and authorise only trained persons to package, mark, label and placard packages and vehicles and prepare manifests or shipping papers.
- Maintain sufficient packaging and labelling supplies.
- Communicate project safety requirements to all employees and subcontractors and document all safety meetings, unsafe acts or conditions and corrective actions.
- Inform the PM/PO of important developments or questions regarding project and task safety.
- Assist with reporting of incidents and safety observations in accordance with the HSSP, [Event Reporting and Investigation](#).

4.3 Health, Safety and Security (HSS) department

- Support project safety plan development (when requested by the PM), including hazardous material transportation hazard information and appropriate safety controls based on this SWP and site-specific concerns.
- Evaluate site conditions related to hazardous materials through field safety audits and inspections when requested by the client, the PO or other management, or when required by local regulations.
- Provide technical support, consultation and training materials that are consistent with this SWP, when requested or applicable.
- Review and update this SWP on a biennial basis or more frequently if required.

4.4 Health, Safety and Security Coordinator (HSSC)

- Promote awareness, understanding and use of this SWP by project team members.
- Facilitate application of this SWP in the context of local regulatory requirements and integration of this SWP into project safety plans.
- Inform the HSS department if the SWP does not adequately address local regulatory requirements.

4.5 Employees, subcontractors and visitors

- Review, understand and comply with project safety plans.

- Do not undertake any activities as related to hazardous material transportation unless properly trained (and certified – if professional license or certification is required).
- Follow all hazardous materials transportation and shipping practices defined in this SWP and as required by local regulations. Refer also to the SWP, [Driving, Transportation and Journey Management](#). In the event of a conflict, the more stringent work practices will be followed.
- Report safety events, issues or concerns to the PM, SSR or other supervisor and in accordance with the HSSP, [Event Reporting and Investigation](#).
- Exercise stop work authority if any task is perceived to be unsafe or if more information is needed to proceed safely.

5. KEY DEFINITIONS

Bulk package – for the purposes of this SWP, a US-specific definition is provided. Bulk packages have a maximum capacity listed below. Non-bulk packages are those with smaller capacity.

- >119 gal/50 L for liquids
- >882 lb/400 kg) or >119 gal/450 L for solids
- Water capacity >1,000 lb/454 kg for gases

Conditionally exempt small quantity generator (CESQG) – A US-specific term. CESQGs generate 100 kg or less per month of hazardous waste, or 1 kilogram or less per month of acutely hazardous waste. Requirements for CESQGs include (see also 40 CFR 261.5):

- must identify all the hazardous waste generated.
- may not accumulate more than 1,000 kilograms of hazardous waste at any time.
- must ensure that hazardous waste is delivered to a person or facility that is authorised to manage it.

Hazardous material – means a substance or material that the agency with jurisdiction (e.g., US DOT) has determined is capable of posing an unreasonable risk to health, safety and property when transported in commerce. The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the US Hazardous Materials Table [see Title 49 of the Code of Federal Regulations Part 172.101 (49 CFR 172.101)] or equivalent, and materials that meet the defining criteria for hazard classes and divisions in 49 CFR 173 or equivalent regulation.

Hazardous waste – for the purposes of this SWP, a US-specific definition is provided. Any material that is subject to the Hazardous Waste Manifest Requirements of the USEPA specified in 40 CFR 262. A material is classified as a RCRA hazardous waste following the Hazardous Waste Determination procedure in 40 CFR 262.11. In order for a substance to be a hazardous waste it must first be a solid waste, which is part of the determination process. Other US states (e.g., California), and other countries or regions, may define hazardous waste differently.

Large quantity generators (LQG) – A US-specific term. A LQG may generate 1,000 kilograms per month or more of hazardous waste, or more than 1 kilogram per month of acutely hazardous waste. Requirements for LQGs include:

- LQGs may only accumulate waste on site for 90 days. Certain exceptions apply.
- LQGs do not have a limit on the amount of hazardous waste accumulated on site.
- At least one employee must be available to respond to an emergency. This employee is the emergency coordinator responsible for coordinating all emergency response measures. LQGs must have detailed, written contingency plans for handling emergencies.
- LQGs must submit a Biennial Hazardous Waste Report.

Limited quantity – for the purposes of this SWP, a US-specific definition is provided. The limited quantity is the maximum quantity per inner packaging or article for transporting dangerous goods as limited quantities. Refer to US DOT Table 172.101. If a packaging requirement is listed in column 8A, then the material may be transported as a limited quantity if it is properly packaged. The numbers in column 8A refer to specific sections of 49 CFR 173. For example, a reference to “150” under column 8A refers to packaging requirements described in 49 CFR 173.150.

Small quantity generator (SQG) – A US-specific term. SQGs may accumulate hazardous waste on site for 180 days without a permit (or 270 days if shipping a distance greater than 200 miles).

- The quantity of hazardous waste on site must never exceed 6,000 kilograms.
- At least one employee must be available to respond to an emergency. This employee is the emergency coordinator responsible for coordinating all emergency response measures. SQGs are not required to have detailed, written contingency plans.

6. WORK PRACTICES

Ramboll employees may work at facilities where hazardous materials and hazardous waste are being generated or transported. Activities may also include transport, generation or other direct interaction with these materials. Improper handling or unauthorised activities could result in potential for property damage, serious injury or illness, or fatality. Risk of non-compliance with applicable regulations would include exposure to potential criminal or civil penalties imposed by government agencies and degradation of our professional reputation. The general public and the environment may also be placed at risk due to an incident involving the transport of hazardous materials or wastes.

Project teams are expected to be familiar with the content of this SWP, locally applicable regulatory requirements and any project-specific requirements. In the event of conflicting requirements for work practices, the more stringent set of requirements will be followed. These requirements must be outlined in the project safety plan.

6.1 Hazardous material or waste determination

Hazardous materials are generally defined as any substance posing an unreasonable risk to health and safety or property. Most persons recognise gasoline, propane, or acetylene gas cylinders as being hazardous materials but may not recognise that many common items like paint, adhesives and spray lubricants may also be considered hazardous materials under applicable transportation regulations. The following section details US-specific requirements. Other countries or regions may provide similar requirements, as referenced in [Section 9](#) (where available).

The first step is to determine whether a substance is a hazardous material as defined by the US DOT or a hazardous waste as defined by the USEPA. Although the Company may provide assistance to waste generators (owners), the ultimate responsibility remains with the generator (owner). This applies to Ramboll responsibilities with respect to waste generated by our manufacturing operations and or any other waste generating activity where Ramboll is the generator.

NOTE: Ramboll must never accept ownership of another generator's waste. All samples not submitted to a laboratory must be returned to the owner and may not be stored indefinitely. Also, if employees will act as the owner's authorised agent, written authorization and specific approval are necessary as outlined in this SWP (see [Section 8.2](#)).

Correct identification of the substance is critical and can be difficult. For guidance, contact the HSS department or other professional who has experience classifying waste and applying RCRA requirements.

Once identified, the US DOT Hazardous Material Table ([49 CFR 172.10](#)) will provide information necessary to properly package and label materials for transportation and prepare shipping papers (or hazardous waste manifests) and identify correct placarding for transportation vehicles.

Another useful reference is the US DOT table in [49 CFR 173.2](#) that lists hazardous material classes with their corresponding definition. The classes and definitions are summarised below.

Class 1.1 Explosives	Class 2.2 Non-flammable gas	Class 5.2 Organic peroxide
Class 1.2 Explosives	Class 2.3 Poison gas	Class 6.1 Poison liquid or solid
Class 1.3 Explosives	Class 3 Flammable/combustible liquids	Class 6.2 Infectious substance
Class 1.4 Explosives	Class 4.1 Flammable solids	Class 7 Radioactive
Class 1.5 Explosives	Class 4.2 Spontaneously combustible	Class 8 Corrosive
Class 1.6 Explosives	Class 4.3 Dangerous when wet	Class 9 Miscellaneous
Class 2.1 Flammable gas	Class 5.1 Oxidizer	ORM-D Consumer commodities

6.2 Materials of Trade (MOT) determination (US)

The following section details US-specific requirements. Other countries or regions may provide similar requirements, as referenced in [Section 9](#) (where available).

Ramboll periodically transports hazardous materials that are incidental to primary business activities. If requirements of this section are met and no other requirements apply, no additional transportation requirements as outlined in other sections of this SWP are applicable.

6.2.1 Aggregate gross weight

Except for a material of trade exemption for Class 9 dilute mixtures of this section, the aggregate gross weight of all hazardous materials on a motor vehicle may not exceed 200 kg (440 pounds) when transported under a MOT exemption. Some materials also have package size limits as outlined in the next section.

6.2.2 Package size limits for different materials

For materials listed below, a MOT exemption is limited to the following maximum container sizes based on the material's packing group designation (see column 5 of the [US DOT Hazardous Material Table](#)):

- Class 3, 8, 9, Division 4.1, 5.1, 5.2, 6.1, or ORM-D material contained in a packaging having a gross mass or capacity less than or equal to the following:
 - Packing Group I: 1 lb/0.5 kg or 1 pint/0.5 L
 - Packing Group II, III or ORM-D: 66 lbs/30 kg or 8 gal/30 L
 - Dilute mixtures of Class 9 (miscellaneous): 400 gal/1,500 L for a diluted mixture, not to exceed 2% concentration

NOTE: Gasoline is a Class 3, Packing Group II Material, so container size is limited to 8 gallons based on the above US DOT requirements. However, several states limit fuel (gasoline) containers to 5 gallons when transporting under a Materials of Trade exemption. For purposes of this procedure, Ramboll requires gasoline, oil/gasoline mix, kerosene and other fuels to be transported in containers with a maximum 5-gallon capacity when relying upon a MOT exception.

- Division 2.1 (flammable gas) or 2.2 (non-flammable gas) in a cylinder with a gross weight not over 100 kg (220 pounds) or a permanently mounted tank manufactured to the American Society of Mechanical Engineers (ASME) Code of not more than 70-gallon water capacity for a non-liquefied Division 2.2 material with no subsidiary hazard.

NOTE: The above applies to acetylene and oxygen cylinder(s) transported on a vehicle to support torch cutting activities. All cylinders used in the US must be US DOT approved and must be capped and secured upright during transport.

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- Division 4.3 (dangerous when wet) in Packing Group II or III contained in a packaging having a gross capacity not exceeding 1 oz/30 mL.
- Division 6.2 (infectious substance) Refer to the US DOT MOT regulation for additional information on infectious waste.
- This section does not apply to a hazardous material that is self-reactive (see 49 CFR 173.124), poisonous by inhalation (see 49 CFR 173.133), or a hazardous waste.
- Class 7 (radioactive) substances, instruments and articles are not authorised for this exemption.

6.2.3 Packaging

- Packaging must be leak tight for liquids and gases, sift proof for solids, and be securely closed, secured against shifting, and protected against damage.
- Each material must be packaged in the manufacturer's original packaging, or a packaging of equal or greater strength and integrity.
- Outer packaging is not required for receptacles (e.g., cans and bottles) that are secured against shifting in cages, carts, bins, boxes or compartments.
- For gasoline, a packaging must be made of metal and conform to US DOT requirements or requirements of the Occupational Safety and Health Administration (OSHA) contained in 29 CFR 1910.106(d)(2) or 1926.152(a)(1).

NOTE: Ramboll requires that gasoline be stored and transported in appropriate metal safety cans.

6.2.4 Hazard communication (for non-bulk packaging)

A non-bulk packaging (and outer packaging, if any) other than a cylinder must be marked with a common name or proper shipping name to identify the material it contains, including the letters "RQ" if it contains a reportable quantity of a hazardous substance.

- A US DOT specification cylinder (except US DOT specification 39) must be marked and labelled as prescribed in US DOT regulations. Each DOT-39 cylinder must display the markings specified in 178.65(i).
- The operator of a motor vehicle that contains a MOT must be informed of the presence of the hazardous material (including whether the package contains a reportable quantity) and must be informed of the requirements for MOT exception.

6.2.5 Claiming MOT exception by drivers

Regulatory authorities do not automatically apply MOT exceptions to drivers who are otherwise transporting incidental quantities of hazardous materials as outlined in this section. The MOT exemption must be claimed by the driver by stating that hazardous materials are being transported under a MOT exemption. The driver must demonstrate general knowledge of MOT requirements.

6.2.6 Other exceptions

A MOT may be transported on a motor vehicle with other hazardous materials without affecting its eligibility for MOT exception.

6.2.7 Training

Transporting hazardous materials under the MOT exception requires that drivers have taken MOT exception training (see [Section 7](#)).

6.3 Waste generator category determination

This section is based on US requirements and is specific to transportation of hazardous wastes. The USEPA defines generators based on the amount and frequency of waste generated, as calculated in accordance with 40 CFR 261.5(b) and (c).

Different classifications of generators must meet different requirements, which have been summarised by the USEPA in a Generator Summary Chart. Although most US states are consistent with USEPA requirements, some states have different definitions for hazardous waste generator classifications. All generators must identify their hazardous waste. Based on quantities calculated above, generators have the following classifications:

- [Conditionally exempt small quantity generator \(CESQG\)](#)
- [Small quantity generator \(SQG\)](#)
- [Large quantity generator \(LQG\)](#)

6.4 Obtain USEPA identification number or US DOT number

In the US, companies that generate, transport, treat, store, or dispose hazardous waste and all persons who store recyclable materials prior to recycling them are required under RCRA to notify USEPA of their hazardous waste activities. These companies must obtain a USEPA identification (ID) number unless their solid waste has been excluded, or they are a CESQG for which both the USEPA and state do not require an ID number. Other countries or regions may provide similar regulations, as referenced in [Section 9](#) (where available).

- USEPA ID number registration (for new ID number) requires completing the Notification of RCRA Subtitle C Activity – Instructions and Form.
- Searching for a USEPA ID number for an existing facility can be performed using the USEPA's online Facility Registry Service Query Page.

US companies that operate commercial vehicles transporting passengers or hauling cargo in interstate commerce must be registered with the Federal Motor Carrier Safety Administration (FMCSA) and must have a US DOT ID number. Many US states have additional requirements to obtain a state DOT ID number for intrastate commerce. Companies required to have a US DOT ID number are those which operate one or more vehicles that are in any of the following categories:

- Has a gross vehicle weight (GVW) or gross combination weight (GCW), or equivalent rating for these qualities, of 10,001 lbs/4,536 kg or more, whichever is greater

- Designed or used to transport more than 8 passengers (including the driver); used to transport passengers for compensation
- Designed or used to transport more than 15 passengers, including the driver, and is not used to transport passengers for compensation
- Used in transporting hazardous materials or hazardous waste transported in a quantity requiring placarding

NOTE: In the US, vehicles owned by Ramboll that require a US DOT number include source testing trailer and truck, stake beds and similar vehicles with a GVW or GCW >10,000 pounds where used to support primary business activities unrelated to transportation. Ramboll provides a US DOT number for display on regulated vehicles.

6.5 Prepare hazardous materials and waste for shipment

Persons preparing materials for shipment must consider whether the materials are subject to hazardous materials or hazardous waste shipping regulations of the country or region. In the US, hazardous waste transportation is regulated under USEPA RCRA requirements, and hazardous materials transportation is regulated under US DOT requirements. USEPA requires specific labelling and manifesting documentation but generally defers to the US DOT for transportation requirements. The following sections describe US-specific requirements. Other countries or regions may provide similar requirements, as referenced in [Section 9](#) (where available).

6.5.1 Hazardous waste (USEPA)

Hazardous waste is packaged, labelled, marked and placarded following US DOT requirements in 40 CFR 262.30 to 262.33. Waste must be shipped using a licensed and registered hazardous waste transporter. USEPA requirements are specific to hazardous waste but are linked to the following DOT shipping requirements for hazardous materials.

6.5.2 Hazardous materials (US DOT)

Hazardous materials must be properly packaged in accordance with US DOT requirements in 49 CFR 173-General Requirements for Shipments and Packaging.

Once packaged, the proper shipping name and identification number must be marked on the package as required in 49 CFR 172 subpart D-Marking. Consider the applicability of "special permit packages" where the packaging needs to be marked by "DOT-SP" followed by number assigned to the special provision.

Packages of hazardous material must have US DOT hazard labels as required by [49 CFR 172 subpart E-Labelling](#). The applicable warning label is specified for the material in the Hazardous Materials Table (49 CFR 172.101). US DOT Chart 15 may be used to identify appropriate US DOT package markings, labelling and placarding.

Hazardous materials that are properly packaged and packages that are properly marked and labelled must be transported by vehicles with appropriate placards as required by [49 CFR 172 subpart F-Placarding](#).

Hazardous Material Shipping & Transport

- US DOT “Table 1” Materials (refer to Table 1 in [49 CFR 172 subpart F](#)) - Any quantities of the following “Table 1” hazardous materials require placarding: explosives (categories 1.1, 1.2, 1.3), poison gas (category 2.3), dangerous when wet (category 4.3), organic peroxides (category 5.2), poison inhalation hazard (category 6.1), or radioactive material (category 7). Table 1 in 49 CFR 172 Subpart F identifies the appropriate placard for each hazardous material category.
- US DOT “Table 2” Materials (refer to Table 2 in [49 CFR 172 subpart F](#)) - Any quantities of the following “Table 2” hazardous materials require placarding except as noted under the “Placarding Exceptions” bullet: explosives (categories 1.4, 1.5, 1.6), flammable gas (category 2.1), non-flammable gas (category 2.2), flammable (category 3), combustible (category “combustible liquid”), flammable solid (category 4.1), spontaneously combustible (category 4.2), oxidizer (category 5.1), organic peroxide (category 5.2), poison (category 6.1), corrosive (category 8) and Class 9 (category 9). Table 2 in 49 CFR 172 Subpart F identifies the appropriate placard for each hazardous material category.
- Placarding Exceptions -Placarding exemptions to requirements are listed below.
 - Placards are not required for the following:
 - Infectious substances
 - Hazardous materials classified as ORM-D
 - Placards are not required for hazardous materials transported in limited quantities as long as the limited quantities are properly identified on a shipping paper or package and meet limited quantity packaging requirements.
 - The shipping paper (manifest) must include the words “Limited Quantity” or “Ltd Qty” following the basic description.
 - The package may be marked using a “square on point” label with a large “Y” in the centre white portion of the label to signify a limited quantity.
 - Hazardous materials in Class 3 (Divisions 4.1, 4.2, 4.3, 5.1 and 6.1), Class 8 and Class 9 prepared in accordance with 40 CFR subpart 173.13.
 - Hazardous materials packaged as small quantities under the provisions of 40 CFR 173.4, excepted quantities under 40 CFR 173.4a, or de minimis quantities under 40 CFR 173.4b of this subchapter.
 - Combustible liquids in non-bulk packaging.
 - “Table 2” Hazardous Material placarding exceptions include:
 - Placards are not required for vehicles transporting <1,001 pounds aggregate gross weight of all Table 2 hazardous materials.
 - Vehicles transporting two or more categories of hazardous materials may be placarded with a “DANGEROUS” placard instead of placarding each specific material as long as the quantity of each hazardous material category is less than 1,001 pounds.
 - As indicated in the previous bullet, all Table 2 hazardous material categories with an aggregate weight of 1,001 pounds or more must be individually placarded.

- All Table 2 hazardous material categories that include bulk packages must be individually placarded.
- Empty non-bulk packages containing only the residue of Table 2 hazardous material are not included for purposes of determining placarding requirements.

6.6 Prepare shipping documentation or manifest

When shipping hazardous waste, prepare appropriate documents as required in the country or region. In the US, a Uniform Hazardous Waste Manifest must be completed in accordance with 40 CFR 262 Subpart B –The Manifest. USEPA provides a Hazardous Waste Electronic Manifest System (E-Manifest), which should be used where practicable. Paper copies of the manifest are also available from USEPA-approved registrants who sell forms to the public.

Hazardous material shipments require preparation of shipping papers as outlined in 40 CFR 172 subpart C-Shipping Papers. A plain English “Guide for Preparing Shipping Papers” is available from the US DOT Pipeline and Hazardous Material Safety Administration (PHMSA). Unlike the Uniform Hazardous Waste Manifest, shipping papers are available from many sources and do not have a standard format but are all very similar and contain information required by the US DOT.

6.7 Transportation of waste across public roads

On occasion, uncharacterised waste is generated in one area and must be transported to another area for staging and characterization such that crossing a public roadway would be required. In the US, according to the US DOT, the owner of the public road (e.g., city, town, or county) may be contacted to request the road crossing(s) to be designated as part of the construction or remediation site or facility, such that the crossings would be largely exempt from US DOT hazardous material transportation requirements related to hazardous waste transportation on public roads. Local jurisdictions may require permits, crossing safety devices, or other requirements if they allow this type of designation to be made.

However, minimum safety requirements should include using waste containers that are in good condition and secured against movement and spillage during transport. Drums must be closed or covered with any openings or bungs sealed. Exterior surfaces of roll-offs and trucks must be free of loose waste material that can spill onto the roadway crossing. Drivers should be properly qualified to operate the type of vehicle used. Refer to [Section 8.6](#), as well as the SWP, [Driving, Transportation and Journey Management](#) for driver qualifications and other requirements for regulated vehicles.

If waste is spilled or discharged while it is being transported, the generator and/or transporter must be prepared and capable of responding appropriately, containing the material if safe to do so, and notifying the appropriate response agencies or other authorities having jurisdiction, as required.

6.8 Recordkeeping and reporting

In the US, the US DOT requires that shipping manifests for hazardous materials be retained for 2 years from the date the shipment was accepted by the initial transporter. The USEPA requires that hazardous waste documentation be retained at specific facilities in accordance with 40 CFR 262.40 and 262.41. Similar requirements may be provided in other countries or regions. Documentation requirements are described in [Section 8](#).

Specific considerations include:

- A generator must keep a copy of each manifest signed for three years.
- A generator must keep a copy of each Biennial Report and Exception Report for a period of at least three years from the due date of the report.
- A generator must keep records of any test results, waste analyses or other determinations for at least three years from the date that the waste was last sent to onsite or offsite treatment, storage or disposal facility.

6.9 Shipping of hazardous materials

Employees may be required to ship minimal amounts of hazardous substances, most commonly, the shipment of preserved environmental samples (e.g., water samples for dissolved metals analysis are typically preserved using nitric acid). Other sampling tasks, like biological sampling, wastewater treatment plant sampling, and management of laboratory chemicals could also require the shipment of hazardous materials.

The shipment of hazardous materials is strictly regulated globally by country-specific and global agencies. Dangerous goods or hazardous materials are divided into hazard classes, some having several separate divisions or subcategories. Substances in a particular hazard class share certain unique hazard characteristics. Shipping requirements are dependent on the class and quantity of the hazardous material, the shipment method (for example, highway, rail, air, sea), the country of origin and destination and whether the shipment is domestic or international.

Exemptions or exceptions may apply for small and excepted quantities of hazardous materials, as they present less of a hazard due to their limited nature. Employees who will ship hazardous materials must be trained in the procedures required to ship those materials. Training for shipping small and excepted quantities of hazardous materials is included in our training programme (see [Section 7](#)).

In general, the following sources of information should always be reviewed prior to shipping a hazardous material:

1. Safety Data Sheet (SDS), Section 14 – Transportation. This section includes the manufacturer's interpretation of the applicable shipping regulation
2. International Air Transport Association (IATA) Dangerous Goods Regulations (DGR) for air shipments
3. Hazardous Material or Dangerous Goods lists
4. Country-specific hazardous material shipping regulations or guidance

Additional information is provided in [Section 10](#).

6.9.1 Small or excepted quantity exemptions

Small quantities of certain chemicals qualify for exemptions. However, applicable shipping requirements must be determined for the hazardous material based on a Hazardous Material or Dangerous Goods list. This list will depend on the governing authority in the country or region and the method of transportation. Additional guidance is provided in [Section 10](#). Contact your local HSS Coordinator or regional representative of the HSS department for region-specific guidance.

The applicable Hazardous Material or Dangerous Goods list will present the information needed to determine which shipping requirements apply to the material in question (e.g., UN number, chemical class, division and risk subcategories, proper shipping name, packing group, excepted quantity). Some hazard classes of chemicals are considered too dangerous for shipment under the small and excepted quantity exemptions. Explosive materials (Class 1) and gases (Class 2) cannot be shipped under these exemptions and should not be shipped by employees. Refer to [Section 10](#) for the specific requirements that must be met for shipping small quantities or excepted quantities of hazardous materials by rail or highway, or by air, respectively.

6.9.2 Packing and shipping of environmental samples

When environmental samples are shipped to a laboratory for analysis, they are frequently shipped by air to order to meet method hold times and maintain cold temperature using ice or freeze packs. The frequent need for air shipping requires careful preparation and understanding of requirements.

For the purposes of this SWP, samples requiring only cold temperature for preservation, or those that may be shipped at ambient temperature, are considered “unpreserved”. Other samples may require preservation by adding a chemical preservative, which is frequently a small volume of concentrated acid or base. Chemically-preserved environmental samples typically require special shipping considerations, as described in [Section 10](#).

Unpreserved environmental samples may include drinking water, groundwater, surface water, soil, sediment, treated municipal and industrial wastewater effluent, or biological specimens, can be shipped as an environmental sample without any restrictions or special labelling. Depending on the country or region, the shipment of unpreserved environmental samples may not be specifically regulated, provided the sample itself does not meet the definition of a hazardous material, hazardous waste or dangerous goods.

As general guidance, unpreserved non-hazardous environmental samples may be shipped using the following requirements. Refer to [Section 9](#) for country- and region-specific requirements (where available), and refer to [Section 10](#) for additional details and example scenarios:

1. Allow sufficient headspace in sample containers (except VOA containers with a septum seal) to compensate for pressure and/or temperature changes (approximately 10 percent of the volume of the container).
2. Ensure lids are tightly sealed.
3. Place samples in separate polyethylene bags and seal with zip closure and/or tape.
4. Select a sturdy cooler in good repair. Secure and tape the drain plug from the inside and outside with fibre or duct tape. Line the cooler with a heavy duty plastic bag.
5. Place cushioning/absorbent material in the bottom of the cooler and then place the containers in the cooler with sufficient space to allow for cushioning material between the containers.
6. Put ice that has been double bagged and sealed on top of and in between the containers. Fill all remaining space between the containers with cushioning material. It is preferable to use absorbent cushioning material (e.g., chemical absorbent, vermiculite or cellulose pads or pouches) rather than non-absorbent material (e.g., plastic air cushions or air-filled plastic wrapping).

7. Securely fasten the top of the large plastic bag lining the cooler with tape.
8. Place chain of custody document(s) into a plastic bag, zip or tape the bag closed and tape the bag to the inner surface of the cooler lid.
9. Close the cooler and securely tape the top of the cooler shut. Chain of custody seals, if required, should be securely affixed to the top and sides of the cooler and covered with additional tape so that the cooler cannot be opened without breaking the seal.

6.9.2.1 Materials restricted from shipping by air

Materials commonly needed for field work that should not be shipped by air include, but are not limited to the following:

- Aerosol containers (e.g., spray paint to mark sample locations)
- Lithium batteries (e.g., for monitoring equipment)
- Calibration gases (e.g., for equipment calibration)
- Any compressed air cylinders

These materials should be purchased or rented locally after arriving at the site, shipped by ground, or shipped directly to the site by the rental company. The requirements for shipping these materials via air are complex and require additional training. If you must ship a restricted item via air, contact your local HSS Coordinator or the HSS department for additional guidance.

6.9.3 Safety and security

To ensure the safety of the people transporting the shipment and those around them, the following precautions should be taken when shipping hazardous materials:

- Hazardous materials must be securely packaged in accordance with applicable regulations (see [Section 10](#)).
- If employees transport the packaged material in their vehicle to either a laboratory or third-party shipper, the package should be secured within the vehicle.
- Hazardous materials should also be secured from theft. Do not leave shipments unattended in a vehicle. If a package or item must be left in a parked vehicle, ensure it is not visible. If not possible to bring the item into a building or secure location, it is preferable to place the item in a locked trunk.
- Schedule direct pickups from the laboratory when possible. Schedule laboratory drop offs for times when laboratory attendants are on duty. If you must drop off a shipment after hours, follow the laboratory's security plan and ensure that chain-of-custody documentation is properly maintained.
- Security plans may be required for companies that transport any quantities of extremely hazardous materials like explosives and relatively large quantities of other hazardous materials, such as flammable liquids. Security plans are not required for Ramboll's routine operations but may be required in special cases. For US-specific guidance, additional information is available in a US DOT publication titled, "Hazardous Material Transportation Security Requirements."

If you suspect a hazardous material has been lost or stolen, contact the PO/PM, local HSS Coordinator or the HSS department immediately. Report the loss as a security event and asset loss in accordance with the HSSP, [Event Reporting and Investigation](#).

7. TRAINING & COMPETENCY

The HSS training programme includes new employee induction training, supervised on-the-job training and annual completion of online modules or classroom instruction related to safety requirements and work practices. Training assignments vary based on employee roles and training classification. Completion of assigned training will be documented by a training completion certificate, which will be stored in the employee's electronic training record.

In addition to the HSS training programme, employees who perform work related to hazardous materials shipping and transport may receive the following supplemental or external training (or equivalent training, depending on the country or region). Contact the HSS department to identify and assign training.

7.1 US DOT Materials of Trade (MOT) exception training (US)

Persons who transport small quantities of hazardous materials (not including hazardous waste) under the US DOT MOT exception must be trained in the DOT requirements for the MOT exemption. No refresher training is required. For Ramboll, this includes anyone who drives regulated vehicles. If persons must transport quantities of hazardous materials that exceed MOT limitations, then US DOT Hazardous Materials Training as outlined in the following section is required.

7.2 DOT hazardous materials transportation training (US)

Training for an employee transporting or shipping hazardous materials must be completed within 90 days after the employee assumes responsibility for shipping hazardous materials or waste. Trained employees must receive the required training again at least once every 3 years.

7.2.1 General awareness/familiarization

Each employee involved in hazardous materials transportation shall be provided general awareness training designed to provide familiarity with the requirements of this SWP and to enable the employee to recognise and identify hazardous materials, hazardous wastes or other dangerous goods.

7.2.2 Function specific training

Each employee involved in hazardous materials transportation shall be provided function-specific training concerning requirements of this SWP and any country or regional requirements specifically applicable to the functions the employee performs.

7.2.3 Safety training

Each employee involved in hazardous material transportation shall receive safety training concerning the following (or equivalent, depending on the country or region):

- Emergency response information (e.g., in the US, as required by 49 CFR 172, Subpart G).
- Measures to protect employees from the hazards associated with hazardous materials to which they may be exposed in the workplace, including specific measures the employer has

implemented to protect employees from exposure (refer to the SWP, [Communication of Chemical Hazards](#)).

- Methods and procedures for avoiding accidents, such as the proper procedures for handling drums, containers or packages containing hazardous materials (refer to the SWP, Hazardous Waste Operations and the HSSP, [Safety Planning](#)).

7.2.4 Security awareness training

Each employee involved in hazardous materials transportation must receive training that provides an awareness of associated security risks and methods designed to enhance transportation security. This training must also include a component covering how to recognise and respond to possible security threats.

7.2.5 In-depth security training

This training is only required when a site-specific Security Plan is required by the client or regulatory agency and does not apply to routine operations.

7.3 RCRA hazardous waste generator training (US)

In the US, there is extensive interaction between the USEPA RCRA programme for hazardous waste and the US DOT hazardous material shipping regulations. Although RCRA hazardous waste generator training is not required unless Ramboll is the generator of hazardous waste, it is required for those who prepare hazardous waste manifests and is recommended for those who manage, handle, store, mark or label, or inspect hazardous waste containers or storage areas.

8. DOCUMENTATION

The following documentation is required, specific to hazardous material shipping and transportation.

8.1 Training documentation

- US DOT hazardous material transportation training - Initial training followed by refresher or repeat training every 3 years. Training is available through online programmes and classroom training by external training consultants. Refer to Section 7.

8.2 Waste manifest signature authorization form

If employee(s) will function as an owner's agent and authorised to sign hazardous waste manifests (or equivalent waste transport documentation required in the country or region), a Waste Manifest Signature Authorization form (available in the [HSS Document Library](#)) must be completed and approved. The approver must be L09 or above.

8.3 Shipping documentation

In the US, shipping documentation must be generated for each shipment of hazardous materials not otherwise exempted and retained for 2 years. Similar requirements typically apply in other countries or regions.

8.4 Safety data sheet (SDS)

In the US, SDS are required to be attached to shipping papers for materials with an available SDS. If the SDS is not available, other equivalent safety information may be acceptable. Similar requirements typically apply in other countries or regions.

8.5 Uniform hazardous waste manifest

In the US, the Uniform Hazardous Waste Manifest must be completed for hazardous waste shipments and retained for 3 years. Similar requirements typically apply in other countries or regions.

8.6 Commercial driver documentation

In the US, commercial driver documentation includes commercial driver license, pre-trip vehicle inspection, driver log book and SDS for hazardous materials carried under the MOT exemption. Similar requirements typically apply in other countries or regions. Refer to the SWP, [Driving, Transportation and Journey Management](#).

9. INTERNATIONAL TILTS

9.1 Asia / Pacific

9.2 Brazil

9.3 Canada

The Transportation of Dangerous Goods (TDG) programme provides safety standards and regulations, provides risk-based oversight and gives expert advice on dangerous goods to promote public safety in the transportation of dangerous goods by all modes of transport regulated by Transport Canada. It is also responsible for TDG research and data analysis and international collaboration to ensure safe and secure transportation of dangerous goods worldwide.

<https://tc.canada.ca/en/dangerous-goods/transportation-dangerous-goods-canada>

9.4 European Union (EU)

The EU, has two labelling systems:

- The CLP Regulation (EC) No 1272/2008 includes the provisions on labelling hazardous chemicals and implements the GHS in the EU. This regulation applies to all EU member states.
- The labelling requirements in the case of transport of hazardous goods is governed by agreements drawn up by the relevant international bodies as laid out in Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods. EU member states must have implemented this directive into national legislation. Implementation means that each member state has transposed the requirements into national legislation but not necessarily word for word. Agreed derogations are also possible for member states and, thus, the rules are not exactly the same throughout the EU. Furthermore, depending on the mode of transportation for the hazardous goods – rail, road, inland water – there are additional specific agreements.

9.5 Mexico

Mexico has a homologated system of US and Canadian requirements for signage and symbols used for transportation of hazardous materials and waste over public roads. If shipping any hazardous material, compliance with Mexico's Secretaría de Comunicaciones y Transportes (SCT) and Mexico and Secretaría del Trabajo y Previsión Social (STPS) is required, primarily [NOM-003-SCT-2008](#). The SCT requirements and signage are similar to US DOT requirements, and the STPS complies with US Hazardous Materials Identification System (HMIS) and National Fire Protection Association (NFPA) requirements

The UN Globally Harmonised System of Classification and Labelling of Chemicals (GHS) became mandatory in Mexico in October 2018.

9.6 United Kingdom (UK)

The EU, has two labelling systems:

- The CLP Regulation (EC) No 1272/2008 includes the provisions on labelling hazardous chemicals and implements the GHS in the EU. This regulation applies to all EU member states.
- The labelling requirements in the case of transport of hazardous goods is governed by agreements drawn up by the relevant international bodies as laid out in Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods. EU member states must have implemented this directive into national legislation. Implementation means that each member state has transposed the requirements into national legislation but not necessarily word for word. Agreed derogations are also possible for member states and, thus, the rules are not exactly the same throughout the EU. Furthermore, depending on the mode of transportation for the hazardous goods – rail, road, inland water – there are additional specific agreements.

9.7 United States (US)

Code of Federal Regulations (CFR), Title 49 (Transportation), Subtitle B – Other regulations relating to transportation. Chapter I – Pipeline and hazardous materials safety administration, Department of Transportation (DOT). Subchapter C – Hazardous Material Regulations.

<https://www.govinfo.gov/content/pkg/CFR-2012-title49-vol2/xml/CFR-2012-title49-vol2-subtitleB-chapI-subchapC.xml>

40 CFR Parts 260 through 273 encompass USEPA hazardous waste regulations under RCRA.

<https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-regulations#haz>

9.8 Other regions

10. ADDITIONAL INFORMATION

10.1 Excepted quantity shipping requirements for air transport

Certain hazardous materials are also eligible for shipping exemptions when being transported via air. The requirements for shipping these excepted, small, quantities are defined by the International Air Transport Association (IATA) in unison with the International Civil Aviation Organization (ICAO) and are global regulations. Thus, no matter where you live in the world, shipments made via air must follow IATA requirements. These requirements are relatively similar to the US DOT ground

requirements, except IATA defines a maximum quantity limit for various materials and labelling requirements are different.

The first step in shipping any suspected hazardous material is looking it up on the applicable Hazardous Material or Dangerous Goods list to review the requirements and potential exemptions that apply. Materials appropriately classed within one of the following hazard classes or divisions may be transported aboard passenger aircrafts, where accepted:

- Division 2.2 (except aerosols)
- Class 3
- Class 4 (PG II & III)
- Division 5.1 (PG II & III)
- Division 5.2, only when contained in a first aid or chemical kit
- Division 6.1
- Class 8 (PG II & III)
- Class 9

There are certain exceptions for shipment by air; always look up the material intended to be shipped in a Hazardous Materials or Dangerous Goods list and understand the requirements of the shipper.

In these cases, the following packaging and labelling requirements must be met:

1. Inner packaging: The maximum quantity of hazardous materials in each inner packaging differs by hazards class. For example, hazard class 3 (methanol) and class 8 (sodium bisulphate) materials are limited to 30 g (1 ounce) or 30mL (1 ounce) for solids or liquids.
2. Outer packaging: Maximum aggregate quantity of hazardous materials contained in each outer packaging follow a coding system, E0-E5.
3. Packaging materials:
 - Inner receptacle is at least 0.2mm thick.
 - Closure of inner receptacle is positively secured.
 - Securely packed with cushioning and absorbent material capable of absorbing the entire contents (if liquid) of the receptacle.
 - Inner receptacle is secured in outer packaging.
 - Package must not contain forbidden materials.
 - Package is of adequate size for all necessary markings and may not be opened or altered.
4. Packaging must withstand package tests.
5. Labelling: excepted quantities of hazardous materials packaged and labelled in accordance with this requirement must be marked with the following label (dimensions of the mark shall be a

minimum of 100 mm x 100 mm), the primary hazard class of the materials, and the name of the shipper (if not shown elsewhere on the package).



6. Documentation: Transportation by air may require shipping papers for certain carriers. Always check with the intended shipping company during project planning.
7. Training: Each person who offers or transports excepted quantities of hazardous materials must be trained in applicable requirements. This SWP and associated training materials generally satisfy this training requirement.

To determine what the excepted quantity is for the hazardous material you wish to ship by air, the IATA has devised an Excepted Quantity (EQ) code, E0 through E5:

Code	Maximum net quantity per inner packaging	Maximum net quantity per outer packaging
E0	Not permitted as Excepted Quantity	
E1	30g or mL	1kg or L
E2	30g or mL	500g or mL
E3	30g or mL	300g or mL
E4	1g or mL	500g or mL
E5	1g or mL	300g or mL

A material designated with the code E0 may NOT be shipped under this exception. The rest of the EQ codes have different inner receptacle and outer packaging limits. E1 through E3 have the same 30g/30mL requirements as US DOT's ground transportation requirements, but E4 and E5 are more restricted at 1g/1mL. Another main difference is the aggregate limits per package, which range from 1g/1mL to 300g/300 mL.

Hydrochloric acid and nitric acid, common environmental sample preservatives, both carry the EQ code E2. The information needed to determine the EQ code is on the SDS, but may not clearly state,

“the EQ code for this material is E2” for example. Look for information labelled “transport category” or “excepted quantity” in Section 14 of the SDS. If this information is not found on the SDS for the material to be shipped, it is possible that it is not a material subject to these shipping regulations. Contact the HSS department for more information.

10.1.1 Example planning scenario

Here is a practice planning scenario. When planning to collect samples, the project team member contacts the laboratory to order containers and asks the lab what size the containers will be and whether any preservatives will be included in the containers. With this information, the project team member can complete the following steps:

Are there any preservatives?

Yes. Proceed to next step.

No. Samples may be shipped by air (or ground). You don’t need to designate your cooler’s contents as hazardous UNLESS you know that the sample will be characteristically hazardous (i.e., ignitable, reactive, toxic, corrosive) or is a material that is considered a listed hazardous waste. Contact the HSS department to discuss.

Is the EQ code of the preservatives known?

Yes. Proceed to next step.

No. Look up the SDS. Ask the laboratory. Contact the HSS department.

Is it E1, E2, E3, E4 or E5?

Yes. Proceed to next step.

No. Materials with an E0 EQ code cannot be shipped by air.

Is the volume of the sample container smaller than the receptacle maximum?

Yes. Ship by air if necessary. Make sure the total weight of the cooler after packing complies with maximum net quantity for packaging, and pack and label as appropriate.

No. With only this information, the samples cannot be shipped by air. Ship by ground. Ask the laboratory about a courier. Find a local laboratory and deliver the samples. Re-evaluate the sampling plan. Contact the HSS Department for support. However, it is still possible, under certain conditions, that samples may be shipped by air. In the next section, additional information will be provided to further evaluate the shipment and alternatives for accomplishing the scope of work.

Can the samples be shipped?

If unsure whether samples can legally be shipped, several steps can be taken and resources made available. If still in doubt, contact your local HSS Coordinator or the HSS department for additional guidance.

Consider the following scenario:

What is to be done if samples contain a hazardous preservative and the laboratory containers exceed the maximum volume for an excepted quantity? For example, if collecting groundwater for analysis of VOCs, the laboratory will provide 40mL VOA vials. The receptacle maximum for an E2 excepted

quantity for a preservative like hydrochloric acid is 30 mL. Since the worst case scenario must be considered (i.e., once filled with groundwater the total container may be hazardous, retaining the characteristics of the preservative), this container cannot be legally shipped by air. This will require collection of additional information. The shipper is responsible for making the hazardous determination and must prove that the samples can be safely and legally shipped.

Determine if it is necessary to collect the sample. Take a look at the big picture for the project. If the sample is not required or non-critical, eliminate it from the scope of work. If the analyte or media needs to be sampled due to client or regulatory requirements, determine how the sample can be transported to the laboratory safely and legally.

Ask the laboratory for help. If unsure that samples will comply with IATA requirements due to sample volume, there may still be options:

- Call the laboratory and ask for help troubleshooting the shipping. Can they provide a smaller sample bottle? Could they provide a greater quantity of smaller volume bottles to allow compliance with container volume limits? Do they have a courier? They may not have a local courier, but if necessary, they may be able to contract a 3rd party courier to pick up the samples at the site. Another option may be to find a local laboratory that, even if they do not offer the required analysis, can work with the selected lab to ship the samples. These options may require additional costs but may offer the best path to complete the scope of work.

Is the shipment hazardous? Shipping regulations require that the shipper determine if the shipment is hazardous. After collecting the environmental sample, will the water or soil mixed with hazardous preservative, exhibit hazardous characteristics? How much is known about the characteristics of the environmental media being collected? Previous environmental reports may be available for review that include pH testing or other analysis of the environmental media.

- Use the dilution testing completed by the USEPA and US DOT as a guide.
 - If it is known that the pH of the groundwater is at or near neutral pH, a water sample may be collected into an acid preserved bottle such that it will no longer exhibit the corrosive, hazardous characteristic of the preservative, allowing samples to be legally shipped by air.
 - To confirm, use a pH meter or pH indicator paper as a field test. Do not use pH paper in a sample bottle to be analysed. Order an extra sample bottle for this purpose.

If there are questions or concerns about these options, contact the HSS department to discuss the sampling and shipping plan.

10.2 Transportation of compressed gas cylinders (US)

In the US, the US DOT regulates transportation of hazardous materials for commerce while OSHA regulates compressed gas cylinder safety for cylinders stored, handled and used in the workplace. The US DOT allows cylinders to be transported horizontally as long as the following conditions are satisfied:

- Cylinders are completely secured from movement in any direction.
- Cylinders should be secured by ratchet-style tie-downs (or equivalent method) and not bungee cords, rope, or tie-wire. Securing cylinders by piling other tools and equipment on or around them is not adequate or acceptable.

- Ideally, a cradle should be used as part of securing cylinders in a horizontal position if feasible.

Refer to the SWP, [Material Storage and Handling](#) for additional requirements pertaining to compressed gas cylinders.

10.3 Quantity exception for highway and rail (US)

In the US, when transported domestically by highway or rail, small quantities of some hazardous materials are eligible for a small quantity exception and subject to minimal shipping requirements per 49 CFR 173.4. Only certain hazard classes of chemicals, in certain quantities, can be shipped under the small quantity exception, including:

Hazard Class	Packing Group	Max Amount per Receptacle	Max Quantity per Package
3 – Flammable Liquids	I, II, III	30mL (1oz)	29kg
4.1 – Flammable Solids	I, II, III	30g (1oz)	29kg
4.2 – Spontaneously Combustible	II, III	30g or mL (1oz)	29kg
4.3 – Dangerous when Wet	II, III	30g or mL (1oz)	29kg
5.1 – Oxidizers	I, II, III	30g or mL (1oz)	29 kg
5.2 – Organic Peroxides	I, II, III	30g or mL (1oz)	29 kg
6.1 – Toxic Substances	I – Zone A or B I – Not Zone A/B II, III	1mL or 1g 30g or mL (1oz) 30g or mL (1oz)	29kg
7 – Radioactive Material	Activity level not exceeding that specified in 173.421, 424-426		
8 – Corrosive Materials	I, II, III	30g or mL (1oz)	29kg
9 – Miscellaneous	Any	30g or mL (1oz)	29kg

The maximum amount of material for all hazard class materials is generally the same, 30g or 30mL (1oz), except for radioactive material and certain Zone A or B toxic substances. These classes and divisions are broken down even further into packing groups or PGs:

- Packing Group I indicates great danger.
- Packing Group II, medium danger.
- Packing Group III, minor danger.
- For certain classes and divisions of chemicals, exemptions are only allowed for the less dangerous packing groups II and III.

10.4 Small quantity exception (US)

Due to the low percentage of preservatives [compared to the sample media] and the size of the sample containers, preserved environmental samples may be shipped by ground domestically in the US as small quantities under US DOT 49 CFR 173.4 when the above-mentioned requirements are met.

In the US only, the regulating authorities Environmental Protection Agency (EPA) and DOT have come to an agreement to allow ground shipment of preserved environmental samples under certain conditions. The acid and base preservatives shown here, when used as a preservative for environmental samples, are not regulated as a hazardous material. This regulatory exception is contingent upon the amount of preservative used. The volume of preservative cannot exceed the amount prescribed by the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM):

- Nitric acid - 0.4 weight percent
- Sulfuric acid - 0.4 weight percent
- Hydrochloric acid - 0.4 weight percent
- Sodium hydroxide - 0.2 weight percent

This agreement, and the determination that the resulting preserved environmental sample was not hazardous, was made as a result of testing. Essentially, the environmental sample dilutes the preservative such that the sample no longer exhibits its hazardous, corrosive characteristic and can be safely shipped. It is the shipper's responsibility to ensure that the proper amounts of preservatives are used. Note that methanol, a frequently used VOC preservative, is not included on this list of acids and bases. Methanol, used even in small quantities as an environmental sample preservative, is considered a hazardous substance. Methanol must be shipped in accordance with applicable regulations.

The small quantity exception may be utilised when shipping materials using the services of 3rd party providers (e.g., United Parcel Service [UPS], FedEx Ground or overland freight carriers) in the US, but not through the US Postal Service. Third-party shipping providers may also follow additional company-specific requirements, so it is recommended to check with the shipper during project set up, prior to shipping small quantities.

10.5 Labelling and packing (US)

Excepted small quantity hazardous materials shipped by ground or rail in the US are subject to the following hazardous shipping requirements:

1. Inner receptacle within quantity limits (in most cases, 30mL or 30g (1oz) of hazardous material).
2. Inner receptacle made of glass, earthenware, metal or plastic (minimum 0.08 in/2mm thick for plastic) and not liquid full at 131F/55C.
3. Each inner receptacle with removable closure has it held securely in place with wire, tape or other positive means.
4. There must be enough absorbent materials to absorb the entire volume of any liquids.

5. Each inner receptacle is packed in an inside packaging (an intermediate packaging), securely packed in a strong outside packaging.
6. The package must pass prototype testing (but does not have to be UN approved and tested).
7. Gross weight does not exceed 64 lbs/29 kg.
8. Package is clearly labelled with the statement, "This package conforms to 49 CFR 173.4". This is the only labelling that is required for shipping via ground transport in the US. No other documentation or labels are required.

The packaging used to ship hazardous materials under this exemption does not have to be UN certified (which is a typical requirement when shipping hazardous materials). However, it does have to meet certain strength and durability tests to ensure it will stand up to shipping conditions. The tests simulate conditions that the package may encounter during its journey, being dropped on all sides, on a corner and being stacked under similar sized packages. Since this testing requirement is prototype, only a representative package needs to be tested.

Each of the following free drops made from a height of 5.9 ft/1.8 m directly onto a solid unyielding surface must result in no breakage or leakage from any inner receptacle and no substantial reduction in the effectiveness of the package:

- One drop flat on bottom
- One drop flat on top
- One drop flat on the long side
- One drop flat on the short side
- One drop on a corner at the junctions on three intersecting edges
- A compressive load test

Most labs or supply companies who ship hazardous materials have a procedure in place for prototype testing of packages. This makes good business sense since they continually ship out the same products and quantities and are subject to shipping regulations. Ramboll, on the other hand, continually performs unique work in a variety of locations, where getting the same exact packaging, box, container or cooler may be infeasible. Whenever possible, request prototype testing reports from the lab or supply company that is being contracted for the job and reuse this packaging when returning the shipment to them. If this is not possible, contact your local HSS Coordinator or the HSS department for guidance.

10.6 Shipping Resources (US)

- On SDS documentation, Section 14 (Transportation) includes the manufacturer's interpretation of the applicable shipping regulation.
- For assistance with US DOT Hazardous Materials Regulation (US ground shipments only), call the US DOT hazardous materials shipping hotline at 1-800-467-4922 for guidance.
- Call the shipping company and ask to speak with a hazardous substance or dangerous goods professional.

- FedEx: 1.800.Go.FedEx, and say “hazardous materials”
- UPS: 1-800-554-9964

If shipping by ground outside the US, contact the local HSS Coordinator or regional representative of the HSS department for guidance.

11. REVISION SUMMARY

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DATE

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VERSION

1.0

SAFE WORK PRACTICE

HEAT AND COLD STRESS

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Figure 7: Work Rest Schedule

Figure 8: Wind Chill Chart

APPENDICES

Appendix A: Heat Stress Planning Worksheet

Appendix B: Dehydration Colour Chart

Appendix C: Additional Cold Stress Guidance

1. PURPOSE

The purpose of this Safe Work Practice (SWP) is to provide instructions for identifying and evaluating specific heat and cold stress hazards, communicating information concerning these hazards and establishing appropriate protective measures.

2. SCOPE

This SWP applies to all Ramboll work areas where work is performed in hot or cold conditions and areas where such conditions may exist related to our work (for example, cold stress may be an unexpected hazard if a person's clothing became wet as a result of splashes or immersion).

In the event of a conflict between this Ramboll SWP and locally applicable regulatory requirements (or project-specific requirements), the more stringent set of requirements will be followed.

3. OVERVIEW

This SWP outlines the requirements to prevent and treat heat or cold stress. Heat and cold stress occur when Ramboll employees work in hot or cold environments for extended periods of time. The task being conducted in these environments can also contribute to heat and cold stress.

- Heat-related illness may result from a combination of factors, including the environment (temperature and humidity), physical exertion and personal risk factors. Individuals who are not acclimated to hot environments are more likely to develop a heat-related illness.
- PPE, such as chemical protective clothing and respirators, can contribute to the onset of a heat-related illness, and this must be considered when developing controls.
- Heat-related illness can be prevented by adequate work/rest breaks, hydration and acclimation periods.
- If an individual develops a heat-related illness, first aid must be rendered, and in extreme cases (heat stroke) immediate medical treatment is required.
- Cold stress also results from a combination of factors, including the environment (temperature and wind speed), clothing and an individual's personal risk factors.
- Wet clothing or skin will result in a more rapid onset of cold stress, such as frostbite or hyperthermia.
- Dressing adequately and layering clothing will aid in preventing cold-related illnesses and injuries. In cold environments, wet clothing should be removed immediately and replaced with dry clothing.
- If an employee begins to become hypothermic, they must be moved to a warm environment and given warm fluids. Moderate to severe hypothermia will require immediate medical treatment.

4. RESPONSIBILITIES

4.1 Project Manager (PM) / Project Owner (PO)

- Request information about relevant hazards from the facility owner and consider the adequacy of the information provided. This information should be included in the project safety plan
- Ensure adequate budget and schedule to comply with requirements outlined in this SWP
- Recognize the potential for heat and cold stress when assigning persons to work under ambient conditions that may be excessively hot or cold
- Develop a project safety plan to identify project-specific hazards and control measures
- Verify that project employees have completed the applicable training requirements
- Support employee use of Stop Work Authority related to heat and cold stress or any other perceived hazard until such hazards are evaluated and controlled to the satisfaction of the project team and HSS department

4.2 Site Safety Representative (SSR)

- Be present at the site to oversee the project or appoint another on-site Ramboll employee as a backup SSR (with approval from the PM)
- Confirm the project safety plan containing relevant heat and cold stress information is provided to site employees as part of their project safety orientation
- Communicate work requirements to Ramboll employees and subcontractors on the project site
- Implement heat and cold stress preventative measures as outlined in this SWP and referenced in the project safety plan
- Inform PM/PO of important developments or questions regarding heat and cold stress or any other project or task safety concerns

4.3 Ramboll Health, Safety and Security (HSS) department

- Support project safety plan development (when requested by the PM) and review proposed heat and cold stress hazard information and safety controls based on this SWP and site-specific concerns
- Provide technical support related to training, assessing heat and cold stress conditions and identifying preventative measures
- Review and update this SWP on a biennial basis or more frequently if required

4.4 Health, Safety and Security Coordinator (HSSC)

- Promote awareness, understanding and use of this SWP by project team members
- Facilitate application of this SWP in the context of local regulatory requirements and integration of requirements into project safety plans
- Inform Ramboll's HSS department if the HSSP does not adequately address local regulatory requirements

4.5 Employees, subcontractors and visitors

- Review, understand and comply with project safety plans
- Do not undertake any activities with heat or cold stress hazards unless properly trained and equipped for site conditions
- Follow heat and cold stress safety practices defined in this SWP, as implemented by the site owner or occupant or as required by local regulations. In the event of a conflict, the more stringent requirements will be followed
- Report safety events, issues or concerns to the Site Supervisor or SSR
- Exercise Stop Work Authority if any task is perceived to be unsafe or if more information is needed to proceed safely

5. KEY DEFINITIONS

Acclimation - Refers to a physiologic adjustment process occurring when a healthy employee accustomed to a temperate environment begins to work in a hotter or colder environment. These adjustments may occur over a period of days to several weeks.

Cold Stress - What constitutes extreme cold and its effects can vary across different areas of the country. In regions that are not used to winter weather, near freezing temperatures are considered "extreme cold." In certain conditions, like if a person's clothing is wet, cold stress may occur in environments that are not typically considered to present cold stress risks.

Heat Index - Refers to a specialized temperature/humidity index (also called the apparent temperature) that is a measure of how hot weather is perceived by the average person at varying temperatures and relative humidity.

Heat Stress - Heat stress refers to the effects of working in hot environments, which can lead to heat-related illnesses.

Heat Wave - Refers to a temperature condition when the apparent temperature exceeds 108°F/42.2°C or is 15 to 20°F /8 to 11°C higher than the noon, midsummer average temperature.

Wet Bulb Globe Temperature (WBGT) - A type of apparent temperature used to estimate the effect of temperature, humidity, wind speed and visible and infrared radiation, which are affected by sun angle and cloud cover. A WBGT device, also referred to as a Wet Bulb Globe Thermometer, is designed to measure these parameters. WBGT is used as a basis for selecting or designing heat stress control measures.

Wind Chill - Refers to the apparent experienced temperature when taking air temperature and wind speed into consideration. It can also refer to the lowering of body temperature due to the passing flow of lower temperature air.

Winter Weather Advisory - Refers to a weather event where a low-pressure system produces a hazard but does not meet warning criteria. Meteorological authorities of the country or region will typically issue advisories (or similar term) for one or more of the following: 3 to 5 inches/8 to 12 centimetres of snow in 12 hours, up to one-half inch or 1.3 centimetres of sleet, freezing rain with sleet/snow, blowing snow or freezing rain with an ice accumulation of less than one-quarter inch.

Winter Weather Warning - Meteorological authorities of the country or region will typically issue warnings (or similar term) for one or more of the following: 6 inches/15 cm of snow in 12

hours or 8 inches/20 cm in 24 hours, or one-half inch/1.3 cm or more of sleet; ice accumulation of one-quarter inch/0.6 cm or more; or blizzard conditions for 3 hours or more.

Winter Weather Watch - Meteorological authorities of the country or region will typically issue weather watches (or similar term) when conditions are favourable for a winter storm event that might threaten life or property but may not yet meet criteria for an advisory or warning.

6. WORK PRACTICES

Ramboll employees may work in a variety of environmental conditions capable of causing heat and cold stress. Environmental conditions include outdoor work during the winter or summer, work in or nearby bodies of water (such as ecological or sediment investigations) and work within industrial facilities with heat or cold sources, such as furnaces, smelters, ovens, freezers or cold rooms. When properly implemented, the guidelines presented in this SWP will help to mitigate the risk of heat and cold stress.

6.1 Heat stress

At times, workers may be required to work in hot environments for long periods. When the human body is unable to maintain a normal temperature, heat related illnesses can occur and may result in serious injury or death. This section outlines the risk factors, symptoms, treatments, assessments and preventative measures necessary to manage heat stress risks in the workplace.

6.1.1 Risk factors

- Risk factors for heat stress include high temperature and humidity, direct sun exposure, radiant heat sources, limited air movement and insufficient fluid intake for hydration.
- These risk factors can be exacerbated by PPE, clothing and strenuous physical activity.
- In addition to environmental and workload risk factors, personal risk factors must also be considered when evaluating and controlling heat stress risks. Individual susceptibility to heat stress varies widely due to physiological differences.
- Human responses to hot environments are extremely varied and depend on the individual's personal susceptibility and the unique environmental conditions to which the person is exposed.
- Figure 1 presents some of the factors that influence an individual's ability to adapt to heat stress conditions.

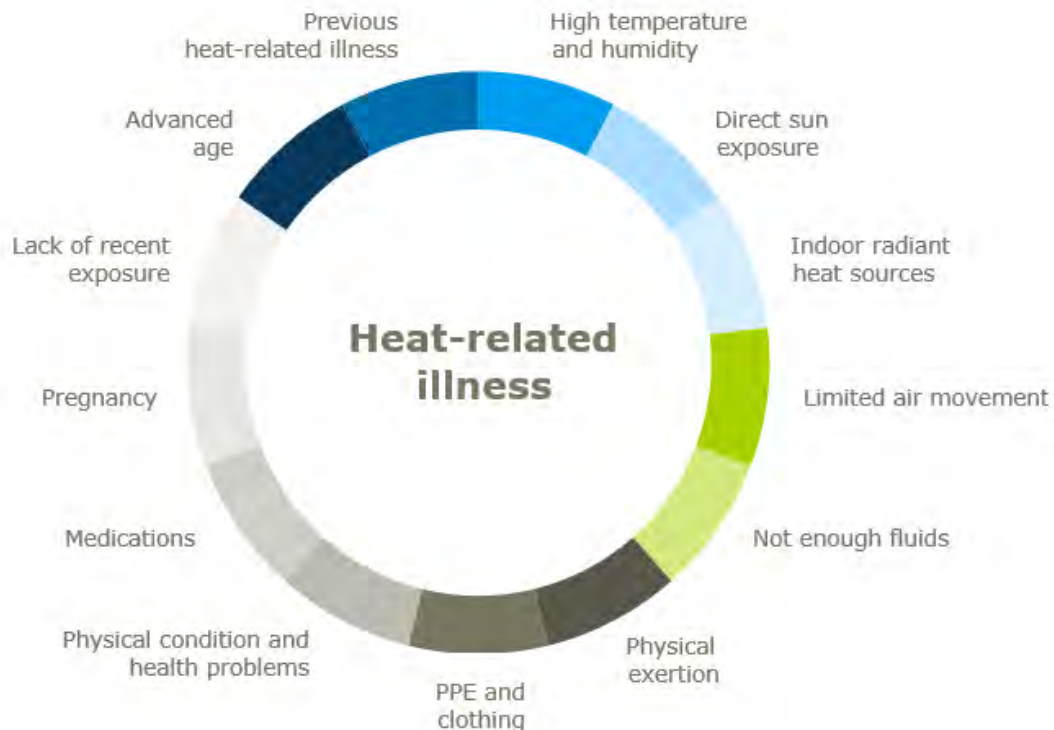


Figure 1. Factors affecting heat stress risk

6.2 Heat-related illness and treatments

In the event of a heat related illness, employees will be administered first aid and will have access to Ramboll's occupational medical provider to facilitate medical evaluation, treatment, medical follow up and ongoing surveillance activities, and documentation as outlined in Ramboll's HSSP, [Medical Surveillance and Fitness for Duty](#). If at any point employees feel symptoms or exhibit signs of heat stress, a Stop Work must be called, first aid will be administered, and additional controls will be selected and implemented before re-starting work if safe to do so. As discussed above, susceptibility to heat stress varies by individual and must be assessed and monitored on a case-by-case basis. Below are the common heat-related syndromes and treatments.

6.2.1 Heat rash

Heat rash is skin irritation caused by sweat that does not evaporate from the skin. Signs and symptoms of heat rash include red clusters of pimples or small blisters. It is more likely to occur on the neck, upper chest, groin, under the breasts and in elbow creases. Treatments may include:

- Provide a cooler, less humid environment
- Keep the affected area dry
- Apply a drying body powder, but do not use ointments and creams

6.2.2 Heat cramps and hyponatremia

Heat cramps and hyponatremia are caused by the loss of body salts and fluids during sweating.

Signs and symptoms of heat cramps and hyponatremia include muscle cramps, pain or spasms in the abdomen, arms or legs. Hyponatremia signs and symptoms may be minimal or severe (e.g., encephalopathy, cerebral and pulmonary edema, respiratory distress or death). Treatments may include:

- Stop Work and move the affected person to a cool, shaded area
- Drink water, have a snack or drink carbohydrate-electrolyte replacement liquids (e.g., sports drinks). When working in environments where heat stress is a hazard, workers should be doing this every 15 to 20 minutes
- Avoid salt tablets unless instructed to do so by a physician or medical professional
- Seek medical evaluation and treatment if the worker has heart problems, is on a low-sodium diet or if cramps do not subside within one hour

6.2.3 Heat exhaustion

Heat exhaustion is the body's response to loss of water and salt from heavy sweating. The signs and symptoms of heat exhaustion are headache, nausea, dizziness, weakness, irritability, confusion, thirst, heavy sweating, decreased urine output and a body temperature greater than 100.4°F/38°C. Heat exhaustion is a medical emergency. Treatments may include:

- Stop Work and move to a cool, shaded area and remove outer clothing. Encourage the worker to take frequent sips of cool water
- Call the local emergency number or take the affected person to a clinic or hospital for emergency medical assistance. If calling for emergency responders, someone should stay with the affected person
- Douse the affected person with cool (not cold) water and circulate air to improve evaporative cooling
- Place cold, wet cloth or ice on head, neck, armpits and groin of worker

6.2.4 Heat stroke

Heat stroke occurs when the body's temperature regulating system fails and body temperature rises to critical levels (greater than 104°F/38°C). Heat stroke is a medical emergency that can result in death. The primary signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; a lack of sweating; hot, dry skin; and an abnormally high body temperature. Treatments may include:

- Stop Work and move to a cool, shaded area and remove outer clothing
- Call the local emergency number or take the affected person to a clinic or hospital for emergency medical assistance. If calling for emergency responders, someone should stay with the affected person.
- Douse the worker with cool (not cold) water and circulate air to improve evaporative cooling
- Place cold, wet cloth or ice on head, neck, armpits and groin of worker
- It is important to note that heat stroke can occur as either "classical" or "exertional" types:
 - Classical heat stroke is a major disruption of the central nervous system, a lack of sweating and high internal body temperature

- Exertional heat stress occurs in physically active individuals who will often continue sweating – this is much more common in occupational settings

6.2.5 Rhabdomyolysis

Rhabdomyolysis is associated with heat stress and prolonged physical exertion, resulting in the rapid breakdown of muscle. Signs and symptoms include muscle cramps, abnormally dark urine (e.g., tea or cola colored), weakness and exercise intolerance. The person may also be asymptomatic. Treatments may include:

- Stop Work, move to a cool, shaded area and drink water
- Arrange for medical evaluation at an occupational medical clinic or hospital and ask to be checked for rhabdomyolysis (i.e., blood sample analyzed for creatine kinase)

6.2.6 Heat syncope

Heat syncope (fainting/light headedness) usually occurs with prolonged standing or sudden rising from a sitting or stooped position. Signs and symptoms include fainting, dizziness and/or light-headedness during prolonged standing or suddenly rising from a sitting or lying position. Treatments may include:

- Stop work, move to a cool, shaded place and sit or lie down
- Slowly drink water, clear juice or sports drink

6.3 Assessing heat stress

The Ramboll PM or designee shall evaluate potential heat stress risks prior to project work, as part of the project safety plan. A Heat Stress Planning Worksheet is included as [Appendix A](#) to assist with evaluating heat stress risk factors and selecting control mechanisms. This worksheet is recommended to be used in combination with a project safety plan. If necessary, a project heat stress control plan should be developed. Heat stress controls must be planned well in advance of field work to allow for acclimation to the heat and integration of the selected control measures into the project scope of work.

- Heat stress regulations are generally consistent around the globe, though some country-specific nuances may apply ([see Section 9, International Tilts](#)). Employees must be familiar with applicable requirements in the country or region where they are working.
- The following sections will review the methods to measure heat stress risk factors and the tools used to predict and prevent heat-related illnesses. Factors that must be considered when assessing potential heat stress risks include the following:

6.3.1 Environmental factors

- Radiant heat, humidity, air temperature and wind speed may be monitored using a WBGT device, also referred to as a Wet Bulb Globe Thermometer. Obtaining real-time data on environmental conditions using a WBGT is the preferred method when monitoring field conditions and assessing heat stress controls.
- Environmental heat measurements should be taken at least hourly during the hottest portion of the workday, during the hottest portion of the year and when a heat wave occurs or is predicted.
- Consider collecting heat measurements before commencing a project, as a conservative measure to understand environmental conditions that may not be well understood or may be difficult to predict.

- This can be especially important when working in indoor spaces that are not well ventilated and may be warmed and/or are subject to increased humidity due to operating equipment rather than weather conditions.
- Tools to assess and plan for future heat stress conditions include:

6.3.1.1 Argonne national laboratory tool

- This US-specific tool uses an algorithmic equation to determine WBGT from user-entered weather data. Similar resources may be available specific to other countries or regions.
- The individual can input local weather centre data from a location near the work area.
- Most data can be obtained from [Weather.com](https://weather.com) other weather forecasting services local to the country or region.
- Irradiance based on cloud cover can be estimated from a chart within the tool or similar local resource.
- Regardless of the tool used and source of the weather information, data used must be reliable and accurate to form a reliable estimate for heat stress.
- The tool may be accessed [here](#) (see Section IV).

6.3.1.2 Heat index

- The heat index is based on published information from the National Oceanic and Atmospheric Administration (NOAA), a US agency, and is a measure of how hot it feels when relative humidity is factored with actual air temperature. Similar resources are available specific to other countries or regions.
- Humidity is an essential gauge for heat stress as it dictates how quickly sweat will evaporate, which is a process that helps our bodies to cool off. However, the heat index is not as complete a measurement as WBGT.
- The heat index was designed for shady, light wind conditions, and this simple analysis does not consider several of the environmental factors that the WBGT takes into account, such as working in full sun.

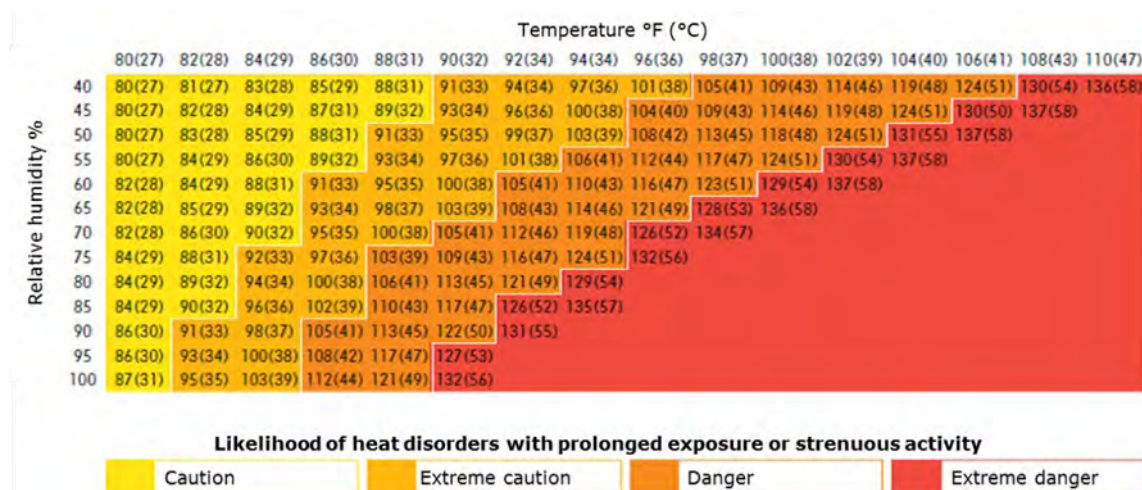


Figure 2. Heat Index

Note: The predictive information in the Heat Index table or similar resource should be used as a guide, rather than as an absolute value.

6.3.2 Physical workload

- The metabolic heat load that an individual produces - from light work to high intensity physical activity

Work category	Metabolic rates (watts)	Examples
Rest	115	Sitting
Light	180	Sitting, standing, light arm/hand work and occasional walking
Moderate	300	Normal walking, moderate lifting
Heavy	415	Heavy material handling, walking at a fast pace
Very heavy	520	Pick and shovel work

Figure 3. Metabolic Rates

6.3.3 Personal protective equipment

- Most heat indices assume a single layer of long sleeves and pants. Any more substantial clothing or PPE, and particularly impermeable PPE, needs to be factored into the heat stress analysis.
- A clothing adjustment factor (CAF) specific to the heat index used should be implemented, as needed (Figure 4).

Clothing worn	Examples	CAF - WGBT °F (°C)
Work clothes (long sleeves and pants)	Standard cotton shirt/pants	0° F/C
Coveralls (with only underwear underneath)	Cotton or light polyester material	0° F/C
Double-layer woven clothing		5.4° F (3° C)
SMS Polypropylene Coveralls		0.9° F (0.5° C)
Polyolefin coveralls	Micro-porous fabric (eg, Tyvek™)	1.8° F (1° C)
Limited-use vapor-barrier coveralls	Encapsulation suits, whole-body chemical protective suits, firefighter turn-out gear	19.8° F (11° C)

Figure 4. Clothing Adjustment Factor

6.3.4 Acclimation

- Worker acclimation is another important consideration when evaluating heat stress. If workers are traveling from their home environment to an area with different environmental conditions or are commencing work with a higher level of heat stress risk factors than their normal activities, they will need time to adjust.
- An adequate amount of time (typically 1 to 2 days with minimal exposure to heat and only light or moderate work rates) should be incorporated into the project schedule for this purpose.
- Heat acclimation can greatly reduce an individual's susceptibility to heat stress.

6.3.5 Carry-over effect

- There is evidence that the previous day's exposure can carry-over creating a cumulative effect. Workers should be aware that they may not develop a heat stress syndrome on the same day as the exposure.
- Individuals may be more susceptible to cumulative effects of heat stress (potentially leading to a heat stress syndrome) over multiple days of exposure to elevated heat conditions.

6.3.6 Heat stress indices and related tools

- Many organizations have established heat stress indices to evaluate heat stress via the factors previously discussed, including environmental conditions, physical workload, clothing and acclimation.
- A heat index tool developed by the American Conference of Governmental Industrial Hygienists (ACGIH), a US organization, may be used to evaluate potential heat stress (Figure 5). Similar tools, including region-specific mobile applications, may be available in different countries or regions.
- Heat index tools typically combine WBGT environmental readings and the metabolic rate of the workload being performed to estimate heat stress and provide limits for safe work.
- Based on the WBGT and metabolic rate, the heat index tool establishes recommended Threshold Limit Value (TLV) for acclimated workers and an Action Limit (AL) (i.e., half the TLV) for unacclimated workers.

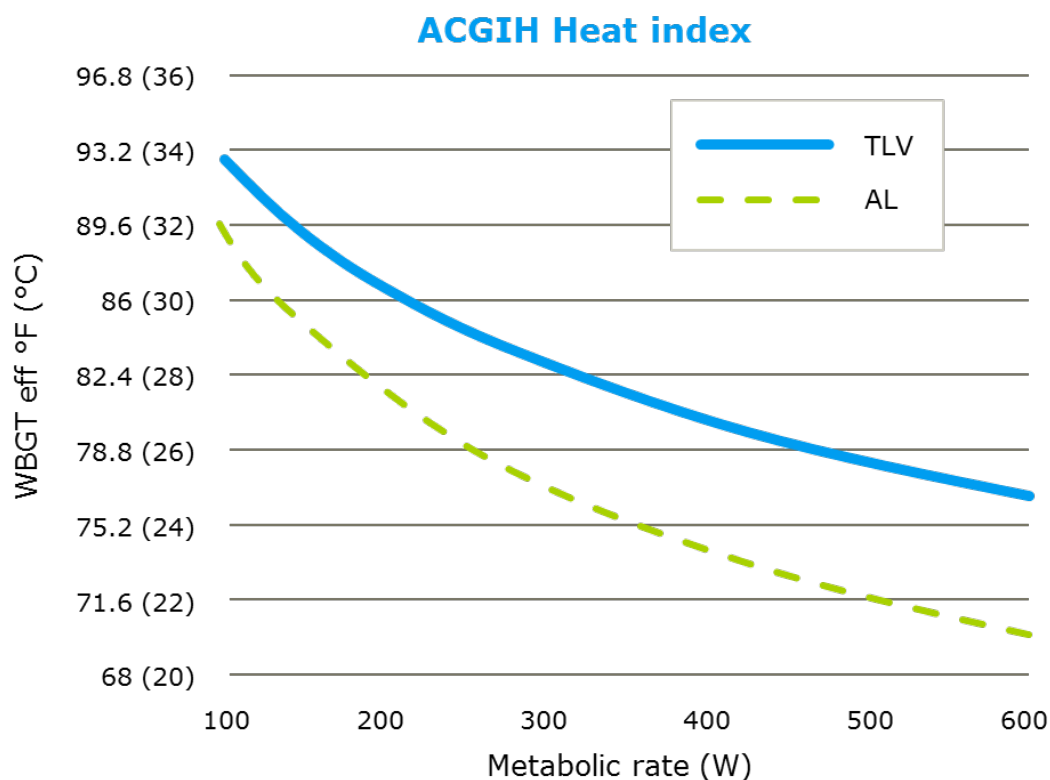


Figure 5. ACGIH Heat Index Tool

- ACGIH has also developed a screening tool to recommend TLVs for heat stress exposure based on WBGT, workload and percentage of time spent performing each job task (Figure 6).

Threshold limit values				
% Work	Workload			
	Light	Moderate	Heavy	Very Heavy
75 to 100% (Continuous)	87.8°F (31.0°C)	82.4°F (28.0°C)	N/A	N/A
50 to 75%	87.8°F (31.0°C)	84.2°F (29.0°C)	81.5°F (27.5°C)	N/A
25 to 50%	89.6°F (32.0°C)	86°F (30.0°C)	84.2°F (29.0°C)	82.4°F (28.0°C)
0 to 25%	90.5°F (32.5°C)	88.7°F (31.5°C)	86.9°F (30.5°C)	86°F (30.0°C)

Figure 6. Threshold Limit Values (TLVs) for Workload Type and Percentage

6.4 Heat stress prevention

6.4.1 Elimination and substitution

The most effective way to prevent heat stress is to eliminate the risk or substitute a task with lower risk.

- Examples would include working indoors or rescheduling work for a cooler season.
- If tasks with heat stress risks cannot be eliminated or substituted with lower-risk tasks, then project teams should rely on other controls as described below and document these controls in the project safety plan.

6.4.2 Engineering controls

Engineering controls can be used to improve heat exchange by modifying air temperature and movement. Outdoor work environments may present challenges for successful application of engineering controls. Please contact the local HSSC or regional HSS department representative for assistance when evaluating the practicality or feasibility of implementing an engineering control to mitigate heat stress risks. Examples of heat stress engineering controls are as follows:

- Spot coolers, fans or blowers to increase heat exchange and improve evaporative heat loss
- Air-conditioned vehicles or trailers worker breaks
- Physical shields if radiant heat from equipment or adjunct processes are an issue
- Equipment or tools to reduce metabolic workload (e.g., rent a properly equipped golf cart to carry sampling equipment for tasks that require walking long distances)
- When shaded areas are not present on the site, establish a shaded area using a tent, umbrella or other sun shade to use for rest breaks or when work tasks are stationary

- Drinking water dispensers, bottled water and/or sports drinks in adequate quantities for workers

6.4.3 Administrative controls

Administrative controls should be heavily relied upon to control heat stress. One of the most effective methods to control heat stress is controlling the exposure to hot environments. Examples of administrative controls are:

- Schedule hot jobs for the cooler part of the day and/or schedule hot jobs on alternate rather than successive days to reduce carry-over effect
- Schedule routine maintenance and repair for cooler seasons
- Postpone tasks that are not urgent
- Alter the work/rest schedule to permit more rest time
- Assess work area and select, if available, an area to work that is shaded from sun (e.g., under a tree)
- Add extra employees to reduce exposure time for all members of the team. Encourage use of Stop Work Authority when a worker feels heat discomfort or any signs or symptoms of heat-related illnesses
- Increase water and other hydrating fluid intake on the job
- Provide breaks in a shaded/cool place, with variable duration in relation to the climate and activity. The SSR must supervise and remind workers to respect break periods and participate in breaks
- Utilize Occupational Exposure Limits to heat exposure based on acclimation and workload
- Create an acclimation plan and schedule
- Minimize work in isolated locations and follow Ramboll's SWP, [Working Alone and Personal Security](#)
- A buddy system should be initiated when heat stress is a job hazard and exposures are above the occupational exposure level
- Buddies should be responsible for observing their co-worker for signs and symptoms of heat stress and be trained to provide first aid and preventative measures if onset of overheating is observed
- Since heat strain stays with the body 1-2 hours following final exposure, buddies should check in with one another after the last exposure to ensure employees are feeling healthy and well
- During pre-work safety briefings, the SSR should instruct supervisors, field employees and subcontractors to recognize early signs and symptoms of heat intolerance, such as weakness, unsteady gait, irritability, disorientation, changes in skin colour or general malaise
- Restrict overtime work in heat stress conditions

6.4.3.1 Work/rest schedule

Another heat stress control is a work/rest schedule. Below are tables developed by NIOSH and the Center for Disease Control (CDC), both US agencies, that are based only on ambient

temperature with adjustment factors for sun and humidity. Similar resources may be available specific to other countries or regions.

Adjusted temperature (°F) ¹	Light work (minutes work/rest)	Moderate work (minutes work/rest)	Heavy work (minutes work/rest)
90	Normal	Normal	Normal
91	Normal	Normal	Normal
92	Normal	Normal	Normal
93	Normal	Normal	Normal
94	Normal	Normal	Normal
95	Normal	Normal	45/15
96	Normal	Normal	45/15
97	Normal	Normal	40/20
98	Normal	Normal	35/25
99	Normal	Normal	35/25
100	Normal	45/15	30/30
101	Normal	40/20	30/30
102	Normal	35/25	25/35
103	Normal	30/30	20/40
104	Normal	30/30	20/40
105	Normal	25/35	15/45
106	45/15	20/40	Caution ²
107	40/20	15/45	Caution ²
108	35/25	Caution ²	Caution ²
109	30/30	Caution ²	Caution ²
110	15/45	Caution ²	Caution ²
111	Caution ²	Caution ²	Caution ²
112	Caution ²	Caution ²	Caution ²

Figure 7. Work Rest Schedule

6.4.3.2 Hydration

- The normal thirst mechanism is not sensitive enough to ensure sufficient water intake; thus, individuals must be encouraged to consistently drink small quantities of potable water that is at temperatures less than 59°F/15°C.
- A good rule of thumb is to drink about 8 ounces/0.2 litre of cool water every 15-20 minutes. Salt, mineral and electrolyte loss should not be an issue for those with a modern diet, as fruits and vegetables are good source for electrolytes – though un-acclimated workers may experience greater salt loss during the first 2 days of hot work. Sports drinks can be consumed in combination with cool water to supplement salt and electrolyte loss, as needed.
- One way to monitor sweat loss and hydration is by monitoring the color of urine output throughout the work period. The Dehydration Color Chart is one analysis of body hydration based on urine color (see [Appendix A](#)). This chart can be printed and posted at the job site when heat stress is a hazard.

6.4.3.3 Heat acclimation plan

- A properly designed and implemented heat acclimation plan can increase the ability of workers to work at a hot job and decrease the risk for heat-related illness. The acclimation plan should be included in the project safety plan, and the PM must consider this plan when scheduling activities for the project.
- Begin with 50% of the normal workload and time spent in the hot environment and then gradually build up to 100% by the 5th day. Implementing acclimation activities is essential for new employees, those traveling to work in a new climate, workers who have been sick or on vacation and all workers during a heat wave. PMs must consider worker acclimation in the project schedule for activities where heat stress is a potential hazard.
- Job reassignments will be coordinated with the PM and must be chosen with knowledge of whether the new task will aid in acclimating the worker to the new job. Inappropriate job reassignment can prolong the acclimation period. The worker may be placed in a low heat stress job. Assigning the worker to a restricted or low heat stress risk job is a helpful method for acclimating workers.

6.4.4 Personal monitoring

Personal monitoring can be done by checking heart rate and recovery heart rate, oral temperature or body water loss. While this type of monitoring will not be required for every project with elevated temperatures, some Ramboll projects may benefit from, or may require such activities to monitor those at risk of developing a heat stress syndrome. If during project planning there are uncertainties relative to the level of controls and monitoring that must be put in place to protect employees, contact the HSSC or HSS department representative for support. Below are examples of personal monitoring protocols:

- To check heart rate, count the pulse for 30 seconds at the beginning of the rest period. If the heart rate exceeds 110 beats per minute (BPM), shorten the next work period by one third and maintain the same rest period. Check the recovery heart rate by comparing the first reading to subsequent readings taken at 2.5 minutes. If the recovery heart rate is greater than 90 BPM or the difference between them is less than 10 BPM, work periods should be reduced.
- Oral temperature must be checked with a clinical thermometer after the work period but before water is consumed. If the oral temperature under the tongue exceeds 99.5°F /37.6°C, the next work cycle should be shortened by one-third.
- Extended work in heat stress conditions may be monitored by weighing each worker at the beginning and end of the work shift. Weight loss should not exceed 1.5% of total body weight; if it does, then fluid intake should be increased.

6.4.5 Personal protective equipment

The final control for heat stress is PPE. PPE, such as reflective clothing and wetted or water-cooled garments, can be effective in reducing heat stress. Below are examples of PPE that can be worn to mitigate the effects of heat stress. If you have questions regarding the selection of PPE, please contact the HSSC or regional HSS department representative.

- Auxiliary cooling systems come in a range of approaches and varying complexity – some research and planning will be required to determine which method is best suited for each site-specific application. Keep in mind that these types of systems add weight, which in turn adds to an individual's workload, and some systems can limit mobility.
 - Cooling vests: Contain ice packs or other cooling materials secured to or integrated within the garment. They must be frozen prior to use, and effective cooling time varies by vest and with environmental factors and metabolic workload. Cooling vests do not provide continuous and regulated cooling and will require re-freezing or replacement of ice packs periodically. The vests do provide increased mobility as they are not tethered to a pump or other energy source.
 - Cooling scarves/pads: Uses crystal polymer or gel cooling technology. These fabric cooling devices can be applied to various areas on the body to reduce body temperature. Most are activated by soaking the fabric in water; they will likely need to be recharged throughout a shift.
- Adjustable and add-on visor and neck shades, which can be used with or without hard hats.
- Long-sleeve shirts: Help to keep the body cooler by clocking skin from the sun.
- Sunscreen on exposed body parts is also recommended. Sunscreens with active mineral ingredients act as physical blockers to the sun and have less impact on aquatic habitats.

Note: Wearing PPE, such as impermeable clothing to protect against other hazards (e.g., chemical and environmental), can significantly increase heat stress risks because it reduces heat loss from the body and can also increase metabolic load.

- When the air temperature exceeds the skin temperature, convective heat gain will be reduced by decreasing air temperature and/or decreasing the air velocity if it exceeds 1.5 metres per second (300 ft/min).
- When air temperature is lower than skin temperature, convective heat loss will be increased by increasing air velocity. The type, amount and characteristics of clothing will influence heat exchange between the body and the environment.
- When the temperature of surrounding solid objects exceeds skin temperature, radiative heat gain will be reduced by:
 - Placing shielding or barriers that are radiant-reflecting or heat-absorbing between the heat source and the employee
 - Isolating the source of the radiant heat
 - Modifying the hot process or operation
- When necessary, evaporative heat loss will be increased by increasing air movement over the employee by reducing the influx of moisture from steam leaks or from water on the workplace floors, or by reducing the vapor content of the clothing worn by the employee will influence the rate of heat exchange by evaporation.

6.5 Cold stress

For some Ramboll projects, employees may be asked to work in cold environments for long periods. When the human body is unable to maintain a normal temperature, cold-related illnesses can occur and may result in serious injury or death. This section outlines the risk factors, symptoms, treatments, assessments and preventative measures that are necessary to manage cold stress in the workplace.

6.5.1 Risk factors

- Situations that present cold stress risks include working outdoors during winter months or working near waterways that may result in splashes or immersion in water <70°F/21°C.
 - Immersion or splashing with cold water can result in cold stress even if the local climate would not normally present a cold stress risk
- Environmental conditions that contribute to cold-related stress include:
 - Low temperatures
 - Wind
 - Dampness
 - Cold water
 - Wind chill (a combination of temperature and wind velocity)

- Individual susceptibility to cold stress varies widely due to physiological and other differences.
- Physiological and other individual risk factors for cold-related stresses may include:
 - Wearing inadequate or wet clothing increases the effects of cold on the body.
 - Taking certain drugs or medications, such as alcohol, nicotine, caffeine and other medications that inhibit the body's response to the cold or impairs judgment.
 - Having a cold, other illness or certain conditions, such as diabetes, heart, vascular and thyroid problems may increase cold stress risks.
 - Becoming exhausted or immobilized, especially due to injury or entrapment, may speed up the effects of cold stress.
 - Individuals of advanced age may be more vulnerable to the effects of cold stress.
 - Lack of personal protective equipment or clothing appropriate for the conditions will quickly increase cold stress risks.

6.6 Cold-related syndromes and treatments

In the event of a cold stress related illness, employees will be administered first aid and will have access to Ramboll's Medical Consultant to facilitate medical evaluation, treatment, follow up and ongoing surveillance activities and documentation as outlined in Ramboll's HSSP, Medical Surveillance and Fitness for Duty (see [Document Library](#)). If at any point employees feel symptoms or exhibit signs of cold stress, a Stop Work must be called, first aid will be administered, and additional controls will be selected and implemented before re-starting work. As discussed above, susceptibility to cold stress varies by individual and must be assessed and monitored on a case-by-case basis. Below are the common cold stress related syndromes and treatments.

6.6.1 Hypothermia

Hypothermia occurs when body temperature falls to a level where normal muscular and cerebral functions are impaired. The first symptoms of hypothermia include shivering, difficulty with complex motor functions, lethargy and mild confusion. These symptoms occur as the core body temperature decreases to around 95°F/35°C. As body temperature continues to fall, hypothermia becomes more severe. The individual falls into a state of dazed consciousness, failing to complete even simple motor functions. The victim's speech becomes slurred, and their behavior may become irrational. The most severe state of hypothermia occurs when body temperature falls below 90°F/32°C. As a result, the body moves into a state of hibernation, slowing the heart rate, blood flow and breathing. Unconsciousness and full heart failure can occur in the severely hypothermic state.

6.6.1.1 Hypothermia treatment

- Seek medical assistance for persons suspected of being moderately or severely hypothermic. If the person is unresponsive and not shivering, assume they are suffering from severe hypothermia.
- Conserve the victim's remaining body heat and provide additional heat sources. Reduction of heat loss can be accomplished by various means: obtaining shelter, removing wet clothing, adding layers of dry clothing or blankets or using a pre-warmed sleeping bag.
- For mildly hypothermic cases or those more severe cases where medical treatment will be significantly delayed, external rewarming techniques may be applied. This includes body-to-

body contact (e.g., placing the person in a prewarmed sleeping bag with a person of normal body temperature), chemical heat packs or insulated hot water bottles. Good areas to place these packs are the armpits, neck, chest and groin. It is best to have the person lying down when applying external rewarming.

- You also may give mildly hypothermic people warm fluids orally but avoid beverages containing alcohol or caffeine.

6.6.1.2 Cold water immersion (accelerated hypothermia)

Cold water immersion creates a specific condition known as immersion hypothermia. It develops much more quickly than standard hypothermia because water conducts heat away from the body 25 times faster than air.

- Typically, people in temperate climates don't consider themselves at risk from hypothermia in the water, but hypothermia can occur in any water temperature below 70°F/21°C.
- Survival times can be lengthened by wearing proper clothing (wool and synthetics and not cotton), using a personal flotation device (PFD, including life vest, immersion suit, or dry suit), having a means of signalling rescuers (strobe lights, personal locator beacon, whistles, flares, waterproof radio).

6.6.2 Frostbite

Frostbite occurs when the skin tissue freezes, causing ice crystals to form between cells and draw water from them, which leads to cellular dehydration. Symptoms include a reddening and extreme numbness of the skin. Frostbite treatment includes:

- Move the affected person to a warm dry area
- Seek medical assistance immediately. Any existing hypothermia should be treated first. Frostbitten parts should be covered with dry, sterile gauze or clean cloth bandages. Do not massage frostbitten tissue because this can cause greater injury
- Severe cases may require hospitalization and even amputation of affected tissue

6.6.3 Trench foot

Trench foot is caused by long, continuous exposure to a wet, cold environment or actual immersion in water. Symptoms include a tingling and/or itching sensation, burning, pain and swelling, sometimes forming blisters in more extreme cases. Trench foot treatment includes:

- Move the affected person to a warm dry area
- Carefully wash and dry, re-warm and slightly elevate affected tissue
- Seek medical assistance as soon as possible

6.7 Assessing cold stress

- POs and PMs shall develop project safety plans that include use of equipment and work practices to prevent injuries resulting from cold stress.
- Cold stress controls must be developed well in advance of field work to allow workers to integrate controls into their regular field practices.
- Cold stress regulations are generally consistent around the globe, although some country-specific nuances may apply. Employees must be familiar with applicable requirements in the

country or region. The project HSSC or a representative of the HSS department can assist in the interpretation and application of local requirements.

- This section will review the means used to measure cold stress and the tools used to predict and prevent cold-related illnesses. Items that must be considered when assessing potential heat stress include the following:

6.7.1 Environmental factors

As discussed above, low temperatures, winds, dampness and cold water can all contribute to cold-related illnesses and these risk factors should be evaluated prior to project work.

- The local weather forecast information should be monitored for winter weather advisories, warnings or watches or similar terms applicable to the country or region
- Temperature readings shall be documented in the project field book to maintain an accurate record of cold stress exposure
- Figures 8a and 8b show the effect of wind chill on exposed skin

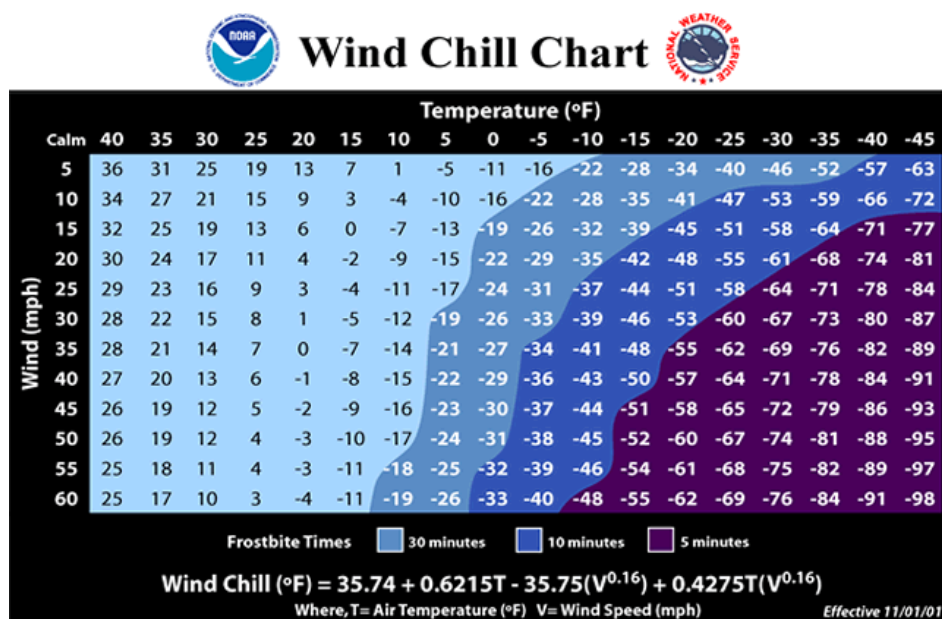


Figure 8a. Wind Chill Chart (Fahrenheit)

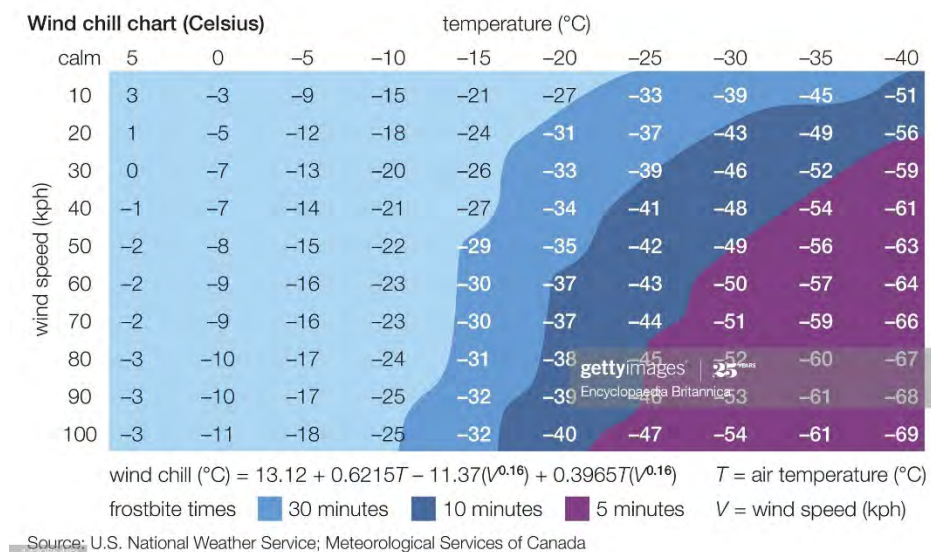


Figure 9b. Wind Chill Chart (Celsius)

6.7.2 Acclimation

Worker acclimation is another main consideration when evaluating cold stress. If workers are traveling from their home environment to an area with different environmental conditions, they will need time to adjust. An adequate amount of time should be incorporated into the project schedule for this purpose. Similar to heat acclimation, cold acclimation can greatly reduce an individual's susceptibility to cold stress.

6.8 Cold stress prevention

6.8.1 Elimination or substitution

The most effective way to prevent cold stress is to eliminate the risk or substitute a task with lower risk.

- Examples would include working indoors or rescheduling work for a warmer season
- If tasks with cold stress risks cannot be eliminated or substituted with lower-risk tasks, then project teams should rely on other controls as described below and document these controls in the project safety plan

6.8.2 Engineering controls

When possible, engineering controls should be used to bring the work environment up to safe temperatures. Below are examples of engineering controls. Outdoor work environments may present challenges for the application of engineering controls. Please contact the local HSSC or regional HSS department representative for assistance when determining the practicality or feasibility of implementing an engineering control to mitigate cold stress risks. Examples of cold stress engineering controls are as follows:

- Placing insulation, shielding or barriers between the cold source and the employee
- Using radiant heaters
- Isolating the source of the cold
- Modifying the cold process or operation

6.8.3 Administrative controls

Administrative controls will be introduced when engineering controls are not adequate or are not feasible. One of the most effective methods to controlling cold stress is controlling the exposure to cold environments. Examples of administrative controls are presented below:

- Schedule jobs for the warmest part of the day
- Schedule maintenance and repair jobs in cold areas for warmer months
- Postpone outdoor tasks that are not urgent
- Increase the number of workers in each team to reduce each worker's individual cold exposure
- Encourage Stop Work Authority when a worker exhibits signs or symptoms of cold stress
- Reduce the physical demands of workers
- Provide warm sweetened liquids to employees and remind employees to drink water in small amounts frequently to prevent dehydration
- Increase cold tolerance by implementing a cold acclimation plan
- Exercise additional caution on the first day of a shift change or after a weekend, even for acclimated employees, because some level of acclimation may be lost during several days outside of work
- Provide warm areas for use during break periods and increase rest allowances
- Restrict overtime work in cold stress conditions
- Minimize the presence of workers in isolated locations
- Initiate a buddy system when cold stress is identified to be a job hazard. Buddies should be responsible for observing their co-worker for signs and symptoms of cold stress and be trained to provide first aid and preventative measures
- Train supervisors and their employees to recognize early signs and symptoms of cold stress

6.8.3.1 Acclimation and rest breaks

- Acclimation and planning for rest breaks are important parts of preparing for work in cold environments. [Appendix C](#) includes a Work/Warm-up Schedule developed by ACGIH, a US organization. Similar guidance for cold stress acclimation and rest breaks may be available in other countries or regions.

6.8.4 Personal protective equipment

Dressing properly is extremely important to preventing cold stress. The type of fabric worn also makes a difference. Cotton loses its insulation value when it becomes wet. Wool, silk and most synthetics, on the other hand, retain their insulation properties even when wet. The following are recommendations for working in cold environments:

- Wear at least three layers of loose-fitting clothing. Layering provides better insulation. Do not wear tight fitting clothing.
 - An inner layer of wool, silk or synthetic to keep moisture away from the body
 - A middle layer of wool or synthetic to provide insulation even when wet

- An outer shell for wind and rain protection, made of a material that allows some breathability or ventilation to prevent accumulation of moisture from perspiration
- Wear a hat or hood or use an insulated hard hat liner. Do not wear a hard hat over a standard hat or insulated hood unless permitted by the manufacturer, as this can interfere with the fit and protection provided by the hard hat.
- Use a knit mask or balaclava to cover the face and mouth (if needed)
- Use insulated gloves to protect the hands (water resistant if necessary). Make sure that gloves used will offer an appropriate level of chemical protection, as required for chemical hazards
- Wear insulated and waterproof boots. Boots should have a safety toe where required. A composite safety toe may be preferred to steel, as steel may conduct heat away from a wearer's foot

7. TRAINING AND COMPETENCY

Ramboll's HSS training program includes new employee induction training, supervised on-the-job training and annual completion of online modules or classroom instruction related to safety requirements and work practices. Training assignments vary based on employee roles and training classification. Completion of assigned training will be documented by a training completion certificate, which will be stored in the employee's electronic training record.

7.1 Heat / cold stress training

Prior to job assignment, Ramboll shall provide training to educate employees who may be exposed to heat/cold stress risks about the hazards and verify that employees have the knowledge and skills required for the application and usage of safe work practices that may be required for specific projects or tasks.

- The degree of training provided shall be defined by the complexity of the job assignment and the associated heat or cold stress hazards

7.2 Refresher training

Scheduled refresher training will be conducted on an annual basis. Retraining shall be provided for authorized and affected employees whenever there is a change in their job assignments, a change in equipment or processes that present a new heat/cold stress hazard, or when their work takes them into other areas where cold/heat injuries could occur.

- Additional retraining shall also be conducted whenever a periodic inspection reveals or whenever Ramboll has reason to believe that there are deviations from or inadequacies in the employee's knowledge of known hazards or in use of equipment or work practices.
- The retraining shall re-establish employee proficiency with equipment, control methods and safe work practices, as necessary.

8. DOCUMENTATION

The following documentation is required, specific to heat and cold stress.

8.1 Monitoring data

Temperature readings and other relevant meteorological, environmental or personal health monitoring data, and descriptions of work cycles and breaks shall be documented in the project

field logbook to maintain an accurate record of project conditions and exposure to heat and cold stresses.

9. INTERNATIONAL TILTS

9.1 Asia / Pacific

9.2 Brazil

9.3 Canada

9.4 European Union (EU)

The European Union and its EU-OSHA do not outline specific heat safety laws. However, several countries in the EU have their own rules and guidelines.

For example, in Germany, a workplace is normally 26°C maximum, but if the outside temperature is higher, it may be allowed to be higher, although an upper limit isn't clearly defined. France doesn't have a maximum temperature limit either, but employers must ensure their employees are safe and provide fresh drinking water. In Spain, the temperature should be between 17 and 27°C where sedentary work is taking place and between 14 and 25°C for light physical work. In Italy, the legislation states that the microclimate is a physical risk agent and that consequently a risk assessment must be carried out.

The main ISO standards that intervene in the thermal stress assessment process are:

- **ISO 16595** Working practices in hot environments
- **ISO 15743** Cold workplaces - Risk assessment and management
- **ISO 13732-1** Methods for the assessment of human responses to contact with surfaces, Part 1: Hot surfaces
- **ISO 7243** Assessment of heat stress using the WBGT (wet bulb globe temperature) index
- **ISO 7933** Analytical determination and interpretation of heat stress using calculation of the predicted heat strain
- **ISO 11079** Determination and interpretation of cold stress when using required clothing insulation (IREQ) and local cooling effects
- **ISO 9886** Evaluation of thermal strain by physiological measurements
- **ISO 9920** Estimation of thermal insulation and water vapour resistance of a clothing ensemble
- **ISO 8996** Determination of metabolic rate

9.5 Mexico

9.6 United Kingdom (UK)

9.7 United States

9.7.1 Employer responsibilities (OSHA Standard: General Duty Clause)

Under the General Duty Clause, Section 5(a)(1) of the Occupational Safety and Health Act of 1970, employers are required to provide employees with a place of employment that "is free from recognized hazards that are causing or likely to cause death or serious harm to employees."

The courts have interpreted OSHA's general duty clause to mean that an employer has a legal obligation to provide a workplace free of conditions or activities that either the employer or industry recognizes as hazardous and that cause, or are likely to cause, death or serious physical harm to employees when there is a feasible method to abate the hazard. This includes heat/cold-related hazards that are likely to cause death or serious bodily harm.

9.7.2 NIOSH recommended standards

The National Institute for Occupational Safety and Health (NIOSH) has published criteria for a recommended standard for occupational heat and cold stress (links: [NIOSH Heat Stress](#); [NIOSH Cold Stress](#)). The NIOSH documents include recommendations for employers about how to prevent heat- and cold-related illnesses.

9.7.3 Criteria for a recommended standard – occupational exposure to heat and hot environments

U.S. Department of Health and Human Services (DHHS), National Institute for Occupational Safety and Health (NIOSH) Publication No. 2016-106, (February 2016).

9.7.4 Heat standards in specific states

Many U.S. states run their own OSHA-approved State Plans. Some states have adopted standards that cover hazards not addressed by federal OSHA standards. The following states have standards for heat exposure:

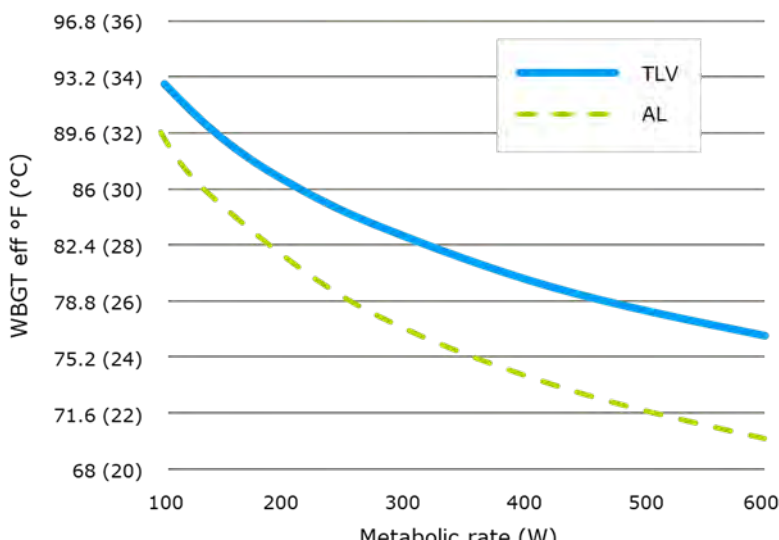
- California: California's Heat Illness Prevention Standard requires employers to provide training, water, shade and planning. A temperature of 80°F triggers the requirements. See CalOSHA's website
- Minnesota: The standard applies to indoor places of employment
- Washington: See Washington State's Outdoor Heat Exposure Rule

10. ADDITIONAL INFORMATION

11. REVISION SUMMARY

APPENDIX A

HEAT STRESS PLANNING WORKSHEET

HEAT STRESS PLANNING WORKSHEET																																				
Brief Project Description	Location																																			
Date(s) of work	Working Hours																																			
1. Investigate weather conditions Use local weather center data from Weather.com or other reputable source to estimate Wet Bulb Globe Thermometer (WBGT) temperature range for the project.																																				
See calculator developed by the Argonne National Laboratory: http://www.osha.gov/dts/osta/otm/otm_iii/wbgtutil.zip	Estimated WBGT Range																																			
2. Calculate Effective Wet Bulb Globe Temperature (WBGT_{eff}) Find the applicable Clothing Adjustment Factor (CAF) from the Reference Information provided. Add that number to the Estimated WBGT Range.																																				
Is Personal Protective Equipment (PPE) beyond a single layer of breathable clothing required to protect against Chemical or Physical hazards? Yes No	WBGT + CAF = WBGT_{eff}																																			
3. Estimate Metabolic Rate by Work Task Group work tasks together considering the physical effort required to perform and assign an estimated metabolic rate in Watts based on the reference information provided.																																				
Work Tasks: 1. 2. 3.	Metabolic Rate: 1. 2. 3.																																			
4. Acclimation Full heat acclimation occurs with relatively brief daily exposure to working in the heat over the course of a few days provides reduced risk to heat stress.																																				
Are workers travelling from to an area that presents different environmental heat factors than their home location, such as temperature and humidity? Yes No If Yes, Non-acclimated workers must be considered separately from those acclimated to the local environment.																																				
5. Assess Heat Stress Levels by Work Task Compare the calculated Metabolic Rate for each Work Task to the WBGT _{eff} using a Heat Index such as the ACGIH Heat Index below.																																				
Drag a representative 'dot' to the graph to represent each work task.  ACGIH Heat index  <table border="1" style="margin-top: 10px; width: 100%; border-collapse: collapse;"> <caption>ACGIH Heat Index Data Points (Estimated)</caption> <thead> <tr> <th>Metabolic rate (W)</th> <th>TLV WBGT_{eff} (°F)</th> <th>TLV WBGT_{eff} (°C)</th> <th>AL WBGT_{eff} (°F)</th> <th>AL WBGT_{eff} (°C)</th> </tr> </thead> <tbody> <tr> <td>100</td> <td>93.2</td> <td>34</td> <td>89.6</td> <td>32</td> </tr> <tr> <td>200</td> <td>88.0</td> <td>31</td> <td>84.0</td> <td>29</td> </tr> <tr> <td>300</td> <td>84.0</td> <td>29</td> <td>80.0</td> <td>27</td> </tr> <tr> <td>400</td> <td>81.0</td> <td>27</td> <td>77.0</td> <td>25</td> </tr> <tr> <td>500</td> <td>78.0</td> <td>26</td> <td>74.0</td> <td>23</td> </tr> <tr> <td>600</td> <td>75.2</td> <td>24</td> <td>71.6</td> <td>22</td> </tr> </tbody> </table>	Metabolic rate (W)	TLV WBGT _{eff} (°F)	TLV WBGT _{eff} (°C)	AL WBGT _{eff} (°F)	AL WBGT _{eff} (°C)	100	93.2	34	89.6	32	200	88.0	31	84.0	29	300	84.0	29	80.0	27	400	81.0	27	77.0	25	500	78.0	26	74.0	23	600	75.2	24	71.6	22	The TLV is the temperature at which there is a heat hazard present for an acclimated worker, and the AL is the temperature at which there is a heat hazard present for a non-acclimated worker. Do any work tasks exceed applicable AL or TLV limitations for Heat Stress? Yes No If limits are reached, controls are necessary to prevent heat-related illness.
Metabolic rate (W)	TLV WBGT _{eff} (°F)	TLV WBGT _{eff} (°C)	AL WBGT _{eff} (°F)	AL WBGT _{eff} (°C)																																
100	93.2	34	89.6	32																																
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500	78.0	26	74.0	23																																
600	75.2	24	71.6	22																																

HEAT STRESS Planning

Hierarchy of Controls Consider the baseline AL and TLVs calculated and determine additional controls required to mitigate risk for heat stress.

Elimination / Substitution (eliminate the need to work during high risk heat stress season, or substitute a task with lower risk level)

Yes	☐	Description:
No	☐	

Engineering Controls (increase air movement e.g., fans, air conditioning, swamp coolers; reflective shields; insulating hot surfaces; providing shade)

Yes	☐	Description:
No	☐	

Administrative Controls (acclimate workers; reacclimate workers after absence; schedule work early or late; use work/rest schedule; limit strenuous work)

Yes	☐	Description:
No	☐	

Heat-Related Personal Protective Equipment (water- or air-cooled garments; cooling vests; sun hats; light colored clothing; sunscreen)

Yes	☐	Describe:
No	☐	

Acclimation Plan Describe the plan to mitigate physical hazards from heat and humidity by gradually introducing employees to the hazard. Depending on the project location and the location of staffing, the acclimation plan may need to be customized on an employee-specific basis.

NOTE: See the end of this worksheet for additional reference information.

Work/Rest Cycle Plan Describe the Work/Rest Cycle Plan. The work/rest cycle should take into account, at a minimum, the chemical/physical-required PPE, the heat hazard-required PPE, the task-specific workloads, hydration and the acclimation plan. The plan may need to be customized on an employee-specific basis.

NOTE: See the end of this worksheet for additional reference information.

Checklist for Operations in High Heat Stress Risk Projects		
	Yes	No
People		
Have the hazards involved in this task been adequately addressed in a health and safety plan or other document with documented approval by project leadership and HSS?	☐	☐
Are you (and others) appropriately trained, medically fit and competent to carry out this task?	☐	☐
Are you (and others) aware of the signs and symptoms of heat-stress related illnesses?	☐	☐
Do I know what to do in an emergency?	☐	☐
System		
Are there any other steps that are needed to further minimize the risk?	☐	☐
Do you know the scope of work and how to do it?	☐	☐
Do you have the right tools, equipment and PPE?	☐	☐
Is there a reliable means of communication to emergency responders?	☐	☐
Are other required control measures in place?	☐	☐
If any "No" answers, or if answers are unknown or more information is needed, use your  STOP WORK AUTHORITY		

HEAT STRESS PLANNING REFERENCE INFORMATION

Workload Metabolic Rates

(OSHA, undated, https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html#illness_prevention)

Work Category	Workload Metabolic Rate (Watts)	Representative Activities
Rest	115	Sitting, limited arm movement
Light	180	Sitting or standing to control machines; perform light hand or arm work; occasional walking; driving
Moderate	300	Walking about with moderate lifting and pushing or pulling; walking at moderate pace
Heavy	415	Heavy material handling; walking at a fast pace
Very Heavy	520	Very intense activity at a fast to maximum pace

Clothing Adjustment Factors (CAF)

(OSHA, undated, https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html#illness_prevention)

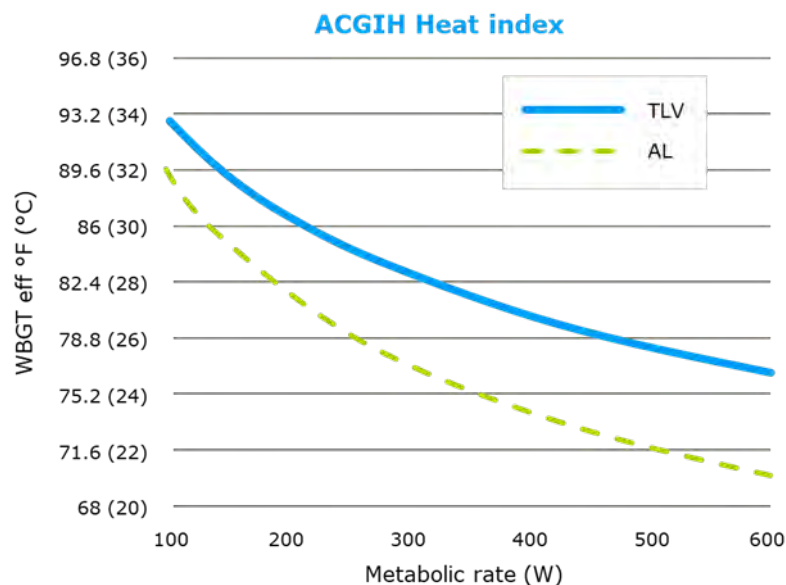
Clothing Worn	CAF
Cotton or Light Polyester Work clothes (e.g., long sleeves and pants)	0
Cotton or Light Polyester Coveralls (e.g., w/only undergarments underneath)	0
Double-layer woven clothing	3
SMS Polypropylene Coveralls	0.5
Polyolefin coveralls (e.g., microporous fabric such as Tyvek™)	1
Limited-use vapor-barrier coveralls (e.g., encapsulating suits, whole body chemical protective suits, firefighter gear)	11

ACGIH Action Limit and Threshold Limit Curve

(OSHA, undated, https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html#illness_prevention)

The TLV is the temperature at which there is a heat hazard present for an acclimated worker, and the AL is the temperature at which there is a heat hazard present for a non-acclimated worker. Once these limits are reached, either through environmental factors or workload, controls are necessary to prevent heat-related illness. Controls include work/rest regimens, shade and hydration.

See also [Work /Rest Cycle and Acclimation Information](#).



Acclimation Guidance

(NIOSH, 6-June-2018, <https://www.cdc.gov/niosh/topics/heatstress/acclima.html>)

Acclimation is the beneficial physiological adaptations that occur during repeated exposure to a hot environment. These physiological adaptations include:

- Increased sweating efficiency (earlier onset of sweating, greater sweat production and reduced electrolyte loss in sweat).
- Stabilization of the circulation.
- The ability to perform work with lower core temperature and heart rate.
- Increased skin blood flow at a given core temperature.

To acclimate workers, gradually increase their exposure time in hot environmental conditions over a 7-14-day period. New workers will need more time to acclimate than workers who have already had some exposure.

Acclimation schedule

For new workers, the schedule should be no more than a 20% exposure on day 1 and an increase of no more than 20% on each additional day.

For workers who have had previous experience with the job, the acclimation regimen should be no more than a 50% exposure on day 1, 60% on day 2, 80% on day 3 and 100% on day 4.

In addition, the level of acclimation each worker reaches is relative to the initial level of physical fitness and the total heat stress experienced by the individual.

Maintaining acclimation

Workers can maintain their acclimation even if they are away from the job for a few days, such as when they go home for the weekend. However, if they are absent for a week or more, then there may be a significant loss in the beneficial adaptations leading to an increased likelihood of heat-related illness and a need to gradually reacclimate to the hot environment.

Some additional information on maintaining acclimation:

- It can often be regained in 2 to 3 days upon returning to a hot job.
- It appears to be better maintained by those who are physically fit.
- Seasonal shifts in temperatures may result in difficulties.
- Working in hot, humid environments provides adaptive benefits, which also apply in hot, desert environments, and vice versa.
- Air conditioning does not typically affect acclimation to outdoor conditions.

Work / Rest Cycle and Acclimation Information

ACGIH screening criteria for heat stress exposure in degrees Celsius for an 8-hour workday 5 days per week with conventional breaks will be used in determining safe exposure for acclimated and unacclimated employees.

Allocation of Work in a Work / Rest Cycle	Acclimated				Action Limit (Unacclimated)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75-100%	31.0 (87.8F)	28.0 (82.4F)	--	--	28.0 (82.4F)	25.0 (77F)	--	--
50-75%	31.0 (87.8F)	29.0 (84.2F)	27.5 (81.5)	--	28.5 (83.3F)	26.0 (78.8F)	24.0 (75.2F)	--
25-50%	32.0 (89.6F)	30.0 (86F)	29.0 (84.2F)	28.0 (82.4F)	29.5 (85.1F)	27.0 (80.6F)	25.5 (77.9)	24.5 (76.1F)
0-25%	32.5 (90.5F)	31.5 (88.7F)	30.5 (86.9F)	30.0 (86F)	30.0 (86F)	29.0 (84.2F)	28.0 (82.4F)	27.0 (80.6F)

APPENDIX B

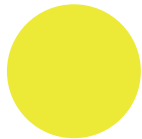
URINE COLOR CHART

Dehydration Color Chart

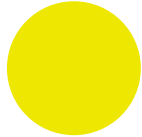
(color represents urine appearance)



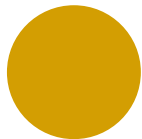
Doing ok. You're probably well hydrated. Continue to drink water periodically.



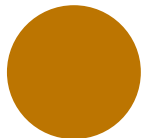
You're just fine. You could stand to drink a little water now, maybe a small glass of water.



Drink about 1/2 bottle of water (1/4 liter) within the hour or drink a whole bottle (1/2 liter) of water if you're outside and/or perspiring.



Drink about 1/2 bottle of water (1/4 liter) right now or drink a whole bottle (1/2 liter) of water if you're outside and/or perspiring.



Drink 2 bottles of water right now (1 liter). If your urine is darker than this or appears red or brown, then you need medical attention.

APPENDIX C

ADDITIONAL COLD STRESS GUIDANCE

TABLE 3. Threshold Limit Values Work/Warm-up Schedule for Four-Hour Shift*

Air Temperature— Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°C (approx.)	°F (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
−26° to −28°	−15° to −19°	(Norm. Breaks) 1		(Norm. Breaks)		75 min	2	55 min	3	40 min	4
−29° to −31°	−20° to −24°	(Norm. Breaks) 1		75 min	2	55 min	3	40 min	4	30 min	5
−32° to −34°	−25° to −29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
−35° to −37°	−30° to −34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease			
−38° to −39°	−35° to − 39°	40 min	4	30 min	5	Non-emergency work should cease					
−40° to −42°	−40° to −44°	30 min	5	Non-emergency work should cease							
−43° & below	−45° & below	Non-emergency work should cease									

Notes for Table 3

- Schedule applies to moderate to heavy work activity with warm-up breaks of ten (10) minutes in a warm location. For Light-to-Moderate Work (limited physical movement): apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (Step 5).
- The following is suggested as a guide for estimating wind velocity if accurate information is not available:
5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.
- If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind chill cooling rate of about 1750 W/m²; 2) all non-emergency work should have ceased at or before a wind chill of 2250 W/m². In general the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.
- TLVs apply only for workers in dry clothing.

*Adapted from Occupational Health & Safety Division, Saskatchewan Department of Labour.

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DATE

May 2021

VERSION

1.0

SAFE WORK PRACTICE

HEAVY EQUIPMENT

AND FORKLIFTS

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1. PURPOSE

The purpose of this Safe Work Practice (SWP) is to outline requirements for heavy equipment maintenance, operator qualifications and safe work procedures when operating or working near mechanized equipment.

2. SCOPE

Heavy equipment covered by this SWP includes excavators, bulldozers, front loaders, backhoes, dump trucks, drilling rigs and similar equipment. Both owned and rented heavy equipment are covered. Also included are powered industrial trucks (PIT), a term that describes forklifts, tractors, platform lift trucks, motorized hand trucks and similar equipment. Country-specific regulations may have specific standards for equipment (as a US example, OSHA requirements are described in [Section 9](#)). For this SWP, “forklift” will be used as a general term when referring to Ramboll requirements for PITs. The requirements for forklifts (and other PITs) will be listed separately from those of other heavy equipment types, as applicable. Requirements listed in this SWP will apply to both heavy equipment and forklifts/PITs unless otherwise specified.

Man lifts, scissor lifts, bucket trucks and cranes are not specifically included in this SWP, although many of the safety precautions associated with heavy equipment are also applicable to these devices. Refer to Ramboll’s SWPs, [Work from Heights - Elevated Work Platforms](#), [Cranes - Mobile](#) and [Cranes - Overhead and Gantry](#).

Heavy equipment includes machines designed for excavation, drilling or other intrusive activities. All intrusive activities, including use of machinery that disturbs or displaces the ground surface, are subject to the requirements of Ramboll’s SWP, [Subsurface Utility Clearance](#).

3. OVERVIEW

This SWP defines work practices for equipment operators and those who work in proximity to operating equipment or heavy machinery. This SWP contains descriptions of work practices, training and competency requirements, equipment safety requirements and documentation.

- Safety equipment – seat belts, fire extinguishers, mirrors, guards, enclosed cabs
- Routine operation – traffic route, overhead hazards, crossings, lighting, fueling, parking/security
- Operation on slopes – manufacturer requirements, ascending/descending, wheel chocks
- Load handling – clearances, load capacity, visibility, towing, rigging, platforms
- Exiting from equipment – parking procedure, lowering attachments, handrails, brakes, wheel chocks
- Approach distances and operator communications – 25 feet/7.6 metres rule
- Blind spots – understanding blind spots, operator communications, extended clearance areas
- Use of spotters – backing, obstructed visibility, contact with operator, distraction, high-visibility clothing
- Protective equipment – rollover protection, protection from debris, signage, lights/reflectors

- Hazardous locations and atmospheres – approved equipment types for dangerous atmospheres
- Subsurface utilities – all intrusive activities are subject to Ramboll's SWP, [Subsurface Utility Clearance](#)
- Traffic control – logistics, right of way, speed limit, flag person, public roadways, traffic control plan
- Inspection – equipment-specific forms, acceptance inspections, daily inspections
- Maintenance – routine/preventative, Resource Manager responsibilities, safe shutdown/LOTO

4. RESPONSIBILITIES

Ramboll employees are not authorized to operate, repair, or maintain heavy equipment or forklifts unless they have received training sufficient for the employee to be competent and qualified for such tasks. Most Ramboll projects utilise subcontractors for the operation of heavy equipment and machinery, or machinery is operated by other contractors not under Ramboll's direction. Ramboll operators and subcontractor operators must have the appropriate knowledge, experience, resources and tools to safely operate the equipment and complete the task.

4.1 Project Manager (PM) / Project Owner (PO)

- Ensure that employees who are assigned to operate heavy equipment and forklifts have sufficient training and experience to operate heavy equipment safely.
- Ensure that equipment is properly maintained in accordance with manufacturer's requirements, rental agreements and generally accepted industry practices following delivery to the project site.
- Budget for and implement non-scheduled maintenance, as well as preventative maintenance for heavy equipment when on-site more than 30 days.
- Ensure that subcontractors implement equivalent acceptance inspections, daily inspections and preventative maintenance for heavy equipment.
- Delegate daily oversight to the Site Safety Representative (SSR) who will monitor employees and subcontractors for compliance with this SWP.
- Support employee use of Stop Work Authority related to heavy equipment and forklifts or any other perceived hazard until such hazards are evaluated and controlled to the satisfaction of the project team and the Ramboll Health, Safety and Security (HSS) department.
- The PM/PO will discuss Stop Work situations with the local HSSC, Safety Ambassador, or regional representative of Ramboll's HSS department, including reporting of incidents and safety observations in accordance with Ramboll's HSSP, Event Reporting and Investigation.

4.2 Resource Manager

- Document a preventative maintenance program for all Ramboll owned heavy equipment and forklifts.
- Ensure that preventative maintenance is completed by qualified individuals.
- Ensure that all heavy equipment and forklifts are stored safely when not in use.

4.3 Site Safety Representative (SSR)

- Ensure all forklift operators are qualified, and re-certifications are completed every 3 years or request assistance from the HSS department for recertifications.
- Coordinate training assignments or provide field training to all affected Ramboll employees. Field training requirements for heavy equipment and forklift safety will be identified in the project safety plan.
- Identify qualified heavy equipment operators when delegated by the PM and authorize the heavy equipment operator to operate heavy equipment for specific work tasks in specific work areas.
- Ensure that employees understand and abide by applicable operations and maintenance practices in this SWP and any other applicable requirements specific to the equipment, country or region.
- Coordinate with equipment operator(s) or other individual trained and experienced with the equipment to complete an "acceptance" inspection. The inspection will be performed when equipment is mobilized to the site and documented on a Ramboll heavy equipment inspection form or equivalent.
- Ensure that equipment not passing the "acceptance" inspection is repaired prior to use or is returned to the rental company.
- Ensure that operators and subcontractors are conducting daily pre-use inspections.
- When defects are reported, take equipment out of service and coordinate repair activities with the Resource Manager.
- Verify the subcontractors are implementing equivalent acceptance inspections, daily inspections and preventative maintenance.
- Communicate all safety concerns or Stop Work situations to the PM.
- Assist with reporting of incidents and safety observations in accordance with Ramboll's HSSP, Event Reporting and Investigation.

4.4 Ramboll Health, Safety and Security (HSS) department

- Support project safety plan development (when requested by the PM), including heavy equipment and forklift hazard information and appropriate safety controls based on this SWP and site-specific concerns.
- Review and update this SWP on a biennial basis or more frequently if required.

4.5 Heavy equipment operator

- Perform daily documented equipment inspections.
- Operate equipment safely and in accordance with manufacturer's guidelines.
- Operate only equipment for which you are qualified for and authorized to operate by Ramboll management.
- Operate heavy equipment that is new or unfamiliar only upon the direct supervision of a qualified heavy equipment operator and with authorization from Ramboll management.
- Use a spotter when vision is obstructed.

- Notify the SSR or other designated management representative when equipment defects are identified and need repair.

4.6 Forklift operator

- Perform daily documented pre-use forklift inspections.
- Operate equipment safely and in accordance with manufacturer's guidelines.
- Use a spotter when vision is obstructed.
- Maintain driver qualification by successfully completing Forklift Re-Certification every 3 years.
- Notify the Site Supervisor or other designated management representative when equipment defects are identified and need repair.
- Operate only equipment for which you are qualified and authorized by Ramboll management.

4.7 Employees / subcontractors / visitors

- Do not operate any heavy equipment and forklifts if unauthorized to do so.
- Restrict access to blind spots without permission from the operator.
- Do not linger in blind spots and, if possible, institute controls to restrict access to these areas.
- Ensure that the heavy equipment operator acknowledges your presence when within 25 feet (7.6 metres) of heavy equipment ("25 feet rule").
- Report any observed unsafe operator behaviours.
- Yield to forklifts and heavy equipment operations in travel lanes.
- Report safety events, issues or concerns to the Site Supervisor or SSL.
- Exercise Stop Work Authority if any task is perceived to be unsafe or if more information is needed to proceed safely.

5. KEY DEFINITIONS

Approved Truck or Approved Industrial Truck - These terms, as used in this SWP, mean a truck that is listed or approved for the intended use by a nationally recognized testing laboratory, using nationally recognized testing standards.

Authorized Operator (or Operator) - Means an employee who has been designated and approved to operate a PIT and has met the requirements under this program to qualify for an Operator's license.

Backhoe - A loader with an articulating hydraulically powered folding boom extending from the rear of the unit. Backhoes are used for surface or subsurface excavation of solids and sludge. Backhoes are used to dig below the surface, such as trenches, building footings and foundations.

Bulldozer - A tractor-driven machine with a broad upright blade at the front to push soil, sand, rubble, or similar material.

Counterweight - The weight that is built into the equipment's basic structure and is used to offset the load's weight and to maximize the equipment's resistance to tipping over.

Excavator - Excavators are machines designed for excavating, trenching and related activities. They can be truck mounted, truck carrier mounted, or self-propelled wheel or track mounted. They are hydraulically operated and generally consist of three structures: the revolving unit, the travel base and the attachment.

Front-End Loader - A machine with a scoop or bucket on an articulated arm at the front for loading and moving excavated soil.

Load Capacity - Describes the maximum weight a lift truck can safely raise at a specified load centre. If the load is not centered at the specified position, the forklift's capacity will be reduced.

Load Centre - The horizontal distance from the vertical face of the forks to the centre of gravity of the load.

Powered Industrial Truck (PIT) - Forklift trucks, fork trucks, platform lift trucks, motorized hand trucks, motorized pallet jacks and other specialized industrial trucks powered by electric motors or internal combustion engines used to carry, push, pull, lift, stack, or tier material. In this SWP, the term "forklift" and associated requirements will include all PITs.

- Powered Pallet Jack – Motor assisted pallet jacks that are used mainly indoors. Photos are included in [Section 10 Additional Information](#).
- Rear Counterweight Forklift - Includes indoor and yard forklifts that operate on propane, gas, electric and diesel with cushion or pneumatic tires for smooth hard surfaces. Photos are included in [Section 10 Additional Information](#).
- Rough Terrain Forklift (Material Handler)- Gas and diesel with pneumatic tires for off-road use on very rough terrain. Photos are included in [Section 10 Additional Information](#).

25 Feet / 7.6 Metres Rule - Persons walking into the work area will maintain this distance from operating equipment at an absolute minimum and requires the approaching person(s) to get the operators attention and permission prior to approaching closer than 25 feet (7.6 metres) to operating heavy equipment. This distance may need to be greater, depending on the type of equipment, types/ranges of motion and operator visibility and blind spots.

6. WORK PRACTICES

6.1 General requirements

Heavy equipment and forklifts will be operated only by designated, experienced and qualified operators as outlined above. Refer to the Training & Competency section in this SWP. The following are general requirements that shall be adhered to when heavy equipment and forklifts are used on-site:

6.1.1 Safety equipment

- If seatbelts are provided on equipment, they shall be used by heavy equipment operators.
- Fire Extinguishers (Class A/B/C, 5 lbs or greater) must be on each equipment unit.
- Heavy equipment shall have all signals and safety devices that are provided by the manufacturer, including lights, reflectors, horn and backup alarm. Backup alarms are required for all heavy equipment and must be distinguishable from the surrounding noise level. Damaged signals and safety devices shall be repaired as soon as possible.
- Heavy equipment shall contain mirrors or other aids for backing operations. Note that some types of equipment may have limited sight lines, equipment or general ability for the operator

to clearly see backward when in motion. A spotter may be needed for some types of equipment.

- Guard belts, gears, shafts, pulleys, fly wheels and other reciprocating, rotating or moving parts shall be guarded to protect workers from becoming caught on, in or between machinery.
- Enclosed glass cabs or windows on heavy equipment shall be maintained and in place with no visible distortion affecting the safe operation of the vehicle.
- Cabs with enclosed glass shall be equipped with appropriate temperature regulating systems (heating and/or air conditioning).

6.2 Driving safety

- Use the available seatbelt at all times when the equipment is in motion.
- When operating heavy equipment at a client facility or other developed property, prior to operating equipment the operator(s) should walk and inspect site-specific traffic routes to become familiar with vehicle movement patterns, blind corners, intersections, potential obstructions or low clearance areas and pedestrian walkways.
- Watch overhead clearances when travelling – maintain a safe distance from overhead utilities and hazards in accordance with Ramboll's SWP, [Overhead Utility Clearance](#).
- Do not pass other heavy equipment travelling in the same direction at intersections, blind spots or other dangerous locations.
- Sound the horn at blind spots and at cross aisles and wherever vision is obstructed.
- Cross railroad tracks diagonally whenever possible. Never cross an active railway at a location other than a vehicle railroad crossing, unless the track has been taken out of service under an approved work permit.
- Maintain a clear view of the path of travel.
- Only travel at speeds that will allow the heavy equipment to be stopped in a safe manner.
- Obey all site-specific traffic signs and speed warnings.
- Requirements of work affecting posture should be considered in the design of work practices and selection of equipment.
- Areas around parked equipment shall be cleared of people and obstacles prior to operation of the equipment.
- When working under limited lighting conditions, all mobile equipment and work areas will be adequately lighted while work is in progress.
- Mechanized equipment will be shut down prior to and during fuelling operations. Closed systems with automatic shutoff, which will prevent spillage if connections are broken, may be used to fuel diesel-powered equipment left running.
- Trucks transporting excavated soils or demolition debris over public highways will have tarps covering the materials.
- Tools and materials will be secured to prevent movement when transported in the same compartment with employees.

6.3 Operation on slopes

- Vehicles and equipment shall be kept in the appropriate gear or drive range when in motion, specifically when ascending or descending a grade.
- Equipment must not be operated on slopes that exceed manufacturer's recommendations. Heavy equipment operators must implement any special operating procedures or precautions that may be required by manufacturers when operating equipment on steep slopes. Inclines shall be ascended and descended slowly.
- When ascending or descending inclines in excess of 10 percent, keep the load upgrade.
- Berms must be used during dumping activities when haul vehicles are required to back up to a steep slope when dumping. The berms must be at least half the tire height of the largest vehicle/tire that will off-loading materials. Berms should not be made of sand, loam or other soft materials that may not be sufficiently strong to stop haul vehicles.
- Wheel chocks or equivalent must be used if the equipment is parked on an incline.

6.4 Load handling

- Raise loads/forks only far enough to clear the road surface. Tilt the mast back to stabilize the load.
- Handle only loads within the rated capacity of the heavy equipment. **Never exceed the load capacity** of the lift when considering the weight of tools, materials and people.
- If the load obstructs the view, then drive with the load trailing.
- Handle only stable or safely arranged loads.
- **No persons will ride on any load.**
- No persons shall place their arms or legs between the uprights of the mast or outside the running lines of the forklift.
- No persons shall walk under the elevated portion of any heavy equipment whether loaded or empty.
- All **towing devices** used on any combinations of equipment will be structurally adequate for the weight drawn and securely mounted.
- Persons will not be permitted to occupy the space between a towed and towing piece of equipment until the towing equipment has been stopped and secured by setting brakes, placing in neutral and chocking.
- Rigging directly to forklift tines/blades is prohibited unless using rigging points approved by the manufacturer or forklift attachments (crane hook attachment) that are engineered for use with forklifts.
- Operators must consult manufacturer's information to verify that load capacities are not exceeded. Refer to Ramboll's SWP, [Rigging](#) for specific rigging procedures.
- When necessary, forklifts may be used to lift people **only** under the following conditions:
 - A safety platform with guardrails is used and is securely attached to the lift carriage and/or forks.
 - Employee(s) on the platform can shut off power to the truck.

- The forklift manufacturer has been consulted regarding the platform and attachment method or the platform is otherwise engineered for use with the forklift.

6.5 Exiting heavy equipment

- Getting off or on any equipment while it is in motion is prohibited.
- Before dismounting, the operator shall secure the equipment from movement by lowering all ground-engaging attachments.
- Steps, handrails and grab irons shall be used, and equipment shall be faced when mounting or dismounting. When climbing onto to from equipment, 3-points of contact shall be maintained. Steps, handrails and grab rails shall be maintained clean and free from slip, trip and fall hazards. Allow extra time in winter or rainy conditions to clean ice, snow and mud from equipment.
- When the operator leaves the heavy equipment unattended, all controls will be in a neutral position, moving elements lowered to the ground, the engine stopped and brakes set.
- Whenever the operator is more than 25 feet/7.6 metres from the forklift OR the forklift is out of his view, the operator shall leave the forklift in a safe condition as follows:
 - Lower the forks to the floor
 - Place operating controls in a neutral or "safe" condition
 - Shut off power
 - Set brakes
 - Block wheels if the forklift is on an incline
- When the operator is 25 feet (7.6 metres) or less from the forklift AND it remains in view, the operator shall leave the forklift in a safe condition, which includes the following as a minimum:
 - Lower the forks to the floor
 - Place operating controls in a neutral or "safe" condition
 - Set brakes

6.6 25 Feet / 7.6 Metres rule

Employees walking in areas where heavy equipment is operating will be kept to an absolute minimum. When foot traffic is unavoidable, all persons must implement the "**25 feet / 7.6 metres rule**." The 25 feet/7.6 metres rule requires persons to get the operator's attention and permission prior to approaching closer than 25 feet (7.6 metres) to heavy equipment. This distance may need to be greater, depending on the type of equipment, types/ranges of motion and operator visibility and blind spots.

6.7 Blind spots

All vehicles have blind spots. Depending on the design, the blind spots associated with heavy equipment can cover large areas surrounding the equipment. Persons must not linger in blind spots when walking or driving near heavy equipment. The **25 feet / 7.6 metres rule** applies and may be extended if blind spots extend further than 25 feet/7.6 metres from the heavy equipment.

6.8 Spotters

Spotters should be used to assist operators whenever equipment is operated in a direction that is obstructed (or partially obstructed) by a blind spot. At a minimum, spotters must be used when:

- Backing up and the operator does not have a full view of the backing path.
- During forward travel when vision is significantly obstructed by loads.

To be effective, spotters must:

- Maintain continuous visual or verbal contact with the operator.
- Not be assigned additional duties while they are acting as spotters.
- Not use personal mobile phones, personal headphones or other items that could pose a distraction during spotting activities unless such devices are used to maintain continuous audio contact with the operator.
- Be provided with high-visibility clothing, especially during night operations.

6.9 Rollover / overhead protection

All bulldozers, tractors, forklifts or similar equipment used in clearing operations or demolition must have guards, shields, canopies and grills to protect the heavy equipment operator from falling and flying objects. The purpose of the requirement is to minimize the possibility of heavy equipment operator injury resulting from overhead hazards, such as flying and falling objects and at the same time to minimize the possibility of heavy equipment operator injury from the cover itself in the event of accidental upset. Some heavy equipment is designed to minimize employee exposure to contaminants, noise and overhead impact.

6.10 Specific equipment requirements

- All equipment left unattended at night, adjacent to a highway in normal use, or adjacent to construction areas where work is in progress, will have appropriate lights or reflectors, or barricades equipped with appropriate lights or reflectors, to identify the location of the equipment.
- A safety tire rack, cage or equivalent protection will be provided and used when inflating, mounting or dismounting tires installed on split rims or rims equipped with locking rings or similar devices.
- Lift trucks, stackers, etc., will have the rated capacity clearly posted on the vehicle to be clearly visible to the heavy equipment operator. When auxiliary removable counterweights are provided by the manufacturer, corresponding alternate rated capacities also will be clearly shown on the vehicle. These ratings must not be exceeded.
- No modifications or additions that affect the capacity or safe operation of the equipment will be made without the manufacturer's written approval. If such modifications or changes are made, the capacity, operation and maintenance instruction plates, tags or decals will be changed accordingly. In no case will the original safety factor of the equipment be reduced.
- If a load is lifted by two or more trucks working in unison, the proportion of the total load carried by any one truck will not exceed its capacity.
- Steering or spinner knobs will NOT be attached to the steering wheel unless the steering mechanism is of a type that prevents road reactions from causing the steering handwheel to spin. The steering knob will be mounted within the periphery of the wheel.

6.11 Hazardous locations

- Only approved forklifts shall be used in hazardous locations where flammable or combustible atmospheres may exist.
- Consult with clients about hazardous locations at their facilities and the required forklift approval designation.
- The most common hazardous locations encountered by Ramboll and the associated approved forklifts that may be used in the locations are outlined in the chart located in [Section 10 Additional Information](#).

6.12 Subsurface utility clearance

All intrusive activities, including use of any machinery that disturbs or displaces the ground surface, are subject to the requirements of Ramboll's SWP, [Subsurface Utility Clearance](#). Contact a representative of Ramboll's HSS department if the project is expected to present complex utility scenarios or if the activity requires deviation from Ramboll requirements.

- All intrusive work will require utility clearance documentation and approval from the Ramboll PM and Clearance Site Supervisor.
- All utilities must be located and marked within and around the excavation area before commencing work.
- Operating mechanized digging equipment in proximity to underground utilities requires soft digging or similar utility avoidance and clearance techniques.
- Use of mechanized equipment is prohibited when utilities or utility uncertainties are identified within a designated safety radius that depends on the type of utility(ies) and the hazard level (based on risk to workers, site operations, community infrastructure, Ramboll's safety record and reputation, and environment).

6.13 Traffic requirements

All applicable local governing authority driving rules shall be followed when driving heavy equipment and haul trucks on public roads. When heavy equipment and haul trucks are operated on Ramboll sites or projects, the following general traffic requirements apply:

- Operators shall understand and adhere to site traffic rights-of-way.
- Speed limits, dependent on risk at the site, shall be posted and observed.
- Vehicles and equipment shall follow as a safe distance as determined by road conditions, vehicle specifications and loading. This should be defined on a site-specific basis.
- Passing shall be limited to areas of adequate clearance and visibility, if allowed.
- Adequate equipment spotters and ground employees should be deployed in conjunction with site-specific needs and heavy equipment tasks.
- A communication place shall be developed by the site to allow the workforce to communicate with operators and spotters.
- High visibility vests are required for all site employees when heavy equipment is in use.
- A flagman with high visibility vest, signs, cones and warning signs shall be provided when it is necessary to control normal vehicular traffic due to vehicles, such as end-dumps, entering or leaving the site.

- The disruption of public roadways will require trained flaggers and traffic markings setup in accordance with local transportation regulatory requirements.

6.13.1 Traffic control plan

On more active sites it can also be helpful to establish a traffic control plan. Depending on the situation, this can be as simple as establishing entry/exit points and where to park and walk. The following are considerations when developing a traffic control plan:

- Draw the basic work area layout and show where work activities will take place and vehicle access points.
- Identify where equipment will be backing and create pedestrian-free zones where possible.
- Plot foot travel paths for those on the ground to get from one area to the next.
- Draw traffic flow for large equipment.
- Determine storage areas and how materials will get to and from staging areas.
- Establish parking areas for workers and visitors.
- Establish restroom and break areas.
- Identify and mark utilities.
- Write notes to explain the diagram and specify duties or employee responsibilities.

6.14 Inspection requirements

Both owned and rented equipment must be in safe operating condition prior to being authorized for use on any Ramboll project or facility.

6.14.1 Acceptance inspection

- Applies to any owned or rented heavy equipment and forklifts arriving on site.
- When equipment arrives on site, the Ramboll Site Supervisor (or designated management representative) will coordinate with equipment operator(s) or other individual trained and experienced with the equipment to perform an "Acceptance Inspection."
- The "Acceptance Inspection" will be documented on an Ramboll equipment inspection form or equivalent checklist but must be in writing and include the name and date of the person performing the inspection and be specific to the type of equipment (e.g., forklift, excavator, skid-steer, etc.).
- Equipment will not be accepted if critical-to-safety defects are identified during the inspection. Critical-to-safety defects are identified on equipment inspection forms, but the Site Supervisor may, at their discretion, reject equipment for other defects also deemed important for safe use of equipment on that site or task.
- Rental companies (rented equipment) or the responsible Ramboll Resource Manager (owned equipment) will be contacted to make repairs or replace the heavy equipment with another unit.
- "Acceptance Inspection" documentation will be retained on site for the duration of the project.

6.14.2 Daily inspections

- Heavy equipment and forklift operators, mechanics or other qualified persons must conduct a walk-around inspection and an operations self-check before any start up and operation.
- The "Daily Inspection" will be documented on a daily log, equipment inspection form ([Section 8](#)) or equivalent. The record must be in writing and include the name of the person performing the inspection and the date.
- Defects will be noted on the inspection form and communicated to the Site Supervisor or designated management representative.
- Equipment will be removed from service if critical-to-safety defects are identified during the daily inspection. The SSR may also reject equipment for other defects deemed important for safe use of equipment for that site, at their discretion. Unsafe equipment shall be removed from service immediately until it is repaired and verified safe for use.
- Equipment may remain in service if defects are not critical-to-safety but must be tagged "Out of Service" or "Do Not Operate" or equivalent tag if a critical defect is identified.
- The Resource Manager or SSR will ensure that repairs are made in a timely manner.
- Daily inspection documentation will be retained on site for the duration of the project.

6.15 Maintenance requirements

- Operating equipment shall be maintained in compliance with manufacturer's recommendations and regulatory requirements, including calibration and maintenance.
- Only persons qualified to perform maintenance shall perform maintenance.
- Maintenance on rental equipment must be performed in accordance with rental contract restrictions, which may include using only original equipment manufacturer (OEM) parts or using specific service companies authorized by the rental company. Rental contracts usually place the burden of repairs on the lessee.
- Maintenance on owned equipment must be performed under the direction of the responsible Resource Manager. The Resource Manager will determine if an employee is qualified to work on heavy equipment or if an outside service company will be required.
- Equipment will be shut down and positive means taken to prevent its operation while repairs or manual lubrications are being done. Equipment that is designed to be safely serviced while running is exempt from this requirement.
- Equipment shall be removed from service and/or locked out and tagged out according to Ramboll's SWP, [Lock Out/Tag Out](#) whenever an unsafe condition is detected. It shall not be returned to service until the issue is resolved.
- Heavy equipment, or parts thereof, which are suspended or held aloft by use of slings, hoists, jacks or hydraulic systems will be substantially **blocked or cribbed** to prevent falling or shifting before employees are permitted to work under or between them.
- Bulldozer and scraper blades, end-loader buckets, dump bodies and similar equipment will be either fully lowered or blocked when being repaired or when not in use. All controls will be in a neutral position, with the motors stopped and brakes set, unless work being performed requires otherwise.

6.15.1 Preventative maintenance

- Preventative maintenance should be based on manufacturer's recommendations.
- Preventative maintenance is a scheduled series of maintenance events based on hours of operation, fuel consumption, or similar measure of equipment use. Preventative maintenance will periodically include tasks that look at issues not easily (or feasibly) observed during daily visual inspections.
- Rental companies typically maintain responsibility for preventative maintenance, but this may not always be the case. Project Managers must understand rental contract terms and conditions and ensure that preventative maintenance is covered by the rental company, Ramboll or other outside service company in accordance with the rental contract and manufacturer's requirements.
- Preventative maintenance for rental equipment is a concern for Ramboll when heavy equipment is in our possession for extended periods. For purposes of this SWP, an extended period is equipment on site more than 30 days. When preventative maintenance is not assumed by the rental company, the PM will determine if qualified site (or "in-house") employees are capable of supporting the manufacturer's preventative maintenance tasks or if an outside maintenance service is required.
- Preventative maintenance for owned equipment will be monitored by the Resource Manager. The Resource Manager will coordinate preventative maintenance tasks with the Project Manager to minimize disruption to project activities.

7. TRAINING & COMPETENCY

Only competent and qualified individuals shall operate heavy equipment and forklifts on Ramboll projects. Subcontractors shall submit proof of employee operator qualification before allowing employees to operate equipment on Ramboll projects.

7.1 Qualified heavy equipment operator

Operators shall be competent through task training and certification. Ramboll competency requirements that shall meet the following **minimum** requirements include:

- How to perform and document pre-operational inspections.
- Knowledge of safety related elements of the equipment, such as how they function, how to determine functionality and what risk the device is mitigating.
- Safe operation of the equipment using all controls.
- Although operating principles are similar between the same types of heavy equipment and forklifts from different manufacturers, operators are still required to orient themselves to differences in controls and safety features that may exist. Operators must review manufacturer's equipment manual or receive an orientation from the equipment rental company.

7.2 Forklift certification

Prior to being authorized to operate a forklift or other PIT, operators must provide a training card or certificate from an equipment rental company or other qualified trainer. Authorization to operate forklifts is specific to the type of lift (e.g., rear-counterweight forklift, rough terrain forklift). Initial forklift training must include classroom training with a written exam and a road test that meets local regulatory requirements.

- Employees must upload a scanned copy of the initial Forklift/PIT training certificate or card into Ramboll Academy. Certifications will be added to their transcript.
- The training certificate or card must show the type of forklifts and/or PIT the employee is qualified to operate.

Subcontractors must submit certification to Ramboll upon request. Subcontractor certifications must identify the type of PIT.

7.2.1 Forklift re-certification

Re- certification is required whenever forklift (or other PIT) operators fail to operate the unit in a manner consistent with this SWP and the manufacturer's safety requirements or after three years, whichever occurs first.

- Forklift re-certification must be documented on the Forklift Operator Recertification form or equivalent.
- Forklift re-certification may be conducted by the operator's Supervisor or by the HSS department.
- Employees must upload Re-Certifications into Ramboll Academy. Forklift certifications will be added to their transcript.

Subcontractors must submit evidence of Re-Certification to Ramboll upon request.

8. DOCUMENTATION

The following documentation is required, specific to Heavy Equipment and Forklifts.

8.1 Forklift training records

A certificate or card following successful completion of classroom training and a "road test." The training must be specific to the type of equipment. Employees are responsible for uploading training documentation into Ramboll Academy, and HSS department can assist when necessary.

8.1.1 Forklift operator recertification form

Documents forklift operator re-certification and must be completed every 3 years. Re-certification may easily be completed in the work area by Site Supervisors. Alternate forms or training certificates from equipment rental companies and other authorized trainers may be accepted in lieu of completing the Forklift Operator Re-Certification form. Employees are responsible for uploading training documentation into Ramboll Academy so that it is added to their transcript.

8.2 Qualified heavy equipment operator letter

Subcontractors will designate their qualified heavy equipment operators on company letterhead. The letter will designate who is qualified and what type of equipment they are qualified to operate. This letter will be maintained in the project files.

8.3 Acceptance and daily inspections

Acceptance and daily inspections must be documented for heavy equipment and forklifts used on Ramboll projects. An Acceptance inspection checklist must be completed by a site management representative when owned or rented equipment is first mobilized to the site but prior to equipment being "accepted" for use. A daily inspection must be completed by operators each day prior to use.

Forms and checklists should be specific to the type of equipment. Checklists for specific types of equipment are used to document Acceptance or Daily Inspections for the equipment listed below:

• Articulated Trucks • Backhoe Loader • Bulldozers • Excavators	• Forklifts/PITs • Off Road Trucks • Skid Steer • Tracked Dump Truck	• Tracked Loader • Vibratory Roller • Wheel Loader

Both Acceptance and Daily Inspections may be documented using the same type of form, provided the form indicates the type of inspection. Inspection records must be maintained on site for the duration of the project.

8.4 Preventative maintenance documentation

Documentation of preventative maintenance must be maintained in the project file. For rented equipment that is on site for more than 30 days, maintenance documentation must be requested from the rental company. For owned equipment, maintenance documentation must be maintained by the Resource Manager.

8.5 Out of service tags

Must be attached to any forklift that is taken out of service because a critical defect was identified on a *Forklift Inspection Checklist*.

9. INTERNATIONAL TILTS

9.1 Asia / Pacific

9.2 Brazil

9.3 Canada

9.4 European Union (EU)

9.5 Mexico

9.6 United Kingdom (UK)

9.7 United States

- Forklift and PIT operators and those working near forklifts must maintain compliance with OSHA regulations (29CFR1910.178).

9.8 Other Regions

10. ADDITIONAL INFORMATION

10.1 Forklifts in hazardous areas chart

Hazardous Location	Approved Forklift Type
Locations where hazardous concentrations of gases and vapours are prevented by mechanical ventilation. An example is the Ramboll Fabrication paint spray booth and a 10-foot radius surrounding the booth.	DY, EE, EX
Locations where volatile flammable liquids or gases are handled, processed or used but are normally confined within closed containers or systems where they can escape only by abnormal operation of equipment.	DY, EE, EX
Adjacent to Class I, Division I locations where hazardous concentrations of vapours or gases might occasionally exist.	DY, EE, EX
Storage of hazardous liquids in sealed containers or storage of liquefied compressed gasses.	DS, DY, ES, EE, EX, GS, LPS
Locations where flammable liquids or gases are used but may only become hazardous by accident or unusual operating condition. Piping without valves, checks, meters and similar devices would not ordinarily be deemed to introduce a hazardous condition, even if used for hazardous liquids and gases.	DS, DY, ES, EE, EX, GS, LPS
D = diesel power DS = diesel with additional safeguards to exhaust, fuel and electrical systems DY = DS units with temperature limitations on electrical equipment E = electrical power ES = electrical with additional safeguards to prevent sparks and limit surface temperatures EE = ES with electrical systems completely enclosed EX = electrical systems are designed to be used in some flammable atmospheres G = gasoline power GS = gasoline with additional safeguards to the exhaust, fuel and electrical systems LP = liquified petroleum gas power LPS = LPS with additional safeguards to the exhaust, fuel and electrical systems	

10.2 Types of forklifts covered by this document



11. REVISION SUMMARY

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VERSION

1.0

SAFE WORK PRACTICE

HOUSEKEEPING & WASTE DISPOSAL

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1. PURPOSE

The purpose of this Safe Work Practice (SWP) is to define Ramboll practices for basic housekeeping and waste disposal requirements, which are necessary to mitigate slips, trips, falls, fires and other housekeeping hazards. This SWP is also intended to facilitate compliance with applicable regulatory requirements of the country or region.

2. SCOPE

This SWP applies to housekeeping and waste disposal requirements at Ramboll offices, client facilities or other sites. Other SWPs that describe housekeeping and waste disposal practices include the SWPs, [Communication of Chemical Hazards](#), [Material Storage and Handling](#), [Office Safety and Environmental Requirements](#) and [Hazardous Waste Operations and Response](#). In the event of a conflict between the SWP and locally applicable regulatory requirements (or project-specific requirements), the more stringent set of requirements will be followed.

3. OVERVIEW

This SWP provides roles and responsibilities, key definitions, work practices, training and documentation requirements for housekeeping and waste disposal. The following work practice topics are addressed:

- **Emergency egress** - Materials may not be stored in aisles, walkways, doorways or stairs such that it narrows or blocks emergency egress.
- **Storage areas** - Material and equipment must be stored so that it does not create a tripping hazard and stacked so that it is not at risk of toppling.
- **Pedestrian traffic** - If material or equipment intrudes onto a pedestrian walkway, barricades must be erected to safely direct pedestrian traffic around the area.
- **Control of cables and hoses** – Cables and hoses must be protected from damage. To prevent tripping hazards, they should not be placed across or through walkways unless appropriate cord covers are used.
- **Daily housekeeping** - Unused material and equipment must be returned to laydown and storage areas daily.
- **Daily waste disposal** - In general, all waste materials must be removed from the site work area daily. Wastes must be disposed at an appropriately permitted disposal facility for the type of waste. Where accumulation or storage of wastes is permissible, wastes will be placed in the designated on-site storage locations and containers daily. All waste disposal will be in accordance with facility owner requirements and applicable regulatory requirements.
- **Waste segregation** - Materials and wastes must be segregated in accordance with their properties. Refer to the material's Safety Data Sheet (SDS) and the SWP, [Communication of Chemical Hazards](#). Potentially contaminated wastes must be segregated from uncontaminated wastes. Refer to the SWP, [Hazardous Waste Operations and Response](#).

4. RESPONSIBILITIES

4.1 Project Manager (PM) /Project Owner (PO)

- Request housekeeping and waste disposal information from the facility owner and consider the adequacy of the information provided. This information should be included in the project safety plan as applicable.
- Provide appropriate resources, including people, budget and schedule to comply with requirements outlined in this SWP.
- Periodically inspect work areas to confirm housekeeping and waste disposal practices, and/or assign this duty to the Site Safety Representative (SSR) or other qualified individual.
- Request assistance from the Health, Safety and Security (HSS) department if potential deficiencies are observed or if technical support is needed to ensure safe implementation of specific projects.
- Support employee use of stop work authority related to housekeeping and waste disposal or any other perceived hazard. Work is to be stopped until the identified hazards are evaluated and controlled to a level that is as low as reasonably achievable with input from the client, project team and the HSS department and in accordance with safe work practices. Refer to the HSSP, [Stop Work Authority](#).
- Discuss stop work situations with the Site Safety Representative (SSR) Health, Safety and Security Coordinator (HSSC), Subject Matter Expert (SME) or a representative of the HSS department, including reporting of incidents and safety observations in accordance with the HSS Process (HSSP), [Event Reporting and Investigation](#).

4.2 Site Safety Representative (SSR)

- Be present at the site to oversee the project or appoint another on-site employee as a backup SSR (with approval from the PM).
- Ensure the project safety plan containing housekeeping and waste disposal information is reviewed with project team members and subcontractors as part of the project safety orientation and toolbox safety meetings.
- Communicate project safety requirements to all employees, subcontractors and visitors and document all safety meetings, unsafe acts or conditions and corrective actions.
- Periodically inspect work areas for housekeeping issues and correct housekeeping deficiencies when observed.
- Inform PM/PO of important developments or questions regarding project and task safety.
- Assist with reporting of incidents and safety observations in accordance with the HSSP, [Event Reporting and Investigation](#).

4.3 Health, Safety and Security (HSS) department

- Support project safety plan development (when requested by the PM) including housekeeping and waste disposal hazard information and appropriate safety controls based on this SWP and site-specific concerns.

- Evaluate site conditions related to housekeeping and waste disposal through field safety audits and inspections when requested by the client, the PO or other management or when required by local regulations.
- Provide technical support, consultation and training materials that are consistent with this SWP, when requested or applicable.
- Review and update this SWP on a biennial basis or more frequently if required.

4.4 Health, Safety and Security Coordinator (HSSC) / Safety Ambassador

- Promote awareness, understanding and use of this SWP by project team members and local office employees.
- Facilitate application of this SWP in the context of local regulatory requirements and integration of this SWP into project safety plans and office safety practices.
- Inform the HSS department if the SWP does not adequately address local regulatory requirements.

4.5 Employees, subcontractors and visitors

- Review, understand and comply with all project and office safety plans.
- Follow all housekeeping and waste disposal safety practices defined in this SWP and other practices as defined by the site owner or occupant or as required by local regulations. In the event of a conflict, the more stringent requirements will be followed.
- Report safety events, issues or concerns (e.g., incidents, injuries, illnesses, near miss, observations of safe or unsafe acts or conditions, etc.) to the PM, SSR or other supervisor and in accordance with the HSSP, [Event Reporting and Investigation](#).
- Exercise stop work authority if any task is perceived to be unsafe or if more information is needed to proceed safely. Refer to the HSSP, [Stop Work Authority](#).

5. KEY DEFINITIONS

No key definitions defined.

6. WORK PRACTICES

Ramboll employees work at offices, facilities and project sites, and at all of these locations, good housekeeping and proper waste disposal are important to minimise the potential for slips, trips, falls, fires and other housekeeping hazards. Project teams, local office leads and local office HSSCs and Safety Ambassadors are expected to be familiar with the content of this SWP, locally applicable regulatory requirements and any project-specific requirements. In the event of conflicting requirements for work practices, the more stringent set of requirements will be followed. These requirements must be outlined in the project safety plan or local office safety plan.

6.1 General housekeeping practices for all work areas

- Aisles and walkways must not be blocked or the width narrowed below that which is required for emergency egress.

- Stairwell doors and other fire doors must not be propped open.
- Access to emergency exits must not be obstructed.
- Minimise damage to finished work including walls, moulding, counters and floor coverings by providing protective cover.
- Materials and equipment must be stored such that it does not create a tripping hazard.
- Materials must be stacked or placed on storage shelves/racks such that it is stable and not at risk of toppling.
- Materials shall not be stored in stairwells.
- Refer to the SWP, [Office Safety & Environmental Requirements](#) for additional housekeeping and waste disposal guidance for Ramboll offices and similar work environments.

6.2 Housekeeping at Ramboll industrial facilities

- Avoid placing material laydown areas that intrude into marked pedestrian walkways or into forklift aisles.
- If temporary obstruction of walkways or aisles is unavoidable, barricades must be erected to safely direct pedestrian traffic or forklifts around materials. Barricades may include traffic cones or warning lines.
- All tools must be put away in gang boxes, tool crib or other designated area at the end of each day.
- Loose (unsecured) tools must not be left on elevated surfaces where they may fall and strike others working below.
- Welding leads must be coiled and put away when not in use.
- Torch cutting hoses must be coiled put away and cylinders closed when not in use.
- Loose cuttings, metal shavings and other debris must be cleaned up daily. Compressed air greater than 30 psi/207 kilopascal must not be used for cleaning.
- Cribbing, pallets and packing materials must be removed daily or sooner if materials are combustible and may contact sparks, slag or other ignition sources.
- Spills of lubricants and other materials must be cleaned up immediately.
- Dispose or store oily rags in covered metal containers.
- Cords and hoses must be protected from damage by forklifts if run across forklift aisles and cable protection channels/ramps will be used.
- To the extent feasible, cords, cables and hoses must be run in a manner that minimises tripping hazards which might include running cords through cable protection channels.
- Rigging equipment must not be left on the floor where it may be damaged by forklifts or dropped tools or equipment. Rigging equipment must be stored in designated areas when not in use.
- Keep lunch/break rooms clean and sanitised.

- Accumulation of snow or ice that creates a hazard will be removed as needed, and/or areas of falling snow or ice will be barricaded.

6.3 Housekeeping at project field sites

- Material laydown and storage areas should be clearly identified by barricades (i.e., cones, signs, ropes, fences, stanchions, etc.).
- Work vehicles, gang boxes, storage containers and toolboxes should be reasonably clean and organised. Tools should not be stored in a manner that causes damage to the tool or injury to persons trying to remove the tool or place the tool into storage areas.

NOTE: Contact the site owner to understand housekeeping and waste disposal requirements before generating waste.

- To prevent injury, nails protruding from boards shall be removed or bent over and all debris shall be kept cleared from work areas, passageways and stairs.
- Fieldwork should be performed in a manner that will minimise and control the production and migration of odours, noise, dust, dirt and debris into adjacent work areas or public areas.
- Excessive mud and stones dragged onto sidewalks and paved roadways should be cleaned up daily.
- Accumulation of snow or ice that creates a hazard will be removed as needed and/or areas of falling snow or ice will be barricaded.

6.4 Waste disposal

At Ramboll offices, waste disposal services and containers are typically provided by the building manager and janitorial workers. At Ramboll industrial facilities, the facility manager will define and communicate the facility-specific procedures for waste segregation and disposal practices. At client facilities or project field sites, Ramboll must comply with regulatory requirements and facility owner requirements, which may vary by country, region or site. In general, the following practices will apply at most client facilities and project sites:

- Scrap lumber, metal, trash, garbage and other similar materials generated shall be stored and disposed of at regular intervals and in accordance with general waste disposal requirements in this SWP.
- Broken glass shall be swept up immediately and put into containers in a manner that will not cause injury to persons who empty waste containers.
- Collect, store and remove combustible waste products at the end of each workday. Promptly remove and dispose of spills of flammable or combustible liquids. All solvent waste, oily rags and flammable liquids shall be kept in fire resistant containers with self-closing lid until removed from work site. Refer to the SWP, [Flammable and Combustible Liquids](#).
- When dropping waste material from a height of more than 20 ft/6 m, use an enclosed wooden chute, or equivalent structure to safely drop the waste material outside of the building.

- Protect fall protection equipment and anchor points around any openings through which waste is to be dropped. Refer to the SWP, [Work from Heights - Fall Prevention and Protection](#).
- When dropping debris through holes, barricade the area below to a height of 42 inches/1 m and extending a minimum of 6 ft/1.8 m past the edges of the opening above. Post appropriate warning signs indicating the falling material hazard.

6.5 Segregation of materials and waste

- Consider storage segregation precautions for all materials. Use safety data sheets (SDS) to determine appropriate storage segregation.
- Identify and label segregated material containers. Following are some examples of materials that must be segregated:
 - Ordinary combustibles such as paper, wood and natural fibre fabrics (see the SWP, [Fire Prevention and Protection](#))
 - Oily or flammable materials, such as oily or solvent-saturated rags (see the SWP, [Flammable and Combustible Liquids](#))
 - Corrosive and caustic materials, such as batteries (see the SWP, [Corrosives Handling](#))
 - Infectious or biohazard materials (see the SWP, [Blood-Borne Pathogens](#))
 - Reactive materials that may self-decompose or self-ignite because of heat, chemical reaction, friction or impact
 - Radioactive materials (see the SWP, [Radiation Hazards](#))
 - Toxic materials, potentially contaminated materials or hazardous wastes (see the SWP, [Hazardous Waste Operations and Response](#))

7. TRAINING & COMPETENCY

The HSS training programme includes new employee induction training, supervised on-the-job training and annual completion of online modules or classroom instruction related to safety requirements and work practices. Training assignments vary based on employee roles and training classification. Completion of assigned training will be documented by a training completion certificate, which will be stored in the employee's electronic training record.

7.1 Training requirements specific to housekeeping and waste disposal

No specific training requirements are identified. However, housekeeping and waste disposal activities at hazardous waste sites, or any site with potential chemical or biological hazards, typically requires additional training for hazard communication and control. Such training requirements are described in SWPs pertaining to these sites or hazard types.

8. DOCUMENTATION

No additional documentation is required for housekeeping and waste disposal, however waste disposal records must be in accordance with applicable regulations for the site or activity, such as manifests or related documentation for hazardous wastes.

9. INTERNATIONAL TILTS

9.1 Asia / Pacific

9.2 Brazil

9.3 Canada

9.4 Europe

9.5 Mexico

9.6 Middle East

9.7 Nordics

9.8 United Kingdom (UK)

9.9 United States (US)

Occupational Safety and Health Administration (OSHA) 29 CFR 1910.22 Walking-Working Surfaces.
<https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.22>

OSHA. 29 CFR 1926.25 Housekeeping. <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.25>

9.10 Other regions

10. ADDITIONAL INFORMATION

11. REVISION SUMMARY

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VERSION

1.0

SAFE WORK PRACTICE

NOISE HAZARDS AND

HEARING PROTECTION

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1. PURPOSE

The purpose of this Safe Work practice (SWP) is to protect employees from unsafe noise levels and manage noise exposures in the workplace.

Ramboll requires that the noise hazards to which Ramboll employees may be exposed are evaluated and that hazards and control measures are communicated to affected employees. This SWP provides guidance for evaluating potential hearing or noise hazards, establishing appropriate protective measures and communicating information concerning these hazards to employees.

2. SCOPE

This SWP applies to work at Ramboll offices, client facilities or other sites where Ramboll employees may be exposed to noise at a level that is unsafe or exceeds regulatory requirements specific to the region. Ramboll's hearing protection program consists of audiometric testing as part of medical monitoring, noise monitoring (when required), engineering and administrative controls and use of personal protective equipment (PPE) that provides an appropriate level of hearing protection.

3. OVERVIEW

All Ramboll employees and subcontractors must be protected from elevated noise levels. Prolonged exposure to high noise levels can result in temporary and permanent hearing loss.

Noise levels in many of Ramboll's work environments are often dynamic. Therefore, a combination of engineering, administrative and PPE must be used to limit exposure to acceptable levels.

- The Action Level is the noise level at which a hearing conservation program and noise monitoring program be implemented. Action levels vary by geography.
- If sound levels above the Action Level are known to exist or are anticipated, the following controls must be implemented:
 - Elimination or substitution – The preferred approach is to eliminate the noise source or replace loud equipment.
 - Engineering Controls - The noise generator should be relocated as far from employees as possible, or a sound reducing barrier can be installed.
 - Administrative Controls – Reduce the amount of time an employee has to spend in environments with elevated noise levels. Place signs and other warning devices that require employees to wear hearing protection.
- PPE – Hearing Protection Devices (HPDs) are the least preferable method of protection but may be necessary when other controls are not feasible or effective.
- HPDs must be worn when noise exposure is above the action level. HPDs must be suitable for the noise level in the work environment.
- The 3 ft/0.9 m Rule of Thumb should be used to determine if sound levels are elevated when sound level data are not available.
- Baseline and periodic audiometric testing are required for all individuals with exposures that exceed the Action Level.

- Training, delivered via Ramboll Academy, must be completed annually for all employees with exposures above the action level.

4. RESPONSIBILITIES

4.1 Project Manager (PM) / Project Owner (PO)

- Request information on noise levels and required hearing protection from the facility owner and consider the accuracy of the information provided. This information should be included in the project safety plan.
- Verify that the project includes adequate budget and schedule to comply with requirements outlined in this SWP.
- Institute feasible engineering, work practice and administrative controls to reduce employee exposure and provide adequate hearing protection devices or other control measures to employees.
- Confirm that employees working on a project or site that includes exposure to noise hazards have completed required training and medical monitoring.
- Arrange for warning signs to be posted in high noise areas of Ramboll-operated facilities or sites.
- Support employee use of stop work authority related to noise hazards or any other perceived hazard until such hazards are evaluated and controlled to the satisfaction of the project team and HSS department

4.2 Site Safety Representative (SSR)

- Verify the project safety plan is reviewed with site employees and subcontractors as part of their project safety orientation, including safety plan elements pertaining to hearing conservation.
- Communicate work requirements to employees and subcontractors on the site.
- Confirm that employees are using hearing protection PPE in areas where required.
- Inform PM/PO of important developments, questions, unplanned hazards or non-conformities regarding project and task safety.

4.3 Ramboll Health, Safety and Security (HSS) department

- Support project safety plan development (when requested by the PM), including noise and hearing hazard information and appropriate safety controls based on this SWP and site-specific concerns.
- Provide technical support in the selection of engineering controls, administrative work practices and hearing conservation PPE when requested.
- Provide hearing conservation training to employees who may be exposed to noise hazards.
- Arrange baseline and annual audiometric tests for employees as part of medical monitoring and provide results to affected employees.
- Conduct field measurements of noise levels when requested or when noise levels are a concern, including personal noise exposure monitoring.

- Identify employee groups who may be at higher risk for hearing loss and should be targeted for audiometric testing beyond what is required as part of medical monitoring.
- Conduct employee noise exposure monitoring and provide results to affected employees.
- Investigate and assign corrective action for hearing loss injuries to prevent further occupational hearing loss.
- Review and update this SWP on a biennial basis or more frequently if needed.

4.4 Health, Safety and Security Coordinator (HSSC)

- Support safety culture and new employee HSS inductions at the local office level, including discussion of this SWP and training resources.
- Promote awareness, understanding and use of this SWP among local office employees.
- Facilitate application of this SWP in the context of local regulatory requirements and integration of this SWP into project safety plans.
- Inform the HSS department if this SWP does not adequately address local regulatory requirements.
- When requested by the PO/PM or HSS department and if appropriately trained to do so, conduct field measurements of noise levels when requested or when noise levels are a concern, including personal noise exposure monitoring.
- Coordinate with HSS department as needed for local investigation and corrective actions related to hearing loss injuries.

4.5 Employees, Subcontractors and Visitors

- Use company provided and approved hearing protection in designated high noise areas.
- Request new hearing protection when needed.
- Properly use and care for the hearing protection PPE.
- Attend training sessions and audiometric tests.
- Report any symptoms that may be related to workplace noise exposures to management.

4.6 Human Resources

- Schedule new employees for baseline hearing conservation exams when their [Medical Surveillance Questionnaire](#) indicates they may be assigned to high-noise work.
- Schedule existing employees for audiometric testing based on direction from HSS department and annual Medical Surveillance Questionnaire from employees.
- Maintain copies of audiometric test results.
- Forward copies of audiometric test results that show a significant work-related hearing loss to HSS department.

5. KEY DEFINITIONS

3 Foot / 0.9 m Rule of Thumb – A rule of thumb where HPDs or other noise control should be used in any area where voices must be raised to communicate with persons standing 3 feet/0.9 m away, which would indicate noise levels between 80 to 90 dBA.

Action Level – The noise level that, when exceeded, requires implementation of a hearing conservation program with noise monitoring program. Action levels vary depending on the country or region. The action level is typically based on an 8-hour time-weighted average (TWA). Region-specific action levels are described in [Section 9](#), International Tilts.

Affected Employee – A person employed by Ramboll on a full or part time basis who is potentially occupationally exposed to noise levels in excess of the applicable action level. Employees will be included at the discretion of the HSS department or local HSSC, based on work activities and potential noise exposures.

Decibel (dB) – A logarithmic measure of sound energy. The bel is referenced to a sound pressure level of 0.00002 Pascal. One decibel is one-tenth of a bel. Decibels may also be expressed as Pascals. A typical dump truck engine operating at a distance of 50 ft/15.2 m produces approximately 88 decibels.

- **A-weighted Decibel (dBA)** – An expression of the relative loudness of sounds in air as perceived by the human ear (as opposed to instrument readings). Decibel values of sounds at low frequencies are reduced. In contrast, in an unweighted decibel scale, no correction is made for audio frequency.

HPDs –PPE intended for hearing protection that includes plugs, bands and muffs. These are to be made available in offices and project sites as required. Refer to Ramboll’s HSSP, [PPE Use and Distribution](#).

Noise Reduction Rating (NRR) – Noise Reduction Rating (NRR) is a unit of measurement used to evaluate the effectiveness of hearing protection devices to decrease sound exposure within a given working environment. This rating is classified by the device’s potential to reduce noise in decibels (dB). It is calculated under laboratory conditions and indicated in HPD specification documents or packaging.

- **Effective NRR** – The effective NRR in the field is calculated by taking the NRR number (in dB), subtract seven and then divide by two. If double HPDs are worn, the higher NRR rating will be used for the previous calculation and then 5 dBA will be added to the result for the second HPD. The total will be subtracted from the higher NRR to estimate the true noise reduction.

Standard Threshold Shift – A standard threshold shift is a change in hearing threshold relative to the baseline audiogram with an average of 10 dB or more at 2000, 3000 and 4000 Hz, in either ear. Countries or regions may define the standard threshold shift with different terms or limits.

Time-Weighted Average (TWA) – The TWA is the average noise level over a period of time and includes continuous, intermittent and impulsive sound levels from 80 dBA to 130 dBA. The TWA is calculated by adding the fractions resulting from the actual time of exposure at a sound level divided by the allowable time at that level.

6. WORK PRACTICES

The following sections describe Ramboll’s preference for using engineering and administrative controls for noise hazards when feasible. When engineering and administrative controls are not sufficient or feasible, requirements for the use of HPDs and periodic noise monitoring are outlined.

6.1 Methods of reducing exposure

- **Elimination and Substitution** - The preferred approach is to eliminate the source of hazardous noise. When elimination is not possible, substitution of the loud equipment with quieter equipment may be the next best alternative to protect workers from hazardous levels of noise.
- **Engineering Controls** - If the hazardous noise cannot be controlled through elimination of the source or substitution of quieter equipment, engineering controls require physical changes to the workplace, such as regular maintenance, redesigning, modifying or substituting equipment to minimize noise sources and using barriers or other isolation methods or acoustic materials that prevent noise from reaching a worker. Examples of engineering controls are:
 - Move noisy equipment (such as an air compressor) farther away from employees
 - Install noise reducing baffles or perimeter barricades
 - Install noise-reducing rubber pads under machinery where appropriate
- **Administrative Controls** - If it is not possible to remove the hazard through elimination, substitution or engineering controls, the next step is to reduce noise using administrative controls. For example, an employer may change an employee's work schedule to avoid too much noise, post signs in the work area or on all sides of the equipment where hearing protection is required or remind employees to close doors to a noisy work area (e.g., doors to a room that house an air compressor or a door on an engine compartment).
- **PPE** - PPE is the least effective method for preventing occupational exposure to noise. Use of PPE is indicated when other controls are not feasible for reducing employee exposure to noise.

6.2 Hearing protection devices (HPDs)

- Ramboll shall provide appropriate HPDs whenever an employee's occupational noise exposure can be reasonably expected to be at or above the applicable action level. A common rule of thumb is that at noise levels above typical action levels, a conversation cannot be conducted by people within 3 feet/0.9 m of each other without raised voices.
- Hearing protection devices must be worn by all employees entering areas that are posted with signs requiring hearing protection.
- High Noise Area Warning signs must be posted at entrance to high noise areas alerting employees to the potential noise hazard and the need to wear hearing protection. Signage should indicate whether hearing protection is always required (below) or required when equipment is operating.

CAUTION
High Noise Area
Hearing Protection Required

- HPDs must be worn by employees conducting any of the following activities (this list is not all-inclusive):
 - Grinding
 - Circular saw or chop saw operation
 - Jackhammer, chip hammer or needle gun operation

- Heavy equipment operation unless inside a cab with the doors closed
- Operations and maintenance or construction activities in areas with pumps, blowers, generators, compressors or similar equipment in operation
- Pile driving activities
- Abrasive blasting
- Paint booth spray painting
- Concrete saw cutting or coring
- Pressure washing

6.3 Monitoring

Many persons are exposed to noise levels that are transient and highly variable, which is characteristic of construction, demolition and remediation projects. Noise monitoring is not normally conducted. However, noise exposure may be assumed to be above the applicable action level based on the type of activity being conducted and reliance on the 3-foot/0.9 m rule of thumb. Noise monitoring may be conducted for extremely high noise areas to verify that HPDs are adequate or may be performed to assess the effectiveness of noise controls, such as mufflers or barrier walls. Ramboll's HSS department should be contacted for assistance in these circumstances.

Work areas with fixed noise sources, such as water and wastewater treatment plants and manufacturing facilities can be evaluated with noise level monitoring. The monitoring can identify areas where HPDs are necessary or where engineering controls can be considered.

- PMs/POs will implement noise monitoring with support from HSS when the requirements for hearing protection are unclear.
- Until noise monitoring is conducted to demonstrate otherwise, PMs/POs will conservatively require the use of hearing protection.
- Ramboll will provide controls for protection against the effects of noise exposure when the sound levels exceed the applicable action level.
- If engineering and administrative controls fail to reduce sound levels to below the applicable action level, PPE will be provided and used to reduce sound levels to the acceptable level.
- Exposure to impulsive or impact noise will not exceed 140 dB peak sound pressure level. Peak sound pressure levels may differ by country or region, and the more stringent criteria will be followed.

6.4 Employee notification and communication

Employees who work with identified noise hazards shall be notified of noise monitoring results and any resulting changes to PPE requirements and other hazard controls within their work environment.

- Employees who work with noise hazards may review noise measurement data and/or observe the data collection process if they so desire.
- Areas where noise levels are consistently above the applicable action level will have signage posted to require HPDs upon entry into those areas.

6.5 Audiometric testing

Audiometric testing is conducted when employees are occupationally exposed to noise levels exceeding the applicable action level. Ramboll maintains an audiometric testing program in accordance with the following. PMs and on-site employees will adhere to local regulations if they are more stringent than Ramboll's requirements:

- Ramboll will establish and maintain an audiometric testing program for employees whose exposures equal or exceed the applicable action level over an 8-hour TWA and will be administered within 6 months of hire, as applicable.
- Audiometric tests will be performed by a licensed or certified audiologist, otolaryngologist, or other physician or by a technician who is certified by the appropriate regulatory authority of the country or region. A technician who performs audiometric tests must be overseen by an audiologist, otolaryngologist or physician.
- Audiograms obtained pursuant to this safe work practice will meet applicable requirements for audiometric measuring instruments as required by the regulatory authority of the country or region.

6.5.1 Baseline audiogram

Ramboll requires that a baseline audiogram be conducted for employees in the hearing conservation program within 4 weeks of being identified. Subsequent audiograms are compared against this baseline audiogram.

- Testing to establish a baseline audiogram will be preceded by at least 14 hours without exposure to workplace noise. Hearing protectors may be used as a substitute for the requirement that baseline audiograms be preceded by 14 hours without exposure to workplace noise. Ramboll will notify employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

6.5.2 Evaluation of audiogram

Each employee's annual audiogram is compared by the audiometric testing service to that employee's baseline audiogram to determine if the audiogram is valid and if a standard threshold shift has occurred. In identifying whether a standard threshold shift has occurred, allowance may be made for the contribution of aging (presbycusis) to the change in hearing level by correcting the annual audiogram. Unless a physician determines that the standard threshold shift is not work related or aggravated by occupational noise exposure, Ramboll will require the following steps be taken when a standard threshold shift occurs:

- Employees exposed or potentially exposed to high noise will be assigned HPDs, trained in their use and care and required to use them. For known high noise job assignments, employees will be fitted and trained prior to job assignment.
- Employees already using hearing protection and show a work-related standard threshold shift will be re-assigned PPE as needed and retrained in the use of such PPE. Employees may be provided with hearing protection PPE offering greater noise reduction if necessary.
- Employees will be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if it is suspected that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.

6.5.3 Follow-up procedure

If a comparison of the annual audiogram to the baseline audiogram indicates that a standard threshold shift has occurred, Ramboll's Medical Consultant will take the following actions:

- Inform the employee within 21 days of the determination.
- Arrange a retest of the employee to obtain a new audiogram within 30 days of being notified by the consultant of the occurrence of a standard threshold shift. The results of the retest will be considered as the annual audiogram.
- Employees with hearing loss who are not/have not been using appropriate HPDs, will be issued the correct HPDs, trained and coached in their use and care and required to use them.
- Employees already using HPDs will have the appropriate HPDs reissued, will be retrained in their use and may be provided with HPDs that have greater attenuation if necessary. Additional engineering and administrative controls will be evaluated and implemented if necessary.
- The employee will be referred for additional medical examinations, as appropriate. The employee will be appropriately informed of the need for additional medical examinations.

7. TRAINING AND COMPETENCY

Ramboll's HSS training program includes new employee induction training, supervised on-the-job training and annual completion of online modules or classroom instruction related to safety requirements and work practices. Training assignments vary based on employee roles and training classification. Completion of assigned training will be documented by a training completion certificate, which will be stored in the employee's electronic training record.

7.1 HSS hearing conservation lessons A through B

Ramboll assigns annual training for employees who may be exposed to noise at or above the applicable action level, which is based on an 8-hour TWA. Assignment of the training program will be based on employee risk classification and specific job duties. Each assigned employee will be informed of the following:

- The effects of elevated noise levels on hearing.
- Engineering and administrative controls that may be used to reduce exposure to harmful noise levels.
- The purpose of HPDs, the advantages, disadvantages and effectiveness of various types and instructions on selection, fitting and care.
- The purpose of audiometric testing and an explanation of the test procedure.

8. DOCUMENTATION

The following documentation specific to noise hazards and hearing protection is required:

8.1 Medical surveillance questionnaire

The [Medical Surveillance Questionnaire](#), which identifies potential high noise work assignments and requires participation in medical surveillance (audiometric testing program), shall be completed by new employees upon hire. More information regarding the questionnaire can be found in Ramboll's HSSP, [Medical Surveillance and Fitness for Duty](#).

8.2 Audiograms

Audiograms shall be generated by the Medical Consultant under Ramboll's audiometric testing program for employees subject to noise exposures potentially above the Ramboll action level.

8.3 Noise monitoring results

The results of noise monitoring will be maintained in project files. Noise monitoring will be performed in work areas as necessary to identify areas above the applicable action level or to evaluate the effectiveness of engineering controls.

9. INTERNATIONAL TILTS

9.1 Asia / Pacific

9.2 Brazil

9.3 Canada

9.4 European Union (EU)

In the European Union the Directives set minimum standards for health and safety. National legislation may require higher standards, so each EU PBU must check the local legislation and standards to be applied. According to EU Directive 2003/10/EC, the exposure action value is fixed from 80 dBA (lower value) to 85 dBA (upper value). The exposure limit value is 87 dB(A).

EU relevant directives:

- Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise).
- Directive 98/37/EC of the European Parliament and of the Council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery.
- Council Directive 89/656/EEC of 30 November 1989 on the minimum health and safety requirements for the use by workers of personal protective equipment at the workplace.
- Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work.

The European Standard related to risk of noise is:

- ISO 1999: specifies a method for calculating the expected noise-induced permanent threshold shift in the hearing threshold levels of adult populations due to various levels and durations of noise exposure; it provides the basis for calculating hearing disability according to various formulae when the hearing threshold levels at commonly measured audiometric frequencies, or combinations of such frequencies, exceed a certain value.

9.5 Mexico

9.6 United Kingdom (UK)

9.7 United States

The action level in the United States is 85 dBA over an 8-hour time weighted average. When this level is exceeded, a hearing conservation and noise monitoring program must be implemented.

See Occupational Safety and Health Administration (OSHA) 29 CFR 1910.95: Occupational Noise Exposure.

<https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.95>

9.8 Other Regions

10. ADDITIONAL INFORMATION

11. REVISION SUMMARY

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1.0

SAFE WORK PRACTICE

OVERHEAD UTILITY

CLEARANCE

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1. PURPOSE

The purpose of this Safe Work Practice (SWP) is to reduce the likelihood of Ramboll project teams or our subcontractors contacting overhead utility lines.

Striking an overhead utility may present an immediate danger to the life, health and safety of our employees, our contractors and the surrounding community and can also cause property damage, trigger financial and legal repercussions and damage Ramboll's professional reputation. When overhead utility hazards are identified and controlled prior to starting work, the risks associated with such hazards can be minimized.

2. SCOPE

This SWP applies to work at client facilities or other sites where overhead utilities are present. The SWP does not apply to work involving cranes, because work involving the use of cranes has more stringent requirements with respect to overhead utility lines. Overhead utility line requirements specific to cranes are provided in Ramboll's SWP, [Cranes - Mobile](#).

In the event of a conflict between the Ramboll SWP and applicable country or region regulatory requirements or project specific requirements, the more stringent set of requirements will be followed.

3. OVERVIEW

This SWP outlines the requirements for Ramboll employees and subcontractors when operating equipment in locations with overhead powerlines and other utilities. This SWP does not apply to cranes, which have specific requirements. Ramboll and regulatory agencies have developed restricted and prohibited work distances. Line identity and voltage must be known to establish safe work distances. Within the **Restricted Work Distance**, work may only be performed with specific line voltage identified and additional safety controls in place. Within the **Prohibited Work Distance**, no work may occur unless the utility is shielded or de-energized by the utility owner.

- Restricted Work Distance:
 - <350 kV – 25 feet/7.6 metres
 - >350 kV – 50 feet/15.2 metres
- Prohibited Work Distances:
 - <50 kV – 10 feet/3.5 metres
 - 50-200 kV – 15 feet/5 metres
 - 200-350 kV – 20 feet/7 metres
 - 350-500 kV – 25 feet/7.6 metres
 - 500-750 kV – 35 feet/10.7 metres

Restricted and Prohibited Work Distances should be measured from the powerline, not the pole. When determining if a piece of equipment will be within the Restricted or Prohibited Work Distance simple trigonometry can be used to determine maximum equipment height in relation to the powerline.

Some equipment types may have less stringent requirements while in transit and not under load, but a minimum clearance of 25 feet should be maintained as a general rule for <350 kV utilities.

4. RESPONSIBILITIES

4.1 Project Manager (PM) / Project Owner (PO)

- Define contractual and legal responsibilities associated with overhead utility-related projects before work begins and preferably at the proposal stage.
- Ensure the project scope of work includes appropriate resources including people, time, and budget to complete the required overhead utility clearance measures detailed in this SWP.
- Assign responsibilities for utility-related activities to trained and experienced employees in a manner consistent with this practice.
- To the extent possible, plan work to avoid overhead utilities, including arranging for appropriate pre-planning inspections of overhead lines as part of scope development.
- Notify Ramboll HSS department if the requirements of this SWP cannot be met.
- Support use of Stop Work Authority as related to overhead lines or any other perceived hazard until such hazards are evaluated and controlled to the satisfaction of the project team and HSS department.

4.2 Site Safety Representative (SSR)

- Implement and enforce the requirements outlined in this SWP.
- Recognize situations where lines are present in or nearby Ramboll's work areas and evaluate if work has any chance to approach closer than safe clearance distances.
- Consult with PMs and the HSS department concerning any project specific issues or hazard controls that may be necessary before starting work near overhead lines.
- Authorize work in the Restricted Work Area ONLY when all requirements outlined in the SWP have been implemented.
- Work with utility owners and subcontractors to ensure that all equipment is located outside of the prohibited zones for overhead utilities.
- Report all safety events, issues or concerns to the PM and in accordance with Ramboll's HSSP, [Event Reporting and Investigation](#).

4.3 Ramboll HSS department

- Support project safety plan development (when requested by the PM) and include overhead utility hazard information and appropriate safety controls based on this SWP and site-specific concerns.
- Make recommendations for additional overhead utility clearance steps to reduce uncertainty and mitigate risk for situations involving complex utility infrastructure and for work directly involving utilities.
- Review all requests for variances to the requirements of this SWP, utilizing practice area experts for technical review if needed.
- Review and update this SWP on a biennial basis or more frequently if needed.

4.4 Health, Safety and Security Coordinators (HSSCs)

- Promote awareness, understanding and use of this SWP by project team members.
- Facilitate application of this SWP in the context of local regulatory requirements and integration of this SWP into project safety plans.
- Inform the HSS department if the SWP does not adequately address local regulatory requirements.

4.5 Employees, subcontractors and visitors

- Review, understand and comply with all project safety plan controls and work practices defining safe overhead utility work.
- Comply with all requirements outlined in this SWP regarding overhead utility clearance.
- Review overhead utility locations in relation to the planned work location.
- Stop work if there are safety concerns related to overhead utility clearance.
- Stop work if there is a potential for equipment or people to enter any Restricted Work Area or Prohibited Work Area, if required safety controls have not been implemented by Ramboll and/or the utility owner.
- Stop work if overhead lines are contacted and respond according to the emergency action plan defined in the project safety plan.

5. KEY DEFINITIONS

Restricted Work Distance – The distance from the line at which safe work requirements must be implemented before work proceeds.

- **Restricted Work Area** – The circumference around the line where work may occur, but only if safe work requirements have been implemented.
- **Restricted Work Height** – The distance from the ground where safe work requirements must be implemented before work proceeds. This distance will vary depending on horizontal distance from the line.

Prohibited Work Distance – Minimum safe clearance distance from the line, at which no work may occur unless the line is deenergized or insulated by the utility owner.

- **Prohibited Work Area** – Minimum safe clearance circumference around the line, within which no work may occur unless the line is deenergized or insulated by the utility owner.
- **Prohibited Work Height** – Minimum safe clearance distance from the ground, at which no work may occur unless the line is deenergized or insulated by the utility owner. This distance will vary depending on horizontal distance from the line.

6. WORK PRACTICES

This section outlines requirements that must be implemented when overhead lines are in the work area. This section will outline how to determine the restricted and prohibited work distances and dimensions.

6.1 Pre-work requirements

An overhead line hazard may exist if overhead lines are present within or adjacent to the area in which field work will be performed and work includes equipment that has the potential to enter restricted work areas around overhead lines. Overhead lines must be identified as a potential hazard even if initial observations indicate that Ramboll or our subcontractor(s) will not approach restricted or prohibited work distances with people or equipment.

The early identification of overhead lines is critical to ensure the proper budget, planning and implementation of safe work requirements. The location and height of the lines, line voltage, minimum clearance distances and controls must be measured in advance and documented in the project safety plan.

6.1.1 Safe clearance distances

Restricted and Prohibited Work Distance must be considered for overhead line safety. In order to select the appropriate safe clearance distances, the line voltage must be understood. Contact the utility owner to confirm line types, voltages and any owner-implemented controls.

In general, overhead line identity and voltage should be investigated if work is occurring within a horizontal distance of 25 feet/7.6 metres from overhead lines suspended on wooden poles or a horizontal distance of 50 feet /15.2 metres from lines suspended on metal poles.

Once line voltage is understood, the following distances will be used to establish the Restricted and Prohibited Work Areas:

- **Restricted Work Distance** – The clearance distance that requires specific safety controls including contacting the utility owner and a detailed assessment of hazards as outlined in this SWP. Restricted Work Distances are as follows:
 - <350 kV – 25 feet/7.6 metres
 - >350 kV – 50 feet/15.2 metres
- **Prohibited Work Distance** – The minimum safe clearance distance, within which work may only proceed if the power line has been deactivated or insulated by the utility owner. The prohibited safe distance depends on the line type and voltage and the utility owner must be contacted to establish this distance. Minimum safe clearance distances also depend on applicable regulations of the country or region and the policies of the utility owner. Country or region-specific regulations that are more stringent than Ramboll safe work practices, where identified, are described in [Section 8](#) of this SWP.
 - <50 kV – 10 feet or 3.5 metres
 - 50-200 kV – 15 feet or 5 metres
 - 200-350 kV – 20 feet or 7 metres
 - 350-500 kV – 25 feet or 7.6 metres
 - 500-750 kV – 35 feet or 10.7 metres

These distances will be used to determine the Prohibited and Restricted Work Areas. Work may be conducted in the Restricted Work Area if controls outlined in [Section 6.4](#) are implemented.

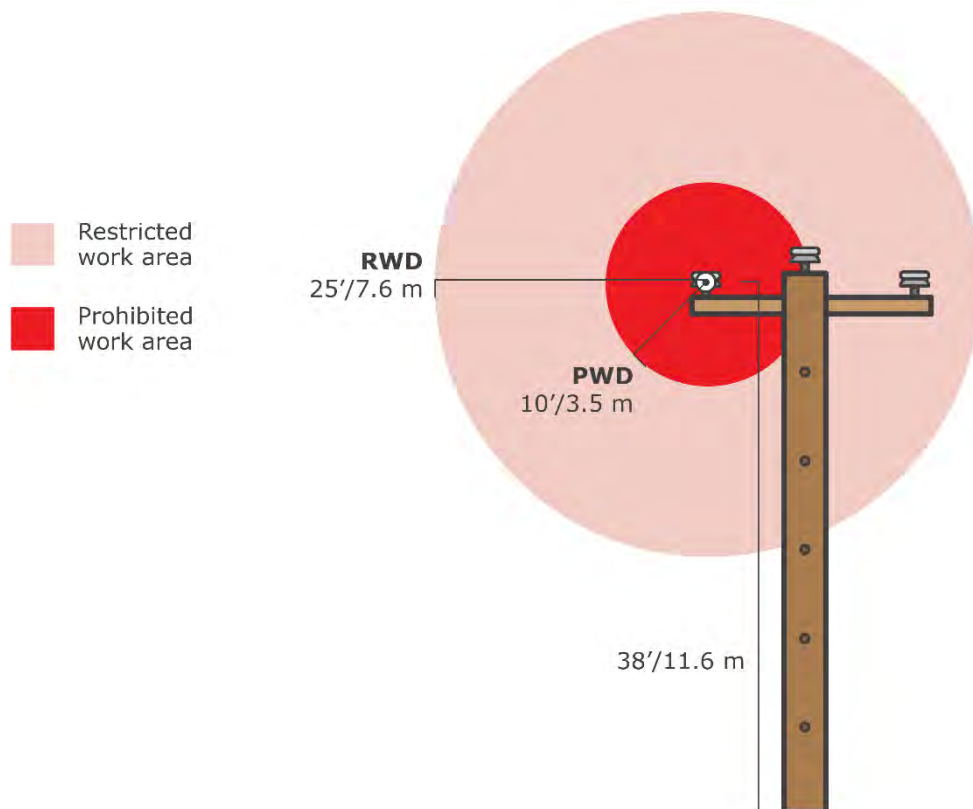
At no time may work be conducted within the Prohibited Work Area unless the lines have been deenergized or insulated by the utility owner.

6.1.2 Determining restricted and prohibited work areas

Once the safe clearance distances are determined, the following steps should be taken to establish the restricted and prohibited work areas for each individual line.

1. Estimate the height of the line based on visual observations, angle measurement and geometric calculations, laser distance measuring devices and/or information from the utility owner. Do NOT come in physical contact with the line or use vertical tools to estimate height.
 2. Subtract the Prohibited and Restricted Work Distance from the height of the lines to determine where Restricted and Prohibited Work Areas begin directly under the line. This would also be considered your Restricted and Prohibited Work Height when working directly under the power line.
- Consider the possibility for wind or temperature changes to cause the line to move or droop.

See the example below using a 12 kV distribution line at a height of 38 feet/11.6 metres and a work location directly below the line. The Restricted Work Area starts at a height of 13 feet/3.9 metres above ground and the Prohibited Work Area starts at a height of 28 feet/8.5 metres aboveground.

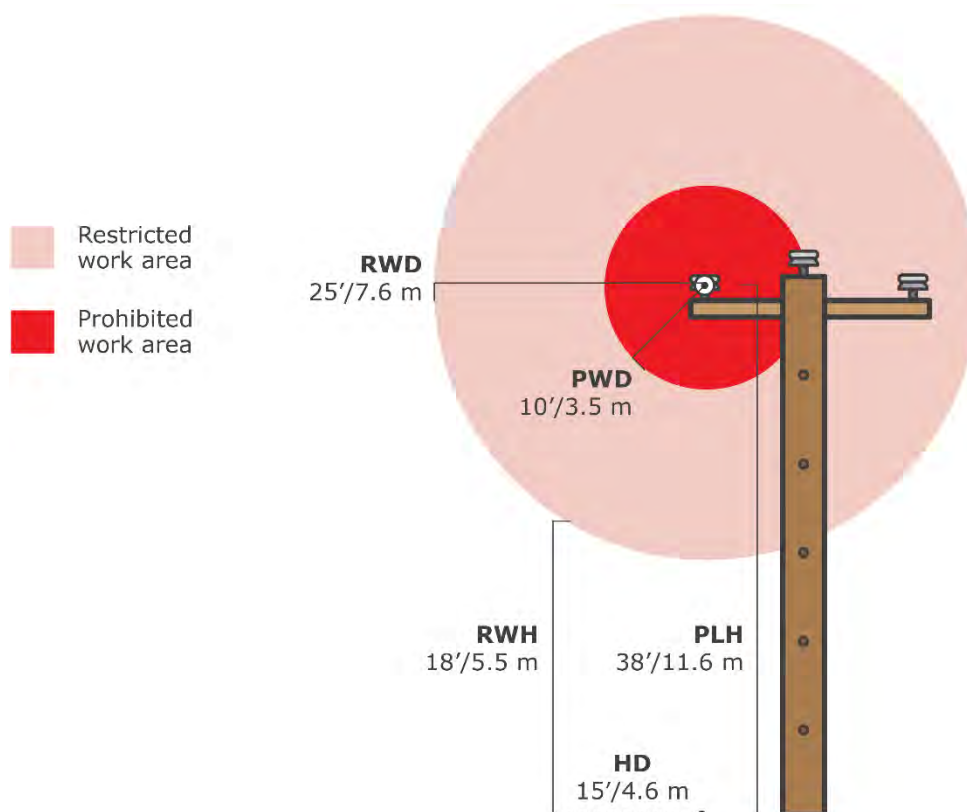


- To determine the Prohibited and Restricted Work Height in areas other than directly below the line, you need to represent the work area and equipment dimensions on a scaled drawing and/or use the equation below:

$$RWH = PLH - \sqrt{RWD^2 - HD^2}$$

RWH	Restricted Work Height
PLH	Power Line Height
RWD	Restricted Work Distance
HD	Horizontal Distance

- See the example below using the same 12 kV distribution line as above and a horizontal distance of 15 feet/4.6 metres. The Restricted Work Area starts at a height of 18 feet/5.5 metres from the ground when work is to occur at this ground position with respect to the overhead line.



- To determine Prohibited Work Areas simply replace the Restricted Work Distance with the Prohibited Work Distance.

Determining the height at which the Restricted and Prohibited Work Areas begin becomes particularly important as the height and voltage of overhead lines increase.

Visually identify the restricted and prohibited distances by using safety fencing, cones, warning lines and/or signs as outlined in the following sections. The SSR will determine if marking is feasible and how to best mark restricted and prohibited distances. Visual identification signals and safety distances will be discussed with equipment operators and other site employees during

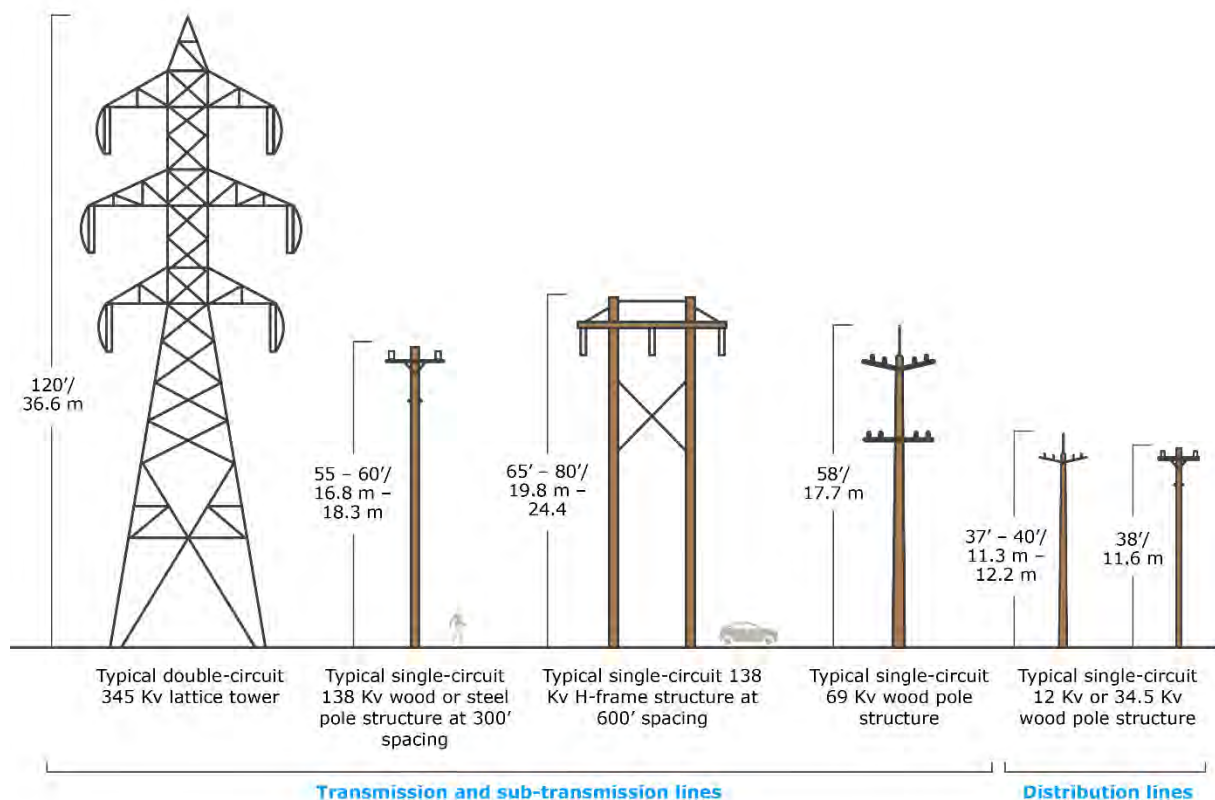
scheduled safety meetings and documented in the project safety plan. Contact your local or regional HSS representative for assistance.

Areas in proximity to prohibited work areas must be clear of stored materials or equipment, such that persons standing on top of materials or equipment will be outside of prohibited work distances.

6.2 General overhead line safe work requirements

Overhead lines that may pose a hazard during the movement and operation of equipment must be identified prior to beginning work on site. The location of the overhead lines, minimum clearance distances and controls must be documented in the project safety plan. When overhead lines are present on a project site the following general safety precautions will be taken:

- ALL overhead lines will be considered energized until identified and confirmed by the utility owner (or other qualified individual) to be de-energized.
- Portable metal ladders or other conductive materials must not be used inside the safe zone surrounding overhead lines as outlined in the next section.
- Operating voltage of power lines will be determined in writing from the site owner or utility company whenever feasible.



6.3 Task specific overhead line requirements

Where lines are confirmed less than 350 kV, the Restricted Work Area is 25 feet/7.6 metres around the line. If work must be performed closer than this distance, then additional safety precautions must be implemented as outlined in this SWP. At no time may work be performed within the Prohibited Work Area surrounding an energized overhead line. The following are safe clearances for specific tasks. However, a safe clearance of 25 feet/7.6 metres should be implemented when feasible.

- Cranes have more stringent requirements as compared to other equipment. Refer to Ramboll's SWP, Crane Safety-Mobile for more information.
- Excavators, aerial lifts and other heavy equipment in use are required to maintain the safe clearance of 25 feet/7.6 metres as outlined above.
- Excavators and other heavy equipment while in transit are required to maintain the following safe clearances, which assume no load and booms are lowered:

0-50 kV	4 feet/1.2 metres
51-345 kV	10 feet/3 metres
346-750 kV	16 feet/4.9 metres

- Scaffolds have specific minimum clearance distances from conductive parts including conductive tools and equipment carried by persons using the scaffold.
- The minimum clearance distance for un-insulated electrical lines is 10 feet/3 metres plus 0.4 inches/1 centimetre per kV above 50kV.
- For insulated lines up to 300 volts, the minimum clearance distance is 3 feet/0.9 metres.
- For insulated lines above 300 volts, the minimum clearance is 10 feet/3 metres plus 0.4 inches/1 centimetre per kV above 50kV.
- Transmission line workers and qualified tree trimmers who have received specialized training for work near energized power lines may be allowed closer approach distances depending on applicable regulations, which are specific to the country or region.
- Other tools, material and mobile equipment – e.g., paint rollers, long-handled cement finishing floats, metal framing, metal roofing materials, gutters, forklifts, dump trucks, concrete pump truck booms and loaders are required to maintain the Restricted Work Distance of 25 feet/7.6 metres (<350 kV) or 50 feet/15.2 metres (>350 kV) as outlined above.

6.4 Safety precautions for the restricted work area

Apply one or more of the precautions listed below if overhead lines cannot be de-energized.

- Request the utility owner to install insulating sleeves.
- Request the utility owner to install warning flags.
- Install a safety barricade under which high-reach equipment must pass. The safety barricade must be positioned such that the equipment will strike the barricade first before approaching the minimum clearance to power lines.

- Designate a spotter who does not perform any other task while equipment or other conductors are moved within restricted work areas. Dedicated spotter must:
 - Be equipped with a visual aid to assist in identifying the minimum clearance distance, such as clearly visible lines painted on the ground, a clearly visible line of stanchions, or a set of clearly visible line-of-sight landmarks.
 - Be positioned to effectively gauge the clearance distance.
 - Use equipment that enables the dedicated spotter to communicate directly with the operator.
 - Give timely information to the operator so that the required clearance distance can be maintained.
- Ideally, work should not take place in proximity to overhead lines during darkness or poor visibility conditions. Portable or vehicle lighting can obscure rather than illuminate overhead lines.

Reduce the risk of accidental contact by erecting ground-level barriers to establish a safety zone to keep people and equipment away from overhead lines.

6.5 Safety precautions for the prohibited work area

Overhead lines must be de-energized prior to conducting work that could potentially enter the Prohibited Work Area. Some smaller power lines may be shielded in lieu of being de-energized. Consult with the utility owner regarding this option.

The safety precautions required for work in the Restricted Work Area must also be implemented for work inside the Prohibited Work Area, in addition to the power lines being de-energized, insulated or otherwise shielded.

6.6 Responding to contact with overhead power lines

Contacting overhead power lines can result in electric shock to those in the area around the equipment as well as a fire if combustible materials are present. The following must be implemented:

- Stop work.
- If you are NOT in danger from fire or being struck by the overhead line:
 - Stay where you are.
 - Move the equipment away from line if possible.
 - Warn others not to approach the area.
- If you are in danger:
 - Equipment operator should jump as far as possible from the equipment and land with both feet on the ground. Do NOT touch the equipment and the ground simultaneously.
 - Hop or shuffle away from the equipment keeping both feet on the ground at the same time.

- Do not touch the equipment until the utility owner says it is safe to do so.
- Call the emergency number.
- Provide first aid and summon medical assistance as needed.
- Notify the SSR, PM, PO, local HSSC or Safety Ambassador and local or regional HSS department representative. The PM will coordinate notification of the client and other entities involved.
- Do not allow anyone to enter the area until the utility provider declares it is safe to do so.

7. TRAINING AND COMPETENCY

Ramboll's HSS training program includes new employee induction training, supervised on-the-job training and annual completion of online modules or classroom instruction related to safety requirements and work practices, including content related to overhead utility clearance. Training assignments vary based on employee roles and training classification. Completion of assigned training will be documented by a training completion certificate, which will be stored in the employee's electronic training record. No additional external training or competency is required to follow the requirements of this SWP.

8. DOCUMENTATION

The following documentation is required, specific to overhead utility clearance.

8.1 Documentation of overhead power lines evaluation

When work takes place within or nearby the restricted work distance to an overhead line, the location and height of overhead power lines, line voltage, utility owner, minimum clearance distance and safety controls as described in this SWP must be documented in the project safety plan and implementation should be recorded as part of daily field logs.

9. INTERNATIONAL TILTS

9.1 Asia / Pacific

9.2 Brazil

9.3 Canada

9.4 European Union (EU)

- The European Standard BS EN 50110-1:2013 establishes requirements for safe work activity for work on or near overhead electrical installations.

9.5 Mexico

9.6 United Kingdom (UK)

9.7 United States

OSHA Minimum Clearance Distances

- 29 CFR 1926.600(a)(6)(i) establishes the Prohibited Work Distance as 10 feet for power lines up to 50 kV.

- 29 CFR 1926.600(a)(6)(ii) establishes the Prohibited Work Distance as 10 feet plus 0.4 inches per kV over 50 kV.

9.8 Other Regions

10. ADDITIONAL INFORMATION

11. REVISION SUMMARY

PREPARED BY

Americas Health, Safety and Security | E&H Health, Safety and Security

APPROVED BY

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DATE

November 2021

VERSION

1.0

SAFE WORK PRACTICE

PPE & SAFETY EQUIPMENT

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1. PURPOSE

The purpose of this Safe Work Practice (SWP) is to establish uniform requirements to ensure that proper personal protective equipment (PPE) and safety equipment are provided to protect, shield or isolate workers from hazards.

2. SCOPE

This SWP applies to work at Ramboll offices, client facilities or other sites where PPE or safety equipment is required. Ramboll will ensure that proper PPE is evaluated and provided for projects under its control and supervision with a potential for employee injury. This SWP is intended to comprehensively address the establishment of appropriate procedures for selecting, maintaining and replacing PPE. In the event of a conflict between this SWP and locally applicable regulatory requirements (or project-specific requirements), the more stringent set of requirements will be followed.

3. OVERVIEW

This SWP provides roles and responsibilities, key definitions, work practices, training and documentation requirements for PPE. All PPE must be used and maintained in accordance with the manufacturer requirements and local regulations. The following work practice topics are addressed:

- **Hierarchy of controls** – PPE is the least desirable control and shall only be used if other control methods are not feasible or effective.
- **PPE levels** – Ramboll designates three categories of PPE: low level, medium level and high level. The PPE level should not be confused with the project risk classification. Many countries have different PPE categories (i.e., Level A, B, C and D in the US).
- **Risk assessments** – An assessment of hazards must be completed to determine what PPE will be required for a task/project. However, generally a hard hat, safety glasses and foot protection will be required for construction, demolition, remediation sites and industrial facilities.
- **Chemical protection** – If chemical exposure is anticipated the proper level of hand/skin protection must be selected. The type of chemical protection should be selected based on the chemical(s) of concern, amount of exposure (incidental vs. splash) and manufacturer recommendations.
- **Respirators** – Respiratory protection must be used and maintained in accordance with the [Respiratory Protection](#) SWP. Respirator users must be trained and medically clear in accordance with that SWP.
- **Donning and doffing** – PPE must be taken on and off to allow maximum protection and to prevent contact with contaminated items.
- **Heat stress** – When selecting PPE, the risk assessment must include the effects that PPE will have on body temperature. Additional heat stress controls may need to be implemented if heavy or impermeable PPE will be worn.

4. RESPONSIBILITIES

4.1 Project Manager (PM) / Project Owner (PO)

- Request PPE and safety equipment information and requirements from the facility owner and consider the adequacy of the information provided. This information should be included in the project safety plan, as appropriate.
- Ensure appropriate resources, including people, budget and schedule to comply with requirements outlined in this SWP.
- Request assistance from the Health, Safety and Security (HSS) department if potential PPE and safety equipment deficiencies are observed or if technical support is needed or if technical support is needed to ensure safe implementation of PPE work practices.
- Support use of stop work authority by employees or subcontractors related to PPE or any other perceived hazard. Work is to be stopped until the identified hazards are evaluated and controlled to the satisfaction of the project team and HSS department and in accordance with safe work practices.
- Discuss stop work situations with the local Health, Safety and Security Coordinator (HSSC), Safety Ambassador or a representative of the HSS department, including reporting of incidents and safety observations in accordance with the HSS Process (HSSP), [Event Reporting and Investigation](#).

4.2 Site Safety Representative (SSR)

- Be present at the site to oversee the project or appoint another on-site Ramboll employee as a backup SSR (with approval from the PM).
- Ensure the project safety plan that contains PPE or safety equipment information is reviewed with site team as part of their project safety orientation and during toolbox safety meetings.
- Communicate project safety requirements to all employees and subcontractors and document all safety meetings, unsafe acts or conditions and corrective actions.
- Inform the PM/PO of important developments or questions regarding project and task safety.
- Assist with reporting of incidents and safety observations in accordance with the HSSP, [Event Reporting and Investigation](#).

4.3 Health, Safety and Security (HSS) department

- Support project safety plan development (when requested by the PM) and include PPE or safety equipment information and appropriate safety controls based on this SWP and site-specific concerns.
- Evaluate site conditions related to PPE through field safety audits and inspections when requested by the client, the PO or other management, or when required by local regulations.
- Provide technical support, consultation and training materials that are consistent with this SWP, when requested or applicable.

- Review and update this SWP on a biennial basis or more frequently if required by local regulation.

4.4 Health, Safety and Security Coordinators (HSSCs) and Safety Ambassadors (SAs)

- Support safety culture and new employee HSS inductions at the local office level, including discussion of this SWP and training resources.
- Provide assistance in PPE ordering, selection and related resources.
- Promote awareness, understanding and use of this SWP among local office employees.
- Facilitate application of this SWP in the context of local regulatory requirements and integration of this SWP into project safety plans.
- Inform the HSS department if the SWP does not adequately address local regulatory requirements.

4.5 Employees, subcontractors and visitors

- Review, understand and comply with project safety plans.
- Do not undertake any activities requiring PPE or safety equipment unless properly trained.
- Follow all PPE safety practices defined in this SWP, as implemented by the site owner or occupant, or as required by local regulations. In the event of a conflict, the more stringent work practices will be used.
- Report safety events, issues or concerns to the PM, SSR or other supervisor and in accordance with the HSSP, [Event Reporting and Investigation](#).
- Exercise stop work authority if any task is perceived to be unsafe or if more information is needed to proceed safely.

5. KEY DEFINITIONS

Personal protective equipment (PPE) - PPE is all equipment or apparel designed to protect, shield or isolate workers from chemical and physical safety hazards. PPE includes head, eye, face, body, hand and foot and, under certain circumstances, respiratory protection. Additional information on PPE used for respiratory protection is provided in the [Respiratory Protection](#) SWP.

6. WORK PRACTICES

Employees may work at facilities where PPE or safety equipment is required and could improperly enter a hazardous area without the proper PPE. Employees and subcontractors should be familiar with PPE information in this SWP or as provided by the various client facilities in which we operate. Project teams are expected to be familiar with locally applicable regulatory requirements and project-specific requirements. In the event of conflicting requirements for work practices, the more stringent set of requirements will be followed. These requirements must be outlined in the project safety plan.

Ramboll will establish overall PPE requirements in this document. Project-specific PPE requirements will be determined through project-specific job hazard analysis by the project safety plan preparer and reviewed and approved by the HSS department and PM/PO.

6.1 Written programme

This written programme will be communicated to all team members that are required to wear PPE or use safety equipment. It encompasses projects/areas where Ramboll is actively working, regardless of the number of workers employed or the number of work shifts.

6.2 Regulatory applicability

Specific standards issued by the applicable regulatory agency will be reviewed as part of the overall job hazard analysis and PPE selection. When regulatory standards apply to a specific job, these standards will be incorporated into the hazard analysis and PPE selection to ensure that the requirements of the standard and hazard analysis are combined to create as optimally safe job conditions as is possible. The PPE guidelines presented here are to be followed unless the requirements in the project region/country or at a job site are more protective.

6.3 Identifying and assessing risk

PPE and safety equipment protects, shields or isolates workers from hazards. Because hazards are present at most construction, remediation, industrial and commercial sites where employees operate in a medium or high-risk work environment, employees may need to wear hard hats, safety glasses with side shields and steel-toed safety shoes or boots, as well as any additional PPE required by the client or host facility, such as metatarsal guards, hearing protection or fire-resistant clothing.

The first step in managing hazards at a workplace is to identify them. At some sites, the hazards are:

- Stable
- Well understood
- Have already been appropriately identified and assessed

Standard PPE, such as hard hats, safety glasses, hearing protection and safety shoes will generally be sufficient for project work taking place in a medium-risk environment, like site visits, audits or walk-throughs of commercial or industrial facilities. The project safety plan or risk assessment will outline the PPE needed for the project. It should be noted that the hazards may not be well understood and may change over time depending on site conditions and the scope of work. The PPE for medium and/or high-risk work environments may include items above and beyond those previously mentioned, such as goggles, face shields, respiratory protection, impervious gloves, coveralls or boot covers.

Protective equipment requirements will vary by site; however, the PM/PO, the SSR, local HSSC or other designated person knowledgeable about PPE will ensure that equipment selected will meet the minimum following requirements:

- Appropriate for the identified hazard
- Maintained in good condition
- Properly stored when not in use to prevent damage or loss
- Clean and fully functional

It is Ramboll's responsibility to make required PPE available to employees and to provide adequate training on how to identify when PPE is necessary, as well as how to use, care for and maintain PPE.

Employees are responsible for the equipment in their possession and must properly use and remove (also known as donning and doffing) and dispose or clean their assigned PPE, as appropriate.

6.3.1 Hierarchy of controls

The hierarchy of controls is the most effective strategy to reduce risks in the workplace. At the top of the hierarchy, elimination or substitution of the hazard is the most effective, while controlling the hazard by implementing the use of PPE is the least effective. Ideally, if a hazard is identified, the project team will be able to eliminate the hazard or substitute with a less hazardous task or location.

Elimination or substitution are not always possible, in which case engineering controls are the next preferred method for protecting workers. These include physical means to mitigate risk such as guardrails to prevent accidental falls, industrial fans to increase ventilation or dust control methods like misting cuttings with water during drilling or digging. After engineering controls, administrative controls are next in order of preference and effectiveness. Administrative controls typically involve changes in workplace procedures, routines and employee training and are used in combination with engineering controls and PPE.

As the final level in the hierarchy of controls, PPE is to be used only when other methods are not feasible or effective in controlling the hazard. PPE may be the final and least effective control in the hierarchy but is one of the most important ways to reduce risk when hazardous work activities or environments are unavoidable. It is imperative that the use of PPE be evaluated for the specific hazards identified at the site and combined with administrative controls, such as training. In addition to selecting the appropriate PPE for the hazard(s) as part of safety planning, PPE users must consistently and competently don and doff their assigned PPE to be adequately protected and to minimise the potential for accidental exposure or injury.

6.3.2 PPE levels

Project safety planning and risk assessments will include consideration of the information gathered about the site hazards and risks to establish the level of PPE required. This evaluation will likely require a coordinated effort between the PM/PO, SSR, the project team and information provided from the client or previous reports. Once the hazard evaluation is complete, PPE is typically assigned to workers as a level or category. The PPE level represents the risk anticipated for workers and includes standard protective items to be worn to protect workers. Any employee who is asked to access or inspect an area that presents new or unexpected hazards, for which the assigned PPE does not mitigate, must stop work to address the health and safety concerns before proceeding.

Employees, with assistance from the SSR and HSS department, should reassess the PPE appropriate to the newly identified hazards. Employees can also choose, at any time during project work, to wear PPE more protective than the assigned items at their discretion, provided they are medically cleared to do so (as in the case of air-purifying respirators). Any changes in PPE, including voluntary upgrades, should be discussed with the project SSR to ensure that this change does not present additional hazards.

The categories of PPE shown here represent the minimum protection required at each of the three PPE levels. PPE levels are defined differently in different regions (see table below). Levels of PPE (low-, medium- or high-level protection) should not be confused with the work environment risk level (low-, medium- or high-risk environment), noting that low-risk environments such as offices do not require PPE, while PPE is typically required for medium- and high-risk work environments. Additional

items of PPE can be added to the standard protective items defined within a level of PPE, depending on site-specific factors.

- **Low-level PPE** – Hard hat (if needed), protective footwear, long pants, work shirt, safety glasses with side shields (if needed), hi-vis vest (if needed), hearing protection (if needed)
- **Medium-level PPE** – Low level PPE (with potential upgrade of eye protection) plus protective gloves and/or protective coveralls (for chemical or physical hazards).
- **High-level PPE** – Low level PPE (with potential upgrade of eye protection) plus inner and outer chemically protective gloves, chemically protective coveralls and respiratory protection.

Levels of PPE (low, medium and high level) are typically assigned under a regulation or government department focussed on worker safety, and these regulations use different terms to refer to levels of PPE. The table below provides a comparison of levels of PPE in a few areas of the world with the Ramboll standard PPE levels reference for. Contact the local HSSC or the HSS department for additional information.

Table 1. Ramboll standard global PPE levels with comparisons

Ramboll PPE levels	US PPE levels (OSHA ¹)	Italy PPE levels	Netherlands PPE levels
Low	D	Category I – Category II	PPE-Light
Medium	Modified D	Category II	PPE-Light to PPE-Intermediate
High	C, B, A	Category III	PPE-Heavy

1 - OSHA – Occupational Safety and Health Administration

Low-level PPE items are covered in detail in [Section 6.5](#). Low-level PPE should only be selected when there are nuisance levels of contamination, limited anticipated exposure to chemicals, and the work environment is stable and well understood (e.g., Phase I ESA, Project site with an engineered barrier, etc.). For medium and high-level PPE, the PPE will build from the low-risk standard PPE items by adding chemical and, under certain circumstances, respiratory protection. Medium- and high-level PPE items are covered in [Section 6.6](#).

6.4 Low-level PPE

This section describes PPE in the low-level category, including skin, head, eye, hearing, foot and general hand protection, including selection, fit and maintenance. This information applies to project work taking place in medium-risk work environments and high-risk environments, and in some cases may also apply to low-risk work environments such as offices, such as the use of work gloves to lift a heavy item.

6.4.1 Skin protection

Skin protection at a low PPE level means taking sensible precautions when exposed to heat, cold, potential injury or chemicals.

Always wear:

- Long pants
- Work shirt with sleeves
- Sturdy closed toe footwear (safety boots with a composite or steel toe may be required if vehicles, equipment, heavy lifts, or other foot hazards are expected)

Never wear:

- Shorts
- Tank tops
- Open-toed shoes

Skin is also at risk for exposure to biological hazards – like plants, animals and bloodborne pathogens – and environmental hazards like the sun and thermal exposures. The following are general guidelines for skin protection:

- Research poisonous plants, insects and animals potentially found at the site and dress appropriately. Refer to the SWP, [Dangerous Plants and Animals](#) for additional information on poisonous plants, insects and animals.
- Work in open areas free of vegetation as much as possible.
- Wear sunscreen and sun protective clothing.
- Dress appropriately in layers during cold weather.
- Wear light coloured, loose and breathable clothing during warm weather.
- Refer to the SWP, [Heat and Cold Stress](#), for additional information on thermal stresses.

Some sites may require that long-sleeved shirts, high-visibility vests and steel-toed shoes be worn by all workers on site. High-visibility clothing or vests are required whenever work will be conducted in and around forklifts, other heavy equipment or vehicular traffic. Employees that visit refineries may also need to don fire-resistant or fire-retardant clothing or coveralls.

6.4.2 Head protection

To protect workers where there is a possible danger of head injury from impact by falling or flying objects, or electrical shocks and burns, head protection must be worn. Typical areas with falling object exposure include construction, demolition and remediation work at field sites and industrial facilities. Generally, hard hats can protect against three types of hazards:

1. Falling or flying objects
2. Head bumps (on structures overhead)
3. Electricity

It is important to make sure the hard hat is appropriate for the potential hazards at the site. Hard hats must protect against impact on the crown and sides of the head and, if there is a potential for electrical exposure, the hard hat must be certified to the appropriate electrical class. Information about the certification can be found inside the hat on a label. If information is not provided on the

hard hat, employees may not use the hard hat for project work. Additional country-specific guidance is included in [Section 10](#).

Requirements for hard hats include:

- Markings on the product shall include the name or identification of the manufacturer, date of manufacturing, standard designation and head size range.
- User information shall include the manufacturer's instructions, application and expected useful life, care and adjustment instructions.
- Users shall visually inspect their hard hats prior to each use per the manufacturer's recommendation. If a hard hat becomes brittle, cracked or damaged, it shall be replaced immediately. Painting on hard hats is prohibited. Suspensions and shells shall be replaced per the manufacturer's recommendation.
- Metal hard hats and cowboy-style hard hats shall not be worn by employees. If used by a subcontractor, they are subject to additional review to ensure they meet client and regulatory requirements.

6.4.2.1 Proper fit and maintenance

The hard hat must be worn properly, and it must be in good condition:

- Inspect the hard hat prior to and after each use.
- Wear the hard hat square on the head, not tipped forward or to either side.
- Hard hats may be worn backwards when the hard hat is designed to be turned backwards and when required by the risk assessment. When hard hats are worn backwards, the inner hard hat band shall be installed correctly, which requires removing, turning and reinstalling the band per the manufacturer directions.
- Never alter or modify the shell or suspension system.
- Do not use paints, solvents, chemicals, adhesives, gasoline or similar substances on the hard hat.
- Do not store the hard hat in direct sunlight.
- The hard hat shell should not touch the head - the suspension system should hold the shell about 1 in/2.5 cm away from the head.
- The suspension system should provide adjustability for a secure fit. Users must be able to bend over and move freely without the hard hat shifting.
- Do not wear a hard hat over another hat like a baseball cap or skull cap. Use an appropriate hard-hat liner for cold weather (thermal liner) and hot weather (absorptive liner). Refer to the manufacturer's instructions to determine what is acceptable under the hard hat.
- Avoid dropping or throwing the hard hat. Impact weakens the protective material.
- Inspect the suspension system for signs of deterioration (e.g., cracking, tearing, fraying, no longer holds the shell away from the head, etc.).

- Inspect the brim or shell for signs of exposure to heat, cold or chemicals (e.g., loss of surface gloss, chalking, flaking, cracks or deformities, etc.).

If any signs of damage or deterioration are identified during inspections, the employee must dispose of the hard hat and obtain a new one. If the hard hat has taken a heavy blow, it should also be replaced, even if no damage is visible. Employees are prohibited from putting stickers on their hard hats unless required by the client. Stickers can obscure signs of damage and wear. Adhesives for the sticker may also damage the hard hat shell.

At a minimum, follow the manufacturer's recommendations for replacing the hard hat. Review regulatory or client requirements in the region for guidelines. In general, the following replacement schedule is recommended:

- Replace the hard hat every five years.
- Replace the suspension every three years.

The replacement schedule applies even if there is no visible evidence of damage or wear. If the employee is working under conditions of intense light or heat, the hard hat should be replaced more frequently.

6.4.3 Eye protection

Work scenarios where eye protection should be worn include, but are not limited to, working with chemicals, around flying objects, in industrial environments, on construction sites, in windy environments or whenever there is a chance of an eye injury. Eye protection is also required when workers may be exposed to extreme heat or intense light. The protective eyewear provided must meet regional- or country-specific safety standards. Additional country-specific guidance is included in [Section 10](#).

The most common types of eye and face protection used by employees include:

- Safety glasses with side shields (clear or shaded lenses)
- Goggles
- Face shields

Specialty eye protection may be required to protect against welding arcs or non-ionizing radiation.

6.4.3.1 Safety glasses

Safety glasses with side shields provide minimum protection and are the most common eye protection used for general working conditions where there may be minor dust, chips or flying particles. The side shields provide angular protection from impact hazards in addition to frontal protection. Glasses may have side shields that fold flat, also known as semi-side shields, or may have full or cup-style side shields. Safety glasses with side shields do not provide the same level of splash or droplet protection as goggles. Some safety glasses have foam or rubber liners to reduce the potential for dust or particles to reach the eye. While useful for dusty or windy environments, these lined safety glasses are also not a substitute for goggles when there is a potential for splashes or droplets.

Safety glasses may also be used to protect against heat and optical radiation that includes visible and near visible light or radiation. Ensure that the safety glasses will provide protection against the hazards identified at the site.

The frames of safety glasses must fit comfortably and correctly to offer the necessary protection. There are different styles available that may be either fixed or adjustable, including:

- Spatula temples, which fit over the ear
- Cable temples, which fit around the back of the ear
- Headband temples, which consist of an elastic strap and are useful for tasks requiring movement

6.4.3.2 Safety goggles

The frames of safety goggles must be properly fitted to the worker's face to form a protective seal around the eyes and are most effective when they fit snugly, particularly from the corners of the eye across the brow. There are different styles available, including:

- Eyecup safety goggles cover the eye sockets completely and are available with direct or indirect ventilation
- Cover safety goggles may be worn over corrective glasses and are available in direct, indirect or non-ventilated types

Ensure that the type of ventilation, direct, indirect or non-ventilated, for the selected goggles is suitable to the potential hazards at the job site. Ventilation helps reduce fogging and improves visibility through the goggle. Ventilated goggles may not be appropriate for use in high-risk or chemical exposure scenarios since the ventilation may allow chemical splash to reach the eyes.

6.4.3.3 Face shield

As opposed to safety glasses or goggles, a face shield can also provide protection to other facial areas and should be used for high-impact, full-face protection. Face shields may be needed when there is exposure to splashing, spraying, chipping and grinding.

Face shields are categorised within the low PPE level. While there may be some appropriate uses of a face shield at medium-risk work environments, medium-risk projects may warrant a re-examination of the project safety plan and assignment of the high-risk category and safety planning documents. Face shields are more commonly used in high-risk work environments.

Face shields should be used in addition to safety glasses or goggles, not as a substitute for them. Face shields provide secondary protection, while safety glasses or goggles provide primary eye protection. Always wear safety glasses or goggles under face shields to provide protection when the shield is lifted. Primary protection helps prevent particles that get under the shield from lodging into the eyes. To provide better face and eye protection from splashes and sprays, a face shield should have crown and chin protection and wrap around the face to the point of the ear, which reduces the likelihood that during higher-risk activities a splash could go around the edge of the shield and reach the eyes.

6.4.3.4 Safety sunglasses

The sun releases energy, or radiation, in many forms. Ultraviolet (UV) rays are invisible to the eye and can damage the eyes. When wearing safety sunglasses or tinted safety glasses, the lenses should:

- Reduce glare
- Filter out 99-100% of UV rays
- Physically protect the eyes from impact
- Not distort colours

Tinted safety glasses may not be appropriate for use indoors or in darker environments, where they may impair visibility. Clear lenses should be worn when lighting is dim or poor or when documenting colour observations is part of the scope of work.

6.4.3.5 Proper eyewear fit and maintenance

Manufacturers make several different sizes of eye and face protection. To ensure a proper and comfortable fit of protective eyewear, follow these guidelines:

- Safety glasses and other safety eyewear should be comfortable when worn, which will increase the chances that they will be used.
- Safety glasses have a three-point fit, meaning the frame should touch the face in three places: at the nose bridge and behind each ear.
- The nose piece should not slide down the face due to sweat or moisture. If the glasses slide down even a small amount, adequate protection may be reduced.
- Goggles and respirators should fit the face snugly to create a proper seal against dust and chemicals.

The eye protection that we have described in this SWP is generally not disposable and should be cleaned before reuse. Eye protection should be cleaned with a disinfectant, rinsed and allowed to air dry in between uses or whenever it becomes soiled. After disinfecting eyewear, place the dry parts or items in a clean, dust-proof container, such as a box or bag, to protect them until reuse. If there is evidence of damage (or if eye protection cannot be cleaned), obtain a replacement pair.

6.4.3.6 Prescription eyewear

Prescription eyeglasses designed for ordinary wear do not protect against workplace hazards, even when equipped with removable side shields. Many non-prescription safety glasses or safety goggles fit comfortably over prescription eyewear and can provide satisfactory protection without impairing the fit of the eyewear.

Contact lenses may be worn with any of the recommended protective eyewear; however, contact lenses may present a significant corneal abrasion risk when working in dusty areas unless tight fitting goggles or a full-face respirator is worn. Contact lens wearers must comply with the site-specific project safety plan as well as rules at job sites where contact lenses may be restricted.

Prescription safety glasses and goggles are also available, as are prescription inserts for full-face respirators. Resources for obtaining prescription safety eyewear vary by country, region and business unit. Employees may be provided with access to an authorised vendor or may participate in a reimbursement programme. More information on these programmes is provided by visiting the [Health & Safety](#) page of Rambla and accessing the local H&S information page for the country or region.

6.4.4 Hearing protection

Hearing protection should be worn by all employees working within an area where noise is sufficient to interfere with general conversation at a normal speaking volume, when noise levels exceed 85 decibels (dBA) and/or when client requirements indicate that its usage is mandatory. When hearing protection is required, multiple forms of hearing protection (e.g., ear plugs, earmuffs) can be used. Hearing protection provided must meet regional- or country-specific safety standards. Additional country-specific guidance is included in [Section 10](#).

A variety of hearing protectors will be available (plugs and muffs) to employees exposed to an 8-hour time weighted average (TWA) of 85 decibels, A-weighted or greater. Hearing protection does not have fitting requirements except that employees are encouraged to wear the type or hearing protector they find most comfortable unless a task-specific work instruction requires use of specific hearing protectors.

- Formable plugs should be rolled and compressed into a very thin cylinder. While compressed, insert the plug well into the ear canal. Reach around the head to pull the ear outward and upward during insertion.
- Pre-moulded or pre-formed plugs should be inserted by reaching around the back of the head to pull the ear outward and upward while inserting the plug until it feels like it is sealed.
- Earmuffs must fully enclose the ears to seal against the head. Adjust the headband so the cushions exert even pressure around the ears. Pull hair back and out from beneath the cushions.
- The fit of ear plugs can be checked by pressing firmly cupped hands over the ears while listening to a steady noise. With properly fitted plugs the noise levels should be about the same when the ears are covered or not covered.

Keep formable plugs and earmuff cushions clean and free from material that can irritate the ear canal. Formable plugs and earmuff cushions may be washed in a mild detergent and warm water. Squeeze excess water from the plugs and air dry. Discard plugs if they harden, do not return to their original size and shape or are dirty. Earmuff cushions should be replaced whenever they become stiff, cracked or do not create an effective seal.

6.4.5 Foot protection

There is a basic minimum standard for shoes appropriate for wear in non-office settings – a sturdy shoe with low heels and non-skid soles. Consider shoes with ankle support if walking over uneven ground or in an area where slips, trips and falls may occur. Sandals and gym shoes are not allowed.

Protective footwear, with steel or composite safety toes, will be required for employees visiting hazardous work sites, industrial facilities and construction sites. In some cases, metatarsal guards may also be required. Refer to site- or client-specific requirements regarding composite toe boots.

Protective footwear should be worn to mitigate the potential hazards listed below and whenever required by a client at the job site.

- Impact from heavy objects falling
- Slips on slick surfaces
- Trip hazards
- Compression from heavy rolling objects (e.g., wheels, drums or barrels)
- Puncture from sharp objects (e.g., nails, wire, tacks, screws or staples)
- Chemicals or environmental contaminants
- Electricity

The certification or rating of the safety shoe must be attached to one of the shoes, normally on the “tongue” and will tell the wearer the type and level of protection provided. Foot protection provided must meet regional- or country-specific safety standards. Additional country-specific guidance is included in [Section 10](#).

6.4.5.1 Footwear maintenance

Safety shoes should be cleaned after every use. Remove dust and dirt from the shoes with a soft cloth and stiff brush while still on the project site. Do not wear safety shoes off the project site if there is a potential to track contaminants into a vehicle, a residence or onto another client’s site. Use a mild soap and water to clean the uppers and soles, if necessary. If the contamination is potentially hazardous, the water used for decontamination should be collected and properly disposed. If a difficult decontamination is anticipated, disposable boot covers should be used.

Inspect the footwear for:

- Cracks, tears, wearing or holes
- Loss of tread
- Separation between soles and uppers

In general, damaged footwear should be replaced. However, for worn treads some brands of footwear can be re-soled. Safety shoes should only be re-soled by the manufacturer or manufacturer’s designated representative to ensure that the safety properties of the shoe will remain intact.

Regular maintenance will help the boots break in and last longer. If wearing leather boots, it is recommended that the leather is periodically conditioned with oil or other manufacturer recommended solution to reduce cracking.

6.4.6 General hand protection

Hand protection may need to be used in any work environment. Even when working in low-risk work environments (offices) and medium-risk work environments (facility sites visits or audits), employees may encounter hazards that could cause hand injuries, such as those shown here:

- Abrasions resulting from lifting heavy objects

- Abrasions resulting from a slip, trip, or fall on uneven or sharp surfaces
- Laceration from using a cutting tool to open packaging
- Exposure to biohazards such as blood
- Heat and cold injuries

In high-risk work environments, hazards may include the following, requiring additional or alternative hand protection that will be discussed further in the next section ([Section 6.5](#)).

- Chemical exposure
- Vibration, such as from using power tools or equipment
- Lacerations, such as from using powered or hand tools
- Electric shock

The HSS department or local HSSC can provide guidance on the proper gloves to wear to mitigate identified hazards and risks at job sites. Employees working in low-risk work environments should wear gloves primarily to protect against physical hazards such as abrasions during lifting or related to cold temperatures. In medium-risk work environments and high-risk work environments, glove requirements may include cut-resistant, puncture-resistant or chemical-resistant gloves.

6.4.7 High-visibility clothing

High-visibility clothing including vests are required for all work areas in or near roadways. Vests are also frequently required for construction, demolition and remediation work areas depending on site-specific requirements. The type, colour, level of reflection and configuration of materials on a high visibility vest is dependent on the type of activity, the site conditions and the local regulatory authority. High-visibility clothing should be inspected for damage and evaluated for required visibility. Items should be replaced or repaired when they are torn, noticeably faded, soiled, cracked, burned, heavily abraded or otherwise damaged. Additional country-specific guidance is included in [Section 10](#), where available.

6.5 Medium- and high-level PPE

This section discusses PPE in the medium-level and high-level categories. The information in this section applies to high-risk work environments and activities, including work at hazardous waste and heavy industrial sites, as well as project sites requiring sampling and potential exposure to chemicals. This section will cover the following:

- Skin and body protection
- Respiratory protection
- Hand protection
- Specialised eye and face protection
- Electrical protection
- Personal flotation devices

- Fall protection
- PPE matrix

Depending on the job site and potential hazards, employees may be required to wear outer coveralls, chemical-resistant or protective suits, or fire-resistant or -retardant clothing. To have a better understanding of the hazards at a site, information must be obtained about the site during pre-project planning. Methods include:

- Discuss potential hazards with the site contact.
- Conduct a preliminary site walk-through.
- Review previous reports.
- Discuss with employees who have previously visited the site.

The selection of the appropriate protective coveralls, hand protection and respiratory protection will depend on the potential chemicals of concern identified at the project site. Employees should base PPE selection on safety data sheets (SDS) for identified chemicals and local regulatory guidance. Contact the local HSSC or the HSS department for assistance. SDSs for potential chemicals of concern must be included in a project-specific safety plan.

6.5.1 Protective coveralls

Dust coveralls are to be used when there is a risk of airborne contamination, such as when drilling soil or rock or cutting concrete, or when working on an asbestos abatement project. These coveralls may be reusable or disposable. The project safety plan should identify whether reusable, that is washable, coveralls should be used, or if the coveralls should be dedicated to the site and disposed after use. The SSR should consider the type of contaminants anticipated at the site when making this determination. Dust coveralls should not be used if there is a risk of exposure to chemicals via splashing. Review the manufacturer's label for protection information to ensure the coveralls are appropriate for the potential hazards anticipated at the site.

Chemically resistant coveralls should be used when there is a splash risk based on the scope of work and the chemicals of concern are present at unknown concentrations or at known concentrations that present a risk when exposed to skin directly or via damp work clothing. Chemically protective coveralls may also be warranted when there is a risk of skin exposure to chemical vapours. Types of coveralls below are listed at increasingly protective levels:

- Splash resistant
- Chemically protective
- Chemically protective with hood
- Chemically protective with hood and boot covers

The factors shown here will help determine what material is appropriate for the chemically protective coveralls. This material compatibility information also applies to glove selection discussed in Section 6.6.4. An evaluation of the PPE material should be available from the manufacturer and should be considered when selecting PPE during project safety plan preparation.

- Permeation

- Amount of chemical that passes through the material over a specified duration
- May not be noticeable without a microscope
- Breakthrough time
- Amount of time it takes a chemical to break through
- Degradation
- Changing the physical property due to chemical interaction
- Penetration
- Large flow of any chemical through protective barrier

As the required PPE level rises from medium to high risk, due to potential exposure to increasingly hazardous chemicals, respiratory protection may also be required to protect against inhalation hazards. The PM/PO should consider engineering controls and administrative controls, such as training and work schedule management, first before considering appropriate PPE. Work and rest schedules should be outlined in the project safety plan, discussed at least daily at the site and documented in the field notebook.

6.5.2 Flame-resistant clothing

Many employees work at client sites, like oil and gas facilities, where flame resistant or retardant clothing (FRC) may be required. Determine the client and site requirements before purchasing flame-resistant clothing. If 100% cotton coveralls are not required, the HSS department recommends Nomex® coveralls. Cotton coveralls are less costly but are very heavy and potentially present a heat stress hazard. When using Nomex® in cold environments, purchase a larger size and layer appropriately underneath.

The use of FRC shall be on a site-by-site basis and shall be determined by risk assessment and shall be included in the project safety plan for the site. An employee or site supervisor may identify a site-specific job and/or area requiring FRC such as when there is potential exposure to flash or arc burn injuries (i.e., electrical circuit). FRC may be required when working at a production facility with hydrocarbon-containing equipment.

FRC garments shall comply with the requirements below:

- Fabric Weight: FRC material shall not weigh less than 4 oz./yd² (150 g/m²)
- FRC materials shall comply with National Fire Protection Association (NFPA) 2112, Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire and tested to ASTM F1930, Standard Test Method for Evaluation of Flame-Resistant Clothing for Protection Against Flash Fire Simulations Using an Instrumented Manikin, or equivalent standard

Reflective stripes shall conform to the International Safety Equipment Association (ISEA) 107, Level 2, American National Standard for High Visibility Safety Products and Headwear, as applicable.

FRC shall be worn and maintained accordingly:

- Team members shall wear FRC as the outer-most garments except when other protective clothing is required (e.g., chemical-resistant suits, welder's leather and PFDs).

- External protective garments shall be made of flame-retardant material.
- Team members shall not wear synthetic blends such as nylon, polyester, rayon or polyethylene under FRC - only natural fibres such as cottons and wools shall be worn under FRCs.
- Only long-sleeved FRCs shall be worn in designated FRC areas or jobs - FRC shall cover the torso, arms and legs (sleeves rolled down and body fully zipped or buttoned up).
- FRC shall be laundered, repaired and taken out of service per the manufacturer's recommendations.

6.5.3 Respiratory protection

The respiratory protection programme is covered under the [Respiratory Protection](#) SWP and includes the following programme elements:

- Procedures for selecting respirators for use in the workplace
- Medical evaluations of employees required to use respirators
- Fit testing procedures for tight-fitting respirators
- Procedures for proper use of respirators in foreseeable emergency situations
- Procedures and schedules for donning, cleaning, disinfecting, storing, inspecting, repairing, discarding and otherwise maintaining respirators
- Procedures to ensure adequate air quality, quantity and flow of breathing air for atmosphere-supplying respirators
- Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations

6.5.4 Hand protection

6.5.4.1 Chemical protection

Proper glove selection for chemical protection should consider the glove's resistance to:

- Chemical degradation
- A chemical penetrating the glove through pinholes, seams or other imperfections
- A chemical flowing through the glove on a molecular level through absorption or diffusion

After the potential chemicals of concern are identified for the project site, review the chemical SDS and use this information to determine the compatibility of the glove with the chemicals of concern. Glove manufacturers may offer guidance glove selection based on the chemical of concern.

Always change gloves if degradation is visible, or if the glove is punctured or torn. Even if the gloves are not visibly deteriorated, they may need to be changed between each sample to avoid cross-contamination.

In addition to chemically protective gloves, employees may need physically protective gloves to protect from vibration, abrasions, lacerations, or other site-specific hazards identified. Physically protective gloves may be made of leather, heavy canvas, various synthetics, or cut-resistant

material. The SSR, local HSSC, or HSS department can provide guidance on the proper protective gloves when preparing the site-specific project safety plan.

6.5.4.2 Cut-resistant gloves

Ramboll prefers that safety knives (e.g., self-retracting blade), scissors, shears or safety cutters be used instead of fixed blade knives, razor knives or box cutters. If the use of a cutting device is required for a certain task, the safest device available that meets the needs of the job should be used.

In the event a fixed blade knife is the only tool that will perform a specified task, the worker shall justify its use in an approved job safety analysis (JSA) or other safe work procedure that provides justification that a razor or fixed blade knife is the only tool suitable for a given task and specifies the use of cut resistant gloves and sleeves (ANSI cut level A5 or greater or equivalent) as well as forearm sleeves (e.g., Kevlar®).



6.5.5 Specialised eye and face protection

The following sections describe eye and face protection for specific activities.

6.5.5.1 Welding goggles and face shields

Electromagnetic energy given off by an arc or flame can injure workers' eyes and is commonly referred to as radiant energy or light radiation. For protection from radiant energy, workers must use PPE, such as safety glasses, goggles, welding helmets, or welding face shields. This equipment must have filter lenses with a certain shade that provides the appropriate level of protection.

- Safety glasses with side shields worn under a welding helmet with a proper lens tint for the type of welding conducted. Refer to the Lens Shade Table in Section 10, Additional Information of the [Hot Work – Welding and Cutting SWP](#).
- Other workers who are not welding but in the immediate area to support welding must wear tinted safety glasses (face shield not required).

6.5.5.2 Laser work

Employees may encounter lasers during fieldwork. Refer to the [Radiation](#) SWP for information on laser work PPE.

6.5.6 Electrical protection

Refer to the [Electrical Safety – Arc Flash](#) SWP for information on electrical safety PPE.

6.5.7 Personal flotation devices

Personal floatation devices (PFDs) provide an individual buoyancy to stay afloat in water. There are several different types and ratings of PFDs depending on the application and water conditions. In general, PFDs must be a high visibility colour; properly sized and fitted to the individual (as applicable); applicable to the type of work and water conditions; and be approved by the local regulatory authority.

PFDs should be fitted with a Safety of Life at Sea (SOLAS) Convention-compliant whistle or noise making device. Prior to each use, the user shall examine PFDs for deterioration or damage that might affect their strength and buoyancy. Defective PFDs shall be removed from service and either repaired or replaced. Additional information on PFDs is provided in the [Water Work - Inland, Near Shore and Facility SWP](#).

6.5.8 Fall protection

Fall arrest equipment shall be suitable for the planned tasks, used only by medically suitable and competent persons and subject to documented regular inspection. Fall arrest equipment shall be used only as a last resort due to the difficulty of a timely rescue. In addition to regularly planned inspections, all fall arrest equipment shall be checked by the user immediately before use. If it is damaged, the equipment should immediately be labelled as faulty and taken out of use. New fall arrest equipment shall be provided before the work task commences. Refer to the SWP, [Work from Heights – Fall Prevention and Protection](#) for additional information on fall protection including harnesses, lanyards, fall arrestors and anchoring devices.

6.6 PPE and safety equipment matrix

PPE and safety equipment requirements will vary by project site. Each project is risk-assessed in a site-specific project safety plan. PPE and safety equipment selection for each task is based on that risk assessment. The project safety plan should outline the necessary PPE needed for a particular task and should include items such as, hard hats, face shields, safety goggles, glasses, hearing protection, foot guards and gloves. Minimum requirements for typical job tasks are provided in the example PPE and safety equipment matrix (Attachment A). Tasks and requirements shown in the matrix should be customised for the site-specific project safety plan to ensure that they are adequately protective. The PPE and safety equipment matrix allows for the addition of specialised equipment (including communication equipment) and/or clothing for use in particular hazard situations, which are risk assessed and chosen prior to work commencing.

6.7 Donning and doffing

Employees must become familiar with how to properly don and doff PPE, which means to put on and take off the PPE. This is particularly important when wearing multiple items of PPE. For PPE to function properly, the following steps must be completed:

- Ensure that the proper PPE is selected and obtained for the job.
- Inspect PPE for damage, tears or other deterioration before use.
- Start with the base layer and inner gloves, adding additional items of PPE as specified in the project safety plan.

- If coveralls are required to protect skin from atmospheric hazards or splashes, use appropriate tape and cut lengths suitable for wrapping around the waist, ankles and wrists before getting dressed. Use care not to restrict circulation in the hands or feet. Form a tab of tape and leave the tab exposed to simplify removing the tape while doffing.

When doffing PPE, reverse the steps taken when donning PPE. For proper glove doffing, refer to [Section 10.2](#). Depending on the hazards at the site, a decontamination process may also be required. Dispose of all disposable PPE as indicated in the project safety plan and clean all reusable PPE (e.g., safety glasses; boots) after each workday or shift.

6.8 PPE-related hazards

PPE mitigates a hazard, but also presents a potential risk. PPE can change an individual's movement and body temperature. Employees need to be fit for duty and aware of the surroundings, especially when wearing PPE. Any changes in PPE, even voluntary upgrades, should be discussed with the SSR or PM/PO to ensure that this change does not present additional hazards (e.g., heat stress). Additional information is provided in the HSSP, [Medical Surveillance and Fitness for Duty](#) and the SWPs, [Respiratory Protection](#) and [Heat and Cold Stress](#).

6.9 Provision and maintenance of PPE

Ramboll will provide project-specific and general overhead PPE to employees. Employees issued PPE are responsible for the equipment in their possession and for properly donning, doffing, maintaining and cleaning PPE. Each office or project should maintain enough PPE supplies to accommodate the level of field activity for the office or project. All expense associated with PPE must be approved in advance by the PM/PO, local HSSC or designee. Defective or damaged PPE must not be used and the maintenance of defective or damaged PPE will only be conducted by authorised manufacturer's representatives.

Resources for purchase and distribution of PPE and other safety equipment vary by country, region and business unit. For example, in the Americas, a [PPE and Safety Equipment](#) resource page is established as part of the [Americas HSS](#) Rambla page. This resource includes a vendor-supported [PPE Portal](#), including available branded items and commonly used or requested items, and is enabled to allow ordering and shipping of approved items by US employees and project teams. [Additional instructions](#) for Americas employees to access the PPE Portal are posted on Rambla. To inquire about PPE ordering in your region, contact the local HSSC, Safety Ambassador or a representative of the HSS department.

7. TRAINING & COMPETENCY

The HSS training programme includes new employee induction training, supervised on-the-job training and annual completion of online modules or classroom instruction related to safety requirements and work practices. Training assignments vary based on employee roles and training classification. Completion of assigned training will be documented by a training completion certificate, which will be stored in the employee's electronic training record.

7.1 Training requirements specific to PPE and safety equipment

Employees shall be adequately trained in the PPE programme and proper use of PPE and other equipment through online HSS training modules, in-person training, or virtual instructor-led training. Employees must be trained in and demonstrate knowledge of the following:

- When and where the PPE or equipment is required
- The type of PPE or equipment required
- How to properly wear the PPE or equipment, including donning and doffing
- Limitations of the PPE or equipment
- Care, maintenance, useful life and disposal of PPE and equipment
- Retraining will be administered when the following situations occur (at a minimum):
 - Changes in the workplace or the type of PPE render previous training obsolete
 - Inadequacies in the employee's knowledge or use of the PPE indicate that the employees have not retained the requisite understanding or skill; or any other situation arises in which retraining appears necessary to ensure safe respirator use

8. DOCUMENTATION

The following documentation is required, specific to PPE and Safety Equipment. These requirements may vary by country, region or business unit.

8.1 Medical surveillance questionnaire

The medical surveillance questionnaire is completed annually as part of Ramboll's medical surveillance programme. Any previous known or suspected chemical exposures above action levels (after accounting for respirator use) should be documented on the employee's medical surveillance questionnaire. Refer to the HSSP, [Medical Surveillance and Fitness for Duty](#).

8.2 Medical and respirator clearance certificate ("fit for duty")

This record is maintained by Human Resources and the HSS department, or in some regions may be maintained by the local HSSC or Safety Ambassador. Medical clearance documentation must also be obtained from any subcontractors who will be wearing respirators on projects and will be maintained in project records. Refer to the HSSP, [Medical Surveillance and Fitness for Duty](#) and the SWP, [Respiratory Protection](#).

8.3 Annual respirator training certificate

Annual respirator training may be required for persons who wear a respirator in work areas that are potentially above local regulatory occupational exposure limits (OEL). Training records are maintained and documented through an online training platform (e.g., Ramboll Academy or equivalent). Refer to the HSSP, [Training Programme](#) and the SWP, [Respiratory Protection](#)

8.4 Annual fit test

This test is required for all persons who wear a respirator in work areas that are potentially above local regulatory OELs. Record is maintained by Human Resources. Qualitative and quantitative fit tests must be documented on a Respirator Assignment and Fit Testing Form (see [HSS Forms Library](#)) unless the fit test was administered during the medical exam or by another outside contractor or vendor. Fit test documentation from Ramboll's Medical Consultant or a third party must meet

requirements under local or regional occupational safety and health regulations. Refer to the SWPs, [Respiratory Protection](#) and [Hazardous Waste Operations and Response](#).

8.5 Voluntary usage of respirator acknowledgement

All persons who elect to wear a respirator when not otherwise required, for example to control nuisance odour, and/or as a precaution when airborne contaminant levels are below occupational exposure limits established under local or regional regulations, must read and understand important information presented in the Voluntary Usage of Respirator Acknowledgement (available in the [HSS document library](#)) and must be medically fit to wear the respirator. Documentation signifying completion of this review will be stored as part of the employee's training record in Ramboll Academy or equivalent training management system.

9. INTERNATIONAL TILTS

9.1 Asia / Pacific

9.2 Brazil

9.3 Canada

CAN/CSA – Z195-02 Protective Footwear. A national standard of Canada approved in March 2003. The CSA Standard Z195, Protective Footwear, covers the design and performance requirements for protective footwear.

<https://www.ccohs.ca/oshanswers/prevention/ppe/footwear.html>

9.4 European Union (EU)

In accordance with **Regulation (EU) 2016/425**, all PPEs must be tested and marked to prove that it can meet the relevant protective standards.

All **eyewear** intended for use in the workplace must meet a core European standard EN ISO 66:2001.

The standard EN352 covers the basic requirements of hearing protection and defines the passive performance requirements. This includes the requirements for size, materials and construction. The EN 13819 includes the testing methods common to all types of hearing protectors covered by EN 352 and the EN 458 covers selection, use, care and maintenance of hearing protectors.

High-visibility protective clothing must comply with EN ISO 20471, the European standard for high-visibility clothing.

The standard EN ISO 20345:2011 specifies basic and additional requirements for **safety footwear**. Footwear meeting this standard must bear the CE mark as **protective gloves**.

Many EN ISO standards exist for many different protective gloves. Gloves manufactured outside the EU may not be designed to comply with the EU PPE Directive. It's therefore important to verify the gloves are compliance with applicable and PPE Directive track record and related EN standards before placing the product on the EU market.



According to the definition of the European Commission, the **CE marking** is a “certification mark that indicates conformity with health, safety, and environmental protection standards for products sold within the European Economic Area (EEA)”. There are 25 CE Directives which affect a wide variety of products, which includes the Personal Protective Equipment (PPE). **The CE mark must be permanently affixed to the PPE** (it is not appropriate to put a sticker with the CE mark on the products).

9.5 Mexico

9.6 United Kingdom (UK)

9.7 United States (US)

American National Standards Institute (ANSI) Z89.1-2014, American National Standard for Industrial Head Protection

ANSI Z87.1-2020, American National Standard for Occupational and Educational Personal Eye and Face Protection Devices

ANSI 105-2016, American National Standard for Hand Protection Classification

ANSI/ISEA 107-2020, American National Standard for High-Visibility Safety Apparel

ASTM F2412, Standard Test Methods for Foot Protection

ASTM F2413-18, Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear

Occupational Safety and Health Administration (OSHA), 29 CFR 1910.133: Eye and face protection. <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.133>

OSHA, 29 CFR 1910.135: Head protection. <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.135>

OSHA, 29 CFR 1910.138: Hand protection. <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.138>

OSHA, 29 CFR 1910.136: Foot protection. <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.136>

OSHA (Construction), 29 CFR 1926.95: Criteria for personal protective equipment. <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.95>

OSHA (Construction), 29 CFR 1926.100: Head protection. <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.100>

OSHA (Construction), 29 CFR 1926.101: Hearing protection. <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.101>

OSHA (Construction), 29 CFR 1926.102: Eye and face protection. <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.102>

OSHA Personal Protective Equipment. Publication 3151-12R 2003. <https://www.osha.gov/sites/default/files/publications/osha3151.pdf>

U.S. Department of Transportation (USDOT) Federal Highway Administration. Manual on Uniform Traffic Control Devices (MUTCD). 2009 with Revisions 1 and 2 dated May 2012.

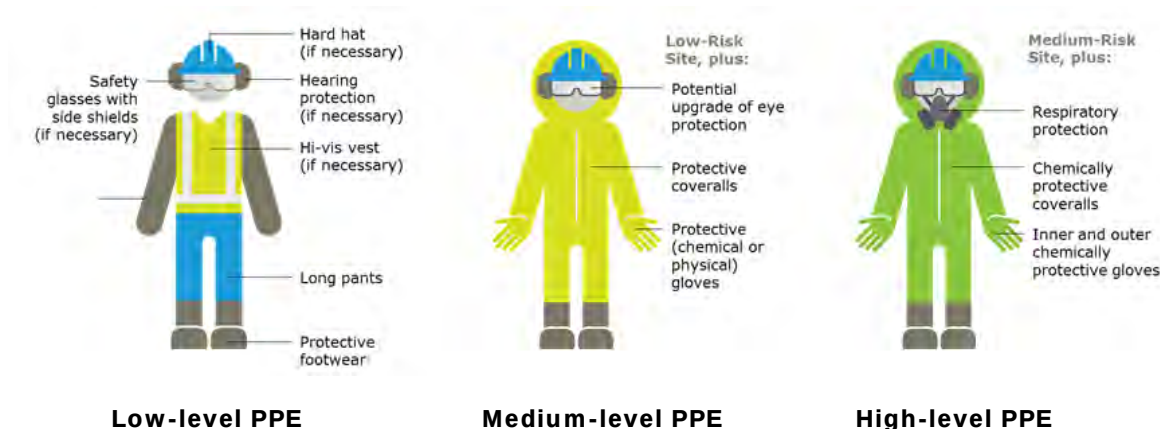
https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm

9.8 Other regions

SS513:2005 (ISO 20345:2004). The Singapore Standard was prepared by the Technical Committee on Personal Safety and Ergonomics under the supervision of the General Engineering and Safety Standards Committee. www.standards.org.sg

10. ADDITIONAL INFORMATION

10.1 Standard global PPE levels



10.2 Proper glove doffing



4. With your ungloved hand, peel off the second glove by inserting your fingers inside the glove at the top of your wrist.
5. Turn the second glove inside out while tilting it away from your body, leaving the first glove inside the second.
6. Dispose of the gloves following safe work procedures. Do not reuse the gloves.
7. Wash your hands thoroughly with soap and water as soon as possible after removing the gloves and before touching any objects or surfaces.



10.3 PPE guidance specific to the United States

In the US, OSHA defines the PPE levels as follows: low-level PPE is defined as Level D, medium-level PPE is defined as Level D Modified, and high-level PPE is defined as Levels C, B and A, becoming more protective in reverse alphabetical order.

Levels of PPE

The four levels of PPE are Levels A, B, C and D, with Level A providing the highest available level of respiratory, skin and eye protection. A summary of the basic PPE ensemble for Levels A, B, C and D is provided below. PPE selection will be tailored to address specific task conditions.

Level A

Level A PPE provides the maximum degree of respiratory, skin and eye protection. A Level A PPE ensemble should include:

- Full-face piece self-contained breathing apparatus (SCBA) or full-face piece supplied air respirator with escape SCBA
- Fully encapsulating, chemical-resistant suit, safety boots and inner gloves
- Hard hat (if overhead or bump hazards exist)

Level B

Level B PPE provides the maximum level of respiratory protection. Since chemical-resistant clothing is not considered gas, vapour, or particulate tight, Level B PPE does not provide the maximum skin protection. However, a good quality, hooded, chemical-resistant one-piece garment with taped wrists and ankles provides a reasonable degree of protection against splashes of liquids and lower concentrations of chemicals in ambient air. It is the minimum level recommended for confined space entries and initial Site entries until the hazards have been further identified. Level B PPE should be used when **any** one of the following criteria is met:

- The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection but less skin protection—this includes atmospheres with immediately dangerous to life or health (IDLH) concentrations of specific substances that do not represent a severe skin hazard or atmospheres that do not meet the criteria for use of air-purifying respirators.
- Atmosphere contains less than 19.5% oxygen.

- Presence of incompletely identified vapours or gases is indicated by air monitoring instruments but vapours and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.

Level C

Level C PPE provides the same level of skin protection as Level B PPE, but a lower level of respiratory protection. Air-purifying respirators can be used only if the substance has adequate warning properties; the individual passes a qualitative fit-test for the mask; an appropriate cartridge/canister is used and its service limit concentration is not exceeded; and site operations are not likely to generate unknown compounds or excessive concentrations of already identified substances. Level C PPE can be used when all the following conditions are met:

- Oxygen concentrations are not less than 19.5%.
- Atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin.
- Types of air contaminants have been identified, concentrations measured and a cartridge or canister is available that can remove the contaminant.
- Atmospheric contaminant concentrations do not exceed IDLH levels.
- Job functions do not require self-contained breathing apparatus (SCBAs).

Modified Level D

Modified Level D PPE provides minimal skin protection (i.e., hand/glove protection along with standard work clothes with optional coveralls) and no respiratory protection. Modified Level D PPE can be used when the following conditions are met:

- Atmosphere contains no known hazard.
- Oxygen concentrations are not less than 19.5%.
- Work functions include minimal contact with contaminated soil, water, groundwater and precludes splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

Level D

Level D PPE provides no skin protection other than standard work clothes and no respiratory protection. Work functions are limited non-hazardous environments and preclude contact with media that may be potentially contaminated at hazardous levels for any type of chemical.

10.3.1 Head protection

Hard hats shall meet the requirements as outlined below from American National Standards Institute (ANSI) Z89.1-2003, Standard for Industrial Protective Helmets. ANSI Z89.1 provides minimum performance requirements to reduce the forces of impact and penetration from falling objects and, where applicable, to provide protection from electrical shock hazards. Additional country-specific guidance may be used to supplement this guidance.

Headwear classification is categorised in terms of impact type and electrical class. All helmets shall meet requirements for impact Type I or Type II.

- Type I is for risk of impact to the crown of the head only. The standard kind of hard hat is called a Type I helmet, which provides protection for the top of the head.
- Type II is for impacts to the crown and sides of the head. Helmets that provide some degree of top and off-centre protection are called Type II helmets.

If there is the potential to be exposed to electrical current, the hard hat must meet the appropriate Electrical Class. Electrical Classes, G, E or C further categorise each Type (1 or 2).

- Class E to reduce danger from higher voltages and proof tested at 20,000 V
- Class G to reduce danger with lower voltages and be proof tested at 2,200 V
- Class C provides no protection against electrical current

10.3.2 Eye protection

All safety glasses will meet the ANSI Z87.1, "Practice for Occupational and Educational Eye and Face Protection." Additional standards apply to safety eyewear for specialised hazards like welding and lasers. Eye and face protection will meet the following requirements:

- Provide adequate protection against the particular hazards for which they were designed
- Reasonably comfortable when worn under the designated conditions
- Fit snugly and not unduly interfere with the movements of the wearer
- Durable
- Capable of being disinfected and easily cleanable
- Kept clean and in good repair

Face shields will also meet ANSI Z87.1 and must be worn for all tasks where there is a risk of chemical splash to the face and tasks that generate extensive flying debris such as grinding, welding, cutting, weed trimming and chainsaw use. Face shields must be worn in combination with safety glasses or goggles.

10.3.3 Hearing protection

The hearing protection will be evaluated for attenuation by the HSS department per 29 CFR 1910.95 Appendix B. The hearing protection must attenuate employee exposure at least to an eight-hour Time-Weighted Average (TWA) of 90 decibels, A-weighted.

10.3.4 Foot protection

Safety shoes or shoe coverings must meet the ASTM F2412/2413 standard. These standards use a safety rating label/code to identify the type and level of protection. For example:

ASTM F 2413-05

F / I / 75 C / 75

The first line indicates which performance standard the shoe manufacturer used for its safety tests. This shoe was tested under the American Society of Testing and Materials (ASTM) standard, a standard widely accepted internationally, ASTM F 2413-05, Standard Specification for Performance Requirements for Protective Footwear. Newer steel toed shoes may have the certification ASTM F 2412-11 Test Methods for Foot Protection.

The second line indicates whether the shoe is Male or Female. In this case, it is a female shoe, marked "F" and also indicates its Impact (I) and Compression (C) resistance/rating. These letters are followed by a number 75, which is the amount of force the shoe was tested to resist.

The third line identifies what other specific types of protection the footwear offers. In this case, Electrical Shock (EH) is noted. EH shoes are intended to provide protection for the wearer against hazards that may result from incidental contact with live electrical circuits, energised conductors, parts, or apparatus.

If the safety shoes are marked with ZN41, this references ANSI Z41, specific to the 1999 Protective Toe section (PT99). This protocol was replaced by the ASTM standards presented here. Contact the manufacturer of the shoe to ensure it meets the current protective standards for the region.

Other protection identifiers used for safety shoes are shown here.

- **Conductive (Cd):** protect the wearer against hazards that may result from static electricity build-up (transfers build up from body to ground).
- **Static Dissipative (SD):** protect the wearer against hazards that may result from very low and very high static electricity build-up.
- **Puncture resistant (PR):** has a puncture resistant plate between inner and outer soles capable of withstanding a minimum puncture resistance of 270 pounds.
- **Chain saw cut resistant (CS):** protect against chain saw cuts.
- **Dielectric insulation (DI):** provide additional insulation if accidental contact is made with energised conductors.

Although not technically part of the coding label, safety shoes can also have thermal insulation and be waterproof. Safety shoes can also come in different forms – rubber boots or waders – depending on the work condition requirements.

10.3.5 High-visibility clothing

The American National Standards Institute (ANSI) / International Safety Equipment Association (ISEA) 107 standard is an industry voluntary consensus standard for design and performance requirements for high-visibility safety apparel. This includes colour, reflection, physical properties, type and configuration of materials. This standard is codified into the Department of Transportation Federal Highway Administration (FHWA).

The standard establishes three primary types:

- Type O ("off-road")
- Type R ("roadway")
- Type P ("public safety")

Type O is defined as apparel that "provides daytime and nighttime visual conspicuity enhancement for workers in occupational environments which pose struck-by hazards from moving vehicles, equipment and machinery, but which will not include exposure to traffic on public access highway rights-of-way or roadway temporary traffic control (TTC) zones." Typical examples include workers in warehouses and refineries.

Type R "provides daytime and night-time visual conspicuity enhancement for workers in occupational environments which include exposure to traffic (vehicles using the highway for purposes of travel) from public access highway rights-of-way, or roadway TTC zones or from work vehicles and construction equipment within a roadway TTC zone." Typical examples include roadway construction workers, airport operations and other activity exposed to vehicles and moving equipment.

Type P apparel "provides daytime and night-time visual conspicuity enhancement for emergency and incident responders and law enforcement in occupational environments which include exposure to traffic (vehicles using the highway for purposes of travel) from public access highway rights-of-way, or roadway TTC zones, or from work vehicles and construction equipment within a roadway TTC zone or from equipment and vehicles within the activity area."

ANSI/ISEA 107 contains four performance classes:

- Performance Class 1
- Performance Class 2
- Performance Class 3
- Supplemental Class E

Each performance class has specific minimum design requirements regarding the background materials, retroreflective/combined performance materials and width of reflective materials used in the garments.

Performance Class 1 is the minimum amount of high-visibility materials to differentiate the wearer from non-complex work environments and is only appropriate for off-road (Type O) environments.

Performance Class 2 have higher amounts of high-visibility materials that allow for better definition of an individual. This class is considered the minimum level of protection for workers exposed to roadway rights-of-way and TTC zones, as required in the FHWA Manual on Uniform Traffic Control Devices (MUTCD).

Performance Class 3 has an even a greater minimum level of high-visibility material the apparel must contain. This class provides more visibility to the wearer in both complex backgrounds and through a full range of movement by the required placement of background, retroreflective and combined performance materials on the sleeves and pant legs (if present). A garment or vest without sleeves worn alone is not considered Class 3 protection.

Supplemental Class E is comprised of high-visibility garments such as pants, bib overalls, shorts and gaiters. These items do not qualify as meeting the requirements of the standard when worn alone, but when a Class E item is worn with a Performance Class 2 or Class 3 garment, the overall classification of the ensemble is Performance Class 3.

11. REVISION SUMMARY

ATTACHMENT A EXAMPLE PPE & SAFETY EQUIPMENT MATRIX

PPE requirements		Drilling operation	Sample collection	Working at heights	Working on / near water	Oil / gas facility
Low-risk level PPE	Hard hat	●	○	●	○	●
	Steel toe shoes	●	●	●	●	●
	Long sleeve / long pants	●	●	●	●	●
	Safety glasses w/ side shields	●	●	●	●	●
	Highly visible clothing	●	○	○	●	●
	Hearing protection	●	○	○	○	●
Medium-risk PPE levels (low risk + items shown)	Flame resistant clothing (FRC)	-	-	-	-	●
	Goggles	-	○	-	-	-
	Face shield	-	○	-	-	-
	Personal flotation device	-	-	-	●	-
	Fall protection	-	-	●	-	-
	Leather gloves	○	○	○	○	○
	Inner chemical gloves	-	●	-	○	○
High-risk PPE levels (medium-risk + items shown)	Outer disposable boots	-	○	-	-	○
	Tyvek suit	○	○	-	-	-
	Outer chemical gloves –	-	○	-	-	○
	Poly-coated Tyvek / Saranex suit					
	Full encapsulated chemical suit					
	Scba					
	Full-face airline Respirator					

PPE requirements		Drilling operation	Sample collection	Working at heights	Working on / near water	Oil / gas facility
	Full-face negative pressure Respirator					
	Half-face negative pressure Respirator					
	Powered air purifying respirator					
H&S supplies	First aid kit	●	●	●	●	●
	Fire extinguisher	○	-	-	○	○
	Mobile phones	○	○	○	●	○
	Walkie talkies				○	
	Water / fluid replenishment	●	●	●	●	●
	Eye wash	-	○	-	-	-
	Sunscreen	○	○	-	○	-
	Insect repellent	-	○	-	○	-
KEY						
-		Not required. If site conditions require, discuss with local HSC and/or H&S department				
○		Recommended				
●		Required				
		To be considered if site conditions require				

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VERSION

1.0

SAFE WORK PRACTICE

SUBSURFACE UTILITY

CLEARANCE

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ATTACHMENTS

Attachment A: SSC Project Planning Checklist

Attachment B: SSC Field Checklist

1. PURPOSE

The purpose of this Safe Work Practice (SWP) is to reduce the likelihood of Ramboll project teams (or our subcontractors) unintentionally contacting or damaging subsurface utilities. The SWP provides guidance and safe work practices for subsurface utility clearance. These practices are collectively and historically referred to within Ramboll using the acronym SSC, which stands for subsurface clearance.

Unintentionally contacting or damaging a subsurface utility may present an immediate danger to the life, health and safety of our employees, our contractors and the surrounding community. Subsurface utility incidents can also cause property damage, trigger financial and legal repercussions, and damage Ramboll's professional reputation. When utility hazards are identified and controlled prior to starting work, the risks associated with such hazards can be minimized.

2. SCOPE

This SWP applies to client facilities or other sites where Ramboll employees and/or subcontractors are performing intrusive work. Intrusive work is defined as any penetration of the soil or any other ground surfacing material (asphalt, concrete, etc.), whether using hand tools or mechanized equipment. Examples include digging test pits or exploratory trenches, excavations or grading for property development or soil remediation, boreholes advanced with hand tools or mechanized drilling equipment, gas spiking, remedial injections, installation of monitoring wells or soil vapor probes, horizontal or directional drilling, and any other on-site activity where penetration of the ground surface is required.

This SWP does not apply to clearance of overhead utility lines. Overhead line clearance safe work practices are discussed separately in Ramboll's SWP, [Overhead Utility Clearance](#).

3. OVERVIEW

This SWP outlines requirements for identifying and locating subsurface utilities before intrusive work to avoid unintentional contact or damage.

- **Public utility notification** is always required, using a utility notification and marking service where available.
- **Private utility clearance** is always required unless specific conditions are met.
- **Critical Zone** (5 feet/1.5 meters) represents the required radius for utility clearance.
- **Critical Clearance** activities will be required if a utility intersects the Critical Zone and the intrusive work cannot be moved.
- **Clearance Site Supervisor** is the Ramboll employee who is responsible to oversee and document utility clearance activities, including identifying historical resources (maps, plans or interviews) and conducting a visual search for surface utility indicators and markings.
- **Pre-Project SSC Planning Checklist** details responsibilities of the Clearance Site Supervisor during safety planning for an intrusive project.
- **SSC Field Checklist** details responsibilities of the Clearance Site Supervisor at the field site before intrusive work begins.
- **Variances** must be requested from the HSS department if deviating from SWP requirements.

- **Technical experts group** will be engaged to review variance applications.
- **Utilities strikes are reportable** and subject to investigation and corrective actions.
- **New to Legacy OBG** – New safe work practice. Utility clearance was previously included in the L-OBG Health and Safety Manual as part of excavation safety requirements.

4. RESPONSIBILITIES

4.1 Project Manager (PM) / Project Owner (PO)

- Define contractual and legal responsibilities associated with intrusive activities and underground utilities as early as possible (e.g., at the proposal stage) and before intrusive work begins.
- Request subsurface utility information or plans from the facility owner and assign qualified and experienced employees to review the information provided.
- Ensure adequate resources including project team members, budget and schedule to comply with requirements of this SWP.
- Assign responsibility for subsurface utility activities and intrusive work to trained and experienced employees.
- Direct the collaborative effort between the Clearance Site Supervisor and Site Safety Representative (SSR) to ensure the field team understands all subsurface utility hazards.
- Confirm that all documentation has been completed for each intrusive event (i.e., pre-project and field SSC checklists, public utility notification, utility plot plan, etc.).
- Support use of Stop Work Authority related to subsurface utility clearance or any other perceived hazard until such hazards are evaluated and controlled to the satisfaction of the project team and HSS department.

4.2 Site Safety Representative (SSR)

- Be present at the site to oversee the project or appoint another on-site Ramboll employee as a backup SSR (with approval from the PM).
- Ensure the project safety plan containing subsurface utility clearance information is reviewed with site team as part of their project safety orientation.
- Communicate project safety requirements to all employees and subcontractors and document safety meetings, unsafe acts or conditions, and corrective actions.
- Report any utility clearance difficulties, uncertainties or variance requests to the local or regional HSS representative.
- Inform PM/PO of important developments or questions regarding project and task safety.

4.3 Clearance site supervisor

- Be present at the site during utility clearance and marking, and/or provide supervision if utility clearance activities are conducted by several different individuals.
- Engage a private utility locating contractor and discuss the project scope to identify the appropriate utility locating methods and technologies.

- Complete the [SSC Pre-Planning Checklist](#) (Attachment A) including notification of public utility owners either individually or through the local utility marking service (e.g., “One-Call”; “Dig Safe”) and document responses from all notified utility owners.
- Complete the [SSC Field Checklist](#) (Attachment B) prior to beginning intrusive work.
- Support the SSR in reporting any utility clearance difficulties, uncertainties, or variance requests to the local or regional HSS representative.
- Authorize intrusive work ONLY when all utilities have been cleared within the Critical Zone or have been confirmed and cleared using soft-dig techniques.
- Recognize situations where overhead power lines may intrude into Ramboll’s work areas and evaluate in accordance with Ramboll’s SWP, [Overhead Utility Clearance](#).
- Stop work if there is a suspicion that utilities have not been properly identified or if an unsafe condition is identified or perceived.
- If utilities are discovered, contacted or damaged, coordinate emergency response and other response activities as defined in this SWP.

4.4 Ramboll Health, Safety and Security (HSS) department

- Support project safety plan development (when requested by the PM) including subsurface utility clearance and appropriate safety controls based on this SWP and site-specific concerns.
- Review and update this SWP on a biennial basis or more frequently if required.
- Review applications for variances and coordinate review by a technical experts group.
- Respond to variance applications in a timely manner, particularly if the need for a variance arises during intrusive work activities.
- Assist in variance-related dialogue between the project team and the technical experts group.
- Grant variance approval after the technical experts group has reached consensus between three or more members. The process for technical review may differ by country or region.
- Host quarterly meetings, or facilitate discussions on an as-needed basis, with technical experts group(s).

4.5 Health, Safety and Security Coordinator (HSSC)

- Promote awareness, understanding and use of this SWP by project team members.
- Facilitate application of this SWP in the context of local regulatory requirements and integration of this SWP into project safety plans.
- Inform the HSS department if this SWP does not adequately address local regulatory requirements.

4.6 Technical experts group(s)

- Support project teams with peer review of complex utility scenarios by reviewing requests for variances from Ramboll’s safe work practices, whether related to Critical Clearance (i.e., clearance of utilities within the Critical Zone) or to Recognized Utility Uncertainty, as defined in this SWP.
- Recommend additional utility clearance steps, technologies and controls for hazards and related liabilities.

- Consult with the HSS department as needed and participate in quarterly meetings with HSS leaders.
- In the US, this group is referred to as the SSC Area Experts Group. Technical experts groups and peer review processes may be named and/or defined differently by country or region.

4.7 Employees, subcontractors and visitors

- Comply with all requirements described in this SWP.
- Do not perform intrusive work without authorization from the PM, SSR and/or Clearance Site Supervisor.
- Review subsurface utility locations in relation to the planned intrusive work location.
- Stop work if there is a suspicion that utilities have not been properly identified or if an unsafe condition is identified or perceived.

Stop work if unknown utilities are discovered or damaged. Follow the response actions described in this SWP ([Section 10.1](#)).

5. KEY DEFINITIONS

5.1 Critical Zone (CZ)

An area of 5 feet/1.5 meters in all directions (horizontal and vertical) around the intrusive work activity.

- **Critical Clearance** – A term that refers to utility clearance methods and activities to safely perform manual clearance and/or establish the precise horizontal and vertical position of utilities within the Critical Zone ([Section 6.3](#)).
- **Reduced Critical Zone (RCZ)** – An area surrounding an intrusive work area that has been reduced (replacing the CZ) after completion of appropriate Critical Clearance activities. The size of the RCZ depends on utility type and the Utility Hazard Level ([Section 6.3.1](#)).

5.2 Electromagnetic and radiofrequency utility locating (EM)

This technology is used in many different types of pipe locating tools and is one of the most common methods to locate underground utilities. Tools include a signal generator (Genny) that generates an electromagnetic energy wave in the radio frequency. The signal can be directly or indirectly applied to utilities containing conductive materials ("active mode"). The generated frequency is detected using a signal receiver, or cable avoidance tool (CAT), which can also detect electromagnetic signals that are generated by most electrical utilities and some communications utilities ("passive mode"). This technology cannot locate plastic, asbestos, concrete, terracotta or non-ductile pipes unless conductive materials are embedded or introduced within the pipe, or a tracer wire is present. This technology is normally limited to depths of 10-15 feet and may be subject to interference from aboveground or belowground objects. A highly trained and experienced operator is needed to select appropriate methods and interpret results.

- **Sondes and Traceable Push Rods** – Sondes and traceable push rods can be inserted into an accessible utility and generate a signal that allows an experienced operator to trace utilities that may be otherwise non-locatable.

5.3 Ground Penetrating Radar (GPR) and related devices

GPR transmits waves of electromagnetic energy into the ground or other surface, which are deflected back up to the surface where a receiver generates and displays a subsurface profile for interpretation by the operator. This type of locating equipment is generally used for buried pipes, tanks, manholes, cables and other objects that cannot be located with other methods such as electromagnetic locating. GPR is significantly affected by site geology and has limited depth of penetration depending on the radio wave frequency that is used. GPR systems designed to locate underground pipes are typically mounted on a cart. A highly trained and experienced operator is needed to properly select the type of antenna and frequencies to apply.

- **GPR Concrete Scanner** - GPR systems designed to locate utilities and structural elements within a concrete slab are smaller and typically hand-held. Required for commercial or industrial slabs if there is potential for in-slab or sub-slab utilities or critical structural elements (i.e., utilities within or immediately beneath a concrete slab).
- **Acoustic Pipe Locator (APL)** - Acoustic location methods have historically been used to locate mostly water lines. With the recent introduction of new APL technologies, now even unmarked plastic pipe (or where tracer wire has broken), water and sewer laterals, or other types of utilities may be located. This instrument sends a series of acoustic waves ("pings") down into the earth and monitors the acoustic wave pattern to produce a subsurface image or profile. APL equipment may be used in soil, grass, concrete, gravel and asphalt. Similar to GPR, the detection depth is proportional to utility size and also depends on acoustic frequency.

5.4 Intrusive work

Any indentation, intrusion, excavation, grading, boring or other activity that penetrates into a surface (soil, asphalt, concrete, etc.), regardless of the depth, area or type of tool or equipment being used.

5.5 Soft dig methods

Methods to positively identify or provide clearance of subsurface utilities with minimal risk of damage to the utility. Typically involves air knife or hydro excavating in combination with vacuum excavation. In some situations, hand digging may qualify as a soft dig method depending on the utility type and control measures, such that the individuals who perform hand digging are protected from hazards related to the target utility, and the utility is protected from damage that may be caused by the hand digging equipment.

5.6 Private utility locator

A subcontractor who employs non-intrusive surface geophysical methods to locate and mark underground utilities and clear intrusive work locations.

5.7 Public utility notification ticket

The record of the intrusive work notification made to public utility companies and/or line locating contractors who are responsible for public utility marking. Organisations that process these public utility notifications may be referred to as a "One Call", "Dig Safe" or "Dig Alert" service.

5.8 Recognized utility uncertainty

Uncertainties related to expected or known underground utilities that cannot be effectively located due to obstructions, lithologic conditions, equipment limitations, or the construction of the utility. Recognized utility uncertainties that are within or potentially within the Critical Zone

will require appropriate Critical Clearance activities and/or a variance from HSS, which typically involves review by a technical experts group.

5.9 Utility quality level

A professional opinion of the quality and reliability of utility information associated with a specific utility or group of utilities. Such reliability is determined by a professional engineer or other qualified professional with responsibility for Subsurface Utility Engineering (SUE) and plan design. In the US, four different quality levels exist (A through D), in order of decreasing quality (Level A is the highest quality and Level D is the lowest). Utility quality levels are assigned only by qualified and appropriately licensed professional engineers. Additional information is provided in [Section 10.2](#).

5.10 Vacuum excavation

Vacuum excavation is a soft-dig method, typically used in combination with air knife or water knife (also called hydro excavation) to break up and loosen soil for removal. A vacuum truck with tank and hose assembly are used to apply a strong vacuum for excavation of limited areas, with the intent to safely clear intrusive locations and expose underground utilities for repair or locating. It may also be referred to as potholing, hydro-digging, hydro-trenching or soft digging.

- **Air or Water Knife** - A soft-dig device that directs compressed air or water to advance a pothole or other excavation. Usually used in conjunction with vacuum excavation equipment.

6. WORK PRACTICES

Ramboll employees may work at sites or facilities where intrusive work is being performed and may directly perform and/or oversee work involving subsurface utility hazards. Unintentional contact with utilities, or contact that is intended (e.g., excavating to expose utilities for repair or removal) but improperly executed, can result in risks to life and health of employees as well as severe property damage. Ramboll project teams are expected to be familiar with the content of this SWP, as well as locally applicable regulatory requirements and any project-specific requirements. In the event of conflicting requirements, the more stringent set of requirements will be followed. Project-specific requirements must be outlined in the project safety plan.

6.1 Pre-field requirements before intrusive work

All intrusive work areas must be evaluated for the presence of subsurface utilities and structures prior to implementing the intrusive work. Planning for intrusive activities begins at the proposal stage when the project owner must request the necessary budget and resources to implement the work safely, and continues with document review, pre-field planning, and on-site utility clearance activities. This section describes requirements and documentation for these activities.

6.1.1 Pre-field planning activities

Planning activities involve several steps that must be completed and documented, including but not limited to the steps identified below. Project teams are required to document these activities using a pre-field planning checklist ([Appendix A](#)), or equivalent, and add this information to the project safety plan.

- Identify Ramboll's Clearance Site Supervisor.
- Identify a site contact who is knowledgeable about utilities, if available.
- Request and review existing or historical utility information, if available.

- Develop a utility plot plan base map, to which all known utility information pertaining to the work areas and the overall site (with detail as relevant to current and potential work areas) will be added.
- Coordinate public utility notification and marking.
- Retain a private utility locator, including discussion of the scope of work and appropriate locating methods to be used.
- Schedule site reconnaissance and private utility locating (attended by Clearance Site Supervisor or designee).

6.1.2 Review existing documents and information

When locating subsurface utilities and structures, all available sources of information should be considered, including but not limited to the following:

- Historical site information (maps, photos, plans, or other files).
- As-built drawings (or design plans, if as-builts not available).
- Easement maps and related public records.
- Documentation from previous utility clearance, repair, or installation activities.
- Utility elevations and location coordinates, if available.
- Interviews with knowledgeable site/facility personnel, if available.

Project teams should document their efforts to seek out existing documents and information while planning intrusive work activities and evaluating utility locating methods. Because the availability or non-availability of site-specific records can affect costs, it is recommended to evaluate availability of utility records and anticipated level of effort for review at the proposal stage.

As-built plans, historic maps, or knowledgeable personnel may not be available, or these resources may not accurately represent existing conditions. Additional lines of evidence are necessary to confirm utility information.

6.1.3 Public utility location services

Most localities require the use of a public utility notification and locating service prior to beginning any intrusive work activities. These services are commonly referred to as "One Call", "Dig Safe" or "Dig Alert" services, and providers typically partner with local utility companies to identify public utilities. **If available, public utility location services must be utilized**, even if the work is to occur on private property or inside a building. If not available, public utilities serving the area of the site must be contacted individually to notify and request utility marking service. The following requirements apply unless there are more stringent local regulations:

- Submit a notification and marking request meeting applicable advanced notice regulations. If local requirements are not established, allow at least two full days' advance notice but not more than 10 business days prior to the starting date of the intrusive work.
- Mark anticipated intrusive work areas with white spray paint or white flags.

- Ensure that the notice ("ticket") received from the location service is valid for the anticipated duration of the intrusive activity.
- Submit change requests, updates or renewals in accordance with local requirements.

Most localities have standardized colours to indicate the various types of utilities. The following table summarizes standard marking colours in the United States. Other standard marking colours may apply in other countries or regions.

Utility	Colour
Electric	Red
Gas / Oil / Steam	Yellow
Communications	Orange
Water	Blue
Sewer	Green
Survey markings	Pink
Proposed Excavation	White

If a utility marking is not present and no response has been received by the person who initiated the public utility notice, the utility owner(s) who do not mark or respond to the notice must be contacted to confirm that their utilities are not present in the intrusive work area. Some public locating services will signify that their respective utilities are not present ("all-clear" notice) via a call, email, or online portal.

6.1.4 Utility plot plan

All intrusive projects must include development of a utility Plot Plan that shows the planned intrusive work areas and all known utility information pertaining to the work area and the overall site (with detail as relevant to current and potential work areas), including information obtained from public utility notification and private utility clearance. Plot Plan requirements are further discussed below:

- Computer-generated plot plans utilizing CAD/GIS are always preferred. Plot plans may also be added by hand to an existing drawing, aerial photograph or site map, but depictions of utilities must be to scale and as accurate as feasible. Plot plans must be legible and use a scale that is appropriate to show important utility details in and around the intrusive work location.
- If the scale of the available site map or aerial photo prevents adequate recording of utility details in and around the work area, alternate methods will be used to create a plot plan at an appropriate scale (e.g., field sketches and measurements, photographs, or GPS coordinates).
- Prior to intrusive activity, the plot plan must be reviewed by the SSL, Clearance Site Supervisor, and the equipment operator (e.g., driller or excavation contractor).
- The review shall be documented in a pre-field checklist, field logbook or appropriate project record.

6.1.5 Private utility location services

Private utility locators use a variety of non-intrusive surface geophysical methods to identify the presence of subsurface utilities and structures. **Ramboll requires the use of these services if available**, regardless of whether the work is taking place on privately owned or public land.

Private utility locating is REQUIRED prior to intrusive tasks unless specific conditions are met, or a variance is granted by the HSS department. If private locating services are not available or if this step is proposed to be bypassed, consult with Ramboll's HSS department before proceeding.

The Subsurface Clearance (SSC) Field Checklist ([Attachment B](#)) is intended to be completed during private utility locating. This checklist, or the equivalent information, must be completed and saved in the project file. In addition, the following procedures shall be followed when using private utility location services:

- Provide a site map to the private utility locator outlining planned intrusive work areas.
- At a minimum, private utility location must occur within the Critical Zone of each intrusive work area. In most cases, private utility location should also extend outside the Critical Zone(s) and typically include locating efforts and observations elsewhere on the property to adequately understand expected utilities and locations.
- The private utility locator will need to review public utility markings and responses in order to assess expected utilities in the work area and in other parts of the site when relevant to current or future phases of intrusive work. Include any aboveground visual indicators of underground utilities nearby in the private locator's scope of work and field discussions.
- Positive identification of all major utilities listed in the SSC Field Checklist should also be expected from the private utility locator.
- Inform the private locating service of any expected or suspected utilities or any existing information obtained through historical records and plan review.
- Ensure that the private utility locator is using the proper utility location technologies for the site and the work being done. The private utility locator may be best suited to determine which and how many different utility locating technologies should be applied to obtain the highest feasible level of confidence for a project. Ramboll's HSS department and/or technical experts groups can assist when necessary.
- Ramboll's Clearance Site Supervisor or SSL must meet with the private utility locator on-site to oversee activities and walk over the planned intrusive work areas.
- The Clearance Site Supervisor or SSL will document utility clearance activities and results in a field logbook or equivalent, take photographs and measurements as needed, complete the SSC Field Checklist (Appendix B), and update the utility Plot Plan.
- The private locator should provide a record of on-site activities, including at minimum the identifiers of specific intrusive work locations that have been cleared, a description of locations cleared, and the locating tools that were used. Some private locating companies can also provide a report with photographs, maps, diagrams and detailed descriptions of clearance activities and results.

6.2 On-site requirements during intrusive work

The following requirements apply to all intrusive activities and must be completed before work begins:

- Confirm that underground utilities have been located and marked, including intrusive work locations. Surrounding or adjacent areas should also be cleared and marked as needed, such

that cleared areas and markings extend 5 feet/1.5 meters beyond the intrusive activity in all directions to identify the Critical Zone.

- Complete the required documentation (e.g., SSC Field Checklist [Attachment B] or equivalent) and keep on site.
- Communicate all potential utility concerns, protocols and safe work distances to Ramboll employees and subcontractors, including equipment operators.
- De-energize electrical utilities and isolate piping where possible, particularly if present in or near Critical Zones.
- Identify emergency shutoffs and add locations to the plot plan.

6.2.1 Maintaining utility markings

A duration of time may pass between public and private utility marking and the time of intrusive work. If this is the case, Ramboll or its subcontractor will be responsible for maintaining utility markings or requesting re-marking. Markings must be consistent in shape, size, and colour with the original marking.

6.2.2 Finalizing intrusive locations and Critical Zones

Finalizing the exact locations of intrusive work will take place after completion of subsurface utility locating using public and private utility locating services.

- If a utility or recognized utility uncertainty is identified within the Critical Zone, intrusive work locations **must be moved** and the Critical Zone re-cleared, or a pre-cleared alternate location must be substituted such that no utilities are present in the Critical Zone.
- If intrusive work locations cannot be moved or substituted, Critical Clearance efforts are required ([Section 6.3](#)). Boreholes or other intrusive activity **must be manually cleared using soft digging techniques** (or other appropriate methods depending on the utility type) beyond the maximum depth of known or suspected site utilities. For excavations, this process may require a soft-dig trench to an appropriate depth along the perimeter of the intrusive area.
- **Exception:** if one or more known utilities are in conflict with the Critical Zone but there are no other uncertainties, **daylighting** the utilities of concern using soft dig methods (to verify depth, location and direction) may be an acceptable Critical Clearance alternative to clearing the borehole or intrusive location with soft dig methods if doing so is infeasible.
- Without the use of soft dig manual clearance or daylighting to clear Critical Zone utilities as described in this SWP, or if a recognized utility uncertainty is not resolved with these methods, **a variance from Ramboll's HSS department is required.**

6.3 Critical clearance

In general, a variance from Ramboll's HSS department is required when a utility (or recognized utility uncertainty) is identified within the Critical Zone and the location cannot be moved.

- Use of soft dig methods within the Critical Zone can obviate the need for a variance (see [Section 6.2.2](#)).
- Other methods may also be acceptable to minimize risk (e.g., manual clearance if appropriate; daylighting of utilities; previous direct experience with utility installation; availability of highly accurate utility plans/elevations; or documented disconnection and abandonment of all utilities serving the site).

These actions are collectively referred to as **Critical Clearance**. The following sections describe Critical Clearance requirements and provide examples of appropriate responses and safety controls for different Critical Clearance scenarios.

6.3.1 Utility hazard level

Regardless of whether a variance is obtained, Critical Clearance activities require an assessment of utility hazard level, which depends on the risk that damaging a utility would pose to employees, the environment, or the community, in order to establish a Reduced Critical Zone (RCZ; see [Section 6.3.2](#)).

High Hazard utilities, if damaged, have a potential to result in one or more of the following:

- Injury or death of workers
- Secondary property damage
- Release of toxic or flammable substances
- Uncontrolled releases from a pressurized line
- Unexpected loss of fire protection systems that are required by local ordinance
- Public or community impacts and/or temporary loss of utility service

Low Hazard utilities do not result in the above factors if damaged.

- They may be repaired at a cost that is acceptable to Ramboll's liability tolerances and project budget, OR
- The client has accepted liability for any damage to the utility that may result from our work.

No Hazard utilities or objects are confirmed abandoned, inert or without any hazard, permanently inactive, approved for demolition or removal, and do not require repair.

High Hazard	Low Hazard	Abandoned / No Hazard
Energized Electrical	LOTO/Inactive Electrical	Abandoned/Inactive
Gas/Flammable	Non-Flammable/Inert	Owner-Verified Status
Toxic/Biohazard	Non-Pressurized	Subsurface Debris
Pressurized	Non-Toxic	No Repair Required
Fire Protection	Site Impact Only	(see Section 6.3.4.3)
Public/Community Impact	Damage/Repair Acceptable	
Damage/Repair Unacceptable		

Critical Clearance requirements are most stringent for High Hazard utilities, and whenever possible project teams should use Lockout/Tagout (LOTO) or similar measures to render the utility safe and inert during the intrusive work. This practice can change the utility hazard level from high hazard to low hazard. See also Ramboll's SWP, [Lockout/Tagout](#).

Another means of reducing the utility hazard level is by the client accepting liability (in writing) for damage to specific utilities that will not or cannot be shut off, or those for which damage/repair would represent an unacceptable liability for Ramboll. An example would be

directional drilling above or below fire protection water lines that would be inside the Reduced Critical Zone (RCZ) of the borehole. This practice cannot apply to electrical lines or any utility that poses an injury or illness risk to workers or the public.

If soft-dig methods are infeasible and our work will be in close proximity to a non-locatable utility, specific steps are required to limit Ramboll liability. A variance from HSS will be required, including technical review and/or consultation with Ramboll's Legal department.

6.3.2 Reduced Critical Zone (RCZ)

The Reduced Critical Zone (RCZ) is a safety radius around an intrusive activity, within which no mechanical digging may be done, and only applies as a substitute for the CZ once the precise horizontal/vertical locations and hazard levels of all CZ utilities are known and appropriate controls are in place. This is typically accomplished by application of soft dig measures (see [Section 6.3.3](#)).

- Utility owners and operators (for both public and private utilities) also usually define a minimum approach distance and may have specific requirements to work within this distance, such as using soft dig methods and having a representative on-site during excavation. Always confirm safe work practices with the utility owner when reduced critical zones are to be applied.
- The table below illustrates types of high risk and low risk utilities and the corresponding RCZ around the intrusive activity.

Utility Hazard Level	RCZ (apply once hazard levels, locations, and depths are known)	Dig Method within RCZ
High Hazard	1.5 feet/46 centimetres	Soft Dig Required
Low Hazard	0.5 feet/16 centimetres	Soft Dig Recommended <i>(hand dig ok for utilities that are resistant to damage, or damage/repair liability is deemed acceptable)</i>

- Unless other more stringent requirements apply, Ramboll's safe work practices require that within the RCZ as defined above, excavation may only be performed using soft dig methods, or alternatively by hand digging, which is only acceptable if certain conditions are met.
- Hand digging may only be used for utilities that do not represent a risk to those using the hand tools, either because the utility is in the low hazard level or because the utility is encased in a material able to withstand impacts from hand tools (see [Section 6.3.3](#)).
- For situations where soft digging or hand digging are not possible and a utility is expected to be encountered within the RCZ (for example, during **directional drilling**), exceptions to the above RCZ distances can only be authorized by obtaining a variance from Ramboll's HSS department including technical expert review.

6.3.3 Using hand-digging as a soft dig method

Hand digging may be used only to clear for (or expose) utilities that are in the low hazard category and/or one or more of the following is true:

- It is isolated/inert or otherwise not presenting a risk to those using the hand tools .
- It is encased in a material that is protective against damage by hand tools.
- It may be damaged by hand tools but does not pose an unacceptable liability for repair.

The following table provides examples of the types of utilities that may permit use of hand digging within the RCZ (if permitted by the utility owner), and those that would require soft dig.

Hand Digging Acceptable	Soft Dig Required
De-energized or protected electrical lines	Energized electrical lines
Utilities that are confirmed protected within an engineered duct bank	Unprotected high hazard utilities or when duct bank or other protection is not confirmed
Isolated, inert gas or fuel lines or pipelines	Active gas or fuel lines or high-pressure gas pipelines
Reinforced concrete sewer main	Unreinforced clay or brick sewer main
Isolated, inert public water lines	Pressurized public water supply lines
Low pressure, private PVC water lines if shutoff is feasible	Low pressure, private clay/unknown water lines, or PVC if shutoff is infeasible
Non-pressurized sewer force main	Pressurized sewer force main
Shallow (<5ft/1.5m) and small diameter PVC sewer laterals	Deep (>5ft/1.5m) or large diameter PVC sewer laterals
Isolated/inert fire protection water lines	Pressurized fire protection water lines
Corrugated steel storm drains	Utilities of unknown type or condition; older utilities; clay pipes
Private telecommunications or fibre optic lines (within protective conduit)	Public telecommunications or fibre optic lines

6.3.4 Critical clearance scenarios

The following subsections describe Critical Clearance and related activities as applied in three different scenarios. These scenarios represent categories of subsurface utility-related work that Ramboll may perform.

6.3.4.1 Avoiding critical zone utilities using hand dig, soft dig or daylighting

For most intrusive investigation or sampling tasks, utility clearance activities are designed to avoid unintentionally contacting or damaging any utilities. When utilities are within the Critical Zone, a variance is required unless using soft dig methods to clear intrusive areas to a depth beyond that of the utility in question, or through an area or depth interval that represents a recognized utility uncertainty.

- **Hand digging** can be used in lieu of soft dig methods only if identified or potential utilities are in the Low Hazard category (see [Section 6.3.1](#)) and do not pose a risk to employees, the environment or the community. In addition, the utility is resistant to damage by hand tools (see [Section 6.3.3](#)); or does not pose an unacceptable liability for repair.

Manual digging or "hand clearance" using manual tools (shovel, hand auger, soil probe) is not a substitute for, nor does it directly satisfy, any of Ramboll's safe work practices for subsurface clearance.

- **Intrusive work that is shallow or only requires hand tools** still requires an assessment of subsurface utilities, including plan review, public utility notification, inspection for visual indicators, and use of a private utility locator. The level of controls applied should match the relative risk of encountering a utility.
 - **Exception:** If Ramboll already has direct project experience (e.g., previous installations or excavations **encompassing the entire intrusive area**), and has detailed as-built plans that describe all utilities in the area, including locations and elevations with verified accuracy, or if the property has never been developed with underground utilities, hand digging or mechanical digging projects may proceed without the use of a private locator (but all other steps are still required).
 - **In any other situation**, a variance is required if project teams propose to not conduct private utility locating.
- **Daylighting:** If soft dig or hand dig clearance is not feasible for the location or task, Critical Zone utilities (or utilities that represent a recognized utility uncertainty) may be daylighted using soft dig methods in order to accurately locate and trace the utility and clear the intrusive area.
 - This assumes that there are no other known utilities or recognized utility uncertainties in conflict with the Critical Zone.
 - Daylighting always requires advance notification and approval of the utility owner.

6.3.4.2 Utility direct interaction (inspect, repair, construct, tie-in, decon/demo)

If the project will involve **direct interaction with a utility** (e.g., tie-in, repair, inspection, construction, decontamination or demolition), follow the steps below to satisfy Critical Clearance requirements and HSS notification/review requirements:

- Complete standard SSC process (plan review, public notification, visual inspection, private locating) ([Section 6.2](#)).
- Assess the hazard level of the target utility; define the RCZ ([Section 6.3.2](#)).
- LOTO, isolate and render inert the target utility. For most high hazard utilities, this reduces the utility hazard level to low hazard, allowing a smaller RCZ and potential to use hand dig methods within the RCZ (as opposed to soft dig methods).
- Confirm location/depth of utility. If unknown, daylight with soft dig or hand dig methods as appropriate (daylighting not required for utility demolition if all utilities are confirmed to be disconnected/abandoned/inert).

- Confirm no other utilities are present within CZ of target utility. If other utilities exist, reapply the same process.
- Mechanical dig to RCZ. Within RCZ, soft dig (or hand dig if appropriate) to expose the utility (Critical Clearance and RCZ are not applicable for utility demolition if all utilities are confirmed to be disconnected/abandoned/inert).
- HSS review is **required** for direct interactions with **high hazard** utilities.
- HSS review is **recommended** for direct interactions with **low hazard** utilities.
- HSS may designate review responsibility to the technical experts group or other service line expert(s).

6.3.4.3 Verified site-wide utility disconnection/abandonment

When we work at demolition sites or redevelopment sites, clients or general contractors may provide documentation of all utility services having been shut off at the property line by the utility owner. If all utilities on site are **confirmed deactivated AND inert** (i.e., not representing a potential for injury or environmental release), some (but not all) of Ramboll's utility clearance safe work practices do not apply, including use of a private utility locator. Appropriate documentation (described below) must be obtained before proceeding with intrusive work, or the area will be subject to Ramboll utility clearance requirements. In addition, project teams must obtain a public utility notification ticket and confirm responses and markings, and perform a visual inspection of intrusive areas and critical zones for surface indicators, including surface markings or temporary utilities.

Documentation requirements are described below:

- Map or drawing, to scale and showing locations of prior utility connections (shut-off points).
- Written communication from all previous utility providers describing date of shutoff, name of operator or technician, and activities performed.
- Project plans or written communication from client or general contractor demonstrating that after public utility disconnections, all utilities potentially remaining are abandoned, inert, and scheduled for in-place abandonment or demolition, and no other temporary or permanent underground utilities are present within/nearby Ramboll's work area.
- Public utility notification ticket issued to Ramboll after notification, and responses.
- Written log entry or SSC Field Checklist (Attachment B) describing visual check for surface indicators.

If any of these documents are not applicable, not obtained and/or not readily available in the project file, full subsurface utility locating requirements will apply, or a variance from Ramboll's HSS department must be issued before proceeding with the work.

6.4 Variances to subsurface utility clearance safe work practices

This section describes the process and requirements to apply for a variance to Ramboll's subsurface utility clearance requirements as detailed in this SWP.

6.4.1 Situations requiring a variance

The following situations would require a variance from Ramboll's HSS department, and would usually also require approval by the designated technical experts group:

- A utility (or a recognized utility uncertainty) is present within the CZ and will not (or cannot) be resolved using soft dig (or hand dig if appropriate).
- Project team proposes to not utilize public utility notification services.
- Project team proposes to not utilize private utility location services and does not have direct experience or detailed as-built drawings with verified utility information (see [Section 6.3.4.1](#)).
- Project team proposes to use hand digging where soft digging would be required under this SWP.
- Project team proposes direct interaction with a utility that meets the definition of a high utility hazard level (see [Section 6.3.1](#)).
- Project team proposes to exclude aspects of this SWP because all utilities are disconnected/inactive, but we do not have full documentation (see [Section 6.3.4.3](#)).
- Project team proposes to deviate from any of the practices defined in this SWP.

6.4.2 Variance process description

The sections below describe Ramboll's expectations and established workflow for variance applications and review by the HSS department and technical experts group.

- Because every situation is different, there is not an established form or worksheet for this process.
- Ramboll's HSS department representatives and technical experts group members are committed to responding to variance applications in a timely manner and will provide additional instruction or submittal requirements as needed.

6.4.2.1 Completion of subsurface utility clearance requirements

These are the expectations for any intrusive project not involving Critical Clearance, consistent with this SWP. Documentation should be available and provided for review upon request.

- Historical site information has been reviewed where available.
- Expected utility types are understood (based on type of site).
- Utility information or maps have been requested from the facility and available documents have been reviewed.
- Public utility notification has been completed and Clearance Site Supervisor has reviewed responses from utility companies.
- Private utility locating has been completed under Clearance Site Supervisor oversight; utility contractor's daily log or report is available.
- Field SSC Checklist and Ramboll's daily log and photos from clearance activities are completed and available.
- Project team has prepared a site utility plot plan showing known public and private utilities in the work area and elsewhere at the site as related to current and potential work areas.
- Project team has assessed whether any expected utilities have not been accounted for and has identified any areas of recognized utility uncertainty.

6.4.2.2 Initial notification to HSS

Advanced notice to HSS (i.e., telephone or email) is always preferred, if possible. HSS will provide advanced notice to the technical experts group as needed, to facilitate scheduling of the review. For short-notice or same-day issues, this information should be combined with the submittal of the variance application and sent to HSS with cc to one or more representatives of the designated technical experts group.

- Contact HSS department representative first and CC the project team members involved (e.g., the PO, PM and SSR).
- Identify site location and type of facility .
- Summarize scope of work.
- Summarize why a variance is needed.
- Identify utilities within CZ.
- Identify any recognized utility uncertainties .
- Justify why the location cannot be moved such that all utilities are outside the CZ.
- Describe the requested variance approval timeline and the desired work date/time.

6.4.2.3 Submit variance request materials to HSS

Compile the following information and email to a representative of Ramboll's HSS department. HSS will review and forward to the technical experts group.

Describe the site and utility scenario, including:

- Type of intrusive activity (including diameter of drill rig tools)
- Type, size, and depth of utilities within CZ
- Recognized utility uncertainties or other data gaps
- Photos of intrusive area and surroundings (preferably annotated with utility information and dimensions)
- Utility plot plan, drawn to scale and including intrusive areas and utilities identified within or nearby the CZ, at a scale appropriate to understand dimensions and scope of work
- Project team's proposed best practice plan to minimize safety hazards and risk of utility damage

6.4.2.4 Best practice planning expectations

Project teams should use the Critical Clearance guidance in this SWP to propose best practices or other methods to minimize safety hazards and risk of damage to utilities in the CZ or in areas that represent a recognized utility uncertainty. Examples of best practices to minimize risk include:

- Identify the type, size, and depth of the utility (confirm with additional utility locating methods; additional discussion with utility owner; additional plan review).
- Understand local requirements for utility notification within a certain safety distance and coordinate with utility companies for their permission when required.

- Take additional steps to render the utility safe, if possible (isolate & de-energize; de-pressurize; LOTO; aboveground physical barrier).
- Maximize the distance between the borehole path or other intrusive activity and the utility.
- Manually clear the borehole with soft dig methods (or hand dig if appropriate) to beyond the expected utility depth, if feasible.
- Daylight the utility of concern using soft dig methods to identify the location, depth and direction of the utility.
- For private, non-locatable utilities that do not present an injury or illness risk, have the client provide a written letter accepting liability for potential damage to the utility (must be signed by an authorized client representative).

6.4.2.5 Variance workflow and interactions

Variance review workflow and interactions are described below.

- Project team member responds directly to questions posed by reviewers regarding site subsurface utilities or historical site information.
- Consider and discuss the alternative approaches suggested by the reviewers and by the project team and ensure project objectives are clearly communicated and understood.
- HSS will notify project team when consensus between three or more members of the review group has been reached.
- Project team commits to implementing the best practice utility clearance procedures as agreed upon by the technical experts group.
- Project team notifies HSS and technical experts group after successful implementation (and/or describe any utility-related problems or issues encountered)

7. TRAINING AND COMPETENCY

Ramboll's HSS training program includes new employee induction training, supervised on-the-job training, and annual completion of online modules or classroom instruction related to safety requirements and work practices. Training assignments vary based on employee roles and training classification. Completion of assigned training will be documented by a training completion certificate, which will be stored in the employee's electronic training record.

7.1 Clearance site supervisor

Ramboll's Clearance Site Supervisor must be in the High Risk training category and must have completed all assigned subsurface utility clearance training modules, internal training certificates, or external training certificates that apply within the country or region. The individual will have relevant field experience that is sufficient to understand clearance requirements and methods for the type of site or project (including within Ramboll, and any prior experience). Project managers are responsible to assign this role to an individual with relevant experience that is commensurate to the type of site, type of intrusive field activities, and potential utility-related hazards.

7.2 Technical expert group

Ramboll's technical expert group members must be in the High Risk training category and current on all assigned subsurface utility clearance training modules, internal training certificates, or external training certificates that may apply within the country or region. The individuals will

have relevant field experience at commercial and industrial sites, including management experience, over a period of at least five years (including within Ramboll, and any prior experience). Participation in a technical expert group is intended as a rotating position and is subject to approval of the individual's PDP manager, service line leader or department head, and Director of Ramboll's HSS department (or designee).

8. DOCUMENTATION

The following documentation is required, specific to subsurface utility clearance.

8.1 SSC project planning checklist

A Project Planning Checklist ([Appendix A](#)) or equivalent must be completed by the Clearance Site Supervisor prior to mobilizing for intrusive work. The purpose of the checklist is to document these efforts and avoid complications or delays in the field as related to access or locating techniques.

8.2 SSC field checklist and utility plot plan

Prior to beginning intrusive work, the SSC Field Checklist ([Appendix B](#)) or equivalent must be completed, and the associated utility plot plan developed or updated for each intrusive work location. The Clearance Site Supervisor must complete the SSC Field Checklist, and utility information, maps and markings must be reviewed with the equipment operators.

- For intrusive locations that are separated by (or elongated along) significant distances, or for intrusive activities in multiple areas with widely varying utility types or concentration, professional judgment must be used to determine whether separate SSC checklists should be completed for intrusive work in separate areas.
- Completed SSC documentation (field checklist, plot plan, public utility notification ticket and responses) must be kept on site and available for review and will be archived in the project files.

8.3 Documentation of utility disconnection and inert status

- See [Section 6.3.4.3](#) for documentation requirements.

8.4 Variance application and issuance

- Written response from three or more members of the technical experts group approving proposed safety controls.
- Written response from a representative of Ramboll's HSS department, granting the variance.

9. INTERNATIONAL TILTS

9.1 Asia Pacific

9.2 Brazil

9.3 Canada

9.4 European Union (EU)

9.5 Mexico

9.6 United Kingdom (UK)

9.7 United States

OSHA 1926.651 - Specific Excavation Requirements

<https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.651>

Utility Quality Levels: American Society of Civil Engineering CI/ASCE 38-02 – Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data

9.8 Other Regions

10. ADDITIONAL INFORMATION

10.1 Responding to contact with a utility

Regardless of the type of utility, the unintentional striking, damaging or dislocating of an underground utility are all considered to be incidents and therefore require incident reporting in accordance with Ramboll's HSSP, [Event Reporting, Investigation, and Corrective Action](#).

- Uncovering or encountering a previously unknown underground utility, even if the utility is not damaged, also must be reported as an incident.
 - **Exception:** If a previously unknown utility is uncovered while using an approved soft dig method and the utility is not damaged, this situation may be reported as either a near miss or as an unsafe condition, rather than as an incident.
- The sections below describe response actions in the event of striking or damaging high-risk utilities including electrical, gas and high-pressure water mains. If a utility is damaged and is in a category other than those outlined below, stop work and contact the utility owner and HSS department representative.

10.1.1 Uncovering an underground utility intact

If an unknown or unexpected underground utility is uncovered intact while not using an approved soft dig method, the following actions should be completed by the field team:

- Stop work in the area of the facility/pipeline or utility.
- Clear everyone from the area.
- Notify the affected utility owner and the public utility notification service, if applicable. The public utility notification service may be able to assist with contact numbers for notifying member companies in the event of any damage.
- Notify the PM, PO and the local or regional representative of Ramboll's HSS department.
- The PM, PO, or designee will notify the Client, property owner or tenant.
- Once the HSS department representative has approved continuation of work, mark the underground structure(s) on the plot plan, backfill as appropriate, and move to an alternate cleared location if available.

ALWAYS ASSUME THAT AN UNDERGROUND PIPE IS ACTIVE AND MAY BE DANGEROUS TO LIFE AND HEALTH!

10.1.2 Damaging/contacting underground electric lines

Damaging underground electrical lines can result in electric shock to those in the area around the equipment. The following steps must be implemented immediately:

- Stop work.
- If you are NOT in danger from fire or otherwise exposed to danger:
 - Stay where you are.
 - Move the equipment away from line if possible.
 - Warn others not to approach the area.
- If you are in danger:
 - Equipment operator should jump as far as possible from the equipment and land with both feet on the ground. Do NOT touch the equipment and the ground simultaneously.
 - Hop or shuffle away from the equipment keeping both feet on the ground at the same time.
 - Do not touch the equipment until the utility owner says it is safe to do so.
- Call the designated emergency response telephone number or use the designated emergency response radio channel.
- Provide first aid and call for emergency medical assistance as needed.
- Notify the PM, PO and the local or regional representative of Ramboll's HSS department.
- The PM, PO or designee will notify the client, property owner or tenant, and Managing Principal.
- Do not allow anyone to enter the area until the utility owner declares it is safe to do so.
- Take photographs from a safe distance and take statements from witnesses at the scene.

10.1.3 Damaging a pressurized gas pipeline

Damaging a gas pipeline could result in an explosive atmosphere in the immediate area. If a gas pipeline is damaged, the following steps must be implemented immediately:

- Stop work.
- Leave tools in place, but shut off any running/energized equipment. Eliminate potential sources of ignition in the area.
- Evacuate the immediate area to a safe distance as site conditions warrant.
- Call the designated emergency response telephone number or use the designated emergency response radio channel.
- Contact the pipeline owner.
- Notify the PM, PO and the local or regional representative of Ramboll's HSS department.
- The PM, PO or designee will notify the client, property owner or tenant, and Managing Principal.

- Do not allow anyone to enter the area until the utility owner declares it is safe to do so.

10.1.4 Damaging a pressurized water main

Although usually less hazardous than damaging an electric line or gas line, damaging a pressurized water main can cause large amounts of property damage, may render fire suppression water utilities inoperable, and can be hazardous to the life and health of those nearby. The following steps should be implemented if a pressurized water main is damaged:

- Stop work.
- Remove tools and confine jetting water if safe and necessary to do so.
- Evacuate the immediate area.
- Call the designated emergency response telephone number or use the designated emergency response radio channel.
- Contact the water utility owner.
- Ensure that water is not creating additional potential hazards (e.g., electrical shorting, flooding, contaminant migration, etc.). Where possible, warn those likely to be affected.
- Notify the PM, PO and the local or regional representative of Ramboll's HSS department.
- The PM, PO or designee will notify the client, property owner or tenant, and Managing Principal.
- Do not allow anyone to enter the area until the utility owner declares it is safe to do so.

10.2 Utility quality levels

Utility Quality Levels are used to describe the level of accuracy and confidence in utility location data on plan drawings for larger or utility-intensive engineering projects. The Quality Level will determine SSC requirements prior to beginning intrusive work and will be considered during variance requests. Information gathered at lower Quality Levels is incorporated into higher Quality Levels; however, information from a higher Quality Level may be obtained before lower Quality Level information. Quality Levels may be used on engineering plans generated or reviewed by Ramboll.

10.2.1 Quality level D

Information derived from existing records or oral recollections.

- As applied to Ramboll's safe work practices, this is information that is typically gathered through records review, plan review, and interviews with a knowledgeable site representative.

10.2.2 Quality level C

Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to Quality Level D information.

- As applied to Ramboll's safe work practices, this Quality Level represents visual observations and information that may be gathered during site reconnaissance visits, while marking intrusive locations, and during private utility locating.

10.2.3 Quality level B

Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities. Private utility locators may provide estimated vertical positions, but they should not be considered highly accurate. Quality Level B data should be reproducible by surface geophysics at any point of their depiction. This information is typically surveyed to applicable tolerances defined by the project and reduced onto plan documents.

- This Quality Level roughly equates to the private locating step of Ramboll's safe work practices. However, depending on the scope, methods and documentation, a private locating effort may not be sufficient to meet project-specific requirements for Quality Level B.

10.2.4 Quality level A

Precise horizontal and vertical location of utilities obtained by the actual exposure (or verification of previously exposed and surveyed utilities) and subsequent measurement of subsurface utilities, usually at a specific point. Minimally intrusive excavation equipment is typically used to minimize the potential for utility damage. A precise horizontal and vertical location and other utility attributes are included in plan documents. Accuracy is typically set to 15-mm vertical and to applicable horizontal survey and mapping accuracy as defined or expected by the project owner.

- This Quality Level roughly equates to soft-dig "daylighting" and Critical Clearance concepts in Ramboll's safe work practices, but these activities are not necessarily sufficient to meet project-specific requirements for Quality Level A.

11. REVISION SUMMARY

Safe Work Practice

Subsurface Utility Clearance

ATTACHMENT A

SSC PROJECT PLANNING CHECKLIST

Safe Work Practice

Subsurface Utility Clearance

ATTACHMENT B

SSC FIELD CHECKLIST