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August 29, 2022

By FedEx and E-mail—charlene.fitch@dnr.mo.gov

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Subject: **Residential Yards Incremental Sampling Methodology Work Plan**
Greenfield Environmental Multistate Trust—Springfield Facility
Former Tronox/Kerr-McGee Facility, 2800 West High Street, Springfield, Missouri
MHWMF Part I Permit No. MOD007129406

Dear Ms. Fitch:

Pursuant to Section 3.2.6 of the Multistate Environmental Response Trust Agreement, Greenfield Environmental Multistate Trust, LLC, Trustee of the Multistate Environmental Response Trust (the Multistate Trust), hereby "seeks the prior approval of the Lead Agency . . . to perform Environmental Actions and any work plans to be undertaken by the Multistate Trust under the oversight of the Lead Agency . . . ." Accordingly, the Multistate Trust hereby submits the Residential Yards Incremental Sampling Methodology (ISM) Work Plan for the Greenfield Environmental Multistate Trust LLC—Springfield Facility, also known as the Former Tronox/Kerr-McGee Facility located at 2800 West High Street, in Springfield, Missouri with Missouri Hazardous Waste Management Facility (MHWMF) Part I Permit No. MOD007129406. The ISM Work Plan outlines the technical scope and procedures to evaluate certain residential properties adjacent to the Clifton Drainage downgradient and north of the Facility that may have creosote impacts in surficial soil.

If you have questions or require additional information, please contact me at (602) 312-6993 or tl@g-etg.com or Babs Garcia at (417) 616-6539 or bgarcia@environmentalworks.com.

Sincerely,

Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust
By: Greenfield Environmental Trust Group, Inc., Member

Tasha Lewis

Tasha Lewis
Program Director

Enclosure: Residential Yards Incremental Sampling Methodology Work Plan

cc: Cynthia Brooks—Multistate Trust
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RESIDENTIAL YARDS INCREMENTAL SAMPLING METHODOLOGY WORK PLAN

Greenfield Environmental Multistate Trust LLC – Springfield Facility
Former Tronox/Kerr-McGee Facility
2800 West High Street, Springfield, Missouri
MHWMF Part I Permit No. MOD007129406

Submitted by

Greenfield Environmental Multistate Trust, LLC
Trustee of the Multistate Environmental Response Trust

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August 29, 2022

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylene
COC	chemical of concern
DNAPL	dense nonaqueous-phase liquid
el.	elevation
EPA	U.S. Environmental Protection Agency
EWI	Environmental Works, Inc.
Facility	Greenfield Environmental Multistate Trust LLC – Springfield Facility, also known as the Former Tronox/Kerr-McGee Facility located at 2800 West High Street in Springfield, Missouri
ft	feet
g	gram
GPS	global positioning system
HDOH	Hawaii Department of Health
Integral	Integral Consulting Inc.
ISM	incremental sampling methodology
ISM Work Plan	Residential Yards Incremental Sampling Methodology Work Plan
ITRC	Interstate Technology and Regulatory Council
kg	kilogram
mL	milliliter
MoDNR	Missouri Department of Natural Resources
MRBCA	Missouri Risk-Based Corrective Action
Multistate Trust	Greenfield Environmental Multistate Trust LLC, not individually but solely in its representative capacity as Trustee of the Multistate Environmental Response Trust
oz	ounce
PID	photoionization detector
QAPP	quality assurance project plan

QA/QC	quality assurance and quality control
RBTL	Tier 1 Risk-Based Target Levels
RSL	Regional Screening Level
SOP	standard operation procedure
SVOC	semivolatile organic compound
TGM	*Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*
Treatment System	product recovery and treatment system
UFZ	Upper Flow Zone

1 INTRODUCTION

This Residential Yards Incremental Sampling Methodology (ISM) Work Plan (ISM Work Plan) for the Greenfield Environmental Multistate Trust LLC – Springfield Facility, also known as the Former Tronox/Kerr-McGee Facility located at 2800 West High Street in Springfield, Missouri (Facility[1]), Missouri Hazardous Waste Management Facility Part I Permit Number MOD007129406, was prepared by Integral Consulting Inc. (Integral) on behalf of the Greenfield Environmental Multistate Trust LLC, not individually, but solely in its representative capacity as Trustee of the Multistate Environmental Response Trust (the Multistate Trust). The Multistate Trust was established and is responsible for performing Environmental Actions[2] pursuant to that certain Consent Decree and Environmental Settlement Agreement (the "Settlement Agreement") entered in the U.S. Bankruptcy Court for the Southern District of New York in the matter of In re: Tronox Incorporated, et al., Case No. 09-10156 (ALG), and that certain Environmental Response Trust Agreement (the "Multistate Trust Agreement" together with the Settlement Agreement, the "Tronox Bankruptcy Agreements") entered into pursuant to the Settlement Agreement on February 14, 2011. The Multistate Trust has continued to implement Environmental Actions, including the corrective action program, since assuming responsibility for the Facility on February 14, 2011. Environmental Actions are performed under the oversight of and approved by Missouri Department of Natural Resources (MoDNR) as the Lead Agency for the Facility.

The ISM Work Plan outlines the technical scope and procedures to evaluate select residential yards adjacent to the Clifton Drainage downgradient of the Facility that may have creosote impacts in surficial soil (Figure 1-1, Table 1-1). Sampling will be conducted using ISM procedures, which reduces data variability and provides an estimate of mean contaminant concentrations in a defined soil volume by using multiple increments of soil within a defined

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[1] The Facility is also referred to as the Former Tronox Facility, Former Tronox/Kerr-McGee Facility, Former Kerr-McGee Facility, Former Tronox/Kerr-McGee Wood Treatment Facility, and/or the Kerr-McGee Chemical Corporation (KMCC) Forest Products Division (FPD), Springfield, Missouri Facility.

[2] Pursuant to Section 1.1.11 of the Multistate Environmental Response Trust Agreement, "'Environmental Actions' means any and all environmental activities authorized or required under Environmental Law that occur after the Effective Date and that are related to any of the Multistate Owned Sites and certain Non-Owned Sites (for which the Multistate Trust will be performing environmental activities as provided herein), including but not limited to response or remedial actions, removal actions, corrective action, closure, or post-closure care, reclamation, investigations, studies, remediation, interim actions, final actions, emergency actions, water treatment, implementation of engineered structures and controls, monitoring, repair and replacement of engineered structures, monitoring equipment and controls, operation and maintenance, implementation, operation and maintenance of institutional controls, coordination and integration of reuse and remedial efforts and initiatives (including, without limitation, multi-stakeholder communications), and, if required, long-term stewardship and perpetual custodial care activities. 'Environmental Actions' also include the above environmental activities relating to the migration of hazardous substances emanating from the Multistate Owned Sites and certain Non-Owned Sites. For the avoidance of doubt, 'Environmental Actions' shall not include natural resource assessment or restoration."

decision unit (soil volume) to create a representative combined sample that contains analytes in the same proportions as the soil throughout the decision unit.

The ISM Work Plan includes procedures for collecting, preparing, and analyzing soil samples. It has been prepared to be consistent with the *Incremental Sampling Methodology Guidance* issued by the Interstate Technology and Regulatory Council (ITRC) in 2012 and revised in 2020 (ITRC 2020). It is also consistent with the *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan* (TGM), issued and maintained by the Hawaii Department of Health (HDOH) Hazard Evaluation and Emergency Response Office (HDOH 2021). The ITRC and HDOH guidance documents are the preeminent sources on ISM in the United States (Missouri does not have an ISM guidance document). The U.S. Environmental Protection Agency (EPA) recently issued an article on the use of ISM at polychlorinated biphenyl cleanup sites (USEPA 2019), in which the two references on ISM are the ITRC and the HDOH guidance documents. Additionally, the ITRC guidance lists the HDOH guidance as its main source and reference.

1.1 PROBLEM STATEMENT AND CONCEPTUAL SITE MODEL

The proposed work entails environmental screening to assess the presence of Facility-related chemicals of concern (COCs, which include semivolatile organic compounds [SVOCs] and benzene, toluene, ethylbenzene, and xylene [BTEX]) in unsaturated surficial soil at nine proposed areas located at seven residential properties downgradient of the Facility along the Clifton Drainage, a small, channelized ephemeral stream channel that is part of the West Fork Spring Branch and originates in the northeast corner of the Facility and drains to the north following the weathered, jointed, and fractured limestone bedrock structure and local topography. The Clifton Drainage is contained in a concrete channel traversing the neighborhood between the Facility and North Clifton Avenue; the stream then transitions to an earthen channel approximately 1,000 feet (ft) northeast of the Facility (Integral 2019). The West Fork Spring Branch transitions back to a concrete channel for the short portion of its alignment where it runs adjacent to the Woodlawn Spring/Golden Hills Detention Basin, where it receives groundwater discharged from Woodlawn Spring/Outfall 003, among other sources.

The Facility is located on the Springfield Plateau, a groundwater province in southwestern Missouri (Integral 2019). The Springfield Plateau Aquifer is the shallowest aquifer in the Facility vicinity; previous investigations have shown that Facility-related impacts to groundwater are generally restricted to the upper portions of the Springfield Plateau Aquifer (i.e., the Upper Flow Zone [UFZ] and an underlying thin localized solutioned zone that occurs beneath the Clifton Drainage) (Figure 1-2). Joints and fractures in the karst of the UFZ and solutioned zone represent potential pathways for preferential groundwater flow from the areas of the Facility located north of an east-west groundwater divide near the southern Facility boundary. Groundwater flow north of the divide (encompassing the Facility former process area and impoundment areas) flows northeast and generally parallels the alignment of the Clifton Drainage (Appendix A).

The Clifton Drainage is likely the surface expression of an underground karst and fracture network, and only bears water in wet seasons (EWI 2016, 2018). Historically, during times of high groundwater when the product recovery and treatment system (Treatment System) was not operational, impacted groundwater discharged to Clifton Drainage (Integral 2019).[3] Stormwater runoff at the Facility flows overland, directed by limited, shallow ditches, and discharges to one of two outfalls. Stormwater Outfall #001 receives surface water runoff from the eastern side of the property and discharges to the Clifton Drainage (Multistate Trust 2020). Clifton Drainage also receives stormwater from surrounding streets (High Street, Truman Ave., and Clifton Ave.). During regional flooding events, residents have reported and Multistate Trust local contractor Environmental Works, Inc. (EWI) personnel have observed, water levels overtopping the drainage channel and flooding the neighboring yards[4] near to where the drainage channel passes under Clifton Ave. (Jacobs 2022; Garcia 2022a,b, pers. comm.).

The proposed investigation areas were selected based on proximity to Clifton Drainage (including where flooding has been reported), observed staining/creosote, or similar elevation to observed staining/creosote (Figure 1-1). Black soil (potentially creosote-impacted) was observed at Area 3 (Property 014) by City of Springfield staff during sewer maintenance excavations that occurred in 2020 (Garcia 2022c, pers. comm.). Creosote or coal tar-like material and odor were observed at Area 5 (Property 037) during a 2009 sewer line installation (Dicks 2009, pers. comm.). These staining/creosote observations were at approximately elevation (el.) 1,263 ft above mean sea level (amsl) (Figure 1-3). Because surficial soil is considered to be the top 3 ft[5], residential yards proximate to Clifton Drainage that generally intersect el. 1,266 ft amsl were selected for sample collection (Figure 1-1)[6].

In addition, during the installation of monitoring well SMW-82 (east of Property 035), oily water was observed bubbling from cracks in Clifton Drainage. While no dense nonaqueous-phase liquid (DNAPL as creosote) has been observed in the monitoring well, odor and minor sheen

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[3] With the Treatment System in place and operational, such discharges are now uncommon and represent a small fraction of the water being conveyed. Further, recent monitoring results show that, during upset conditions, comingled groundwater with surface water does not exceed stormwater permit limits or benchmarks. (Multistate Trust 2021).

[4] EWI personnel have observed flooding at Properties 33 and 35 (Garcia 2022b, pers. comm.). These properties are shown in Figure 1-1.

[5] Missouri guidance considers 0–3 ft bgs to be the zone that a residential receptor could come into contact with or be exposed to COCs in soil via ingestion, dermal contact, or inhalation of vapor and particulates (MoDNR 2006).

[6] Should the results of this investigation indicate the need for remediation in one or more of these areas, or observations of staining/creosote in surficial soil, adjacent properties/areas, moving away from Clifton Drainage, may be selected for additional sample collection.

have been observed (Jackson 2019, pers. comm.). Proposed sample areas were selected to include areas with observed impacts and adjacent areas at similar elevation.

1.2 PROJECT OBJECTIVES AND APPROACH

Clifton Drainage is known to convey surface water and, during times of high groundwater when the Treatment System was not operational, daylighted groundwater (that became surface water) from the Facility (Integral 2019). Environmental data and field observations indicate that Facility-related COCs are present in soil and groundwater to the northeast of the Facility, including in the vicinity of the residential neighborhood along Clifton Drainage northeast of the Facility (EWI 2018, 2020a, 2022; Integral 2019). Groundwater is already being monitored at the Facility and in this neighborhood (EWI 2022). The purpose of this investigation is to evaluate whether Facility-related Clifton Drainage discharges have impacted surficial soils of adjacent residential properties. Nine proposed areas within seven residential properties will be evaluated (Figure 1-1).[7] The results of this soil sampling effort will be used to evaluate whether additional investigation or remediation is warranted.

Data quality objectives are provided in Table 1-2. Presented are the data collection objectives, investigation approach, and decision factors or criteria that will guide the data assessment and follow-up actions. If DNAPL or staining is encountered, that increment will be removed from the decision unit; the increment may be added to a new decision unit to capture DNAPL/staining or may be collected for separate laboratory analysis, which may include fingerprinting (BTEX, SVOCs) or analytes other than BTEX/SVOCs if potential onsite sources (e.g., fuel tanks, chemical storage) are noted. Areas containing Facility-related DNAPL or staining in surface soil will be targeted for remedial activities. Additionally, while not part of the ISM sample collection process, soil cores of subsurface soil (deeper than 3 ft) will be retrieved and evaluated for the presence or absence of staining, DNAPL as creosote, or elevated photoionization detector (PID) readings. These observations will be provided to the property owner, MoDNR, the City of Springfield, City Utilities, and Greene County and kept on file by EWI in case of utility work notifications[8].

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[7] Four of these properties (014, 015, 016, and 033) were also included in a vapor intrusion investigation conducted between 2017 and 2018 to evaluate whether residential indoor air had Facility-related volatile COCs present at concentrations above action levels and whether the source of the volatile contaminants (if present) was the Facility or other background sources (Jacobs 2022). The results showed that the volatile compounds detected in indoor air were linked to background sources, and not vapor intrusion related to the Facility.

[8] These observations will be used to update the Utility Caution Protocol (Jacobs 2020).

1.3 PROJECT SCOPE OF WORK

Soil sampling and laboratory analysis will be used to obtain quantitative data regarding the presence of Facility-related COCs at concentrations above relevant screening levels (see below) in surficial soil. The primary scope of work components are as follows:

- Soil sampling: Unsaturated, surficial soil sampling (0 to 3 ft below ground surface [bgs]; MoDNR 2006) will be performed according to ISM. A preliminary recommendation of sampling decision units is provided in this ISM Work Plan (Section 2.1); however, final sampling areas may be adjusted based on field conditions and site constraints.
- Laboratory analyses: Surficial soil samples will be analyzed for Facility-related SVOCs and BTEX (Section 2.2).
- Data evaluation: Analytical results will be compared to EPA Resident Soil Regional Screening Levels (RSLs) or Missouri Risk-Based Corrective Action (MRBCA) Residential Land Use Soil Tier 1 Risk-based Target Levels for ingestion, inhalation, and dermal contact (RBTLs).[9] Comparison to the RSLs or RBTLs will be used to guide decisions on the need for further evaluation or corrective action.
- Soil observation: Subsurface soil cores will be collected and evaluated for the presence or absence of staining, creosote, or elevated PID readings.

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[9] RBTLs were obtained from MRBCA guidance documents (MRBCA 2006, 2013). For Facility-related constituents, the 2013 RBTLs were identical to the corresponding 2006 RBTLs. Where RBTLs were provided in the 2006 guidance, but were absent in the 2013 guidance, the 2006 RBTLs were used.

2 SAMPLING AND ANALYSIS ACTIVITIES

This section describes the incremental soil sampling and analysis activities that will be conducted as part of the scope of work. The fieldwork will be conducted by EWI,[10] a qualified local contractor.

2.1 INCREMENTAL SOIL SAMPLING

Soil sampling will be conducted using incremental sampling of decision units, as recommended in the TGM and in the ITRC guidance. A decision unit is a logical sampling area, such as a portion of a yard, and an incremental sample is an aggregate sample composed of a large number of spatially distributed sample increments from within a decision unit. The incremental sample is designed to be representative of the average soil from the decision unit area.

2.1.1 Access Agreements

As discussed in Section 1.2, seven properties will be evaluated, contingent upon property owners providing access. The owner or resident of each property will need to sign an access agreement (Appendix B) prior to commencement of field activities.[11] Should an owner/resident refuse access, alternate neighboring properties, such as Properties 004, 013, 017, 031, and 040, may be considered.

2.1.2 Decision Units

Sample areas (Section 1.2) will each be considered separately to refine the evaluation. The top 3 ft of soil will be evaluated, consistent with Missouri guidance that considers 0–3 ft bgs to be the zone that a residential receptor could come into contact with or be exposed to COCs in soil via ingestion, dermal contact, or inhalation of vapor and particulates (MoDNR 2006). Incremental samples will be collected at 1-ft depth intervals within the top 3 ft in each area. This results in a total of 27 decision units (nine proposed sample areas each with three depth intervals).

Recommended decision units are identified in this ISM Work Plan (Table 2-1). Actual decision units may vary from those planned in this ISM Work Plan, based on field conditions or access issues. The extent of the various decision units will be documented in the field logbook and provided on maps in a report of findings.

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[10] EWI is an approved Multistate Trust contractor.

[11] In the case of a rental property, the owner will be contacted in addition to the tenant.

2.1.3 Increment Distribution

The collection of 50 increments is appropriate for release scenarios where the relative degree of contaminant heterogeneity is uncertain (TGM Section 4.2.2). The TGM recommends a systematic random increment collection scheme for the collection of an incremental sample from a decision unit (TGM Section 4.2.4). This sampling design is also described in ITRC guidance (ITRC 2020, Section 3.1.5.5). Increments are collected in a grid fashion at a fixed spacing, beginning from a random starting point in the decision unit. Increment locations are evenly spaced between all axes of the grid to the extent feasible in the field. For systematic random sampling, rather than selecting a random location for each grid cell within a decision unit, randomization is performed only once, and the randomly selected location within a cell is then applied to all other cells. Systematic random sampling is proposed for this investigation.

The increment spacing is calculated as the square root of the quotient of the decision unit area divided by the targeted number of increments. This means that the calculated spacing reflects hypothetical division of the decision unit into a number of cells equal to the targeted number of increments. The area of each cell is calculated as the total area of the decision unit divided by the number of increments. Taking the square root of this area yields the length of each side of the cell, assuming a square shape. Actual increment collection locations reflect a random offset of this grid, with increments collected from an identical (i.e., systematic) location within each cell.

Figure 2-1 provides a diagram representing a systematic random sampling approach as a systematic grid with increment collection from an identical, random start location within the grid cells. Site-specific sampling grids will be determined in the field to account for site features (e.g., walkways, pools, fountains, cement slabs, decks, rocks) where adjustments are necessary.

The grid approach is well suited for the collection of field replicates. For this project, three decision units will be sampled in triplicate fashion (further discussed in Section 3.3). Using the same grid as described above, a decision unit can be sampled in triplicate by collecting increments from three different locations within the same grid cell (Figure 2-1). Triplicate Sample A will be composed of all soil increments collected at the A locations, triplicate Sample B will be composed of all soil increments collected at the B locations, and so forth, using dedicated tools for each triplicate sample.

The grid pattern may need to be modified to account for access constraints or to work around permanent structures and impervious surfaces at the various yards.

2.1.4 Sample Collection

Samples will be collected with a track-mounted direct push technology sampler (e.g., a Geoprobe®). Drilling and sample collection will follow EWI Standard Operating Procedures

(SOPs) No. 2: Direct Push Auger Soil Borings Planning and Oversight and No. 3: Soil Logging & Sampling for Direct Push and Hollow-Stem Auger Rotary Drilling (Appendix C).

The ITRC guidance (ITRC 2020, Sections 4.4.2 and 4.6) describes methods for collecting soil ISM samples from cores. While under ideal circumstances the entire core depth interval should be considered as an increment and combined with the other increments to create an ISM sample, this approach generates very large ISM samples that pose logistical problems. Depending on the core diameter, subsampling of the core may be needed in the field to reduce final sample mass. The target sample mass is 1.5 kilograms (kg). Depending on core diameter, the core sample in the target depth interval would generate too large of a sample. If so, mass reduction in the field is needed. Mass reduction techniques are described in detail in Section 4.6 of the ITRC guidance (ITRC 2020), which is provided in Appendix D.

Figure 2-2 provides an example schematic of subsurface decision units, with increment collection from various depth intervals of all borings.

Sample cores from each boring will be obtained within a 4-ft acetate liner, which will be opened to expose the soil core from the surface to the target depth of 3 ft bgs. In up to two locations per sample area, borings will be advanced to 10 ft bgs or to refusal to evaluate for the presence or absence of staining, creosote, or elevated PID readings in subsurface soil (no samples will be collected for analysis).

2.1.4.1 SVOC Sample Collection

Upon core collection, the coring tube will be opened and a representative vertical wedge of the core for each 1-ft interval will be collected for analysis. An individual increment consists of a wedge of soil, approximately one-third of the core, collected from across the entire length of each 1-ft depth interval. To form a complete ISM sample, each individual increment from the same depth interval of the 50 separate cores are combined, as described in Appendix D (ITRC 2020, Section 4.6.1.1). Depending on soil type, wedge sampling may not be possible. In this case, plug subsampling is practical and shall be performed instead. Plugs or measuring cups are used to collect a designated amount of soil from random locations within each 1-ft interval to form one increment. Each increment from the same depth interval of 50 separate cores are combined to form a complete ISM sample, as described in Appendix D (ITRC 2020, Section 4.6.1.2).

Increments are placed directly into the container that will hold the final ISM sample. This sample should not be further homogenized, other than the ISM processing procedures that will be performed by the analytical laboratory (Section 2.2). The target sample mass for non-volatile analyses is 1.5 kg; therefore, each increment will be approximately 30 grams (g). The 1.5-kg mass allows for the analytical laboratory to perform the soil sample preparation per TGM and ITRC guidance.

2.1.4.2 BTEX Sample Collection

Volatile BTEX compounds require one (or more) Encore or Terracore plugs per increment. If soil in the cores appears homogeneous with no localized staining, 1 plug per increment (equal to 12-inch plug spacing) is acceptable. Supplies for additional plugs should be on hand in the event that layering or staining is observed. Sample handling and mass reduction for volatile analysis requires prompt collection and preservation techniques to minimize the potential loss of volatile organic compounds (VOCs), as described in Appendix D (ITRC 2020, Section 4.6.2). Soil increments for volatile analyses will be collected with an Encore or Terracore plug[12] (approximately 5 g of sample) from the open cores and will be placed directly into a 1,000 milliliter (mL) amber glass bottle with a predetermined volume of methanol as preservative (1 mL per 1 g of sample). The Encore or Terracore plugs should be completely filled with soil before placing into the amber glass bottle so that each increment has the same volume of soil. A 1,000 mL amber glass bottle is sufficient for 50 increments. This sample collection procedure is based on methods described in EPA SW-846 Method 5035A, with a minor modification to the sample container to accommodate the increased number of increments and methanol volume per ISM sample.

For the volatile analyses (BTEX), a small glass jar will also be used to collect additional soil for percent moisture determination, so that the laboratory can report the results in dry weight. A second increment of soil for percent moisture evaluation will be collected in the same manner as the ISM for volatile samples, but this second increment will be placed in an unpreserved container (4 ounce [oz] or larger) and submitted to the laboratory (ITRC 2020, Section 4.2.5).

Soil sample locations will be documented with the use of a Leica Zeno GG03 SmartAntenna that connects to Lieca Zeno 5 global positioning system (GPS) handheld unit (or similar device). The GPS unit will also record approximate elevation information.

2.1.4.3 Soil Descriptions

The following observations will be recorded in the field logbook (SOP No. 3: Soil Logging & Sampling for Direct Push and Hollow-Stem Auger Rotary Drilling):

- Soil texture (Unified Soil Classification System classification)
- Soil color (Munsell classification)
- Heterogeneity of soil texture and color across the core and the increment.
- Presence of debris (natural or anthropogenic objects)
- Presence of oily sheen or obvious contamination

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[12] The same plug can be used for a given ISM sample.

- Odor (for example, petroleum) or PID readings
- Decision unit coordinates
- GPS coordinates of the boundaries of each decision unit.

2.1.5 Yard Restoration Plan

Following drilling, each borehole will be backfilled with soil from the core, assuming the absence of staining or creosote, or with bentonite chips, to approximately 8 inches below land surface. Bentonite chips will be hydrated using approximately 5 oz of fresh water for every 1 pound of bentonite. Boreholes will be filled to the surface with commercially purchased topsoil.

At the completion of the sampling in each decision unit, the yards will be re-seeded on the boreholes themselves and in the tracked area(s), as needed, to return the yards to an in-kind condition. The properties will be revisited approximately 2 weeks following field activities to check for subsequent issues (e.g., settling). Field staff will take before and after photographs of each property at the time of the event, and during the post-event follow-up visit.

2.2 LABORATORY ANALYTICAL PROCEDURES

It is anticipated that samples will be processed by PACE (Green Bay, Wisconsin) and analyzed by PACE (Lenexa, Kansas). Upon receipt by the analytical laboratory, samples will be prepared for analysis in accordance with ISM procedures outlined below and consistent with the TGM (HDOH 2021), ITRC guidance (ITRC 2020), and laboratory standard operating procedures. This will include air drying, sieving to less than 2 mm, and incremental subsampling to collect analytical aliquots, as described in Section 5.3 of ITRC (2020). Sample processing specifically for volatile ISM sampling is described in Section 5.3.6 of ITRC (2020).

Samples will be analyzed for SVOCs using EPA Method SW8270C and BTEX by SW8260C. A complete analyte list is provided in Table 2-2. The laboratory will also measure percent moisture in the processed sample aliquot as a check that soil was sufficiently air-dried.

2.3 SAMPLE CHAIN-OF-CUSTODY AND TRANSPORTATION

Sample coolers and packing material will be supplied by the analytical laboratories. Individual sample containers will be labeled, placed into plastic bags, and sealed. Soil samples for analysis of SVOCs will be placed in resealable plastic bags,[13] while samples for BTEX analysis will be

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[13] Sealable plastic bags are approved for this use in the TGM. Wide-mouth glass jars are an acceptable alternative if required by the laboratory.

placed in 1,000 mL glass bottles and samples for moisture content will be placed in separate, smaller glass jars. Ice in sealed, heavy-duty plastic bags will be placed in the cooler for delivery to the laboratory. When a cooler is full, the completed chain-of-custody form will be placed into a resealable bag and taped to the inside lid of the cooler. If temperature blanks have been provided by the laboratory, one temperature blank will be placed in each sample cooler.

Each cooler will be wrapped with packing tape to prevent opening and sealed with one laboratory-provided chain-of-custody seal. Coolers containing samples for chemical analysis will be transported to the appropriate laboratory by courier. Preserved BTEX bottles require ground transportation because of limitations in shipping methanol via air. Full chain-of-custody procedures are presented in EWI SOP No. 5: Chain of Custody Documentation (Appendix C).

After the samples have been received by the laboratory, they will be stored under refrigeration (≤6°C). If chemistry samples are requested for archive, they will be stored at -20°C.

2.4 SAMPLE IDENTIFICATION

Sample identifiers will be assigned to each sample as it is collected, and the proposed identifiers are presented in Table 2-1. Sample identifiers consist of codes designed to fulfill several purposes, including identifying related samples (i.e., replicate samples) to provide for proper data analysis and interpretation, and tracking individual sample containers to confirm that the laboratory receives the material associated with each sample. To accomplish these objectives, each container will be assigned a unique sample identifier.

Sample identifiers for this investigation will consist of the following elements:

- Prefix “SS”: designating soil samples
- Property ID: three-digit number, as indicated in Table 1-1 and Figure 1-1
- Yard designation: F for front yard, B for backyard
- Depth interval: in feet
- Date: in MMYYYY format.

For example, a 0–1 ft sample collected from the front yard of Property 015 on July 5, 2022, would be identified as SS-015-F-0-1_072022.

The equipment blank, field blank, and trip blank will follow the format of EB-MMYYYY, FB-MMYYYY, and TB-MMYYYY using the date collected in two-digit month, four-digit year format.

2.5 DECONTAMINATION PROCEDURES

Decontamination of sampling equipment will be conducted consistently to maintain the quality of the samples collected, as described here and consistent with the EWI Quality Assurance Project Plan (QAPP) for the Facility (EWI 2020b). Reusable field tools and equipment will be cleaned and decontaminated with a nonphosphate detergent (such as Alconox) and triple-rinsed with distilled water between sample collection efforts at each decision unit. Tools and equipment will not be cleaned between increments of the same decision unit, but will be cleaned before proceeding to the next decision unit. Cleaned small equipment will be stored in plastic bags, whereas large equipment will be stored on plastic sheeting. Materials to be stored on plastic sheeting for more than a few hours will be covered. Disposable equipment intended for one-time use will not be decontaminated but will be packaged for appropriate disposal.

Sampling personnel will wear disposable nitrile gloves, which will be changed after handling each composite or ISM sample, and between sampling decision units to limit cross-contamination.

2.6 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste generated during the work will include excess soil from sampling and sample processing, decontamination fluids, and disposable sampling materials such as used personal protective equipment, paper towels, etc.

Investigation-derived waste will be handled consistent with EWI SOP No. 18, Investigative Waste Management (Appendix C).

Excess soil remaining after sample processing and not returned to the boring location will be containerized in a Department of Transportation-approved 55-gallon drum which will have lids firmly secured when not receiving waste and prior to being transported to the Facility by EWI for management and disposal. For soil, a representative sample will be collected from the contents of each drum at the completion of field sampling activities and will be analyzed for various parameters to characterize the waste prior to disposal (parameters provided in Table 2-3). Disposal of this waste will be selected based on sampling results for excess soil. A licensed waste hauler will pick up the waste drums for offsite disposal at a facility approved by the Multistate Trust. A Multistate Trust representative (or designee) will sign the waste manifest(s).

Wastewater from the equipment decontamination process will be containerized in 5-gallon buckets and transported to the Facility, where it will be combined with other off-Facility purge and decontamination water for off-Facility disposal (these wastes cannot be treated via the Treatment System [Wastewater Permit Number 720]). Off-Facility purge water and decontamination water will be profiled and disposed of directly to the designated Publicly Owned Treatment Works Facility.

Following the removal of excess soil from gloves, paper towels, etc., disposable materials used in sample collection will be bagged in plastic garbage bags and disposed of as nonhazardous solid waste.

3 QUALITY ASSURANCE AND QUALITY CONTROL

This section presents the quality assurance and quality control (QA/QC) procedures that will be implemented so that the investigation data results are defensible and usable for their intended purpose. These procedures are consistent with the EWI QAPP for the Facility (EWI 2020b).

3.1 CHAIN-OF-CUSTODY MAINTENANCE

A chain-of-custody form will be used to document sample collection and shipment to the laboratory for analysis. The chain-of-custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Until the samples are transported, the custody of the samples will be the responsibility of EWI. A chain-of-custody form similar to the one included at the end of SOP No. 5 will be used.

3.2 SAMPLE IDENTIFICATION

Samples will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory, as described in Section 2.4. Each sample will have a preassigned, descriptive, unique sample identifier. Each sample container will be labeled to include the sample identifier, date and time of collection, sampler(s), analytical parameters, preservation method, and sample matrix.

3.3 FIELD QUALITY CONTROL CHECKS

Field quality control samples will be used to assess sample variability and whether cross-contamination between samples has occurred during sampling. If quality control problems are encountered, corrective actions (if appropriate) will be implemented to meet the data quality specifications.

3.3.1 Trip Blanks

Trip blanks (minimum of one per cooler) are provided by the laboratory for analysis for VOCs. Trip blanks are prepared by the laboratory and contain a designated volume of methanol. The trip blanks are shipped with the sample jars, kept in storage and transported with the samples collected, and returned to the laboratory unopened for analysis of VOCs.

3.3.2 Field Blanks

Field blanks are analyte-free water (methanol for VOCs) poured into the container in the field, preserved, and shipped to the laboratory with field samples. They are used to assess contamination from field conditions during sampling. One field blank will be collected for SVOC and VOC analysis.

3.3.3 Equipment Blanks

Equipment blanks are a sample of analyte-free media that has been used to rinse common sampling equipment to check the effectiveness of decontamination procedures. They are used to assess contamination from field conditions during sampling. One equipment blank will be collected for each type of reusable sampling equipment.

3.3.4 Temperature Blanks

Temperature blanks will be used by the laboratory to measure the temperature of the samples upon receipt at the testing laboratory. Temperature blanks will be prepared at the testing laboratory by pouring distilled/deionized water into a vial and tightly closing the lid. The blanks will be transported unopened to and from the field in the cooler with the sample containers. A temperature blank shall be included with each sample cooler transported to the testing laboratory.

3.3.5 Field Replicates

Field replicate samples will be collected and analyzed to provide a measure of total sampling and analysis error, with statistical evaluation described in Section 3.6. The TGM recommends collecting triplicate incremental samples (incremental sample plus two replicate samples) from 10 percent of the decision units sampled; therefore, three decision units will be sampled in replicate fashion and an additional six samples will be collected to meet this guidance (TGM 2021). Incremental collection methods for replicate samples are described in Section 2.1.3. Replicates will be assigned unique sample identifiers. Replicate ISM samples will be collected from one location type at one property, as indicated in Table 2-1. The selection of decision units for replicate collection may vary slightly from those planned in this ISM Work Plan, based on field conditions, access issues, or other unforeseen field constraints.

3.4 LABORATORY QUALITY CONTROL CHECKS

Laboratory quality control samples include laboratory method blanks, surrogate standards, laboratory control samples, laboratory replicates, and matrix spike and matrix spike duplicate samples. The laboratory will also process one (laboratory) equipment blank per day with the samples for SVOC analysis. Extensive and detailed requirements for laboratory quality control procedures are provided by EPA and standard method protocols that will be used for this study. Each method protocol includes descriptions of quality control procedures, and many incorporate additional quality control requirements by reference to separate quality control chapters in the protocols. Quality control requirements include control limits and requirements for corrective action in many cases. Quality control procedures will be completed by the laboratory, as required in each protocol.

As required by EPA SW-846 methods, performance-based control limits are established by the laboratory. These and all other control limits specified in the method descriptions will be used by the laboratory to establish the acceptability of the data or the need to reanalyze the samples.

3.5 DATA VALIDATION

A Level 4 quality assurance report package will be requested for data submitted to the laboratory. Level 4 data validation will be performed for 10 percent of the collected data, and Level 2B quality validation will be completed for the remaining samples. The Level 2B data package includes explanation of data flags applied by the laboratory; a case narrative documenting noncompliance with the laboratory quality assurance manual and corrective action of noncompliance events, if any; sample analytical data sheets; surrogate recovery reports; laboratory reports that document the necessary quality control samples, including method blanks, laboratory control samples and their duplicates, surrogate spikes, matrix spike and matrix spike duplicate samples, and initial and continuing calibration blanks; sample receipt checklist; and client chain-of-custody forms. Level 4 data validation will include verification of continuous calibration for the laboratory equipment, a review of sample chromatograms, and verification of analyte identification and calculations.

Chemical laboratory data will be validated by EWI according to protocols set forth in the *National Functional Guidelines for Organic Superfund Methods Data Review* (USEPA 2020) and consistent with EWI SOP No. 17: QA/QC Review of Laboratory Analytical Reports (for Level 2B validation), and SOP No. 17B: QA/QC Review of Analytical Laboratory Results for Level 4 Data Packages: Volatiles and Semivolatiles Analysis (for Level 4 validation) (Appendix C). The assessments will be completed using EWI's "QA/QC Review of Laboratory Analytical Reports" form for Level 2B and "Level 4 Data Validation Forms" for samples selected for Level 4 assessment, which will be filled out and attached to analytical reports. Additional data verification and validation procedures are detailed in Section D of the QAPP (EWI 2020b). Data validation for all samples will include review of the data and comparison to laboratory performance criteria (method detection limits, level of quantification, holding times, precision, and bias, as specified in Table 1 of the QAPP [EWI 2020b]). Attainment of these quantitative performance criteria will confirm that the data collected are sufficient and of adequate quality for their intended uses. Data that do not meet these criteria will be qualified during data validation, their limitations will be noted, and qualifiers will be added to the tabulated data, when appropriate. Issues noted in Level 4 review of processed chromatograms will be discussed with the laboratory, with resolution or remaining issues documented in the final report.

3.6 STATISTICS FOR DATA EVALUATION

Replicate incremental samples will be collected at a 10 percent frequency (Section 3.3.5). The ITRC and TGM guidance documents recommend the collection of three field replicates, yielding three different values from which to compute summary statistics. The relative standard deviation is a measure of the precision in replicate samples, typically three replicates (ITRC 2020). For each replicate sample group, a relative standard deviation will be calculated as the standard deviation of the sample replicates divided by the mean of the sample replicates, multiplied by 100 percent. A preliminary target relative standard deviation of less than 35 percent will be indicative of low sampling/analytical variability error. Replicate data with a relative standard deviation greater than 35 percent will be further evaluated for data usability. As ITRC and TGM guidance documents point out, high relative standard deviations can become unavoidable when concentrations are very low, approaching the method reporting and detection limits.

4 DOCUMENTATION AND REPORTING

This section describes documentation procedures while in the field, and also outlines the investigation report that will be prepared once laboratory results are received and data validation is completed.

4.1 FIELD DOCUMENTATION

A complete record of field activities will be maintained as described in this section.

4.1.1 Field Logbook

Field logbooks must be used to record daily activities during field sampling events. Modifications, decisions, and/or corrective actions to the study design and procedures identified in this ISM Work Plan will be discussed with and approved by the Integral project manager prior to field implementation and will be documented in the field logbook.

4.1.2 Field Data Management

Daily field records (a combination of the field logbook, GPS records, and chain-of-custody forms) will make up the main documentation for field activities. Upon completion of sampling, hard copy notes and forms will be scanned to create an electronic record for use in creating appendices to the data report. Information on sampling locations, dates, equipment, and other conditions, as well as sample identifiers, will be entered into a project database.

4.1.3 Photographs

Photographs will be taken at representative sampling locations and other areas of interest at the site or sampling area and will serve to confirm information entered in the field logbook. Property condition will be photographed before and immediately following the field event, as well as at the 2-week follow-up. Photographs will be date-stamped and a brief description of each one will be recorded in the field logbook, along with the name of the person taking the photograph.

4.2 INVESTIGATION REPORT

A report of the findings will be generated to summarize the results of the screening, sampling, and analysis activities. Soil chemistry data generated by this investigation will be compared with the EPA RSLs or MRBCA RBTLs (Section 1.3 for details). The soil chemistry data will be presented in tables containing sampling locations, concentrations with validated qualifiers as appropriate, and exceedances, if any, of the screening levels.

A data report will be prepared with the following information:

1. Introduction
2. Deviations from the ISM Work Plan
3. Maps showing actual sampling locations/decision unit boundaries
4. Data tables
5. Data evaluation
6. Recommendations for additional investigation or remediation, if any
7. Appendices, including laboratory reports and data validation reports and key photographs.

4.3 PROPERTY OWNER LETTERS

A letter summarizing the data collected, associated findings, and recommendations for additional actions, if any, will be prepared for each property that is sampled, and the letters will be submitted to the property owner after validation of the data for the property and preparation of the property-specific letter. Copies of the letters, with property owner's personally identifiable information removed, will be submitted to MoDNR, the City of Springfield, City Utilities, and Greene County.

5 SCHEDULE

The following table summarizes the anticipated schedule following MoDNR approval of this ISM Work Plan. The schedule is subject to receipt of access agreements and laboratory timetables.

Activity	Responsible Party	Time after ISM Work Plan Approval
MoDNR ISM Work Plan Approval	MoDNR	09/30/22 (anticipated)
Access Agreement Acquisition	EWI	6 weeks
Field Sampling Event	EWI	12 weeks
Laboratory Analysis, Data Importation/Management, Data Validation	EWI	16 weeks
Draft Report and Draft Property Owner Letters: Multistate Trust Review Copies	Integral	23 weeks
Multistate Trust Draft Report/Letter Comments	Multistate Trust	25 weeks
Property Owner Letter Mailing	Integral	27 weeks
Draft Report: MoDNR Review Copy	Integral	27 weeks

6 REFERENCES

Dicks, D. 2009. Personal communication (e-mail to R .Nussbaum and M. Rader, Missouri Department of Natural Resources, Jefferson City, MO, dated February 27, 2009). Missouri Department of Natural Resources, Jefferson City, MO.

EWI. 2016. Remedial Action Optimization Work Plan, Former Tronox Facility, Springfield, MO, MOD007129406. Prepared by Environmental Works, Inc., Springfield, Missouri. August 16.

EWI. 2018. RAO Update and Recommendations Memorandum (Revised), Former Tronox Wood Treating Facility, Springfield, Missouri. Prepared by Environmental Works, Inc., Springfield, Missouri. August 30.

EWI. 2020a. Residential Property Sampling Work Plan—Revision 3, Greenfield Environmental Multistate Trust LLC—Springfield Facility, Former Tronox/Kerr-McGee Facility; 2800 West High Street, Springfield, Missouri, MHWMF Part I Permit No. MOD007129406. Prepared by Environmental Works, Inc., Springfield, Missouri. August 5.

EWI. 2020b. Quality Assurance Project Plan, Missouri Hazardous Waste Management Facility Permit Number MOD007129406. Prepared by Environmental Works, Inc., Springfield, Missouri. April.

EWI. 2022. 2021 Annual Groundwater and Corrective Action Report, Greenfield Environmental Multistate Trust LLC—Springfield Facility, Former Tronox/Kerr-McGee Facility; 2800 West High Street, Springfield, Missouri, MHWMF Part I Permit No. MOD007129406. Prepared by Environmental Works, Inc., Springfield, Missouri. February 28.

Garcia, B. 2022a. Personal communication (e-mail to S. Ashurst, Integral Consulting Inc., Seattle, WA, dated April 27, 2022, regarding Clifton Drainage area flooding observations). Environmental Works, Inc., Springfield, MO.

Garcia, B. 2022b. Personal communication (e-mail to S. Ashurst, Integral Consulting Inc., Seattle, WA, dated June 17, 2022, regarding Clifton Drainage area flooding observations). Environmental Works, Inc., Springfield, MO.

Garcia, B. 2022c. Personal communication (e-mail to S. Ashurst, Integral Consulting Inc., Seattle, WA, dated April 20, 2022, regarding City of Springfield sewer maintenance excavation observations in 2020). Environmental Works, Inc., Springfield, MO.

HDOH. 2021. Technical guidance manual for the implementation of the Hawai'i contingency plan. Interim final (July 2021), as updated at https://health.hawaii.gov/heer/tgm/. Hawaii State Department of Health, Honolulu, HI.

Integral. 2019. Final Off-Facility Investigation Work Plan, Former Tronox/Kerr-McGee Facility 2800 West High Street, Springfield, Missouri, EPA ID Number MOD007129406. Prepared by Integral Consulting Inc., Seattle, Washington. July 31.

ITRC. 2020. Incremental sampling methodology update. https://ism-2.itrcweb.org/. The Interstate Technology & Regulatory Council, Washington, DC. October.

Jackson, J. 2019. Personal communication (e-mail to M. Hogan., Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust, dated June 11, 2019). Environmental Works, Inc., Springfield, MO.

Jacobs. 2020. Utility Caution Protocol for City Utilities and City of Springfield Infrastructure Near the Former Tronox/Kerr-McGee Facility, Greenfield Environmental Multistate Trust LLC—Former Tronox/Kerr-McGee Facility; 2800 West High Street, Springfield, Missouri. Prepared by Jacobs, Denver, Colorado. November.

Jacobs. 2022. Vapor Intrusion Investigation Summary Report, Greenfield Environmental Multistate Trust LLC—Springfield Facility, Former Tronox/Kerr-McGee Facility; 2800 West High Street, Springfield, Missouri, MHWMF Part I Permit No. MOD007129406. Prepared by Jacobs, Denver, Colorado. May 2.

MoDNR. 2006. Missouri Risk-Based Corrective Action Technical Guidance. Prepared by Missouri Department of Natural Resources. April.

MoDNR. 2013. Missouri Risk-Based Corrective Action Process for Petroleum Storage Tanks. Prepared by Missouri Department of Natural Resources. October 17.

Multistate Trust. 2020. Missouri Hazardous Waste Management Facility Part I Consolidated Permit Application for Former Tronox/Kerr-McGee Facility at Springfield, Missouri, EPA I.D. No. MOD007129406. Prepared by Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust. March.

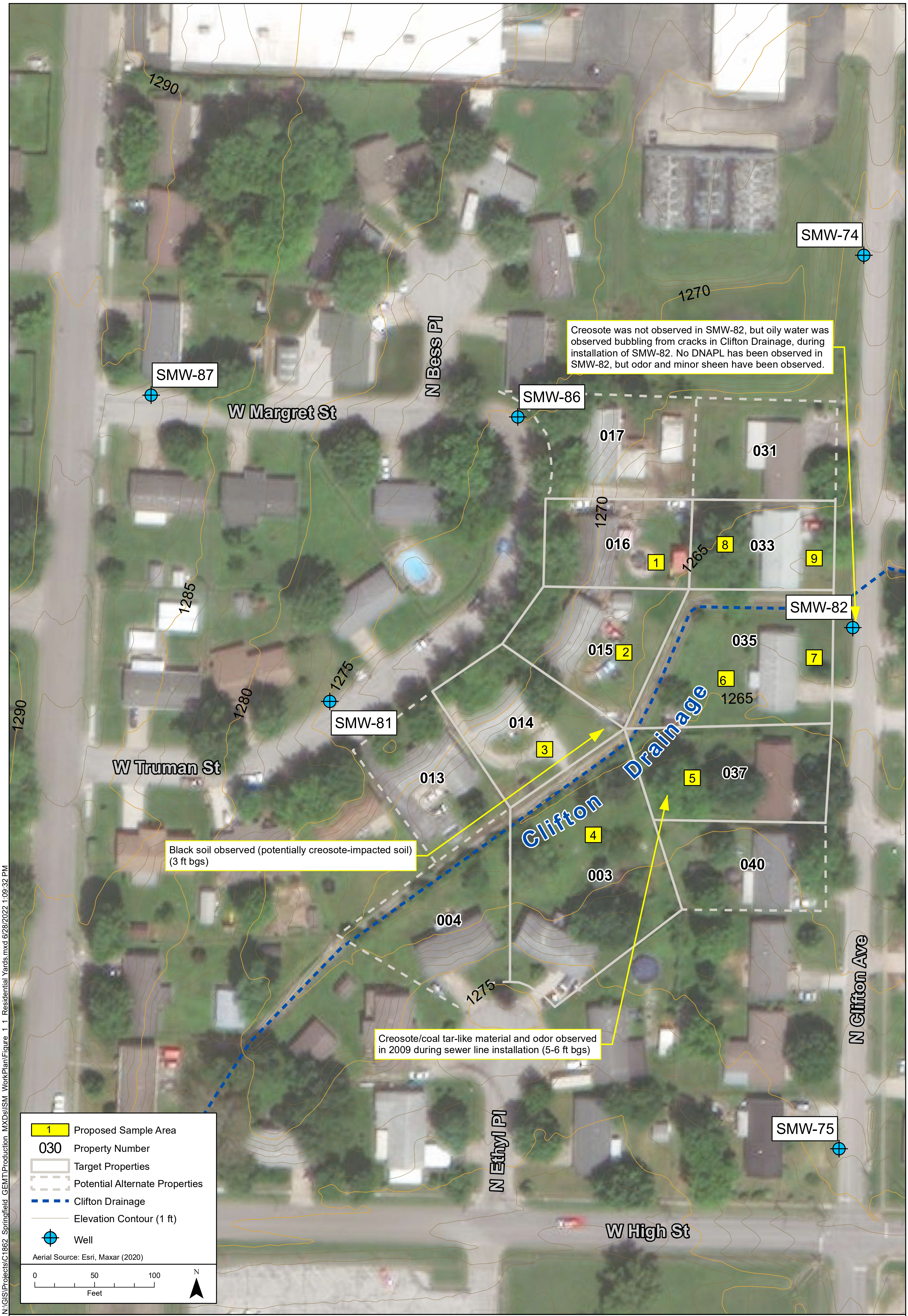
Multistate Trust. 2021. Written Notification of Unauthorized Discharge Greenfield Environmental Multistate Trust LLC—Springfield Facility Former Tronox/Kerr-McGee Facility, 2800 West High Street, Springfield, Missouri: MHWMF Part 1 Permit No. / EPA I.D. No. MOD007129406, MSOP MO-0117331. Prepared by Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust. March.

USEPA. 2019. Incremental Sampling Methodology (ISM) at Polychlorinated Biphenyl (PCB) Cleanup Sites. Available at: https://www.epa.gov/sites/default/files/2019-08/documents/incremental_sampling_methodology_at_pcb_cleanup_sites.pdf. U.S. Environmental Protection Agency. August.

USEPA. 2020. EPA 540- R- 20-005, National Functional Guidelines for Organic Superfund Methods Data Review, November 2020. Office of Superfund Re mediation and Technology Innovation, Washington, DC. November.

USEPA. 2021. Regional Screening Levels (as of November 2021). https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables. Accessed April 15, 2022. U.S. Environmental Protection Agency.

Figures



N:\GIS\Projects\C1862 Springfield GEMT\Production MXDs\ISM WorkPlan\Figure 1 1 Residential Yards.mxd 6/28/2022 1:09:32 PM

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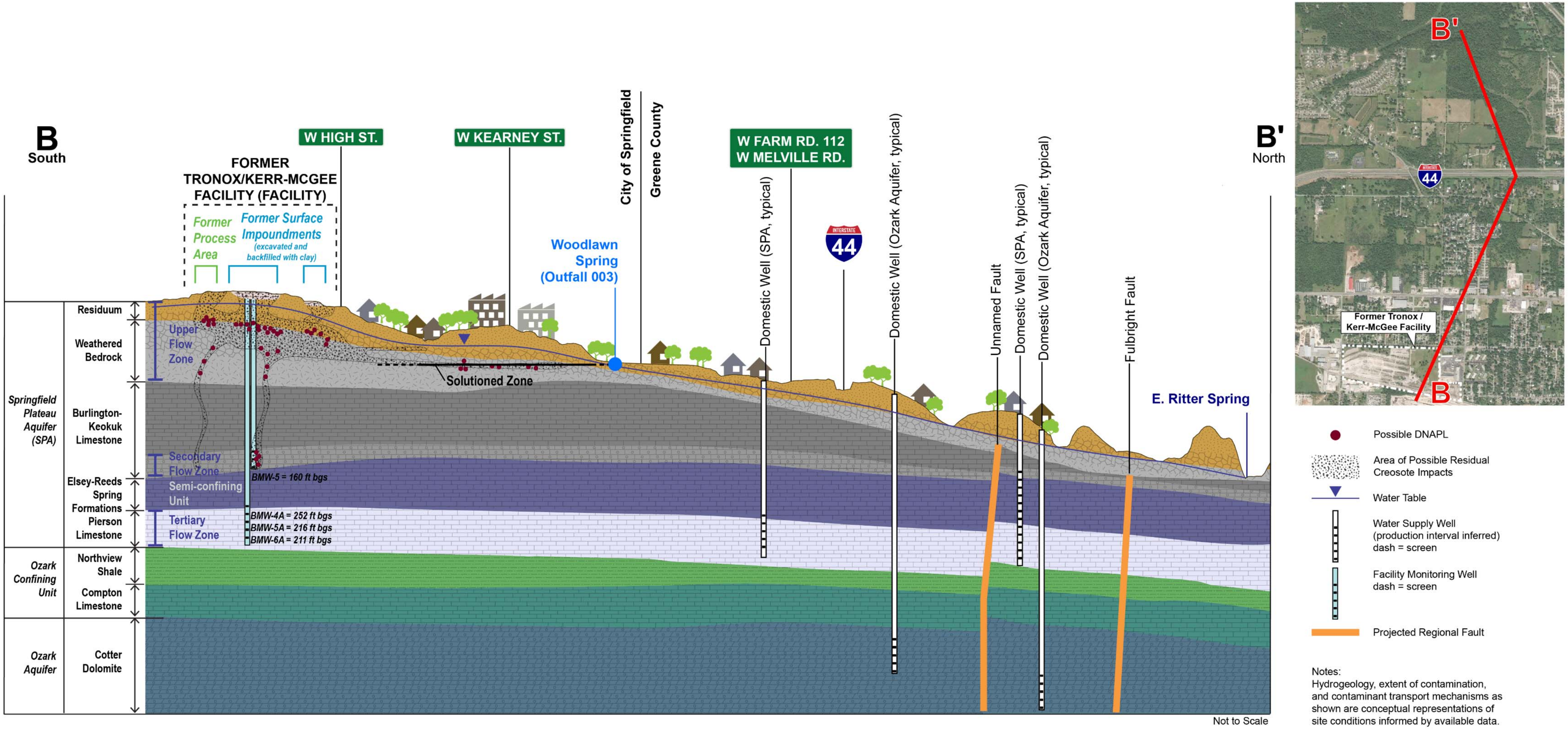
Trustee of the Multistate Environmental Response Trust

Prepared by: integral consulting inc. ENVIRONMENTAL WORKS

Figure 1-1.
Select Residential Yards for Incremental Sampling Evaluation
with Annotations of Staining/Creosote Observations
Greenfield Environmental Multistate Trust LLC - Springfield Facility
2800 West High Street, Springfield, Missouri
Residential Yards Incremental Sampling Methodology Work Plan
August 2022



Notes:
Hydrogeology, extent of contamination, and contaminant transport mechanisms as shown are conceptual representations of site conditions informed by available data.

4/15/2022

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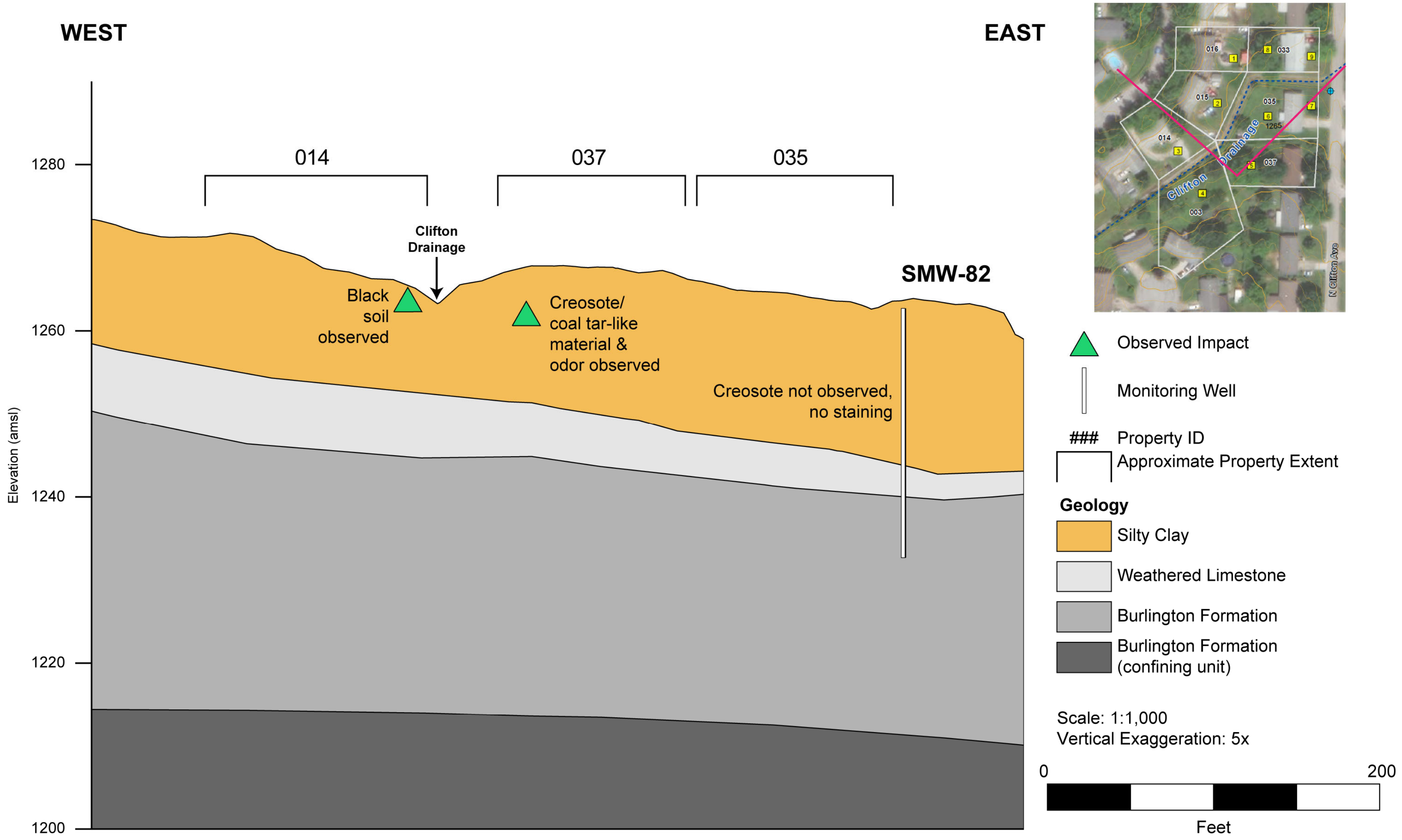
Trustee of the Multistate Environmental Response Trust

Prepared by: integral consulting inc. ENVIRONMENTAL WORKS

Source: Integral (2019)

Figure 1-2.
Schematic Cross Section and Conceptual Site Model
Greenfield Environmental Multistate Trust LLC - Springfield Facility
2800 West High Street, Springfield, Missouri
Residential Yards Incremental Sampling Methodology Work Plan
August 2022



6/27/2022

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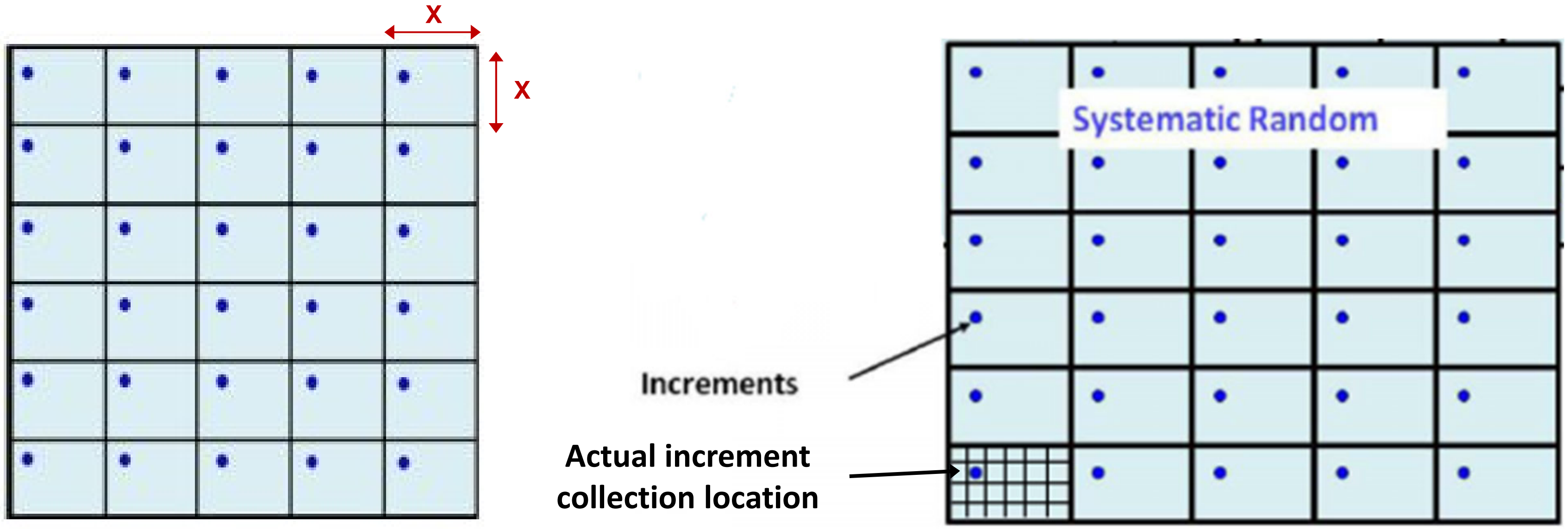
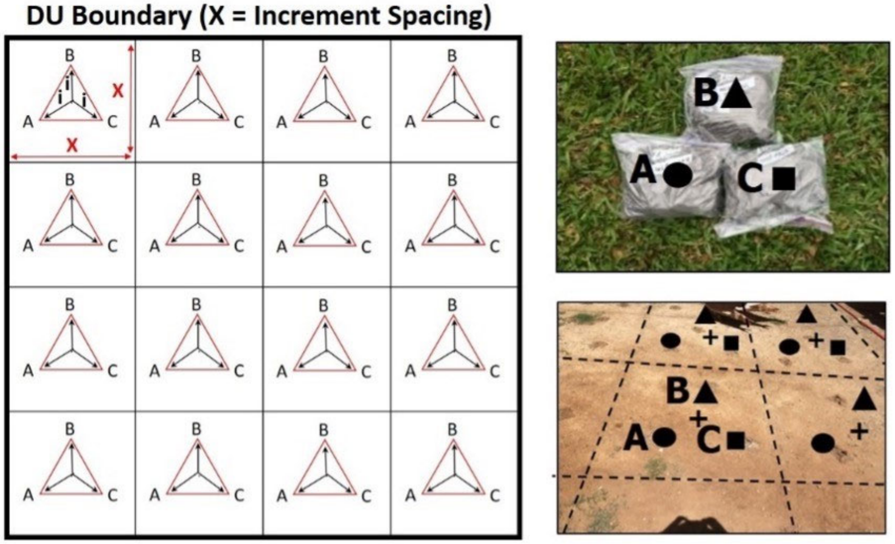
Figure 1-3.
Residential Yards Soil Staining/Creosote Observations Cross Section
Greenfield Environmental Multistate Trust LLC – Springfield Facility
2800 West High Street, Springfield, Missouri
Residential Yards Incremental Sampling Methodology Work Plan
August 2022



Replicate Sampling:



$$X = \text{Increment Spacing} = \sqrt{\frac{\textit{Decision Unit Area}}{\textit{\# of Increments}}}$$

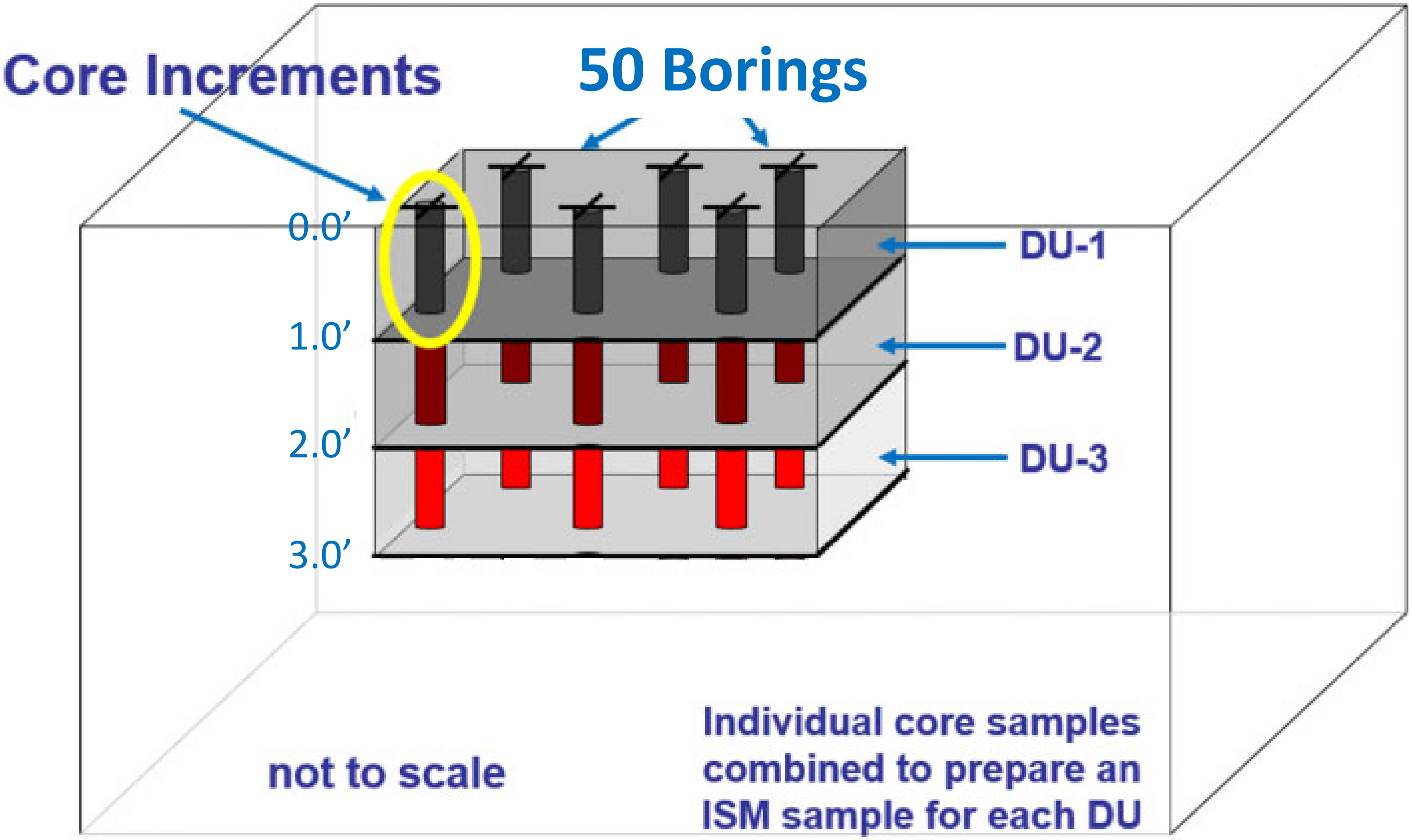
Sources: ITRC (2020); HDOH (2021)

6/27/2022

Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral consulting inc. ENVIRONMENTAL WORKS

Figure 2-1.
Systematic Random Sampling Grid Diagram with Replicate Example
Greenfield Environmental Multistate Trust LLC – Springfield Facility
2800 West High Street, Springfield, Missouri
Residential Yards Incremental Sampling Methodology Work Plan
August 2022



Source: ITRC (2020), modified

6/27/2022

Prepared for: Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

Prepared by: integral consulting inc. ENVIRONMENTAL WORKS

Figure 2-2.
Subsurface Incremental Sampling Decision Units Diagram
Greenfield Environmental Multistate Trust LLC – Springfield Facility
2800 West High Street, Springfield, Missouri
Residential Yards Incremental Sampling Methodology Work Plan
August 2022

Tables

Table 1-1. Target Properties and Sample Areas for Incremental Sampling Methodology Investigation

Proposed Sample Area	Property Number	Yard	Street
1	016	Back	W TRUMAN ST
2	015	Back	W TRUMAN ST
3	014	Back	W TRUMAN ST
4	003	Back	N ETHYL PL
5	037	Back	N CLIFTON AVE
6	035	Back	N CLIFTON AVE
7	035	Front	N CLIFTON AVE
8	033	Back	N CLIFTON AVE
9	033	Front	N CLIFTON AVE

Notes:

Property Number aligns with property numbers assigned for the Vapor Intrusion Investigation (Jacobs 2022).

Personally identifiable information has been excluded.

Potential alternate neighboring properties (e.g., Properties 004, 013, 017, 013, 031, and 040) may be considered if an owner/resident of a target property refuses access.

Table 1-2. Data Quality Objectives

Issue Statement	Data Collection Objective	Investigation Approach / Scope Overview	Decision Factors or Criteria
There are potential impacts to soil in the residential neighborhood along Clifton Drainage northeast of the Facility. It is unknown if there are surficial soil impacts to local residential yards.	• Obtain surface soil data from select residential yards at 1) areas generally of lower elevation along the Clifton Drainage or 2) where potential impacts have been observed, both to evaluate the presence or absence of Facility-related COCs, and if present, the concentration thereof.	• Perform unsaturated, surficial soil sampling (0-3 ft bgs) following incremental sampling methodology where access is granted. • If NAPL or staining is encountered, that increment will be removed from the decision unit. Field assessment will determine if a new decision unit focused on the impacted area should be made or if individual soil sample(s) for analysis will be collected. Areas containing Facility-related NAPL or staining in surfiical soil will be targeted for future remediation. • Analyze soil samples for Facility-related COCs (SVOCs and BTEX).	• Replicate samples will be statistically evaluated (relative standard deviation) as a measure of precision. A preliminary target relative standard deviation of less than 35 percent will be indicative of low sampling/analytical variability. Replicate data with a relative standard deviation greater than 35 percent will be further evaluated for data usability. • If Facility-related COCs are not detected at concentrations above EPA Resident Soil RSLs or MRBCA Residential Land Use Soil Tier 1 RBTLs, or if staining/creosote is not present, no further action is necessary. • If Facility-related COCs are detected at concentrations above EPA Resident Soil RSLs or MRBCA Residential Land Use Soil Tier 1 RBTLs, or if staining/creosote is present, data/observations will be used to guide decisions on the need for further evaluation or remediation.
The presence, absence, depth, or extent of impacts in subsurface soils is unknown.	• Collect and log subsurface soil cores to evaluate the presence or absence of staining, creosote, or elevated PID readings.	• Advance soil borings to 10 ft bgs or to refusal in up to two locations per sample area. (No samples will be collected for analysis.)	• Observations will be provided to the property owner and kept on file by EWI in case of utility work notifications.

Notes:

bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene, xylene
COC = chemical of concern
EPA = U.S. Environmental Protection Agency
EWI = Environmental Works, Inc.
Facility = Greenfield Environmental Multistate Trust LLC – Springfield Facility, also known as the Former Tronox/Kerr-McGee Facility located at 2800 West High Street in Springfield, Missouri
MRBCA = Missouri Risk-Based Corrective Action
NAPL = non-aqueous phase liquid
PID = photoionization detector
RBTL = risk-based target level
RSL = regional screening level
SVOC = semivolatile organic compound

Table 2-1. Proposed Decision Units for Incremental Soil Sampling and Sample Containers and Preservation

Proposed Sample Area	Property Number	Location Type	Decision Unit Sample ID	Sample Type	SVOC by 8270C (Cool ≤6°C)	BTEX by 8260C (Cool ≤6°C, Methanol)	Moisture: BTEX (Cool ≤6°C)
1	016	Backyard ISM sample: Soil cores 0-3 ft bgs, 1-ft intervals	SS-016-B-0-1_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-016-B-1-2_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-016-B-2-3_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
2	015	Backyard ISM sample: Soil cores 0-3 ft bgs, 1-ft intervals	SS-015-B-0-1-A_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-015-B-1-2-A_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-015-B-2-3-A_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-015-B-0-1-B_MMYYYY	QC sample	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-015-B-1-2-B_MMYYYY	QC sample	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-015-B-2-3-B_MMYYYY	QC sample	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-015-B-0-1-C_MMYYYY	QC sample	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-015-B-1-2-C_MMYYYY	QC sample	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-015-B-2-3-C_MMYYYY	QC sample	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
3	014	Backyard ISM sample: Soil cores 0-3 ft bgs, 1-ft intervals	SS-014-B-0-1_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-014-B-1-2_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-014-B-2-3_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
4	003	Backyard ISM sample: Soil cores 0-3 ft bgs, 1-ft intervals	SS-003-B-0-1_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-003-B-1-2_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-003-B-2-3_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
5	037	Backyard ISM sample: Soil cores 0-3 ft bgs, 1-ft intervals	SS-037-B-0-1_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-037-B-1-2_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-037-B-2-3_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)

Table 2-1. Proposed Decision Units for Incremental Soil Sampling and Sample Containers and Preservation

Proposed Sample Area	Property Number	Location Type	Decision Unit Sample ID	Sample Type	SVOC by 8270C (Cool ≤6°C)	BTEX by 8260C (Cool ≤6°C, Methanol)	Moisture: BTEX (Cool ≤6°C)
6	035	Backyard ISM sample: Soil cores 0-3 ft bgs, 1-ft intervals	SS-035-B-0-1_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-035-B-1-2_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-035-B-2-3_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
7		Front yard ISM sample: Soil cores 0-3 ft bgs, 1-ft intervals	SS-035-F-0-1_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-035-F-1-2_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-035-F-2-3_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
8	033	Backyard ISM sample: Soil cores 0-3 ft bgs, 1-ft intervals	SS-033-B-0-1_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-033-B-1-2_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-033-B-2-3_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
9		Front yard ISM sample: Soil cores 0-3 ft bgs, 1-ft intervals	SS-033-F-0-1_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-033-F-1-2_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
			SS-033-F-2-3_MMYYYY	Normal	2-gallon Ziplock baggie	1 x 1,000 mL AG	4-oz. glass (or larger)
		Equipment Rinse Blank	—	QC sample	2 x 1000 ml AG	—	—
		Field Blank	—	QC sample	2 x 1000 ml AG	—	—
		Methanol Trip Blank	—	QC sample	—	3 x 40 ml vials, pH < 2 HCl	—

Notes:

— = not applicable
AG = amber glass
bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene, xylene
HCl = hydrochloric acid
ISM = incremental sampling methodology
QC = quality control
SVOC = semivolatile organic compound

Table 2-2. Analytes, Laboratory Analytical Methods, Detection Limits, Reporting Limits, and Screening Levels

						Screening Level		
Facility-Related Chemical of Concern [a]	CAS No.	Analytical Method	Units	Method Detection Limit	Reporting Limit	EPA Resident Soil RSL [b,c]	Risk Basis [d]	MRBCA Residential Land Use Tier 1 RBTLs [e]
Volatile Organic Compounds								
Benzene	71-43-2	SW8260C	mg/kg	0.00049	0.005	1.2	C	177
Ethylbenzene	100-41-4	SW8260C	mg/kg	0.00046	0.005	5.8	C	7,450
Toluene	108-88-3	SW8260C	mg/kg	0.00035	0.005	4,900	N	6,210
Xylene	1330-20-7	SW8260C	mg/kg	0.0011	0.005	580	N	7,830
Semivolatile Organic Compounds								
Acenaphthene	83-32-9	SW8270C	mg/kg	0.0561	0.33	3,600	N	3,130
Acenaphthylene	208-96-8	SW8270C	mg/kg	0.0602	0.33	—		4,180
Anthracene	120-12-7	SW8270C	mg/kg	0.0628	0.33	18,000	N	15,700
Benzo[*a*]anthracene	56-55-3	SW8270C	mg/kg	0.0591	0.33	1.1	C	6.20
Benzo[*a*]pyrene	50-32-8	SW8270C	mg/kg	0.0654	0.33	0.11	C	0.620
Benzo[*b*]fluoranthene	205-99-2	SW8270C	mg/kg	0.0991	0.33	1.1	C	6.19
Benzo[*k*]fluoranthene	207-08-9	SW8270C	mg/kg	0.0551	0.33	11	C	62
Carbazole	86-74-8	SW8270C	mg/kg	0.0583	0.33	—		242
2-Chlorophenol	95-57-8	SW8270C	mg/kg	0.0615	0.33	390	N	342
Chrysene	218-01-9	SW8270C	mg/kg	0.0622	0.33	110	C	599
Dibenz[*a,h*]anthracene	53-70-3	SW8270C	mg/kg	0.0663	0.33	0.11	C	0.620
Dibenzofuran	132-64-9	SW8270C	mg/kg	0.0613	0.33	78	N	137
2,4-Dimethylphenol	105-67-9	SW8270C	mg/kg	0.0616	0.33	1,300	N	1,130
2,4-Dinitrophenol	51-28-5	SW8270C	mg/kg	0.119	1.67	130	N	110
Fluoranthene	206-44-0	SW8270C	mg/kg	0.0609	0.33	2,400	N	2,280
Fluorene	86-73-7	SW8270C	mg/kg	0.0583	0.33	2,400	N	2,200
Indeno[1,2,3-*cd*]pyrene	193-39-5	SW8270C	mg/kg	0.0669	0.33	1.1	C	3.77
2-Methylnaphthalene	91-57-6	SW8270C	mg/kg	0.0453	0.33	240	N	273
Naphthalene	91-20-3	SW8270C	mg/kg	0.0541	0.33	2.0	C	36.3
Phenanthrene	85-01-8	SW8270C	mg/kg	0.0667	0.33	—		2,170
Phenol	108-95-2	SW8270C	mg/kg	0.025	0.33	19,000	N	11,700
Pyrene	129-00-0	SW8270C	mg/kg	0.0575	0.33	1,800	N	1,710

Notes:

[a] As defined in Table 1 of the Facility's Missouri Hazardous Waste Management Facility (MHWMF) Part I Permit No. MOD007129406.

[b] EPA RSLs - Generic Tables (November 2021): https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

[c] RSLs for residential soil (November 2021) are based on a one-in-a-million (1E-06) individual excess cancer risk for carcinogens and a hazard quotient of 1.0 for non-carcinogens. (USEPA 2021)

[d] Risk basis notation: C = cancer endpoint drives screening level; N = non-cancer endpoint drives screening level

[e] MRBCA Tier 1 RBTLs for Residential Land Use, Surficial Soil via ingestion, inhalation, and dermal contact (MRBCA 2006, 2013). 2006 and 2013 values, where overlapping, were identical. Chemicals of concern included in the 2006 MRBCA guidance but not included in the 2013 MRBCA document were retained.

EPA = U.S. Environmental Protection Agency

Facility = Greenfield Environmental Multistate Trust LLC – Springfield Facility, also known as the Former Tronox/Kerr-McGee Facility located at 2800 West High Street in Springfield, Missouri

MRBCA = Missouri Risk-Based Corrective Action

RBTL = Risk-Based Target Levels

RSL = regional screening level

— = not applicable / no standard

Table 2-3. Waste Characterization Parameters (Solids)

Analyte	Analytical Method
Conventionals	
Reactive cyanide	EPA 9012
Total cyanides	EPA 9010C
Flashpoint	ASTM D92
Paint filter	EPA 9095
pH	EPA 9045
Reactivity to water	ASTM D5058-90
Total solids	SM 2540D
Reactive sulfide	EPA 9034
Total sulfides	EPA 9030B
Specific gravity	SM 2710F
Total organic carbon	EPA 9060
Oil&Grease	EPA 9071
Ammonia - N	EPA 350.1
Phosphorus - P	EPA 365.4
Total Analyses	
Semivolatile organic compounds	EPA 8270
Volatile organic compounds	EPA 8260
TAL metals [a]	EPA 6010/7470/7471
PCBs	EPA 8082
TCLP Herbicides	
2,4-D	EPA 1311/8151
2,4,5-TP (Silvadex)	
TCLP Pesticides	
Chlordane	EPA 1311/8081
Endrin	
Heptachlor	
Heptachlor epoxide	
Lindane	
Methoxychlor	
Toxaphene	
TCLP Semivolatile	
o-Cresol	EPA 1311/8270
m-Cresol	
p-Cresol	
Cresol (Total)	
1,4-Dichlorobenzene	
2,4-Dinotrotoluene	
Hexachlorobenzene	
Hexachloro-1,3-butadiene	
Hexachloroethane	
Nitrobenzene	
Pentachlorophenol	
Pyridine	
2,4,5-Trichlorophenol	
2,4,6-Trichlorophenol	

Table 2-3. Waste Characterization Parameters (Solids)

Analyte	Analytical Method
TCLP Metals	
Antimony	EPA 1311/6010/7470
Arsenic	
Barium	
Beryllium	
Cadmium	
Chromium	
Chromium. Hexavalent	
Cobalt	
Copper	
Lead	
Mercury	
Nickel	
Selenium	
Silver	
Thallium	
Vanadium	
Zinc	
TCLP Volatiles	
Benzene	EPA 1311/8260
Carbon tetrachloride	
Chlorobenzene	
Chloroform	
1,2-Dichloroethane	
1,1-Dichloroethene	
1,2-Dichloromethane	
Methyl ethyl ketone	
Tetrachloroethene	
Trichloroethene	
Vinyl chloride	

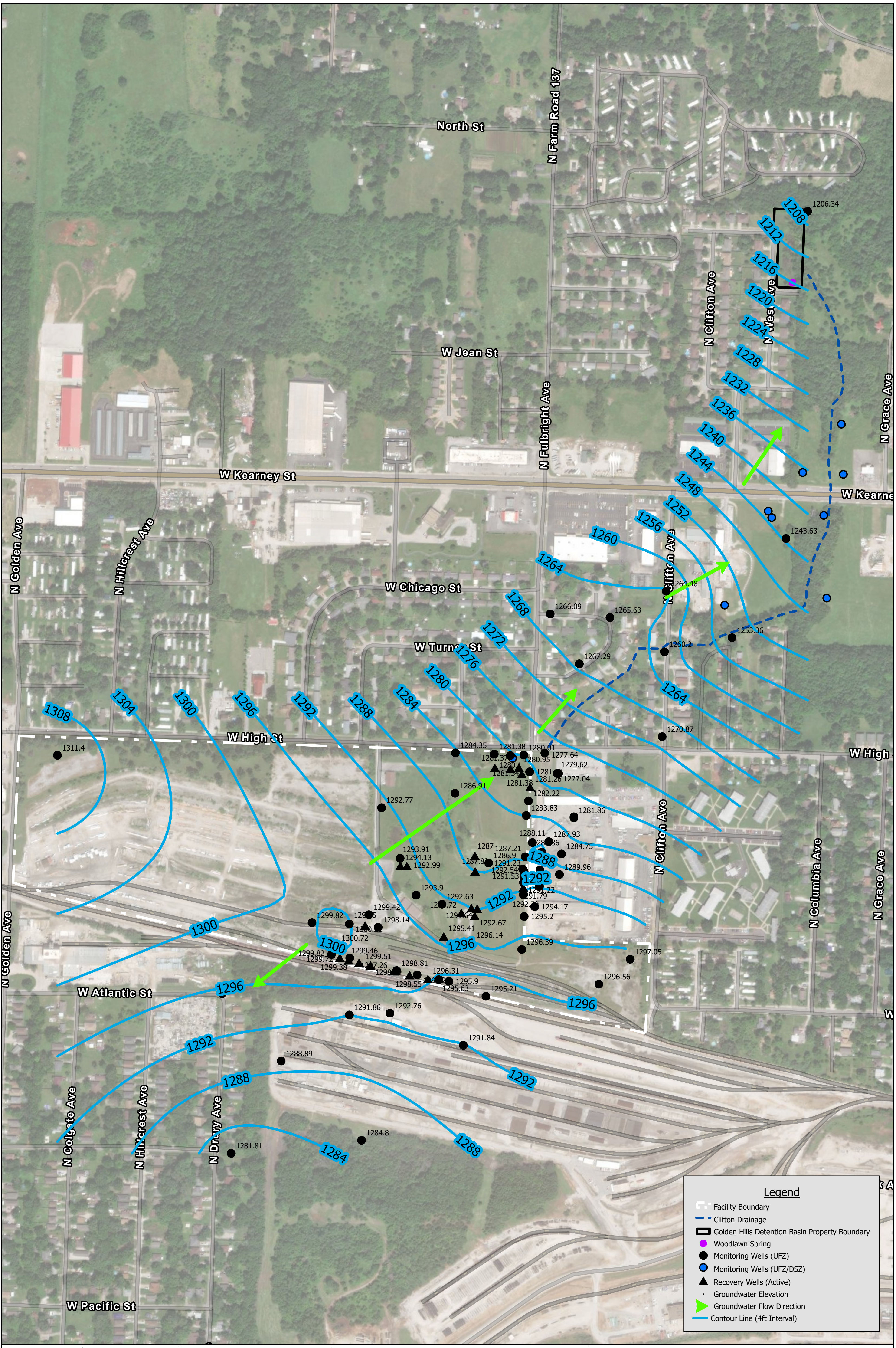
Notes:

[a] Will include hexavalent chromium.

EPA = U.S. Environmental Protection Agency
PCB = polychlorinated biphenyl
TAL = target analyte list
TCLP = toxicity characteristic leaching procedure

Appendix A

Potentiometric Surface Map: Upper Flow Zone



D:\Projects\Multistate_Trust\Springfield\ArcGIS_Pro\Multistate_Trust_Springfield_2021.aprx

NORTH

CHECKED BY:
B. GARCIA

EWI #150683
DRAWN BY: JPG
JAN 21, 2022

SCALE IN FEET
0 120 240 480
APPROXIMATE

PREPARED BY:
ENVIRONMENTAL WORKS

PREPARED FOR:
Greenfield Environmental Multistate Trust, LLC, Trustee of the Multistate Environmental Response Trust

1H2021 Potentiometric Surface Map: Upper Flow Zone

FORMER TRONOX/KERR-MCGEE FACILITY
2800 WEST HIGH ST.
SPRINGFIELD, GREENE COUNTY, MISSOURI

FIGURE
3-5

Appendix B

Residential Property Sampling Access Agreement

Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust
Greenfield Environmental Trust Group, Inc., Member
P.O. Box 723, Durham, NH 03824
(602) 312-6993
tl@g-etg.com

RESIDENTIAL PROPERTY SAMPLING ACCESS AGREEMENT

I [PRINT NAME] ________________________ hereby give permission to the Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust, and its employees, agents and contractors (collectively, the Multistate Trust), to enter upon and have access at reasonable times to the home/business located at [PRINT ADDRESS] _____________________________________, Springfield, MO (the Property). The Property is owned by [PRINT OWNER'S NAME] ______________________, who, if not me, can be reached at [INSERT PHONE NUMBER AND ADDRESS] ____.

The Multistate Trust is granted permission to enter the Property for the following purposes and activities, all **at no cost to me**:

(1) Collect soil samples from the top three feet of the front and backyards of the Property. Sampling will require collecting samples from up to 30 locations in each yard.
(2) Reseed impacted areas of the Property following completion of sample collection, with a follow-up visit two weeks post-sampling by the Multistate Trust's local Contractor performing the work.
(3) Send the collected samples to a specialized laboratory for analysis.

I understand that the Multistate Trust will provide a summary of the final sampling results for the Property to me.

This permission is given by me voluntarily, on behalf of myself and all other co-owners of the Property, with knowledge of my right to refuse and without threats or promises of any kind.

Signed By: __________________________ Date: _____________
Name: ______________________________
Phone: ______________________________
Email: ______________________________

Please mail or email the signed agreement to:

Greenfield Environmental Multistate Trust LLC, Trustee
Attn: Craig Kaufman
P.O. Box 723
Durham, NH 03824
ck@g-etg.com

Please call Tasha at (602) 312-6993 with questions. *

*Alternatively, call Barbara Garcia (local Multistate Trust representative) at 417-380-3370 to request pick up of this agreement. She will come to your home to pick up this agreement.

Appendix C

Standard Operating Procedures

ENVIRONMENTAL WORKS SCIENCE. SAFETY. GRIT. INGENUITY.	**Version** **4.0**	**SOP No. 2: Direct Push Auger Soil Borings Planning and Oversight**
Standard Operating Procedures (SOP)		**Responsible Department:** Remediation **Page 1 of 10**

1.0 OBJECTIVE/APPLICABILITY

The Objective of this Standard Operating Procedure (SOP) is to provide procedures for planning and observing direct push and hollow-stem auger drilling with considerations for sample collection.

This SOP serves as a reference tool to facilitate consistency among Environmental Works, Inc. (EWI) personnel. These operating procedures may be varied as required, depending upon site conditions, equipment limitations, or limitations imposed by the project or client. In all instances, the ultimate procedures employed should be documented and associated with the final report.

2.0 SCOPE AND PERSONNEL APPLICATION

During any drilling operation, the purpose and ultimate reason for drilling need to be kept in mind. Oversight of drilling for sampling is normally performed by technical personnel (commonly EWI scientists and engineers). Any personnel performing these functions should be trained in proper planning and field techniques. The person performing the function is responsible for ensuring that all equipment and materials necessary for drilling are on-hand for the job. If there is any question regarding the purpose of the drilling, the person should confer with the project manager prior to mobilization to the worksite.

3.0 EQUIPMENT

Equipment and materials needed for oversight of drilling operations to include sampling may include but is not limited to the following (this list excludes items specifically used for sample collection).

a. A work plan outlining project drilling objectives and locations
b. Field notebook or field documentation sheets
c. Small engineering tape measure (measurements recorded in tenths of feet)
d. Paper towels
e. Nitrile or appropriate disposable gloves
f. Photoionization detector (PID) and calibration gas for volatile organic compound (VOC) sites (including diesel and gasoline sites, chlorinated VOCs, etc.)
g. Camera (digital camera or phone camera)
h. Fine-tipped Sharpie (permanent marker)

i. Trash bags

j. PPE appropriate for the site and COCs; must include hardhat, high visibility safety vest, safety glasses with side shields, ear protection, and steel-toed boots

k. Soil boring logs, Air Monitoring Logs, well construction forms

l. Munsell Soil or Rock Color Chart

m. Project Sampling Plan, Quality Assurance Project Plan

n. Site Safety and Health Plan, Tailgate Safety Form

o. Traffic cones, barricades, caution tape

p. Utility paint, survey flags/stakes

q. Measuring wheel/tape (100ft capability, measured in tenths of feet)

r. Tools

- 1/2” and 9/16” socket wrench for monitoring well vaults
- 15/16” socket for 55-gallon drums
- Flathead screwdrivers for prying up well vaults.

4.0 EQUIPMENT

4.1 General Planning and Procedures PRIOR to Mobilizing to the Field

1) Plan out number of bores, depths, samples needed and sample collection desired, well completion types (screened or open bore bedrock, above or below ground completion of wells) and intervals, size and depths of borings and wells needed, materials needed for well construction, etc. prior to contacting drilling personnel for a quote or to schedule the work.

2) Research and verify the State regulations and requirements for borehole abandonments, annular spaces for well casings and screens, filter pack requirements for monitoring wells, registrations or reporting requirements, and regional drilling restrictions or requirements (i.e., casing depth requirements). Discuss with the Drilling Manager if there are any questions. Do not rely on the on-site drillers to know this information. Drilling personnel may be from out of state and unfamiliar with the local regulations.

3) If collecting soil samples, plan the type of sample desired and specify to driller: 2-foot split spoons of varying diameters (2”-3” depending on auger size), Shelby tubes, and 5-foot continuous samplers of varying diameter (1.25”-4”) such as Dual-Tube® and Macrocore® samplers.
4) If installing wells, plan large enough casing diameters to accommodate purpose of the well or bore (i.e., is a pump going to be installed?)
5) If installing wells, in general use PVC for metals sampling or non-corrosive environments. In corrosive environments (includes high concentrations of chlorinated solvents), use stainless steel casing and screen.
6) Arrange for utility clearances both above and below ground well in advance of the drilling (for example, Missouri or Kansas 811 one-call services). Notifying the state “one-call” service is a requirement for every EWI drilling project. Even if the client performs the utility clearance, EWI personnel must obtain written verification – and preferably on-site inspection – of utility clearance prior to commencing drilling. If utility clearance is being performed by EWI personnel, see SOP#(GPR) for GPR guidance.
7) Arrange for needed equipment, sampling containers, and special items well prior to job startup (i.e., PID monitoring, plastic for berms, drums for cuttings or waste water, or other special tanks or contingency items such as absorbents and floor-dry for spill cleanup).
8) Plan out decontamination procedures and decontamination (decon) areas with driller and client prior to job startup. Drillers should construct a decon pad that allows them to collect decon water.
9) Plan out waste handling, sampling, and disposal responsibilities prior to job startup.
10) Ensure a <u>current</u> Site Safety and Health Plan (SSHP) is available;
11) Prepare SSHP Tailgate Safety Meeting form with pertinent data before the field event.

4.2 General Procedures in the Field and During Drilling Operations

Use Daily Field Logs, Boring Logs, Air Monitoring Logs, etc. to record all pertinent information and activities as the job progresses (example logs are in the Attachments). Examples of what to record:

  - Documentation that Utility Clearance was performed (One-call ticket #, make note in field log/logbook of EWI GPR utility clearance, take photographs of marked utilities, etc.).
  - Documentation that initial SSHP was reviewed, and daily Tailgate Safety briefings were performed.
  - Names of drillers, type of drill rig (make, model), condition of drill rig (should be clean, no mud/dirt, oil etc.), and serial/State registration number.
  - Other personnel working on the task with you.
  - Key events, start and end times, footages reached, unusual PID readings or observations
  - Any problems arising – causes, details of discussions and decisions with client or regulatory agencies.

1) Measure lengths, inside and outside diameters of drilling rods, hollow stem augers, bits, samplers, well casing and screens – anything that will go in the hole – and <u>record in field notes</u> using pictures as needed. Sometimes drillers need to change the size of bits or augers – <u>record changes in bit sizes and depths where changes occur on the boring log</u>. This requires periodic communication with the driller. Approach driller from their line of sight and ask questions (current depth of hole, size of tooling, etc.). Record this information in field logbook, or boring logs, as applicable.
2) Set up the Exclusion Zone and Contaminant Reduction Zone perimeters appropriate for the project work and per the SSHP prior to starting drilling. This is advisable even if contaminants are not present to minimize pedestrian encounters. If contaminants are present, appropriate PPE and decon stations must be set up prior to drilling.
3) Logging station: This is a place to set the soil core for logging and sampling. This could be a folding table covered with plastic, or the truck tailgate covered with plastic. Another alternative is to set up a plastic-covered plywood stand (use sawhorses). Use a fresh or well-cleaned piece of plastic for each borehole.
4) Distances and directions from known locations (building corners, etc.) to the boring shall be measured and written on the field boring log for each boring

or well installed, in addition to collecting GPS latitude/longitude/elevation data.

5) When sampling for VOCs or SVOCs, measure <u>and record</u> PID background readings immediately prior to start of drilling, and record breathing zone and background readings every 5 feet of depth or at points of any discoloration or odors.

6) Take photographs of the wellhead, drill rig, and samples for each borehole, and for any unusual circumstance and document in field notes.

7) All separate borings, including step-outs due to refusal or relocated borings for any reason, will be given a unique boring name. Each boring shall have its own field boring log prepared with appropriate notes as to the reason for stepping out, the geographical distances and directions between borings, and other information to provide complete documentation on the field log as well as in the field notes. Normally borings are named "SB-XX"; step-out borings can be numbered and lettered SB-XX**A**, SB-XX**B**, etc. Use the project specific naming convention, if available.

10) Divide your time between watching drilling activities, taking PID breathing space readings, collecting samples, logging soil, and recording everything. Avoid getting fixated on any one task at the expense of others. Remember that safety (i.e., breathing zone monitoring and drilling operations) is the top priority, followed by sample collection.

4.3 Procedures and Issues Specific to Direct Push Technology (DPT) Drilling

1) A DPT rig will push through cover materials, such as asphalt or gravel. Commonly, concrete is cored first, unless the rig has a concrete bit. Follow your project data quality objectives to determine the first interval of soil to collect for analysis. Generally, cover materials are not collected for analysis.

2) Drilling for samples may be performed using a Macrocore® (2-inch diameter) or using Dual Tube® drilling with a smaller 1.25-inch diameter sampler. In both cases, the samplers will be 4 or 5 feet long and contain an acetate liner to collect the core. The smaller dual-tube system is used for non-cohesive geologic conditions where core may fall out through the larger sampler, or where the hole will not stay open to avoid sloughing. However, the Dual

Tube® sampler may also be used for cohesive soils. Note that less sample volume is collected using the dual tube system, so there could be insufficient sample volume if several analytes are required. This may require the hole to be off-set by a foot or so to drill down and collect the additional sample volume.

3) The sampler acetate tube should be measured to verify length, to provide an accurate reference for determining recovery.

4) Decontamination of drill samplers and rods (or augers, if used) should be conducted between samples and wells. The extent and techniques for decontamination can vary between simply brushing to remove gross surficial material, to standard soap and rinse scrubbing with or without a Hotsy®-type steam pressure sprayer. The appropriate methodology depends on project and regulatory requirements, as specified in the project sampling plan and/or quality assurance project plan.

5) If monitoring wells are to be installed using direct push technology, the maximum diameter will be 1-inch, depending on State regulations for monitoring well construction (a variance may be required). Groundwater samples may be collected at selected footage intervals without installation of a monitoring well. DPT rigs may be equipped with a temporary well screen that can be inserted through the drill rods and "opened" at the desired depth. Tubing and a pumping or vacuum apparatus is used to extract groundwater so that a sample can be collected for analysis. Note that this technique yields a sample of undeveloped and unpurged groundwater.

6) DPT drilling may also be used for installing soil vapor points. For additional information related to soil vapor installation/sampling, refer to SOP #10.

4.4 Procedures and Issues Specific to Auger Drilling

1) Auger drilling methods are commonly utilized to install monitoring wells greater than 1-inch in diameter. Auger rigs are larger and more powerful than DPT rigs, and are capable of drilling larger diameter and deeper boreholes than DPT drilling methods. Auger rigs can drill boreholes with an outside diameter from 4 to larger than 12 inches.

2) Augers can be solid stem or hollow stem. Hollow stem augers allow for soil sampling during drilling (split spoon, Shelby tube, or continuous sampler),

and allow for construction of a monitoring well inside the augers. In contrast, when using a solid stem auger, the augers must be removed from the borehole prior to constructing a well, provided that the borehole does not collapse. For this reason, hollow stem augers are more commonly used for monitoring well installation, even if soil sampling is not required. The inside diameter (ID) of hollow stem augers is about 2 to 4 inches smaller than the outside diameter (OD). Auger flights are commonly 5-ft long.

3) If monitoring wells are to be installed, be sure to plan large enough hollow stem augers to allow well construction inside the augers (per "Monitoring Well Construction" requirements for your State).
4) Auger drilling produces larger quantities of soil cuttings (relative to DPT), so containment, management, and disposal of soil cuttings must be planned prior to drilling. Saturated soil commonly produces a soupy cuttings mixture that can easily flow away from the wellhead area.
5) A good management technique is to set up plastic or plywood (with a hole cut in the center) around the wellhead for dry to moist cuttings placement if contaminants are known or could be anticipated, or to keep the work area clean if no contaminants are anticipated. Soil cuttings can be shoveled onto plastic and covered, or place in 55-gallon open-top drums.
6) If wet, soupy cuttings are anticipated, ensure that a berm with plastic sufficient to contain liquid runoff around the wellhead is constructed.
7) Auger flights are decontaminated between wells, and samplers are decontaminated between samples, if sampling is conducted. If full scale decontamination is to be used, plan for a bermed area to contain spray water, and drums to contain decontamination fluids and mud that will be produced.
8) Auger drilling involves large equipment and heavy components, which are lifted manually and by drill hoist. It is the safety observer's job to watch for dangerous situations, particularly when auger flights are being lifted and hoisted.

4.5 Completion Procedures and Hole Abandonment

1) At the completion of all drilling and sampling, the boring log must be checked to verify that it contains specific bore location, start and completion times,

driller names (company and individual), type of drill equipment, sampling methodology (i.e. "2-in. diam., 4-ft. acetate liner), PID detections (including "0"), soil and groundwater sample IDs, intervals, analysis requested, and total depth (noting "refusal" if the case). Measure the location of the borehole with a direction and a distance from a known stationary object, such as to an existing well or corner of a building that has been surveyed in the past.

2) If not converted into monitoring wells, boreholes need to be abandoned and plugged per State regulations. These steps explain the general procedure:
    a. If possible, determine the actual depth of the borehole in case the hole collapsed, to calculate the volume of bentonite needed to plug the hole. Record the depth of the open borehole.
    b. Pour bentonite pellets into the borehole up to the zone of saturation (note that some States require use of a tremie pipe in the saturated zone). If possible, tamp the pellets to insure compaction and no bridging in the bore.
    c. Above the zone of saturation, add bentonite chips or pellets in one-foot lifts and hydrate with potable water.
    d. Tamp the hydrated bentonite to compact the bentonite and to prevent bridging.
    e. Repeat until the borehole is plugged to land surface. If within a building, the bentonite should extend to the base of concrete, and a concrete plug poured in the opening with the top smoothed.
    f. Record the abandonment procedure on the boring's field lithologic log with types and quantities of fill material used.

3) Mark each bore at ground surface with a labeled wooden stake driven into the ground or utility flags, or by permanent marker/paint.

4) The back of the drilling rig and all equipment that went downhole needs to be decontaminated before the drill rig leaves the site. All equipment decon water will be collected and subsequently disposed of at approved treatment facility.

5) Drill cuttings, decon water, and all trash (including acetate liners and cores) need to be properly stored and protected until disposed.

5.0 SAFETY

Safety is the top priority when performing field tasks and every employee with EWI has the right and authority to stop work if they observe a safety issue. An abundance of caution is required when working with, or around, heavy equipment such as drill rigs. Ensure the immediate area around the drill rig coned off and an exclusion zone has been established. Keep the area near the drilling activities clean and clear of debris or tooling that could present a tripping hazard. Hard hats, hearing protection, steel toed boots, and safety glasses are always required when working near or in the vicinity of an operating drill rig.

When moving between drilling locations, it is important to allow the driller ample space to maneuver the drill rig. Maintain line of sight with the operator of the drill rig when it is being moved. If you cannot see the operator, they cannot see you.

During drilling activities, your working area should be positioned outside of the exclusion zone in a low hazard area within view of the drilling activities. This allows a safe distance to be maintained while being able to observe all activities being undertaken.

Review all pinch points on the rig, equipment storage locations, emergency kill switches, and exclusion areas of any drill rig prior to beginning any work. Discuss in detail all safety measures and precautions during the Tailgate Safety Meeting at the beginning of each day. Invite the drilling professionals to share their own safety concerns/comments as they are more familiar with the immediate dangers of operating the equipment.

Acute or chronic exposure to chemically-contaminated soil could result in bodily injury. Routes of exposure include inhalation, ingestion, and dermal contact. Consult the appropriate chemical safety data sheet (SDS) before mobilization so that proper PPE and monitoring are planned and implemented.

Conduct an on-site safety meeting each day before the start of fieldwork utilizing a Tailgate Safety Meeting form. Review safety hazards (e.g. high-traffic areas, exposure to chemicals, alertness to heavy equipment, PPE, health monitoring, and emergency procedures). Take appropriate action if personnel are injured on-site per EWI policy guidance.

When working with potentially hazardous substances, follow the United States Environmental Protection Agency (US EPA), Occupational Safety and Health Administration (OSHA), EWI Corporate Health and Safety Plan, and site-specific health and safety plan.

6.0 REFERENCES

- "Corporate Health and Safety Plan" Environmental Works, Inc.
- "HAZWOPER Training Manual: 40-Hour Hazardous Waste & Emergency Response Training" Safety Source, Inc.

7.0 VERSION HISTORY

This document is subject to periodic review and updates as technologies, methodologies, and industry standard practices change. The table below summarizes updates to this SOP.

Version Number	Date	Changes Made	Edited By
1.0	6/30/09	Original Version	
2.0	2/17/15		Bob Lanning
3.0	11/2/18		Bob Lanning
4.0	2/21/2022		Jake Pfannenstiel

Environmental Works, Inc. SOP No. 2

Direct Push and Auger Soil Borings - Planning & Oversight

ATTACHMENTS

Soil Boring Log

Air Monitoring Log

Date: To:	Project No.:	**Boring ID**
Logged By:	Project Name:	
Drilling Company:	Client:	
Driller(s):	Site Address:	ENVIRONMENTAL WORKS
Drilling Method(s):	Boring Location:	
Sampling Equipment:		
Hole Size:	Total Depth:	

Depth (feet)	Description	Class.	PID (ppm)	Rec.	Sample Interval	Remarks

Date:	Project Name:	Project No.:	**Boring ID:**

Depth (feet)	Description	Class.	PID (ppm)	Rec.	Sample Interval	Remarks

VAPOR MONITORING FORM

ENVIRONMENTAL WORKS

Site: ____________________

EWI #: ____________________

Date: __________ Personnel: ____________________ Weather: ____________________

Weather: ____________________ Barometric Pressure: ____________________ Source: ____________________

Instrument Used: ____________________

Calibration Date/Time: ____________________

Background PID reading: ____________________

Time	Area Description	PID reading (ppm)

Page _____

ENVIRONMENTAL WORKS INC.	**Standard Operating Procedure (SOP)**	Issue Date: 6-30-09 Updated:
Procedure No. 3: Soil Logging & Sampling for Direct Push and Hollow-Stem Auger Rotary Drilling		Technical Reference: Bob Lanning Page: 1 of 7

Skills Required:

1) 40-hour HAZWOPER training (if sampling on hazardous waste sites)
2) Understanding of, and ability to make decisions regarding, site-specific objectives
3) Training in soils characterization and sampling
4) Training and ability to use PID
5) Knowledge of corporate Safety requirements and health and safety plan

1.0 OBJECTIVE / APPLICABILITY

The Objective of this Standard Operating Procedure (SOP) is to provide the proper procedure for characterizing and logging soil during direct push and hollow-stem auger drilling.

This SOP serves as a reference tool to facilitate consistency among Environmental Works, Inc. (EWI) personnel. These operating procedures may be varied as required, depending upon site conditions, equipment limitations or limitations imposed by the project or client. In all instances, the ultimate procedures employed should be documented and associated with the final report.

2.0 SCOPE AND PERSONNEL APPLICATION

Soil characterization and logging is performed to provide qualitative information for evaluating site conditions, extent of contamination, and potential for contaminant transport. Soil sampling is done to provide quantitative analytical data for total amounts of chemicals of concern (COCs) in the soil at specified locations and depths. These analytical data are compared to federal and State regulatory levels (e.g., Missouri Risk-Based Corrective Action (MRBCA) target levels), to provide information for remediation decision-making.

Soil logging and sampling is normally performed by technical personnel (commonly EWI scientists and associate scientists). Any personnel performing these functions should be trained in proper identification and techniques. The person performing the function is responsible for ensuring that all equipment and materials necessary for logging and sampling are on-hand for the job. If there is any question regarding materials, the logger/sampler should confer with the project manager prior to mobilization to the work site.

3.0 EQUIPMENT

Equipment needed for soil logging and sampling may include but is not limited to:

a. A work plan outlining project soil sampling requirements
b. Field notebook or field documentation sheets
c. Plastic for logging table
d. Table for logging (portable table or plywood and sawhorses, 3'x5'
e. Small tape measure
f. Soil sampling spatula (or stainless steel spoon or butter knife)
g. Small spray bottle
h. Small plastic bucket for rinse/used gloves, etc.

i. Paper towels
j. Munsell color charts (in plastic baggies)
k. Soil characterization guide sheets
l. Appropriate tool for cutting acetate liners (with extra blades)
m. Sandwich size baggies (zip-lock type)
n. Quart size baggies (zip-lock type)
o. Nitrile or appropriate disposable gloves
p. Terra Core Soil Kits (includes 1 methanol 40ml vial, 2 sodium phosphate tribasic 40ml vials, 2 unpreserved 40ml vials, 1 unpreserved amber jar, and 1 disposable Terracore^{RM} sampler) if required for sampling.
q. PID and calibration gas for VOC sites (including diesel and gasoline sites)
r. Camera (digital best)
s. Collection jars appropriate for analytes (provided by analytical laboratory)
t. Soil trip blank(s) (provided by analytical laboratory)
u. Temperature blank(s) (provided by analytical laboratory)
v. Sample labels
w. Chain of Custody (COC)
x. Cooler to store samples
y. Ice
z. Packing tape
aa. Duct tape
bb. Fine-tipped Sharpie
cc. UPS/Fed-Ex Shipping label(s)
dd. Custody Seal(s)
ee. Trash bags
ff. PPE appropriate for the site and COCs
gg. Soil boring logs, Air Monitoring Logs
hh. Site Safety and Health Plan, Tailgate Safety Form

4.0 PROCEDURES

4.1 General Procedures

1) Setup and organize logging area well before drilling starts. Have PID on and calibrated. Organize materials to be readily available within reach.
2) Know the type of soil sampling to be performed (Geoprobe 2” liners, 1” liners, 2-foot split spoons 2”-3” diameter, Shelby tube, 5-foot continuous samplers 3”-4” diameter, or grab samples from auger cuttings) and plan ahead how logging, sampling, PID readings will best be done. Procedures will vary whether operating alone or with another person.
3) The general procedure steps for logging and sampling are:
    - Note general geology, obvious areas of impact, recovery
    - Slit the core lengthwise, measure and record PID readings
    - Note water saturation level
    - Select horizons to sample and collect samples

- Collect small representative samples in baggies (labeled with depth)
- Perform detailed lithologic characterization of core
- Measure PID readings inside baggies, use for Munsell color determination
- Measure and record recovery (inches of core / inches sampler length)
- Take pictures of core

4) Stop driller if you get behind in logging and sampling a run. Don't just let sample tubes collect waiting for processing. Complete and accurate data are needed.
5) Divide your time between watching drilling activities, taking PID breathing space readings, collecting samples, logging soil, and recording everything. Avoid getting fixated on any one task at the expense of others.
6) Use Daily Field Logs, Boring Logs, and Air Monitoring Logs to record all pertinent information and activities as the job progresses. You do not have to record repetitive information. Example boring logs and air monitoring logs are attached.

4.2 Lithologic Characterization

Examine each different geologic material in the core, noting and recording the following properties for each type in the order presented. Different guide sheets in the attachments provide detailed explanations how to characterize each property, as well as an abbreviated list for use in the field.

- **MAIN TYPE OF MATERIAL** (fill, sand, clay, etc.)
  and **SUPPLEMENTAL** (sandy, silty, clayey, gravelly)

  (Usually written like Silty CLAY, or Clayey SAND, or Gravelly CLAY, or CLAY and GRAVEL (if 50/50). If mixture, note percentage of lesser (e.g., CLAY w/ 20% GRAVEL)

- **GRAIN SIZE** (if not clay) – fine, medium, coarse.

  For gravel also give size range in inches (e.g., 1/8" to pea size) and roundness (e.g., angular, subrounded, rounded)

- **SORTING AND GRADING** (if not clay):

  Poorly sorted (all different sizes) to well sorted (all same size)
  Poorly graded (different sizes all mixed up in position) to
  well graded (different sizes occur in sequential layers – coarse to fine)

- **COHESIVENESS**

  Very soft, soft, firm, stiff, v. stiff, hard *if cohesive*
  Very loose, loose, med dense, dense, extreme dense *if non-cohesive*
  Plasticity for clays (non-plastic, low, medium, or high plasticity)

- **COLOR**

  Note overall color. If two distinct colors, specify both. Note supplemental, like "mottled" or "brown laminations, etc". Specifically note areas of impact or discoloration. Use Munsell color charts, comparing soil to color spots and recording the Munsell color code. Add text color later from Munsell code sheet. OK to note "multicolored" without Munsell codes if many colors. Recommend keeping Munsell charts in large plastic baggies to protect color spots. See example Munsell color spots and code sheets in the attachments.

- **SATURATION**

  Note & record dry, damp, slightly moist, moist, very moist, saturated (or wet)

  Saturation can be difficult to determine in clay. Clay may be saturated and not appear "wet" – attempt to squeeze a small amount of sample to see if water is released.

- **ODOR**

  State either "no odor" or any noted odor, e.g., "petroleum-like". Limit use of specifics, e.g., diesel or gasoline, and always use "-like".

- **ANY INDICATORS OF CONTAMINATION**

  Discoloration, free product, odors

Abbreviations on field sheets are OK if logical. Include a key if not. The following are examples of log entries:

> CLAY, 20% pea gravel, subround, stiff, low plastic, olive brn (2.5Y 4/3) w/ orange mottling, moist, no odor or visual impact
>
> Clayey SAND, fin-gr, well sort, soft, pale brn (10YR 6/3) w/ dk gray irreg patches to ½", saturated, petroleum-like odor, impact in dk discolored areas
>
> 5.5′-6′: GRAVEL lens, poor sorted 1/8" – ½", well graded (coarse down), med dense, lt gray (5YR 7/1) and dk gray (5YR 4/1), v. moist, no odor or visual impact

While all of the above properties are needed to fully characterize geologic materials, the following are the key properties that must be recorded:

- Type of material including supplemental types
- Grain size if not clay
- Color by Munsell charts
- Saturation level
- Indications of impact

4.3 PID Measuring and Sampling Cores (liners, split spoons, Shelby tubes, continuous samplers)

1) Spoons/samplers/Shelby tubes should not be opened, or acetate liners cut open, until you are ready to begin logging.
2) As soon as the core is exposed, use a sampling spatula or other flat, dull-blade knife to slit the core lengthwise and measure PID readings. Carefully insert the

PID tip into the space made while "twisting" the spatula/knife - care must be taken to avoid plugging the PID tip. Measure every 6" and at areas of suspected impact. With a team of two persons, one person should measure starting depth and reading, while the 2nd person records the values – both the depth and reading should be noted on the boring log. If working alone, measure and record no more than 3 readings at a time to maintain accuracy.

3) Once core PID readings are recorded, and general lithology, saturation level, and potential areas of impact have been identified, samples must be collected.
4) Collect samples using a spatula/flat knife decontaminated between sampled horizons to fill sample jars. Collect samples as quickly as possible, remembering that samples for VOC analysis must be packed as tightly as possible in the sample container without over-pushing, squeezing samples. Label the sample container, insert in a baggie, and place in a cooler with ice. If time-constrained, write sample ID, depths, and time on lid and add labels later. If using a 5035 kit, see the 5035 SOP for proper procedures.
5) Samples should be given logical identifications to include the collection depth, e.g.: SB-4: 4.5-5 for a sample collected from SB-4 between 4.5'-5'.
6) Clearly depict sample horizons and ID on the boring log, noting depths.
7) After samples are collected, take depth baggies and measure headspace with PID after at least 5 minutes, and record. Beware of saturated samples, which can produce a temporary peak in PID readings. These baggies are also a good way to evaluate Munsell color of the interval when time allows

4.4 Logging and Sampling from Auger Cuttings

If hollow stem drilling is conducted without use of split spoons, Shelby tubes, or continuous samplers, grab soil samples for characterization and chemical analysis can still be collected from auger cuttings returned to the surface from the augers. The following are considerations and procedures related to soil sampling in these conditions.

1) There are limitations and potentially adverse effects from sampling auger cuttings that should be considered in collecting samples:
   - Collecting samples while actively augering involves your movement close to the drill rig and moving parts, so this action requires keen attention to detail and situational awareness.
   - The actual depth of the sample is uncertain, because there is a time delay in the sample reaching the surface while the augers continue downward.
   - Detailed PID depth profiles cannot be discerned due to mixing of thinner horizons of soil by the augers; however, auger movement can release more volatiles and yield more readily detected elevated PID readings.
   - If the chemicals of concern are highly volatile, it is likely that movement of the augers and the heat of friction will reduce the volatile content of samples, so results must be considered as minimal concentrations.

  - Finer details of lithology (thin horizons, sorting, grading, coloration, contamination details) are not possible when logging auger cuttings.
  - Moisture content can be difficult to accurately determine because of heat drying soils. However, saturated soil commonly produces a soupy return, making identification of true saturation easy to determine.

2) If samples are collected from auger cuttings, they must be collected using a sampling implement (not gloved hands) and placed rapidly into containers to minimize loss of volatiles. The freshest, most recently arrived sample should be selected. "Old" soil that has been stuck on augers should not be used.
3) Samples for lithologic description and color should be grabbed at regular intervals and set aside for logging and marked somehow with depth. Samples for PID headspace should be placed in baggies labeled with depth.
4) Actual depth of the augers immediately at the time of fresh sample collection should be recorded. Many variables (soil type, density, moisture content, power of the rig, etc.) result in unpredictable lag time of cutting reaching the surface.
5) Appropriate naming for grab samples from augers would be: SB-4: 6G for a grab sample collected at 6 ft depth. Depth cannot be determined accurately enough to provide a range over which a single grab sample was collected.
6) Use of auger cuttings for samples, technique of collection, and definition of depth assignment should be noted on the boring field log.

5.0 FIELD QA/QC SAMPLING PROCEDURES

Quality assurance/quality control sampling should be performed to assure quality of field analytical data. The following QA/QC sampling should be done as appropriate for regulatory or client requirements, or project constraints:

- Select 10% of total samples for duplicate sampling and analysis, with a minimum of one sample collected per event. Duplicate samples should be assigned a fictitious name, but one that can be recognized (e.g., add a "2" after the primary sample name: SB-32 as a duplicate of SB-3).
- Collect and analyze one field blank sample when collecting water samples.
- Utilize Trip Blanks sent from the laboratory when VOC sampling.
- Collect one equipment rinsate blank from geoprobe macrocores, split spoons, continuous samplers, or sampling utensils after being decontaminated.

Field duplicate samples are analyzed to check for sampling and analytical reproducibility.

Trip blanks will be used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage. One laboratory-supplied trip blank will be forwarded with each cooler containing samples and analyzed for VOCs.

Field blanks will be collected to assess possible impact from external contaminant sources in the area of sampling. Blanks will be collected by filling sample bottles with dionized/distilled water at the logging/sampling table and submitted for analysis of VOCs.

Equipment rinsate blanks will be taken to assess the effectiveness of decontamination and any potential impact on cross-contamination between samples. Blanks will be prepared by routing deionized/distilled water through decontaminated sampling equipment and before field sample collection. Rinsate blanks can be submitted for VOC and/or other analytes, depending on what the analytes of concern are at the job site.

6.0 SAFETY

Acute or chronic exposure to chemically-contaminated soil could result in bodily injury. Routes of exposure include inhalation, ingestion, and dermal contact. Consult the appropriate chemical material safety data sheet (MSDS) before mobilization so that proper PPE and monitoring are planned and implemented.

Conduct an on-site safety meeting each day before the start of field work utilizing a Tailgate Safety Meeting form. Review safety hazards (e.g. high-traffic areas, exposure to chemicals, alertness to heavy equipment, PPE, health monitoring, and emergency procedures). Take appropriate action if personnel are injured on-site per EWI policy guidance.

When working with potentially hazardous substances, follow the United States Environmental Protection Agency (US EPA), Occupational Safety and Health Administration (OSHA), EWI Corporate Health and Safety Plan, and site-specific health and safety plan.

7.0 REFERENCES

- "Corporate Health and Safety Plan" Environmental Works, Incorporated.
- "HAZWOPER Training Manual: 40-Hour Hazardous Waste & Emergency Response Training." Safety Source, Inc

Environmental Works, Inc. SOP No. 3

Soil Logging & Sampling for Direct Push and Hollow-Stem Auger Rotary Drilling

ATTACHMENTS

Soil Boring Log

Air Monitoring Log

GEOLOGIC LOGGING – INFO AND ORDER TO RECORD

Visual Percent Estimation Charts (un-named)

Field Guide for Soil and Stratigraphic Analysis v.2

Unified Soil Classification System

Soil Classification System (Modified U.S.C.)
Conventional Soil Descriptions

Instructional Diagram for Determining Soil Texture by Feel

Munsell color chart (example pages)

Munsell Soil Color Names (example pages)

Date: To:	Project No.:	**Boring ID**
Logged By:	Project Name:	
Drilling Company:	Client:	
Driller(s):	Site Address:	ENVIRONMENTAL WORKS
Drilling Method(s):	Boring Location:	
Sampling Equipment:		
Hole Size:	Total Depth:	

Depth (feet)	Description	Class.	PID (ppm)	Rec.	Sample Interval	Remarks

Date:	Project Name:	Project No.:	**Boring ID:**

Depth (feet)	Description	Class.	PID (ppm)	Rec.	Sample Interval	Remarks

ENVIRONMENTAL WORKS

Environmental Works, Inc.

Soil Boring Log

Date/Time: ____________________

Sampler: ____________________

Boring ID: ______________________________

Driller: ____________________

Site Name: ______________________________

Drill Equipm't and Method: ______________________________

Location: ______________________________

Depth	Recovery	Sample Depth / ID	PID BZ	Sample PID	Description of Material	USCS

Page ____ of ____

DIRECT AIR MONITORING LOG

Page ____ of ____

LOCATION:__________ DATE:__________ DRILLER:__________ MONITOR:__________
WEATHER:__________ TEMP:__________ WIND:__________
MONITORING INST:__________ READINGS: PPM___ PPB___

TIME	DEPTH	BREATH ZONE	HOLE/ CASING	PIT/ TANK	BACK GROUND	BORING – COMMENTS

GEOLOGICAL LOGGING – INFO AND ORDER TO RECORD

MAIN TYPE OF MATERIAL (sand, clay, clay, etc.)
and **SUPPLEMENTAL** (sandy, silty, clayey with %)

GRAIN SIZE sand – fine, medium, coarse - and supplemental
gravel –size in inches, roundness, % if supplemental

SORTING AND GRADING (for sands and gravels)
Sorting (size): Poor to well
Grading (size mix): Poor to well

COHESIVENESS
Very soft….soft…firm…stiff… v. stiff… hard *(cohesive)*
Plasticity for clays
Very loose…loose…med dense…dense…extreme dense *(non-cohesive)*

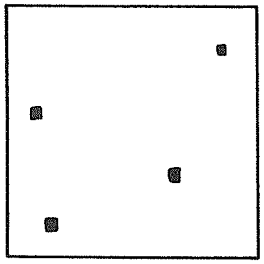
COLOR Name (Munsell number)

SATURATION
Dry…damp…slightly moist…moist…very moist…saturated

ODOR

ANY INDICATORS OF CONTAMINATION

CHARTS FOR ESTIMATING PROPORTIONS OF MOTTLES AND COARSE FRAGMENTS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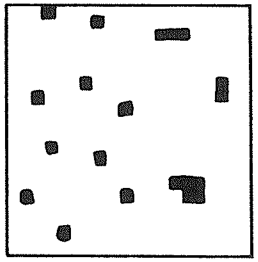
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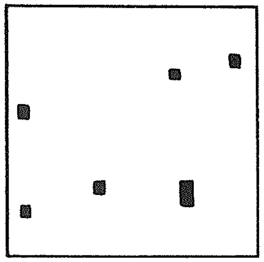
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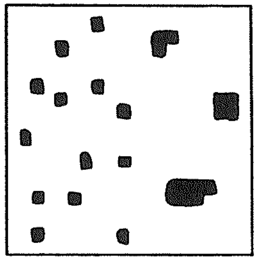
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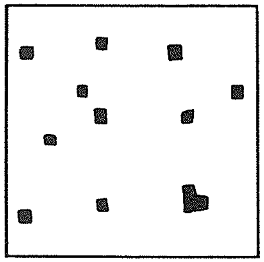
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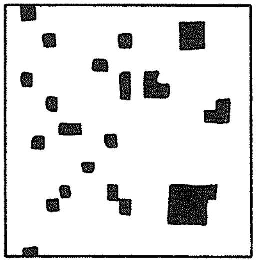
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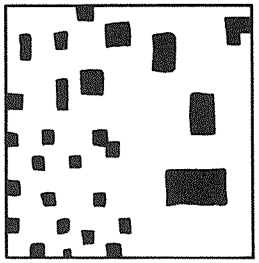
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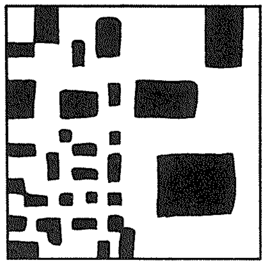
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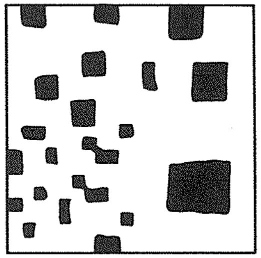
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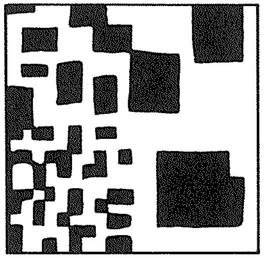
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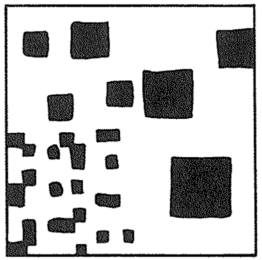
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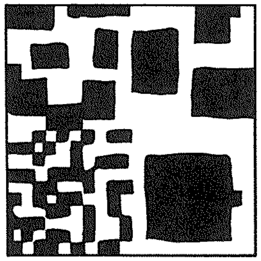
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Each fourth of any one square has the same amount of black

FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS v.2

midwest GEOSCIENCES group
www.midwestgeo.com

START HERE

DENSITY OR CONSISTENCY

COARSE GRAINED DEPOSITS N-VALUE	
0-4	► VERY LOOSE
5-10	► LOOSE
11-29	► MEDIUM DENSE
30-49	► DENSE
>50	► VERY DENSE

FINE GRAINED DEPOSITS N-VALUE	q_u (tsf)	
0-2	<0.25	► VERY SOFT
3-4	0.25-0.50	► SOFT
5-8	0.50-1.0	► MEDIUM
9-15	1.0-2.0	► STIFF
16-30	2.0-4.0	► VERY STIFF
>30	>4.0	► HARD

COLOR
Use Standard Munsell Color Notation

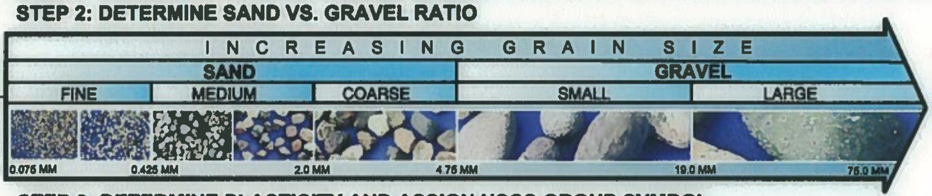
IS THE COLOR A MATRIX COLOR?
- YES → **MATRIX COLOR** List in sequence, dominant first
- NO → IS THE COLOR FROM A COATING OR CONCENTRATION?
  - YES → **COATING or CONCENTRATION** Note frequency, color, and size
  - NO → **MOTTLE** Note contrast, color, and size

CLASSIFICATION
Unified Soil Classification System - adopted ASTM D2488

STEP 1: IS SEDIMENT COARSE GRAINED OR FINE GRAINED?

COARSE-GRAINED DEPOSITS
>50% coarse-grained sediments, <50%fines

STEP 2: DETERMINE SAND VS. GRAVEL RATIO



STEP 3: *CONTINUE WITH SAND OR GRAVEL ON FLOW CHART (REVERSE)*

FINE-GRAINED DEPOSITS (organic and inorganic)
>50% fines, <50% coarse-grained sediments

STEP 2: DETERMINE PLASTICITY AND ASSIGN USCS GROUP SYMBOL

INCREASING PLASTICITY

NON PLASTIC	LOW PLASTICITY	MEDIUM PLASTICITY	HIGH PLASTICITY
ML	CL		CH

STEP 3: *CONTINUE WITH GROUP SYMBOL ON FLOW CHART (REVERSE)*

MOISTURE

- MOISTURE ABSENT ► DRY
- DAMP ► MOIST
- VISIBLE WATER ► WET

FOR NON-PLASTIC FINES
- WATER RISES TO SURFACE SLOWLY ► SLOW DILATENCY
- WATER RISES TO SURFACE QUICKLY ► RAPID DILATENCY

PLASTICITY
(Use with CLASSIFICATION)

- WILL NOT SUPPORT 6mm DIAMETER ROLL IF HELD ON END ► NON-PLASTIC
- 6mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 4mm DIA. ROLL DOES NOT ► LOW PLASTICITY
- 4mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 2mm DIA. ROLL DOES NOT ► MEDIUM PLASTICITY
- 2mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF ► HIGH PLASTICITY

6mm ④ ②

COHESIVENESS

- 6mm DIAMETER ROLL CANNOT BE FORMED ► NONCOHESIVE
- 6mm DIAMETER ROLL CAN BE FORMED ► COHESIVE

SEDIMENTARY STRUCTURE

- UNIFORM ► MASSIVE
- BEDS >30cm ► THICKLY BEDDED
- BEDS 3cm to 30cm ► BEDDED
- BEDS 0.5cm to 3cm ► THINLY BEDDED
- BEDS <0.5cm ► LAMINATED

SECONDARY SOIL STRUCTURE (IN SOLUM ONLY)
- Spheroidal peds or granules usually packed loosely ► GRANULAR
- Irregular, roughly cubelike peds with planar faces (angular or subangular) ► BLOCKY
- Flat and horizontal peds ► PLATY
- Vertical, pillarlike peds with flat tops ► PRISMATIC
- Vertical, pillarlike peds with curved tops (which are commonly "bleached") ► COLUMNAR

WEATHERING ZONE ABBREVIATION

MODIFIER SYMBOL (if present)		1st SYMBOL		2nd SYMBOL		LAST SYMBOL (if present)	
MOTTLED	► M	OXIDIZED	► O	LEACHED	► L	SECONDARY CARBONATE	► 2
JOINTED	► J	REDUCED	► R	UNLEACHED	► U		
		UNOXIDIZED	► U				

EXAMPLE
- solum
- OJL
- MOJL
- MOJL2
- MOJU
- MRJU
- RJU
- RU
- UU

SECONDARY GRAIN SIZE INFORMATION

- < 5% ► TRACE
- 6% to 15% ► FEW
- 16% to 30% ► LITTLE
- 31% to 49% ► SOME

- ► UNIFORM (poorly graded)
- ► NON-UNIFORM (well graded)

- ► FINE SAND
- ► MEDIUM-GRAINED SAND
- ► COARSE-GRAINED SAND
- ► FINE GRAVEL
- ► COARSE GRAVEL

FOR GLACIAL DIAMICTONS
- ► CLAST FRACTION
- ► CLAST LITHOLOGY

DEPOSITIONAL ENVIRONMENT

VARIOUS DEPOSITIONAL ENVIRONMENTS (Interpretation)
- ► EOLIAN (LOESS)
- ► FLUVIAL
- ► ALLUVIAL
- ► LACUSTRINE
- ► COASTAL
- ► RESEDIMENTED

GLACIAL DEPOSITIONAL PROCESSES
- ► SUBGLACIAL
- ► GLACIOFLUVIAL
- ► GLACIOLACUSTRINE
- ► RESEDIMENTED

GENERALIZED RESEDIMENTATION PROCESSES
- ► MASS SLUMP
- ► SEDIMENT FLOW
- ► COLLUVIUM

STRATIGRAPHIC NAME

USE FORMAL STATE GEOLOGICAL SURVEY NOMENCLATURE WHEN POSSIBLE;
IF NOT POSSIBLE, ASSIGN SITE-SPECIFIC UNIT NAME ACCORDING TO DEPOSITIONAL ENVIRONMENT / FACIES ASSEMBLAGE

STRATIGRAPHIC CONTACT

010106

- < 10 cm ► **SHARP** (or **ABRUPT** for pedogenic alternation)
- > 10 cm (Note transition interval) ► **GRADATIONAL** (or **TRANSITIONAL** for weathering zone change)

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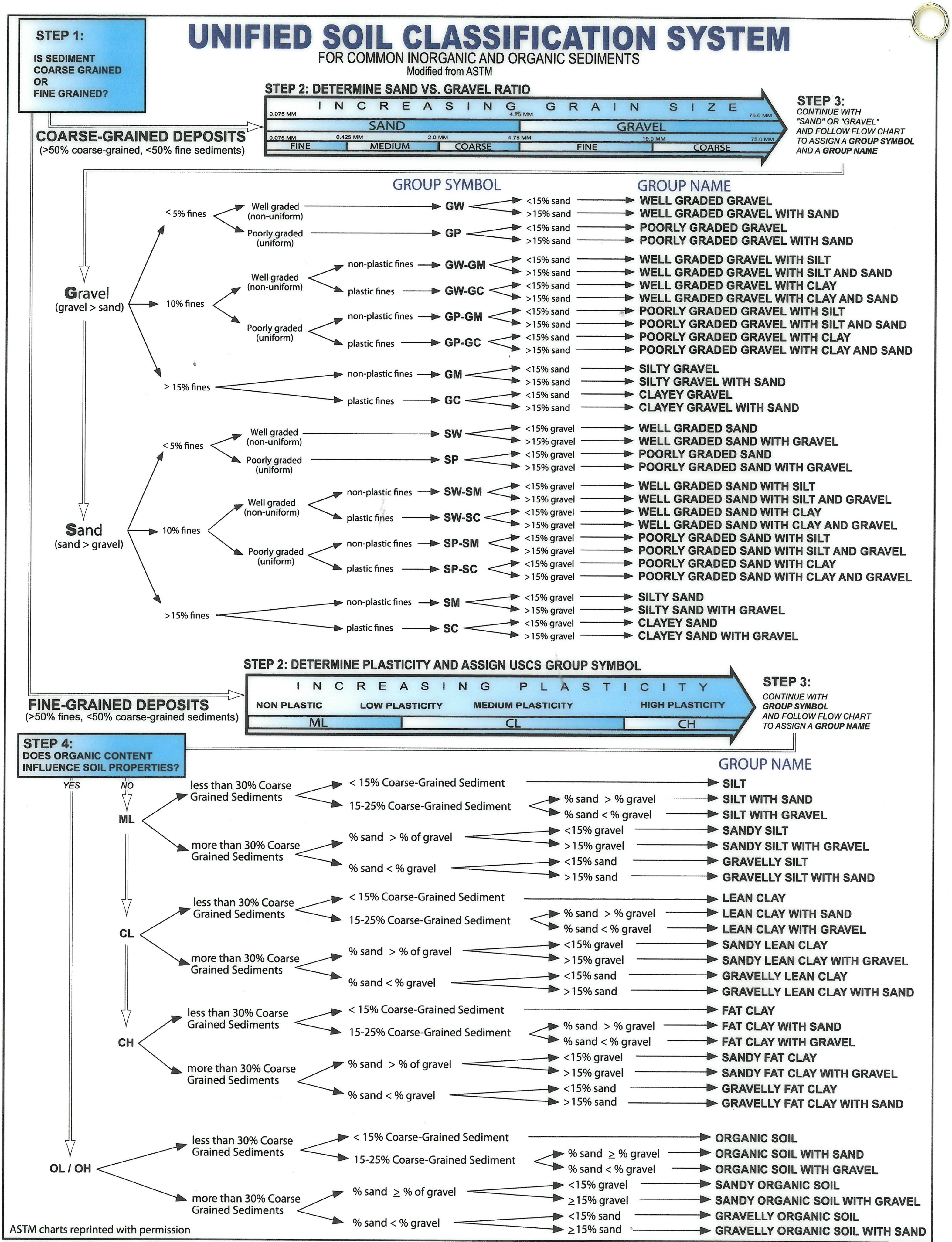
UNIFIED SOIL CLASSIFICATION SYSTEM

FOR COMMON INORGANIC AND ORGANIC SEDIMENTS
Modified from ASTM



STEP 1:
IS SEDIMENT COARSE GRAINED OR FINE GRAINED?

COARSE-GRAINED DEPOSITS
(>50% coarse-grained, <50% fine sediments)

STEP 2: DETERMINE SAND VS. GRAVEL RATIO

INCREASING GRAIN SIZE

0.075 MM – 4.75 MM	4.75 MM – 75.0 MM
SAND	GRAVEL

0.075 MM – 0.425 MM	0.425 MM – 2.0 MM	2.0 MM – 4.75 MM	4.75 MM – 19.0 MM	19.0 MM – 75.0 MM
FINE	MEDIUM	COARSE	FINE	COARSE

STEP 3: CONTINUE WITH "SAND" OR "GRAVEL" AND FOLLOW FLOW CHART TO ASSIGN A **GROUP SYMBOL** AND A **GROUP NAME**

	Fines	Gradation	Fines type	GROUP SYMBOL		GROUP NAME
Gravel (gravel > sand)	< 5% fines	Well graded (non-uniform)		GW	<15% sand	WELL GRADED GRAVEL
					>15% sand	WELL GRADED GRAVEL WITH SAND
		Poorly graded (uniform)		GP	<15% sand	POORLY GRADED GRAVEL
					>15% sand	POORLY GRADED GRAVEL WITH SAND
	10% fines	Well graded (non-uniform)	non-plastic fines	GW-GM	<15% sand	WELL GRADED GRAVEL WITH SILT
					>15% sand	WELL GRADED GRAVEL WITH SILT AND SAND
			plastic fines	GW-GC	<15% sand	WELL GRADED GRAVEL WITH CLAY
					>15% sand	WELL GRADED GRAVEL WITH CLAY AND SAND
		Poorly graded (uniform)	non-plastic fines	GP-GM	<15% sand	POORLY GRADED GRAVEL WITH SILT
					>15% sand	POORLY GRADED GRAVEL WITH SILT AND SAND
			plastic fines	GP-GC	<15% sand	POORLY GRADED GRAVEL WITH CLAY
					>15% sand	POORLY GRADED GRAVEL WITH CLAY AND SAND
	> 15% fines		non-plastic fines	GM	<15% sand	SILTY GRAVEL
					>15% sand	SILTY GRAVEL WITH SAND
			plastic fines	GC	<15% sand	CLAYEY GRAVEL
					>15% sand	CLAYEY GRAVEL WITH SAND
Sand (sand > gravel)	< 5% fines	Well graded (non-uniform)		SW	<15% gravel	WELL GRADED SAND
					>15% gravel	WELL GRADED SAND WITH GRAVEL
		Poorly graded (uniform)		SP	<15% gravel	POORLY GRADED SAND
					>15% gravel	POORLY GRADED SAND WITH GRAVEL
	10% fines	Well graded (non-uniform)	non-plastic fines	SW-SM	<15% gravel	WELL GRADED SAND WITH SILT
					>15% gravel	WELL GRADED SAND WITH SILT AND GRAVEL
			plastic fines	SW-SC	<15% gravel	WELL GRADED SAND WITH CLAY
					>15% gravel	WELL GRADED SAND WITH CLAY AND GRAVEL
		Poorly graded (uniform)	non-plastic fines	SP-SM	<15% gravel	POORLY GRADED SAND WITH SILT
					>15% gravel	POORLY GRADED SAND WITH SILT AND GRAVEL
			plastic fines	SP-SC	<15% gravel	POORLY GRADED SAND WITH CLAY
					>15% gravel	POORLY GRADED SAND WITH CLAY AND GRAVEL
	>15% fines		non-plastic fines	SM	<15% gravel	SILTY SAND
					>15% gravel	SILTY SAND WITH GRAVEL
			plastic fines	SC	<15% gravel	CLAYEY SAND
					>15% gravel	CLAYEY SAND WITH GRAVEL

FINE-GRAINED DEPOSITS
(>50% fines, <50% coarse-grained sediments)

STEP 2: DETERMINE PLASTICITY AND ASSIGN USCS GROUP SYMBOL

INCREASING PLASTICITY

NON PLASTIC	LOW PLASTICITY	MEDIUM PLASTICITY	HIGH PLASTICITY
ML	CL		CH

STEP 3: CONTINUE WITH **GROUP SYMBOL** AND FOLLOW FLOW CHART TO ASSIGN A **GROUP NAME**

STEP 4:
DOES ORGANIC CONTENT INFLUENCE SOIL PROPERTIES?

YES → OL / OH
NO → ML, CL, CH

				GROUP NAME
ML	less than 30% Coarse Grained Sediments	< 15% Coarse-Grained Sediment		SILT
		15-25% Coarse-Grained Sediment	% sand > % gravel	SILT WITH SAND
			% sand < % gravel	SILT WITH GRAVEL
	more than 30% Coarse Grained Sediments	% sand > % of gravel	<15% gravel	SANDY SILT
			>15% gravel	SANDY SILT WITH GRAVEL
		% sand < % gravel	<15% sand	GRAVELLY SILT
			>15% sand	GRAVELLY SILT WITH SAND
CL	less than 30% Coarse Grained Sediments	< 15% Coarse-Grained Sediment		LEAN CLAY
		15-25% Coarse-Grained Sediment	% sand > % gravel	LEAN CLAY WITH SAND
			% sand < % gravel	LEAN CLAY WITH GRAVEL
	more than 30% Coarse Grained Sediments	% sand > % of gravel	<15% gravel	SANDY LEAN CLAY
			>15% gravel	SANDY LEAN CLAY WITH GRAVEL
		% sand < % gravel	<15% sand	GRAVELLY LEAN CLAY
			>15% sand	GRAVELLY LEAN CLAY WITH SAND
CH	less than 30% Coarse Grained Sediments	< 15% Coarse-Grained Sediment		FAT CLAY
		15-25% Coarse-Grained Sediment	% sand > % gravel	FAT CLAY WITH SAND
			% sand < % gravel	FAT CLAY WITH GRAVEL
	more than 30% Coarse Grained Sediments	% sand > % of gravel	<15% gravel	SANDY FAT CLAY
			>15% gravel	SANDY FAT CLAY WITH GRAVEL
		% sand < % gravel	<15% sand	GRAVELLY FAT CLAY
			>15% sand	GRAVELLY FAT CLAY WITH SAND
OL / OH	less than 30% Coarse Grained Sediments	< 15% Coarse-Grained Sediment		ORGANIC SOIL
		15-25% Coarse-Grained Sediment	% sand ≥ % gravel	ORGANIC SOIL WITH SAND
			% sand < % gravel	ORGANIC SOIL WITH GRAVEL
	more than 30% Coarse Grained Sediments	% sand ≥ % of gravel	<15% gravel	SANDY ORGANIC SOIL
			≥15% gravel	SANDY ORGANIC SOIL WITH GRAVEL
		% sand < % gravel	<15% sand	GRAVELLY ORGANIC SOIL
			≥15% sand	GRAVELLY ORGANIC SOIL WITH SAND

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SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS MORE THAN HALF COARSE FRACTION LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, < 5% FINES
			GP	POORLY-GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, < 5% FINES
		DIRTY GRAVELS	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES > 12% FINES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES > 12% FINES
	SANDS MORE THAN HALF COARSE FRACTION SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS	SW	WELL-GRADED SANDS, GRAVELLY SANDS, < 5% FINES
			SP	POORLY-GRADED SANDS, OR GRAVELLY SANDS, < 5% FINES
		DIRTY SANDS	SM	SILTY SANDS, SAND-SILT MIXTURES > 12% FINES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES > 12% FINES
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE SIZE)	SILTS BELOW "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY
			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS
			CI	INORGANIC CLAYS OF MEDIUM PLASTICITY SILTY CLAYS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	ORGANIC SILTS & ORGANIC CLAYS BELOW "A" LINE ON PLASTICITY CHART		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
			OH	ORGANIC CLAYS OF HIGH PLASTICITY

CONVENTIONAL SOIL DESCRIPTIONS

Cohesive (clays etc.)		Non-Cohesive (granular)	
Consistency	'N' Blows/ft.	'N' Blows/ft.	Rel Density
Very soft	0 - 2	0 - 3	Very loose
Soft	2 - 4	4 - 9	Loose
Firm	4 - 8	10 - 29	Medium Dense
Stiff	8 - 15	30 - 49	Dense
Very Stiff	15 - 30	50 - 80	Very Dense
Hard	30	80	Extremely Dense

GRAIN SIZE CLASSIFICATION

COBBLEY	ABOVE 3 In.
GRAVEL	3 In. TO No. 4 (4.76 mm)
COARSE GRAVEL	3 In. TO 3/4 In.
FINE GRAVEL	3/4 In. TO No. 4 (4.76 mm)
SAND	No. 4 (4.76 mm) TO No. 200 (0.074 mm)
COARSE SAND	No. 4 (4.76 mm) TO No. 10 (2.0 mm)
MEDIUM SAND	No. 10 (2.0 mm) TO No. 40 (0.42 mm)
FINE SAND	No. 40 (0.42 mm) TO No. 200 (0.074 mm)
SILT	No. 200 (0.074 mm) TO 0.002 mm
CLAY	LESS THAN 0.002 mm

The following adjectives may be employed to define percentage ranges by weight of minor component:

and	50 - 36%
some	35 - 21%
little	20 - 11%
trace	10 - 1%

ENVIRONMENTAL WORKS SCIENCE. SAFETY. GRIT. INGENUITY.	**Version** **2.0**	**SOP No. 5: Chain of Custody Documentation**
Standard Operating Procedures (SOP)		**Responsible Department:** Remediation

1.0 OBJECTIVE / APPLICABILITY

The objective of this Standard Operating Procedure (SOP) is to describe the proper procedure for transferring environmental samples to another person or analytical laboratory using a Chain of Custody document (see Attachments).

This SOP should serve as a reference tool and facilitate consistency among Environmental Works, Inc. (EWI) personnel. These are standard operating procedures that may be varied as required, depending upon site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented in field notes and included in the project documentation.

2.0 SCOPE

Due to the evidentiary nature of environmental samples collected during investigations, the possession of samples must be documented from the time of collection until they are disposed of following analytical analyses. After collecting and properly labeling sample containers, all samples must be maintained under Chain of Custody procedures.

3.0 EQUIPMENT

The following equipment is needed for the Chain of Custody procedure:

a. Site logbook or field notes
b. Chain of Custody form
c. Sample and shipping labels (if mailing samples)
d. Zip-lock® plastic bags and tape (if taping to a cooler)
e. Cooler for securing samples and ice (unless low-temperature preservation is not required)

4.0 PROCEDURE

4.1 Pre-Operation (sample collection)

1. Collect each sample and place it in an appropriate sample container.
2. Cap the container and fill out a label for the sample, using waterproof ink, including the name of sampler, date, time, unique sample ID, and desired analysis. Place the label around the sample container, partially over the cap, creating a custody seal.
3. If sampling for soil or groundwater, place all samples in Zip-lock® plastic bags with cushioning wrap for glass containers and put them in a cooler with ice.
4. Record all important information in the Site logbook or field notes.

4.2 Operation

1. Once the samples have been collected and properly stored in a cooler, fill out the Chain of Custody form. Form entry may vary with laboratories, but should include these minimum items:
   - Project name, number, and location
   - Name of sampler
   - Chemical analyses and methods to be used
   - Requested due date (turn-around time [TAT]). If a rush TAT is requested, also make note in the comments section to draw the lab's attention (e.g. 48-hr TAT)
   - Each sample's unique sample ID, date, and time it was collected
   - The correct matrix code (e.g., soil, water, or sludge). Refer to the matrix code shown on the COC
   - Type and number of containers associated with each sample
   - Type of preservative(s)
   - Place a diagonal line through unused sample entry rows and write "no others"
   - Page number and number of pages (e.g. Page 1 of 2)
   - Additional instructions or comments for the laboratory, such as:
     - Hold for analysis
     - 48-hr TAT
     - Potential product in sample. This lets the lab know to run separately to prevent dilution of other samples with low concentrations. (Dilution causes reporting limits to be high, which means samples with low concentrations are inaccurately reported as not detected.)
   - Signature of sampler at bottom of page along with date signed
   - Relinquished by signature along with date and time

   Note that erroneous information cannot be erased on the Chain of Custody. Errors must be lined out and initialed.

2. If the COC is a multi-copy form, tear out the appropriate copy for EWI records prior to shipping; otherwise, make a copy or take a photo.

3. Make a PDF of the photo or copy and upload to the project folder.

4.3 Post-Operation

- Place all sample containers in a large plastic bag (e.g. a trash bag) and place in cooler.
- Pack the cooler with sufficient cushioning/packing material to prevent breakage. The less movement between containers, the lower the chance of breakage.
- Fill the large plastic bag with enough ice to completely cover the samples and keep them cool until received by the laboratory.
- Twist the top of the bag closed and secure to keep ice and samples inside.
- After packing the cooler, place the Chain of Custody in a Zip-lock® plastic bag and tape it to the inside lid of the cooler.
- Tape the cooler closed and place signed custody seals and shipping labels* on the outside of the cooler. Take a photo of the cooler(s) once sealed, showing the custody seal on each cooler. This is useful in case the lab sample custodian inadvertently marks that no custody seal is present when they check in the cooler(s). Provide photos to the project manager.
- Fill out field notes and the daily equipment log (see Attachments) and scan all field documents to the project folder.
- Deliver paperwork to the Project Manager.

*If the sample cooler is to be hand-delivered or picked up by a courier, a shipping label is not necessary.

5.0 SAFETY

Acute or chronic exposure to hazardous substances potentially contained in samples could result in health issues. Routes of exposure include inhalation, ingestion, and dermal contact. Consult the appropriate chemical material safety data sheet (MSDS) for anticipated hazardous substances before the initiation of sampling soil, groundwater, or another medium.

6.0 REFERENCES

To properly implement this procedure, please look to the following documents for further information related to this SOP.

- “Corporate Health and Safety Plan” Environmental Works, Incorporated.
- “HAZWOPER Training Manual: 40-Hour Hazardous Waste & Emergency Response Training.” Safety Source, Inc.

- "Guidance for Quality Assurance Project Plans: EPA QA/G-5" US Environmental Protection Agency, December 2002.
- "Sampler's Guide: Contract Laboratory Program Guidance for Field Samplers" US Environmental Protection Agency, October 2014.
- "Operating Procedure: Sample and Evidence Management" US Environmental Protection Agency – Region 4, May 25, 2016.

7.0 VERSION HISTORY

This document is subject to periodic review and updates as technologies, methodologies, and industry-standard practices change. The table below summarizes updates to this SOP.

Version Number	Date	Changes Made	Edited By
1.0	06/30/09	Original Version	Suzan Gonder
2.0	06/04/21	Update	Yvonne Huff

Environmental Works, Inc. SOP No. 5
Chain of Custody Documentation

ATTACHMENTS

Example Chain of Custody Forms

Field Documentation Forms

ACCUTEST
Laboratories

10165 Harwin Drive, Ste. 150, Houston, TX 77036
TEL. 713-271-4700 FAX: 713-271-4770
www.accutest.com

FED-EX Tracking #	Bottle Order Control #
Accutest Quote #	Accutest Job #

Client / Reporting Information			Project Information	
Company Name			Project Name	
Address			Street	
City	State	Zip	City	State
Project Contact		E-mail	Project #	
Phone #			Fax #	
Sampler's Name			Client Purchase Order #	

Accutest Sample #	Field ID / Point of Collection	SUMMA # MEOH Vial #	Collection Date	Collection Time	Collection Sampled By	Matrix	# of bottles	Number of preserved Bottles HCl	NaOH	HNO3	H2SO4	NONE	NaHSO4	MEOH	ENCORE	Requested Analysis											LAB USE ONLY

Matrix Codes
- DW - Drinking Water
- GW - Ground Water
- WW - Water
- SW - Surface Water
- SO - Soil
- SL - Sludge
- OI - Oil
- LIQ - Other Liquid
- AIR - Air
- SOL - Other Solid
- WP - Wipe

Turnaround Time (Business Days)

Approved By: / Date:

☐ 10 Day *STANDARD* ____________
☐ 5 Day *RUSH* ____________
☐ 3 Day *EMERGENCY* ____________
☐ 2 Day *EMERGENCY* ____________
☐ 1 Day *EMERGENCY* ____________
☐ Other ____________

Emergency & Rush T/A data available VIA LabLink

Data Deliverable Information

☐ Commercial "A"
☐ Commercial "B"
☐ Reduced Tier 1
☐ Full Tier 1
☐ TRRP13
☐ EDD Format ______

Commercial "A" = Results Only

Comments / Remarks

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler: 1	Date Time:	Received by: 1	Relinquished by 2	Date Time:	Received by: 2
Relinquished by: 3	Date Time:	Received by: 3	Relinquished by: 4	Date Time:	Received by: 4
Relinquished by: 5	Date Time:	Received by: 5	Custody Seal #	Preserved where applicable ☐	On Ice ☐ Cooler Temp.

APEX LABS

CHAIN OF CUSTODY

COC ____of____

Lab # ____________________

12232 S.W. Garden Place, Tigard, OR 97223 Ph: 503-718-2323 Fax: 503-718-0333

Company:
Project Mgr:
Project Name:
Project #

Address:
Phone:
Fax:
Email:

Sampled by:

						ANALYSIS REQUEST																			
This image cannot currently be displayed. Site Location: OR WA Other: ________ SAMPLE ID	LAB ID #	DATE	TIME	MATRIX	# OF CONTAINERS	**NWTPH-HCID**	**NWTPH-Dx**	**NWTPH-Gx**	**8260 BTEX**	**8260 RBDM VOCs**	**8260 Halo VOCs**	**8260 VOCs**	**8270 SIM PAHs**	**8082 PCBs**	**8081 Chlor. Pest**	**RCRA Total Metals (8)**	**Al, Sb, As, Ba, Be, Cd Ca, Cr, Co, Cu, Fe, Pb Hg, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Tl, V, Zn**	**TCLP Metals (8)**	**1200- COLS**	**1200-Z**					
	1																								
	2																								
	3																								
	4																								
	5																								
	6																								
	7																								
	8																								
	9																								
	10																								

Normal Turn Around Time (TAT) = 7-10 Business Days

TAT Requested (circle)

24 HR **48 HR** **72 HR**

4 DAY **5 DAY** **Other: ______________**

SAMPLES ARE HELD FOR 30 DAYS

SPECIAL INSTRUCTIONS:

RELINQUISHED BY: Signature: Date:	**RECEIVED BY:** Signature: Date:	**RELINQUISHED BY:** Signature: Date:	**RECEIVED BY:** Signature: Date:
Printed Name: Time:	Printed Name: Time:	Printed Name: Time:	Printed Name: Time:
Company:	Company:	Company:	Company:

Chain of Custody/Order Form

Page _____ of _____

ENVIRONMENTAL
WORKS INC.
1016 W. Battlefield • Springfield, Missouri 65807
(417) 890-9500 • FAX (417) 823-9659

Report To:

Purchase Order #:

Project Name:

Project Location:

City/State:

Date Due:

Sampled By:

Lab#	Client Sample ID	Matrix	Date/Time	Preservative	Analysis/Method							
	1.											
	2.											
	3.											
	4.											
	5.											
	6.											
	7.											
	8.											
	9.											
	10.											

Relinquished By	Date	Time	Received By	Date	Time	Sample Receipt Notes
						Temperature
						Preserved Properly
						Method of Shipment

Special Handling:

Submission #

Pace Analytical™
www.pacelabs.com

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of 1

Section A **Required** Client Information:	Section B **Required** Project Information:	Section C Invoice Information:
Company: Environmental Works Inc.	Report To: Max Hoffman	Attention: Accounts Payable
Address:	Copy To:	Company Name: SEE SECTION A
1455 E. Chestnut Expy, Spfd, MO, 65802		Address:
Email To: mhoffman@environmentalworks.com	Purchase Order No.:	Pace Quote Reference:
Phone: 417-207-6694 Fax:	Project Name: Piedmont Bulk Plant	Pace Project Manager: Brown, Angie
Requested Due Date/TAT:	Project Number: 150666	Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER

☐ UST ☐ RCRA ☐ OTHER ________

Site Location

STATE: MO

Section D
Required Client Information

Valid Matrix Codes

MATRIX	CODE
DRINKING WATER	DW
WATER	WT
WASTE WATER	WW
PRODUCT	P
SOIL/SOLID	SL
OIL	OL
WIPE	WP
AIR	AR
OTHER	OT
TISSUE	TS

Requested Analysis Filtered (Y/N)

ITEM #	SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COLLECTED COMPOSITE START TIME	COLLECTED COMPOSITE END/GRAB DATE	COLLECTED COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Y/N ➡ ⬇Analysis Test➡													Residual Chlorine (Y/N)	**Pace Project No./ Lab I.D.**
1																																
2																																
3																																
4																																
5																																
6																																
7																																
8																																
9																																
10																																
11																																
12																																

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS			
	Max Hoffman/EWI									
							Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: Max Hoffman

SIGNATURE of SAMPLER:

DATE Signed (MM/DD/YY):

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.08, 12-Oct-2007

SAMPLE CHAIN OF CUSTODY

Send Report To

Company____

Address____

City, State, ZIP________________________________

Phone #___________________Fax #_________________

SAMPLERS *(signature)*

PROJECT NAME/NO.	PO #

REMARKS

Page # _________ of _________

TURNAROUND TIME
☐ Standard (2 Weeks)
☐ RUSH____________________
Rush charges authorized by:
____

SAMPLE DISPOSAL
☐ Dispose after 30 days
☐ Return samples
☐ Will call with instructions

						ANALYSES REQUESTED												
Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS							Notes

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

FORMS\COC\COC.DOC

CHAIN OF CUSTODY

Environmental Works, Inc.

1731 Locust Street Kansas City, MO 64108

Client / Reporting Information

Company Name Environmental Works, Inc.

Project Contact Yvonne Huff

E-Mail

Address 1731 Locust Street

City Kansas City **State** MO **Zip** 64108

Phone No. 816-285-8410 **Fax No.** 816-285-8409

Samplers's Name

Project Information

Project Name / No.

Bill to

Address

City **Stat** MO

Phone No.

Client Purchase Order #

Matrix Codes

DW - Drinking Water
GW - Ground Water
WW - Wastewater
SO - Soil
SL - Sludge
OI - Oil
LIQ - Other Liquid
SOL - Other Solid

	Field ID / Point of Collection	Collection		Matrix	# of bottles	Preservative								Requested Analyses											LAB USE ONLY
		Date	Time			HCl	NaOH/ZnAce	HNO3	H2SO4	ENCORE	NaHSO4	MEOH	NONE	ASTM D2216 - GRAVIMETRIC MOISTURE (%)	ASTM D2937 - DRY UNIT WEIGHT (g/cc)	ASTM D2216 - VOLUMETRIC MOISTURE (cc/cc)	ASTM D2974 - FOC (g-C/g-soil)	POROSITY	ASTM D854 - SPECIFIC GRAVITY	SIEVE ANALYSIS	Proctor				
				Solid	bucket																				

Turnaround Time (Business days)

Approved By:/ Date:

☐ **10 Day *STANDARD*** ____________________
☐ **5 Day *RUSH*** ____________________
☐ **4 Day *RUSH*** ____________________
☐ **3 Day *EMERGENCY*** ____________________
☐ **2 Day *EMERGENCY*** ____________________
☐ **1 Day *EMERGENCY*** ____________________
☐ **Other** ____________________

Data Deliverable Information

☐ **Level I**
☒ **Level II**
☐ **Level III**
☐ **Level IV**

☐ **State Forms**
☐ **EDD Format**___________
☐ **Other**________________

Comments / Remarks

SAMPLE CUSTODY MUST BE DOCUMENTED BELOW EACH TIME SAMPLES CHANGE POSSESSION, INCLUDING COURIER DELIVERY

Relinquished by Sampler: 1	**Date Time:**	**Received By:** 1	**Relinquished By:** 2	**Date Time:**	**Received By:** 2
Relinquished by: 3	**Date Time:**	**Received By:** 3	**Relinquished By:** 4	**Date Time:**	**Received By:** 4
Relinquished by: 5	**Date Time:**	**Received By:** 5	**Custody Seal #**	**Preserved where applicable** ☐	**On Ice** ☐ **Cooler Temp.**

H&P Mobile Geochemistry Inc.
2470 Impala Drive, Carlsbad, CA 92010
& Field Office - Signal Hill, CA
W handpmg.com E info@handpmg.com
P 760.804.9678 F 760.804.9159

VAPOR / AIR Chain of Custody

DATE:__________
Page ____**of**_____

Lab Client and Project Information

Lab Client/Consultant:
Project Name / #:
Lab Client Project Manager:
Project Location:
Lab Client Address:
Report E-Mail(s):
Lab Client City, State, Zip:
Phone Number:

Sample Receipt (Lab Use Only)

Date Rec'd:
Control #:
H&P Project #
Lab Work Order #
Sample Intact: ☐ Yes ☐ No ☐ See Notes Below
Receipt Gauge ID:
Temp:
Outside Lab:
Receipt Notes/Tracking #:
Lab PM Initials:

Reporting Requirements

☐ Standard Report ☐ Level III ☐ Level IV
☐ Excel EDD ☐ Other EDD:________________
☐ CA Geotracker Global ID:___________________

Turnaround Time

☐ 5-7 day Stnd ☐ 24-Hr Rush
☐ 3-day Rush ☐ Mobile Lab
☐ 48-Hr Rush ☐ Other:_____

Sampler Information

Sampler(s):
Signature:
Date:

Additional Instructions to Laboratory:

**** Preferred VOC units (please choose one):***
☐ µg/L ☐ µg/m^3 ☐ ppbv ☐ ppmv

SAMPLE NAME	**FIELD POINT NAME** (if applicable)	**DATE** mm/dd/yy	**TIME** 24hr clock	**SAMPLE TYPE** Indoor Air (IA), Ambient Air (AA), Subslab (SS), Soil Vapor (SV)	**CONTAINER SIZE & TYPE** 400mL/1L/6L Summa, Tedlar, Tube, etc.	**CONTAINER ID (###)**	**Lab use only:** Receipt Vac	**VOCs Standard Full List** ☐ 8260SV ☐ TO-15	**VOCs Short List / Project List** ☐ 8260SV ☐ TO-15	**Oxygenates** ☐ 8260SV ☐ TO-15	**Naphthalene** ☐ 8260SV ☐ TO-15	**TPHv as Gas** ☐ 8260SVm ☐ TO-15m	**Aromatic/Aliphatic Fractions** ☐ 8260SVm ☐ TO-15m	**Leak Check Compound** ☐ DFA ☐ IPA ☐ He	**Methane** by EPA 8015m	**Fixed Gases by ASTM D1945** ☐ CO2 ☐ O2 ☐ N2				

Approved/Relinquished by: Company: Date: Time: Received by: Company: Date: Time:
Approved/Relinquished by: Company: Date: Time: Received by: Company: Date: Time:
Approved/Relinquished by: Company: Date: Time: Received by: Company: Date: Time:

**Approval constitutes as authorization to proceed with analysis and acceptance of conditions on back*

Pace Analytical®
www.pacelabs.com

Pace Analytical Services, LLC
9608 Loiret Blvd.
Lenexa, KS 66219
(913) 599-5665

Client: ____________________

Client Sample ID: ____________________

Date Collected: ____________________ Time: ____________________

Collected by: ____________________

Analysis: ____________________

Preservative: ☐None ☐HNO_3 ☐H_2SO_4 ☐NaOH ☐HCl

☐$Na_2S_2O_3$ ☐MeOH ☐Zn Acetate ☐Other:____________________

TestAmerica Anchorage
2000 W. International Airport Road
Suite A10
Anchorage, AK 99502
phone 907.563.9200 fax 907.563.9210

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Client Contact	**Project Manager:**	**Site Contact:**	**Date:**	COC No:
Your Company Name here	**Tel/Fax:**	**Lab Contact:**	**Carrier:**	_______ of ______ COCs

Address

City/State/Zip

(xxx) xxx-xxxx Phone

(xxx) xxx-xxxx FAX

Project Name:

Site:

P O #

Analysis Turnaround Time

Calendar (C) or Work Days (W) __________

TAT if different from Below _________

☐ 2 weeks
☐ 1 week
☐ 2 days
☐ 1 day

Job No.

SDG No.

Sample Identification	**Sample Date**	**Sample Time**	**Sample Type**	**Matrix**	**# of Cont.**	**Filtered Sample**																			Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ____________

Possible Hazard Identification

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

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For __________ Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:

Cooler Shipment Checklist

Fill out one cooler shipment checklist for each cooler after it has been packed with samples

Project Name Multistate Trust Springfield
Address 2800 West High Street
City, State Springfield, MO
Date, Time

SAMPLE CHECKLIST	YES	NO	COMMENTS
SAMPLE LIDS ARE TIGHT AND CUSTODY SEALS IN PLACE?	☐	☐	
ARE ALL SAMPLE NUMBERS, DATES, TIMES AND OTHER LABEL INFORMATION LEGIBLE AND COMPLETE?	☐	☐	
HAVE ALL SAMPLE NUMBERS, DATA, TIMES AND OTHER SAMPLING DATA BEEN LOGGED INTO THE SAMPLE LOG BOOK?	☐	☐	
DO SAMPLE NUMBERS AND SAMPLE DESCRIPTIONS ON THE LABELS MATCH THOSE IN THE COC?	☐	☐	
HAVE THE SAMPLES BEEN PROPERLY PRESEVED?	☐	☐	
HAVE THE CHAIN OF CUSTODIES BEEN FILLED OUT COMPLETELY AND CORRECTLY?	☐	☐	
DOES THE ANALYTICAL SPECIFIED ON THE COC MATCH THE ANALYTICAL SPECIFIED IN THE SCOPE OF WORK?	☐	☐	
HAVE THE TRIP BLANKS BEEN INSPECTED FOR HEADSPACE?	☐	☐	
HAVE THE COC'S BEEN PROPERLY SIGNED IN THE TRANSFER SECTION?	☐	☐	

PACKAGING CHECKLIST	YES	NO	COMMENTS
HAS EACH SAMPLE BEEN PLACE INTO AN INDIVIDUAL PLASTIC BAG?	☐	☐	
HAVE ALL THE SAMPLES BEEN PLACED INTO THE COOLER IN AN UPRIGHT POSITION?	☐	☐	
IS THERE ADEQUATE PACKING OF SAMPLES SO THAT WILL NOT TOUCH DURING SHIPMENT?	☐	☐	
HAVE AN ADEQUATE NUMBER OF ICE BAGS BEEN PLACED AROUND AND ON TOP OF THE SAMPLE?	☐	☐	
HAS FRESH BLUE ICE OR WATER ICE BEEN ADDED TO THE COOLER THE DAY OF SHIPMENT?	☐	☐	
HAS THE COOLER BEEN FILLED WITH ADDITIONAL CUSHIONING MATERIAL?	☐	☐	
HAS THE COC BEEN PLACED IN A ZIPLOCK BAG AND TAPED TO THE INSIDE OF THE LID OF THE COOLER?	☐	☐	
HAVE CUSTODY SEALS BEEN PLACED ONTO THE LID?	☐	☐	
HAS THE COOLER BEEN LABELED "THIS SIDE UP"?	☐	☐	
IF REQUIRED, HAS THE COOLER BEEN LABELED WITH THE DOT PROPER SHIPPING NAME, UN NUMBER, AND LABEL?	☐	☐	
HAS THE LABORATORY PERFORMING THE ANALYSES BEEN NOTIFIED OF THE SHIPMENT OF SAMPLES?	☐	☐	

PROBLEMS/RESOLUTIONS:

PREPARED BY: SIGNATURE:

ENVIRONMENTAL WORKS SCIENCE. SAFETY. GRIT. INGENUITY.	**Version** **3.0**	**SOP No. 17: QA/QC Review of Laboratory Analytical Reports**
Standard Operating Procedures (SOP)		**Responsible Department:** Remediation **Page 1 of 6**

1.0 OBJECTIVE / APPLICABILITY / SCOPE

The objective of this Standard Operating Procedure (SOP) is to provide information and procedures for EWI personnel to perform a technical review of analytical data generated by a laboratory. The data review process provides information on the analytical limitations of data based on specific QC criteria.

Topics and procedures discussed in this SOP are supported in reference to the United States Environmental Protection Agency (US EPA) Contract Laboratory Program (CLP) National Functional Guidelines for Organic and Inorganic Data Review and Data Review for Non-Chemists.

This is a standard operating procedure, which should be followed as closely as possible, but varied depending upon specific site data quality objectives, regulatory oversight requirements for the site, and contract agreements with the laboratory. Discrepancies in use of reporting associated with this SOP must be documented in project records and appropriate reports.

2.0 ACRONYMS AND DEFINITIONS

See the listing of laboratory report definitions and acronyms found in Attachment A; following are additional definitions or report definitions to emphasize.

Quality Assurance (QA): Refers to a program for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure the standards of quality are being met.

Quality Control (QC): A process by which persons review the quality of all factors involved in production.

Accuracy: A QA/QC function that quantifies a laboratory’s ability to generate data that agrees with the true concentration or a reference value.

Precision: A QA/QC function that quantifies a laboratory’s ability to generate reproducible data for multiple analyses of the same sample.

Holding Time: The time from sample collection to the time of extraction or analysis. One of the most critical aspects that can affect a sample’s data quality.

Method Detection Limit (MDL): The lowest concentration of a chemical that can be distinguished from the absence of that chemical (a blank) for a given analytical method within a stated confidence limit.

Reporting Limit (RL): lowest reported concentration at a high confidence level of quantification provided on the sample analysis data report, after corrections have been made for sample dilution, sample weight, and for soils and sediments, the amount of moisture in the sample.

Estimated Quantity (J): Reported concentration of an analyte that falls between the MDL and the RL; quantification confidence level is lower than that of the reporting limit.

Laboratory Control Sample (LCS): Known concentrations of target analytes in pure blank water, in mid-calibration range, to test equipment accuracy within control limits.

Matrix Spike/Matrix Duplicate (MS/MSD): Known concentration of target analytes put into two field samples to allow duplicate testing of results; percent recovery comparison evaluates accuracy and precision of the method.

Surrogate (S): Known concentration of non-target analytes (not found at site) put into field samples to test percent recovery for assessing accuracy of the method and potential for matrix interference.

3.0 PROCEDURES

The following outlines the procedures for QA/QC review of laboratory analytical results. These procedures provide details for filling out the QA/QC checklist (Attachment B), which is utilized as the formal review for each data package. Write in the sampling event/laboratory project number, the project site, the laboratory used, the name of the reviewer, and the date in the appropriate boxes at the top of all pages. Then conduct a review utilizing the following procedures and the checklist. Procedures are applicable for review of all analytes and sample media types. Also see the annotated laboratory report found in Attachment C, which serves as a guide of what to look for on the lab reports.

3.1 Data Packages

(1) Transfer the portable document format (PDF) and, if available, the electronic data deliverable (EDD) data packages to the project directory.

(2) Review the PDF and the EDD versions of the data package for completeness.

(3) Verify that analytical results in the PDF format match the EDD. Note that J-flagged (estimated) data values and MDLs may not be entered into the EDD; Check the PDF for these values.

3.2 Invoice

(4) Verify that the invoice for the sample analysis has been approved and given to accounting. If not, mark "no" on the checklist and follow-up with the laboratory.

(5) Verify that the invoice includes the following:
   a. The correct client project name;
   b. The correct laboratory project number;
   c. The correct quantity of the samples analyzed;
   d. The correct method(s) of analysis;
   e. The correct sample matrix; and,
   f. The correct pricing.

(6) Approve the invoice and give to accounting. Make sure to write any special instructions (e.g. no markup for PSTIF sites), if applicable, on the invoice prior to turning in to accounting.

3.3 Chain-of-Custody (COC)

(7) Confirm project information was entered correctly on the COC.

(8) Review the COC for completeness (see EWI SOP #5).

(9) Confirm that the COC has been signed and dated as received by the laboratory representative.

(10) Review laboratory comments on the COC (i.e. cooler temperature, sample conditions) as well as the laboratory completed "cooler receipt form" or "sample receipt checklist." List any unusual conditions noted by the laboratory on page 2 of the QA/QC review checklist.

3.4 Samples

(11) Verify that all samples sent to the laboratory were analyzed and the results were reported.

(12) Check the data for anomalies and compare to the applicable target levels and historic data. If there are anomalies with no qualifier, contact the laboratory to discuss.

(13) If duplicate or split samples were collected, compare the results to the primary sample, noting discrepancies on page 2.

(14) Check the sample results for qualifiers (flags). If a sample has a qualifier, note it on page 2.

(15) Check the reporting limits/MDL for each sample and compare them to the required limits for the site. If reporting limits are not met, then explain the discrepancies on page 2 and contact the laboratory to discuss.

Note that estimated (J) values are not normally provided unless requested for the project. Pending DQOs, estimated values can be requested post-analysis; however, the laboratory may charge an additional cost for this.

3.5 Hold Times

(16) Review the hold time for each sample; regulatory hold times vary for different analyses. Attachment D contains a hold time chart for organic and inorganic chemicals of concern. <u>This is a critical parameter for data quality</u>.

(17) Make sure the time between <u>sampling date/time</u> and <u>extraction or analysis date/time</u> does not exceed the hold time for that analysis.

(18) Contact the laboratory for explanation, significance, and options if samples were analyzed out of hold time.

3.6 QA/QC Deliverables Review and Evaluation

(19) Make sure the laboratory provided the appropriate QA/QC deliverables, as requested on the COC (i.e., Level 1 – Level 4). There are four possibilities for QA/QC deliverables; the most frequently requested is Level 2. A description of Level 2 report deliverables can be found in Attachment E.

(20) If a pH preservative was used, note appropriate levels (>11 for TSP, ≤2 for HCl). Record discrepancies on page 2.

(21) Review QA/QC data for acceptable results of laboratory Surrogates (S); these may be listed with each sample or separately in the laboratory QC section of the report. Percent recovery has to fall within listed percent range. If outside limits, should be noted by a qualifier code. Note specifics on page 2 and contact the laboratory for significance. High contaminant levels may disrupt surrogate detections.

(22) Review QA/QC data for acceptable results of laboratory Method Blank; should be one for each analytical method run. Note absence of detections (ND) and associated Surrogates (S) within % range limits. If detections, record specifics on page 2, and note QC Batch group and associated

samples – similar concentrations of analytes in sample will be suspect. Record affected samples in Comments on page 2. Contact the laboratory for explanation.

Note: common lab external contaminants are acetone, methylene chloride, phthalates, iron, nickel, copper, and zinc.

(23) Review QA/QC data for acceptable results of Laboratory Control Samples (LCS) and if applicable the Laboratory Control Samples Duplicate (LCSD); should be an LCS for every Method Blank sample. Make sure LCS % recoveries are within the percent recovery limits.

If the LCS % recoveries are outside the limits, note specific discrepancies and affected samples on page 2, and contact the laboratory for effect on samples. Use following guide regarding potential effect:

- LCS % above limit & sample is ND = No issue
- LCS% above limit & sample is high = May be biased High
- LCS% below limit & sample is high = May be biased Low
- LCS% below limit & sample is ND = Potential false negative

The relative percent difference (RPD) value for the LCS/LCSD should be less that 20 (dependent on Sampling and Analysis Plan – SAP and DQOs). Note specifics on page 2 and contact the laboratory for significance. High contaminant levels may disrupt results.

(24) Review QA/QC data for acceptable results of laboratory Matrix Spikes (MS) /MS Duplicates (MSD). Percent recoveries must fall within listed percent range, and relative percent difference (RPD) must not exceed max RPD listed. If any parameters outside limits, should have a qualifier code. Note specifics on page 2 and contact the laboratory for significance. High contaminant levels may disrupt results.

Note: MS/MSD failures are not used as accept/reject criteria for sample data. Method Blank detections and LCS failures are more critical.

(25) Review analytical data for acceptable results of field blanks, trip blanks, rinsate blanks, and duplicates. Record specifics of blank detections on page 2 and note significant differences (> 50% for low concentrations and >20% for high concentration ranges, or as specified in project sampling plan) in duplicate values on page 2.

4.0 REFERENCES

(1) U.S. EPA. November 2002. Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8).

(2) U.S. EPA. March 2006. Guidelines for Data Review of Contract Laboratory Program Analytical Services Volatile and Semivolatile Data Packages. Standard Operating Procedure 901, U.S. EPA Region 9.

(3) U.S. EPA. October 2014. Laboratory Data Review for the Non-Chemist

(4) U.S. EPA Contract Laboratory Program. April 2016. National Functional Guidelines for Inorganic Superfund Data Review (U.S. EPA-542-B-16-001).

(5) U.S. EPA Contract Laboratory Program. June 2008. National Functional Guidelines for Superfund Organics Data Review (U.S. EPA-540-R-08-01).

(6) Pace Analytical Laboratories, in-house training at EWI headquarters, March 5, 2010.

(7) U.S. DOD. February 2018. Environmental Data Quality Workshop - General Data Validation Guidelines

5.0 VERSION HISTORY

This document is subject to periodic review and updates as technologies, methodologies, and industry standard practices change. The table below summarizes updates to this SOP.

Version Number	Date	Changes Made	Edited By
1.0	11/1/10	Original Version	
2.0	4/1/13		B. Garcia
3.0	8/16/21		J. Jackson

Environmental Works, Inc. SOP No. 17

QA-QC of Laboratory Analytical Data Reports

ATTACHMENTS

A - Laboratory Report Definitions and Acronyms

B - QA-QC Checklist

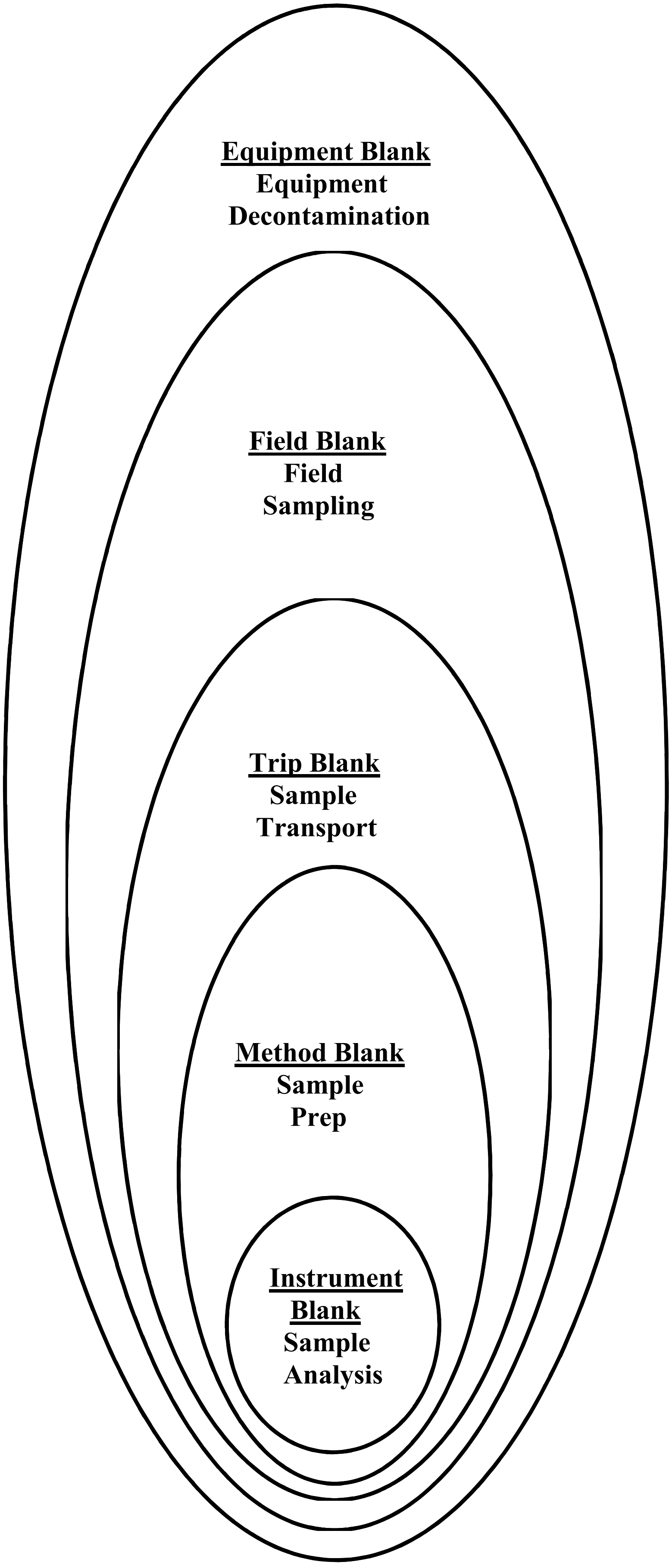
C - Example Laboratory Report, Annotated

D - Hold Time Chart

E - Level 2 Deliverables

Region III Fact Sheet
Quality Control Tools: Blanks

The primary purpose of blanks is to trace sources of artificially introduced contamination. The diagram below shows how comparison of different blank sample results can be used to identify and isolate the source of contamination introduced in the field or the laboratory. See page 2 for a definition of each blank, its purpose and collection frequency.



Equipment Blank results include total field and laboratory sources of contamination.

Field Blank results include total ambient conditions during sampling and laboratory sources of contamination.

Trip Blank results include shipping and laboratory sources of contamination. Volatiles only.

Method Blank results show only laboratory sources of contamination.

Instrument Blank results show only laboratory sources of contamination.

FIELD BLANKS

Rinsate/Equipment Blank: A sample of analyte free water poured over or through decontaminated field sampling equipment prior to the collection of environmental samples.

Purpose: Assess the adequacy of the decontamination process. Assess contamination from the total sampling, sample preparation and measurement process, when decontaminated sampling equipment is used to collect samples.

Frequency: 1 blank/day/matrix or 1 blank/20 samples/matrix, whichever is more frequent.

Field Blank: A sample of analyte free water poured into the container in the field, preserved and shipped to the laboratory with field samples.

Purpose: Assess contamination from field conditions during sampling.

Frequency: 1 blank/day/matrix or 1 blank/20 samples/matrix, whichever is more frequent.

Trip Blank: A clean sample of a matrix that is taken from the laboratory to the sampling site and transported back to the laboratory without having been exposed to sampling procedures. Typically, analyzed only for volatile compounds.

Purpose: Assess contamination introduced during shipping and field handling procedures.

Frequency: 1 blank/cooler containing volatiles.

LABORATORY BLANKS

Method Blank: A blank prepared to represent the matrix as closely as possible. The method blank is prepared/extracted/digested and analyzed exactly like the field samples.

Purpose: Assess contamination introduced during sample preparation activities

Frequency: 1 blank/batch (samples prepared at one time.)

Instrument Blank: A blank analyzed with field samples.

Purpose: Assess the presence or absence of instrument contamination.

Frequency: Defined by the analytical method or at the analyst's discretion (e.g., after high concentration samples).

COMPARING BLANKS**:** The source of contamination introduced in the field or laboratory can be deduced by comparing blank results. An equipment blank could potentially be contaminated in the field, during transport to the lab or in the lab. The method blank, on the other hand, could only be contaminated in the lab. Using all blanks (appropriate for the project) described in this fact sheet will facilitate the identification of contamination sources.

Temperature Indicator (often called a Temperature Blank, but is not a blank): A VOA vial or other small sample bottle filled with distilled water that is placed in each cooler. Upon arrival at the laboratory, the temperature of this vial is measured. The temperature indicator or blank is not analyzed and does not measure introduced contamination, therefore, is not a blank.

Purpose: To evaluate if samples were adequately cooled during sample shipment

Frequency: 1 blank/cooler

Contact: Region 3 QA Staff at R3 ESC-QA@epa.gov or (410) 305-2629

QA/QC Review of Laboratory Analytical Reports

Sampling Event:	Project Site Name:	Laboratory Used:	Report Reviewed By:
Lab Project No:	Site City, State:	Lab City, State:	Date:

QA/QC Checklist

Yes No N/A

☐ ☐ ☐ Raw data have been transferred to project directory (PDF, EDD).

☐ ☐ ☐ Invoice approved and given to accounting.

☐ ☐ ☐ Chain-of-Custody (COC) has been signed/dated as received by laboratory.

☐ ☐ ☐ Confirm the project information was entered appropriately on the COC.

☐ ☐ ☐ Review laboratory comments on the COC (ie cooler temperature, sample conditions), as well as the lab-completed “COOLER RECEIPT FORM.

Unusual Conditions: YES ☐ NO ☐

If YES, list conditions on page 2

☐ ☐ ☐ Verify that all samples sent to the laboratory were analyzed and results reported.

☐ ☐ ☐ Verify proper sample holding times were observed for the particular analysis/parameter.

☐ ☐ ☐ Were Duplicate or Split samples collected? YES ☐ NO ☐

If so, compare to the primary sample, note discrepancies on Page 2.

☐ ☐ ☐ Analytical data checked for anomalies and compared to applicable target levels and historic data.

☐ ☐ ☐ Laboratory provided appropriate QA/QC deliverables as requested on the COC (i.e. Level 1 – Level 4).

☐ ☐ ☐ Analytical results in the PDF format match the EDD (if provided).

☐ ☐ ☐ Required reporting limits met for all samples/analytes. If not, explain discrepancies and how resolved with laboratory on Page 2.

☐ ☐ ☐ Reported QA/QC data provide acceptable results for laboratory spikes, surrogates, and duplicates with all RPD values within limits***.

☐ ☐ ☐ Reported QA/QC data provide acceptable results for Laboratory Control Samples (LCS) and Method/Equipment Blanks***.

☐ ☐ ☐ Field, Trip, and Rinsate Blanks report acceptable results***.

*** Describe all QA/QC and Blanks discrepancies on Page 2

QA/QC Review of Laboratory Analytical Reports

Project / #:______________________ Lab Project # _______________ Date: ____________

Summary of QA/QC Observations

Sample ID	Lab Proj #	Observation	Requested Action	Comments

SAMPLE SUMMARY

Project: JUMP 8
Pace Project No.: 6065663

Lab ID	Sample ID	Matrix	Date Collected	Date Received
6065663001	SB-1 3'	Solid	09/08/09 11:40	09/09/09 07:17
6065663002	SB-1 4.5-5'	Solid	09/08/09 11:50	09/09/09 07:17
6065663003	SB-1 9-9.5'	Solid	09/08/09 12:00	09/09/09 07:17
6065663004	SB-1 14-14.5'	Solid	09/08/09 12:15	09/09/09 07:17
6065663005	SB-2 2.5-3'	Solid	09/08/09 12:45	09/09/09 07:17
6065663006	SB-2 4.5-5'	Solid	09/08/09 12:55	09/09/09 07:17
6065663007	SB-2 7-7.5'	Solid	09/08/09 13:00	09/09/09 07:17
6065663008	SB-2 14.5'	Solid	09/08/09 13:10	09/09/09 07:17
6065663009	SB-3 9'	Solid	09/08/09 12:30	09/09/09 07:17
6065663010	PT-1	Water	09/08/09 13:50	09/09/09 07:17
6065663011	TRIP BLANK	Water	09/08/09 13:50	09/09/09 07:17
6065663012	TRIP BLANK	Solid	09/08/09 13:50	09/09/09 07:17

CHECK TIMES (DAYS)
should not be more than one day

our sample #

LAB ID reference

EWI Sample ID

Lab Sample ID

Can also compare here for no more than one day

ANALYTICAL RESULTS

Project: JUMP 8
Pace Project No.: 6065663

Sample: SB-1 3' **Lab ID: 6065663001** Collected: 09/08/09 11:40 Received: 09/09/09 07:17 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260 MSV GRO and Oxygenates	Analytical Method: EPA 5035A/8260							
TPH-GRO	**2.1**	mg/kg	0.60	1		09/10/09 13:17		
Benzene	ND	mg/kg	0.0060	1		09/10/09 13:17	71-43-2	
Toluene	ND	mg/kg	0.0060	1		09/10/09 13:17	108-88-3	
Ethylbenzene	ND	mg/kg	0.0060	1		09/10/09 13:17	100-41-4	
Xylene (Total)	ND	mg/kg	0.012	1		09/10/09 13:17	1330-20-7	
Naphthalene	ND	mg/kg	0.024	1		09/10/09 13:17	91-20-3	
Methyl-tert-butyl ether	**0.0074**	mg/kg	0.0060	1		09/10/09 13:17	1634-04-4	
tert-Amylmethyl ether	ND	mg/kg	0.0060	1		09/10/09 13:17	994-05-8	
tert-Butyl Alcohol	ND	mg/kg	0.030	1		09/10/09 13:17	75-65-0	
Ethyl-tert-butyl ether	ND	mg/kg	0.0060	1		09/10/09 13:17	637-92-3	
Diisopropyl ether	ND	mg/kg	0.0060	1		09/10/09 13:17	108-20-3	
Toluene-d8 (S)	112	%	81-121	1		09/10/09 13:17	2037-26-5	
4-Bromofluorobenzene (S)	112	%	75-131	1		09/10/09 13:17	460-00-4	
1,2-Dichloroethane-d4 (S)	108	%	77-131	1		09/10/09 13:17	17060-07-0	
Percent Moisture	Analytical Method: ASTM D2974-87							
Percent Moisture	**23.1**	%	0.10	1		09/10/09 00:00		

compare for HOLD TIME

Surrogate

% should be within range

If a QC issue, there should be a qualifier code here

ANALYTICAL RESULTS

Project: JUMP 8
Pace Project No.: 6065663

Sample: SB-1 4.5-5' **Lab ID: 6065663002** Collected: 09/08/09 11:50 Received: 09/09/09 07:17 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260 MSV GRO and Oxygenates	Analytical Method: EPA 5035A/8260							
TPH-GRO	**585**	mg/kg	28.1	50		09/11/09 16:45		
Benzene	**2.1**	mg/kg	0.28	50		09/11/09 16:45	71-43-2	
Toluene	**0.27**	mg/kg	0.0052	1		09/10/09 13:34	108-88-3	
Ethylbenzene	**13.1**	mg/kg	0.28	50		09/11/09 16:45	100-41-4	
Xylene (Total)	**8.8**	mg/kg	0.56	50		09/11/09 16:45	1330-20-7	
Naphthalene	**6.8**	mg/kg	1.1	50		09/11/09 16:45	91-20-3	
Methyl-tert-butyl ether	**0.012**	mg/kg	0.0052	1		09/10/09 13:34	1634-04-4	
tert-Amylmethyl ether	ND	mg/kg	0.0052	1		09/10/09 13:34	994-05-8	
tert-Butyl Alcohol	ND	mg/kg	0.026	1		09/10/09 13:34	75-65-0	
Ethyl-tert-butyl ether	ND	mg/kg	0.0052	1		09/10/09 13:34	637-92-3	
Diisopropyl ether	ND	mg/kg	0.0052	1		09/10/09 13:34	108-20-3	
Toluene-d8 (S)	154	%	81-121	1		09/10/09 13:34	2037-26-5	S2
4-Bromofluorobenzene (S)	149	%	75-131	1		09/10/09 13:34	460-00-4	S2
1,2-Dichloroethane-d4 (S)	122	%	77-131	1		09/10/09 13:34	17060-07-0	
Percent Moisture	Analytical Method: ASTM D2974-87							
Percent Moisture	**20.7**	%	0.10	1		09/10/09 00:00		

Note outside of range

qualifier code (see "Qualifiers" page near end of lab report)

pH >11.0 (TSP)
~ 2 (HCl)

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www.pacelabs.com

Pace Analytical Services, Inc.
9608 Loiret Blvd.
Lenexa, KS 66219
(913)599-5665

Associated QC Batch

If detections in method Blank, will affect these samples

QUALITY CONTROL DATA

These will be method Blanks for every method run

Project: JUMP 8
Pace Project No.: 6065663

QC Batch: MSV/23475
QC Batch Method: EPA 5035A/8260
Analysis Method: EPA 5035A/8260
Analysis Description: 8260 MSV GRO and Oxygenates
~~Associated Lab~~ Samples: 6065663001, 6065663002, 6065663006

METHOD BLANK: 534417
Matrix: Solid
Associated Lab Samples: 6065663001, 6065663002, 6065663006

METHOD BLANK

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Benzene	mg/kg	ND	0.0050	09/10/09 11:37	
Diisopropyl ether	mg/kg	ND	0.0050	09/10/09 11:37	
Ethyl-tert-butyl ether	mg/kg	ND	0.0050	09/10/09 11:37	
Ethylbenzene	mg/kg	ND	0.0050	09/10/09 11:37	
Methyl-tert-butyl ether	mg/kg	ND	0.0050	09/10/09 11:37	
Naphthalene	mg/kg	ND	0.020	09/10/09 11:37	
tert-Amylmethyl ether	mg/kg	ND	0.0050	09/10/09 11:37	
tert-Butyl Alcohol	mg/kg	ND	0.025	09/10/09 11:37	
Toluene	mg/kg	ND	0.0050	09/10/09 11:37	
TPH-GRO	mg/kg	ND	0.50	09/10/09 11:37	
Xylene (Total)	mg/kg	ND	0.010	09/10/09 11:37	
1,2-Dichloroethane-d4 (S)	%	93	77-131	09/10/09 11:37	
4-Bromofluorobenzene (S)	%	103	75-131	09/10/09 11:37	
Toluene-d8 (S)	%	106	81-121	09/10/09 11:37	

WANT ND

Check within range limits

Check for codes

LABORATORY CONTROL SAMPLE: 534418

LCS

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Benzene	mg/kg	.05	0.046	91	79-117	
Diisopropyl ether	mg/kg	.05	0.044	89	72-127	
Ethyl-tert-butyl ether	mg/kg	.05	0.047	94	78-124	
Ethylbenzene	mg/kg	.05	0.047	94	82-118	
Methyl-tert-butyl ether	mg/kg	.05	0.044	88	70-118	
Naphthalene	mg/kg	.05	0.060	120	74-138	
tert-Amylmethyl ether	mg/kg	.05	0.049	99	79-121	
tert-Butyl Alcohol	mg/kg	.25	0.23	91	64-131	
Toluene	mg/kg	.05	0.051	103	78-117	
TPH-GRO	mg/kg	4	3.8	94	60-126	
Xylene (Total)	mg/kg	.15	0.14	95	79-119	
1,2-Dichloroethane-d4 (S)	%			92	77-131	
4-Bromofluorobenzene (S)	%			100	75-131	
Toluene-d8 (S)	%			108	81-121	

should be one for each method group

want all within limits

QUALITY CONTROL DATA

Project: JUMP 8
Pace Project No.: 6065663

QC Batch: MPRP/9633
QC Batch Method: EPA 3010
Associated Lab Samples: 6065663010
Analysis Method: EPA 6010
Analysis Description: 6010 MET

METHOD BLANK: 534635
Matrix: Water
Associated Lab Samples: 6065663010

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Lead	mg/L	ND	0.0050	09/11/09 10:37	

LABORATORY CONTROL SAMPLE: 534636

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Lead	mg/L	1	0.97	97	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 534637 534638

Parameter	Units	6065773001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Lead	mg/L	ND	1	1	0.98	0.98	98	97	75-125	0	20	

MS/MSD

Note 2 Lab ID's

both to be within limits

< Max

QUALIFIERS

Project: JUMP 8
Pace Project No.: 6065663

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.
ND - Not Detected at or above adjusted reporting limit.
J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
MDL - Adjusted Method Detection Limit.
S - Surrogate
1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.
Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.
LCS(D) - Laboratory Control Sample (Duplicate)
MS(D) - Matrix Spike (Duplicate)
DUP - Sample Duplicate
RPD - Relative Percent Difference
Pace Analytical is NELAP accredited. Contact your Pace PM for the current list of accredited analytes.
U - Indicates the compound was analyzed for, but not detected.

BATCH QUALIFIERS

Batch: MSV/23475

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

Batch: MSV/23547

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

Batch: MSV/23548

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

ANALYTE QUALIFIERS

H6	Analysis initiated more than 15 minutes after sample collection.
M0	Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.
S2	Surrogate recovery outside laboratory control limits due to matrix interferences (confirmed by similar results from sample re-analysis).

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: JUMP 8
Pace Project No.: 6065663

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
6065663001	SB-1 3'	ASTM D2974-87	PMST/4473		
6065663002	SB-1 4.5-5'	ASTM D2974-87	PMST/4473		
6065663003	SB-1 9-9.5'	ASTM D2974-87	PMST/4473		
6065663004	SB-1 14-14.5'	ASTM D2974-87	PMST/4473		
6065663005	SB-2 2.5-3'	ASTM D2974-87	PMST/4473		
6065663001	SB-1 3'	EPA 5035A/8260	MSV/23475		
6065663002	SB-1 4.5-5'	EPA 5035A/8260	MSV/23475		
6065663006	SB-2 4.5-5'	EPA 5035A/8260	MSV/23475		
6065663010	PT-1	SM 4500-H+B	WET/19439		
6065663010	PT-1	EPA 3010	MPRP/9633	EPA 6010	ICP/8497
6065663006	SB-2 4.5-5'	ASTM D2974-87	PMST/4479		
6065663007	SB-2 7-7.5'	ASTM D2974-87	PMST/4479		
6065663008	SB-2 14.5'	ASTM D2974-87	PMST/4479		
6065663009	SB-3 9'	ASTM D2974-87	PMST/4479		
6065663010	PT-1	SM 2540D	WET/19462		
6065663003	SB-1 9-9.5'	EPA 5035A/8260	MSV/23547		
6065663004	SB-1 14-14.5'	EPA 5035A/8260	MSV/23547		
6065663005	SB-2 2.5-3'	EPA 5035A/8260	MSV/23547		
6065663007	SB-2 7-7.5'	EPA 5035A/8260	MSV/23547		
6065663008	SB-2 14.5'	EPA 5035A/8260	MSV/23547		
6065663009	SB-3 9'	EPA 5035A/8260	MSV/23547		
6065663010	PT-1	EPA 8260	MSV/23548		
6065663010	PT-1	EPA 410.4	WETA/10941		

USE TO DETERMINE / VERIFY
WHICH SAMPLES ARE IN
WHIC QC BATCH

LAB PROJECT NUMBER FOR THESE SAMPLES

Pace Analytical
www.pacelabs.com

Sample Condition Upon Receipt

WO# : 60138722

60138722

NOTE COOLER TEMP

Client Name: Environmental Works

Optional
Proj Due Date:
Proj Name:

Courier: Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace ☐ Other ☑ via

Tracking #: ______ Pace Shipping Label Used? Yes ☐ No ☑

Custody Seal on Cooler/Box Present: Yes ☑ No ☐ Seals intact: Yes ☑ No ☐

Packing Material: Bubble Wrap ☐ Bubble Bags ☑ Foam ☑ None ☐ Other ☐

Thermometer Used: ~~T-112~~ / T-194 **Type of Ice:** [✓ Wet] Blue None (circle one) ☐ Samples received on ice, cooling process has begun

Cooler Temperature: 2.6

Temperature should be above freezing to 6°C

Date and Initials of person examining contents: 2/14/13

Chain of Custody present:	☑Yes	☐No	☐N/A	1.
Chain of Custody filled out:	☑Yes	☐No	☐N/A	2.
Chain of Custody relinquished:	☑Yes	☐No	☐N/A	3.
Sampler name & signature on COC:	☑Yes	☐No	☐N/A	4.
Samples arrived within holding time:	☑Yes	☐No	☐N/A	5.
Short Hold Time analyses (<72hr):	☐Yes	☑No	☐N/A	6.
Rush Turn Around Time requested:	☐Yes	☑No	☐N/A	7.
Sufficient volume:	☑Yes	☐No	☐N/A	8.
Correct containers used:	☑Yes	☐No	☐N/A	
Pace containers used:	☑Yes	☐No	☐N/A	9.
Containers intact:	☑Yes	☐No	☐N/A	10.
Unpreserved 5035A soils frozen w/in 48hrs?	☐Yes	☐No	☑N/A	11.
Filtered volume received for dissolved tests?	☐Yes	☐No	☑N/A	12.
Sample labels match COC:	☑Yes	☐No	☐N/A	
Includes date/time/ID/analyses Matrix: WT				13.
All containers needing preservation have been checked	☐Yes	☐No	☑N/A	
All containers needing preservation are found to be in compliance with EPA recommendation.	☐Yes	☐No	☑N/A	14.
Exceptions: VOA, coliform, TOC, O&G, WI-DRO (water), Phenolics	☑Yes	☐No		Initial when completed / Lot # of added preservative
Trip Blank present:	☑Yes	☐No	☐N/A	
Pace Trip Blank lot # (if purchased): 101512-3				15.
Headspace in VOA vials (>6mm):	☐Yes	☑No	☐N/A	16.
Project sampled in USDA Regulated Area:	☐Yes	☐No	☑N/A	17. List State:

NOTE ANY DISCREPANCIES

Client Notification/ Resolution: Copy COC to Client? Y [✓ N] Field Data Required? Y [✓ N]

Person Contacted: ______ Date/Time: ______

Comments/ Resolution: ______

NOTE LAB PM SIGN-OFF

Project Manager Review: ______ Date: 2/19/13

F-KS-C-003-Rev 7, 04December2012

Analytical Method / Hold Time Chart

Analyses	Matrix	Method	Container	Temperature	Preservative	Holding Time
INORGANICS						
Biocehmical Oxygen Demand (BOD)	W or WW	405.1	1 L/AG	Cool, 4°C		DAYS 2
Anions: Bromide, Chloride, Fluoride, Nitrate, Nitrite, Ortho-Phos and Sulfate	W or WW	300/4500	500 mL/P	Cool, 4°C		2 for NO_2, NO_3, OrthoP; all others 28
	S or SW	9056	4 oz./G			28
Cyanide	W or WW	335.2/4500	1 L/P		NaOH, pH>12	14
	S or SW	9010A	4 oz./G	Cool, 4°C		14
Mercury	W or WW	245.1	500 mL/P		HNO_3, pH<2	28
	S or SW	7470/7471	4 oz./G	Cool, 4°C		28
Total Metals ICP/ICP-MS	W or WW	200.7/200.8	500 mL/P		HNO_3, pH<2	180
	S or SW	6010B	4 oz./G	Cool, 4°C		180
TCLP Metals	S or SW	1311/6010/7471	8 oz./G	Cool, 4°C		14 (Leach)
						180 (on extract)
ORGANICS						
BTEX / GRO (Gasoline Range Organics)	W or WW	8021/8015	4 x 40 mL Voa Vial	Cool, 4°C	HCl, pH<2	14
	S or SW	8021/8015	4 oz./G	Cool, 4°C		14
Oil & Grease and / or TPH	W or WW	1664	1 L/AG each	Cool, 4°C	H_2SO_4, pH<2	28
	S or SW		8 oz./G			28
DRO (Diesel Range Organics)	W or WW	8015	1 L/AG each	Cool, 4°C		7
	S or SW		8 oz./G			14
Volatile Organic Compounds (VOCs)	W or WW	524/624/8260	Vial	Cool, 4°C	HCl, pH<2	14
	S or SW	8260	4 oz./G			14
Organochlorine Pesticides and/or PCBs	W or WW	508/608/8081/8082	1 L/AG each	Cool, 4°C		7
	S or SW	8082	8 oz./G			14
Semivolatile Organics, Polynuclear Aromatics (PNAs/PAHs)	W or WW	625/8270	1 L/AG	Cool, 4°C		7
	S or SW	8270	8 oz./G			14
TCLP Semivolatiles, Pesticides, and Herbicides	S or SW	1311/8270/8081/8082/8151	8 oz./G	Cool, 4°C		14 (Leach)
						7 (on extract)
TCLP Volatiles	S or SW	1311/8260	8 oz./G	Cool, 4°C		14 (Leach)
						7 (on extract)
ICP Metals: Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Ni, Na, Pb, Se, Si, Sn, Sr, Tl, Ti, Vn, Zn						
ICP-MS Metals: Ag, Al, As, B, Ba, Be, Bi, Cd, Cr, Co, Cu, Hg, Mn, Mo, Ni, Pb, Se, Tl, U, Vn, Zn						

Abrreviations:

Analysis
BOD = biochemical oxygen demand
ICP = inductively coupled plasma
ICP-MS = inductively coupled plasma mass spectrometry
TCLP = toxicity characteristic leaching procedure
BTEX = benzene, toluene, ethylbenzene, xylenes
GRO = gasoline range organics
TPH = total petroleum hydrocarbons
DRO = diesel range organics
VOCs = volatile organic compounds
PCBs = polychlorinated biphenyls
PNAs = polynuclear aromatics
PAHs = polynuclear aromatic hydrocarbons

Matrix
W = water
WW = wastewater
S = soil/sediment
SW = solid waste

Container
L = liter
AG = Amber Glass
mL = milliliter
P = plastic
oz = ounce
G = glass

Preservative
HCl = hydrochloric acid
HNO_3 = nitric acid
NaOH = sodium hydroxide
H_2SO_4 = sulfuric acid
TSP = Trisodium phosphate

Metals
Ag = Silver
Al = Aluminum
As = Arsenic
B = Boron
Ba = Barium
Be = Beryllium
Bi = Bismuth
Ca = Calcium
Cd = Cadmium
Co = Cobalt
Cr = Chromium
Cu = Copper
Fe = Iron
Hg = Mercury
K = Potassium
Li = Lithium
Mg = Magnesium
Mn = Manganese
Mo = Molybdenum
Na = Sodium
Ni = Nickel
Pb = Lead
Se = Selenium
Si = Silicon
Sn = Tin
Sr = Strontium
Ti = Titanium
Tl = Thallium
U = Uranium
Vn = Vanadium
Zn = Zinc

Level 2 Report Deliverables

Cover/Signature Page
Table of Contents
Report Narrative
Executive Summary
Method Summary
Method/Analyst Summary
Sample Analtytical Data Sheets
Surrogate Recovery Report (may be with each separate analysis)
QC Reports (Method Blanks, LCS, LCSD, MS/MSD)
Method Blank Report (should be one for each analytical method)
Initial and Continuing Calibration Blanks (Metals Inorganic Fractions)
Pre-Digestion Matrix Spike Recoveries Summary (Metals Inorganic Fractions)
QC Batch / Sample Association Summary
Glossary / Qualifiers (batch and analyte runs)
Sample Receipt Checklist
Client Chain of Custody

Note: The report deliverables may vary by laboratory

Acronyms:
DF = Dilution Factor
DUP - Duplicate
J = Estimated quantity (> MDL but < RL)
LCS = laboratory control sample
LCSD = laboratory control sample duplicate
MDL = Method Detection Limit
MS = matrix spike
MSD = matrix spike duplicate
ND = not detected at or above the reporting limit
RL = Reporting Limit
RSD = Relative Percent Difference
S = Surrogate
U = Undetected

ENVIRONMENTAL WORKS INC.	**Standard Operating Procedure (SOP)**	Issue Date: 11/9/2018	
Procedure No. 17B: QA/QC Review of Laboratory Report Level 4 Data Package for Volatile and Semivolatile Analysis		Technical Reference: Barbara Garcia	
		Page:	1 of 34

Skills Required by the Reviewer:

1) Must know site-specific data quality objectives (DQO) and corporate quality assurance.
2) Must have a complete understanding of the intended use of the data.
3) Must understand all components of laboratory reports, including QA/QC parameters, instrument forms, and instrument raw data.

1.0 OBJECTIVE / APPLICABILITY / SCOPE

The objective of this Standard Operating Procedure (SOP) is to provide additional information for EWI personnel to perform a technical review of analytical data packages including documentation of sampling, shipping, sample analysis, sample identification, raw data, and associated quality control (QC) samples. SOP No 17B contains data validation requirements and procedures for volatile and semivolatile analysis by gas chromatography/mass spectrometry. The content of this SOP references Procedure No. 17 QA/QC Review of Laboratory Analytical Reports.

Topics and procedures discussed in this SOP are supported in reference to the United States Environmental Protection Agency (US EPA) Contract Laboratory Program (CLP) National Functional Guidelines for Organic and Inorganic Data Review.

This is a standard operating procedure, which should be followed as closely as possible, but varied depending upon specific site data quality objectives, regulatory oversight requirements for the site, and contract agreements with the laboratory. Discrepancies in use of reporting associated with this SOP must be documented in project records and appropriate reports.

2.0 ACRONYMS AND DEFINITIONS

See the listing of laboratory report definitions and acronyms in the Attachments; following are additional definitions or report definitions to emphasize.

Accuracy: A QA/QC function that quantifies a laboratory's ability to generate data that is in agreement with the true concentration or a reference value.
Estimated Quantity (J): Reported concentration of an analyte that falls between the MDL and the RL; quantification confidence level is lower than that of the reporting limit.

GC/MS: Gas chromatograph/mass spectrometry

Holding Time: The time from sample collection to the time of extraction or analysis. One of the most critical aspects that can affect a sample's data quality.

Laboratory Control Sample (LCS): Known concentrations of target analytes in pure blank water, in mid-calibration range, to test equipment accuracy within control limits.

Matrix Spike/Matirx Duplicate (MS/MSD): Known concentration of target analytes put into two field samples to allow duplicate testing of results; percent recovery comparison evaluates accuracy and precision of the method.

Method Detection Limit (MDL): The lowest concentration of a chemical that can be distinguished from the absence of that chemical (a blank) for a given analytical method within a stated confidence limit.

Precision: A QA/QC function that quantifies a laboratory's ability to generate reproducible data for multiple analyses of the same sample.

Quality Assurance (QA): Refers to a program for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure the standards of quality are being met.

Quality Control (QC): A process by which persons review the quality of all factors involved in production.

Reporting Limit (RL): lowest reported concentration at a high confidence level of quantification provided on the sample analysis data report, after corrections have been made for sample dilution, sample weight, and for soils and sediments, the amount of moisture in the sample

Surrogate (S): Known concentration of non-target analytes (not found at site) put into field samples to test percent recovery for assessing accuracy of the method and potential for matrix interference.

3.0 PROCEDURES

As Level 4 data validation may not be required on 100% of a sample results, a standard QA/QC checklist as described in SOP 17 should be filled out for each data package. See SOP No 17 for the stepwise procedures for filling out this checklist. Based on the project specific requirements for frequency of Level 4 data validation, the additional procedures with associated documentation will be followed:

3.1 Preliminary Review:

Compile necessary data package elements to ensure all the information needed to determine data usability is available. This should include (but is not limited to):

- Completion of QA/QC Checklist from SOP No 17
- Documentation specific to sample data package (including Modification Requests)
- Site Specific requirements and field quality control samples
- Copy of Quality Assurance Project Plan (QAPP) or similar document
- Email or telephone/communication logs

3.2 Data Review Narrative:

The reviewer should complete a Data Review Narrative that includes comments that address the problems identified during the review process and state the limitations of the data associated with a sample or a sample delivery group (SDG). The EPA CLP sample numbers, analytical methods, extent of the problem(s), and assigned qualifiers should also be listed in the document. A copy of this document along with the laboratory data should be provided to the client or appropriate agencies.

See Table 1. For Data Qualifiers and Definitions

3.3 Method Specific Data Review for Volatile and Semivolatile Analysis:

I. Preservation and Holding Times

Review Items
Form 1A-OR, Form 1B-OR, COC, Form DC-1, raw data, sample extraction sheets, and SDG narrative.

Objective
The objective of this section is to verify the validity of the results based on the preservation and holding time of the sample from the time of collection to the time of extraction and from the time of extraction to the time of analysis.

Criteria

See Table 2A. Preservation and Holding Time Actions for Volatile Analysis
See Table 2B. Preservation and Holding Time Actions for Semivolatile Analysis

Evaluation

1. Review the SDG Narrative to determine if the samples were properly preserved and arrived at the laboratory in proper condition (e.g., received intact, appropriate sample temperature at receipt, pH, and absence of air bubbles or detectable headspace). If there is an indication of problems with the samples, the sample integrity may be compromised.
2. Verify that the analysis dates and the raw data are identical.
3. Establish technical holding times by comparing the sample collection dates on the TR/COC Record documentation with the dates of analysis

Action

Record action based on observations per Table 2A. Preservation and Holding Time Actions for Volatile Analysis

Record action based on observations per See Table 2B. Preservation and Holding Time Actions for Semivolatile Analysis

Note details on Data Review Summary (Appendix 1)

II. Gas Chromatograph/Mass Spectrometer Instrument Performance Check

Review Items

Form 5-OR, BFB/DFTPP mass spectra, and mass listing

Objective

The objective of performing Gas Chromatograph/Mass Spectrometer (GC/MS) instrument performance checks is to ensure adequate mass resolution, identification, and to some degree, sensitivity, and to document this level of performance prior to analyzing any sequence of standards or samples.

Criteria

The BFB and DFTPP instrument performance check must meet the ion abundance criteria listed. See Table 3A. Ion Abundance Criteria for BFB for volatile analysis and Table 3B. Ion Abundance Criteria for DFTPP for semivolatile analysis.

Evaluation

1. Verify that the BFB/DFTPP Instrument Performance Check is analyzed at the specified frequency and sequence.
2. Compare the data presented on Form 5-OR for each Instrument Performance Check with each mass listing submitted to ensure the following:
    a. Form 5-OR is present and completed for each required BFB/DFTPP at the specified frequency.
    b. The laboratory has not made transcription errors between the data and the form. If there are major differences between the mass listing and Form 5-OR, a more in-depth review of the data is required. This may include obtaining and reviewing additional information from the laboratory.
    c. The appropriate number of significant figures has been reported (number of significant figures given for each ion in the Ion Abundance Criteria column) and that rounding is correct.
    d. The laboratory has not made any calculation errors.
3. Verify from the raw data (mass listing) that the mass assignment is correct and that the mass listing is normalized to the specified m/z of 95, 174, and 176, respectively for volatile analysis and mz 198 for semivolatile analysis.
4. Verify that the ion abundance criteria are met.
5. If possible, verify that spectra are generated using appropriate background subtraction techniques. Since the BFB/DFTPP spectrum is obtained from

chromatographic peaks that should be free from co-elution problems, background subtraction should be performed in accordance with the following procedure:

a. Three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged.
b. Background subtraction must be accomplished using a single scan acquired within 20 scans of the elution of BFB/DFTPP, but the BFB/DFTPP peak must not be subtracted as part of the background.

NOTE: All mass spectrometer instrument conditions must be identical to those used for sample analysis. Background subtraction actions resulting in spectral distortions for the sole purpose of meeting the method specifications are contrary to the Quality Assurance (QA) objectives, and are therefore unacceptable.

Action

Note details on Data Review Summary (Appendix 1)

1. If the instrument performance check is not analyzed at the specified frequency and sequence, qualify detects and non-detects in the associated samples as unusable (R).
   a. In the event that samples cannot be reanalyzed, examine all calibrations associated with the sequence to evaluate whether proper qualitative criteria were achievable. If so, it may be possible to salvage usable data from the sequence. Otherwise, qualify the data as unusable (R).

2. If minor transcription errors are found to be insignificant to data quality and can be corrected on a copy of the form, no further action is required.

3. If the laboratory failed to provide the correct forms, or if significant transcription calculation errors are found, notify the EPA Regional CLP COR, who may contact the laboratory to request the necessary information. If the information is not available, use professional judgment to assess the data, and notify the EPA Regional CLP COR.

4. If the mass assignment is in error, qualify detects and non-detects in the associated samples as unusable (R).

5. If the ion abundance criteria are not met, use professional judgment to qualify detects and non-detects in the associated samples.

6. Annotate decisions to use analytical data associated with noncompliant BFB/DFTPP instrument performance checks in the Data Review Narrative.

III. Initial Calibration

Review Items: Form 6A-OR, quantitation reports and chromatograms

Objective

The objective of initial calibration (ICAL) is to ensure that the instrument is capable of producing acceptable qualitative and quantitative data.

Criteria

1. ICAL should be performed at the specified frequency and sequence. Each GC/MS system must be calibrated with a minimum of five concentrations to determine instrument sensitivity and the linearity of GC/MS response for the purgeable target analytes and Deuterated Monitoring Compounds (DMCs).
    a. ICAL standards must be analyzed prior to any analysis of the ICV, samples, and required blanks and within 12 hours of the associated instrument performance check at the beginning of each analytical sequence, or as necessary if the CCV acceptance criteria are not met.
    b. ICAL standards must contain all required target analytes and DMCs at specified concentrations

        For volatile analysis, the calibration standards are to be prepared at 0.50, 1.0, 5.0, 10, and 20 µg/L for non-ketones, and 5.0, 10, 50, 100, and 200 µg/L for ketones

        - All three xylene isomers (o-, m-, and p-xylene) must be present in calibration standards.
        - Concentrations for o-xylene must be at 0.50, 1.0, 5.0, 10, and 20 µg/L, while the total concentrations of the m- plus the p-xylene isomers must be at 0.50, 1.0, 5.0, 10, and 20 µg/L.

        For semivolatile analysis:

        - The calibration standards are to be prepared at 5.0, 10, 20, 40, and 80 ng/µL for each target analyte and associated DMCs, except 1,4-Dioxane, twenty-one target analytes and six DMCs listed in Section C.1.c, and DMC 1,4-Dioxane-d_8. For 1,4-Dioxane and 1,4-Dioxane-d8, the calibration standard concentrations are at 2.0, 4.0, 8.0, 16, and 32 ng/ µL.
        - The ICAL standard concentrations are at 10, 20, 40, 80, and 160 ng/µL for twenty-one target analytes and six DMCs: Benzaldehyde, Phenol, Bis(2-chloroethyl) ether, 2-Methylphenol, 2,2'-Oxybis(1-chloropropane), Acetophenone, 4-Chloroaniline, Caprolactam, Hexachlorocyclopentadiene, Atrazine, Carbazole, Fluoranthene, 3,3'-Dichlorobenzidine, Di-n-

octylphthalate, 2,4-Dinitrophenol, PCP, 4-Methylphenol, 4,6-Dinitro-2-methylphenol, 3-Nitroaniline, 4-Nitroaniline, 4-Nitrophenol, Phenol-d_5, Bis(2-chloroethyl) ether-d_8, 4-Methylphenol-d_8, 4-Chloroaniline-d_4, 4-Nitrophenol-d_4, and 4,6-Dinitro-2-methylphenol-d_2. For the optional analysis of Polycyclic Aromatic Hydrocarbons (PAHs) and PCP using the SIM technique, the calibration standard concentrations are at 0.10, 0.20, 0.40, 0.80, and 1.6 ng/µL for each target analyte of interest and the associated DMCs. PCP concentrations are at 0.20, 0.40, 0.80, 1.6, and 3.2 ng/µL.

2. The Relative Response Factor (RRF), Mean RRF, and Percent Relative Standard Deviation (%RSD) must be calculated for each target analyte and DMC accordingly.
3. The RRF for each target analyte and DMC in each ICAL standard must be ≥ Minimum RRF value in applicable Table 4A/B.
4. The %RSD of the ICAL RRF for each target analyte and DMC must be ≤ Maximum %RSD value in Table 4A/B.

NOTE: The technical acceptance criteria specified in a "Request for Quote (RFQ) for Solicitation" of a Modified Analysis may impact some of the preceding evaluation criteria. A copy of this document should be present in the CSF, when applicable.

Evaluation

1. Verify that the ICAL is performed at the specified frequency and sequence.
2. Verify that the correct concentrations of the target analytes and DMCs are used in each ICAL standard.
3. Verify that the RRF, mean RRF, and %RSD for each target analyte and DMC are reported on Form 6A-OR. Recalculate the RRFs, mean RFF and %RSDs for at least one target analyte and DMC associated with each internal standard, and verify that the recalculated values agree with the laboratory reported values on Form 6A-OR.
4. Verify that the RRF is ≥ Minimum RRF value in Table 4 for each target analyte and DMC.
5. Verify that the %RSD is ≤ Maximum %RSD value in Table 4 for each target analyte and DMC.

NOTE: For data obtained from the CLP, information regarding noncompliant ICALs can be obtained from the NFG reports and may be used as part of the evaluation process.

Action

Note details on Data Review Summary (Appendix 1)

1. If the ICAL is not performed at the specified frequency and sequence, use professional judgment to qualify detects and non-detects in the associated samples as unusable (R).

2. If the ICAL is not performed at the specified concentrations, qualify detects in the associated samples as estimated (J) and non-detects in the associated samples as estimated (UJ).
3. If errors are detected in the calculations of the RRFs, mean RRF, or %RSDs, perform a more comprehensive recalculation.
4. If the RRF is < Minimum RRF value in Table 4 for any target analyte, use professional judgment to qualify detects in the associated samples as estimated high (J+) or unusable (R), and non-detects in the associated samples as unusable (R).
5. If the RRF is ≥ Minimum RRF value in Table 4 A/B for any target analyte, detects and non-detects in the associated samples should not be qualified.
6. If the %RSD is > Maximum %RSD value in Table 4A/B for any target analyte, qualify detects in the
7. If the %RSD is ≤ Maximum %RSD value in Table 4A/B for any target analyte, detects and non-detects in the associated samples should not be qualified.
8. No qualification of the data is necessary based on the DMC RRF, mean RRF and %RSD data alone. Use professional judgment to evaluate the DMC RRF, mean RRF, and %RSD data in conjunction with the DMC recoveries to determine the need for data qualification.
9. Based on the project-specific Data Quality Objectives (DQOs), a more in-depth review may be necessary. The following guidelines are recommended:
    a. If the %RSD criteria of any target analyte are not met and the %RSD criteria are still not satisfied after eliminating either the high or the low-point of the ICAL:
        - Qualify detects in the associated samples as estimated (J).
        - Use professional judgment to qualify non-detects in the associated samples.
    b. If the high-point of the ICAL curve is outside of the %RSD criteria (e.g., due to saturation):
        - Qualify detects in the associated samples with analyte concentrations greater than the high-point concentration as estimated (J).
        - Detects in the associated samples with analyte concentrations within the calibration range should not be qualified.
        - Non-detects in the associated samples should not be qualified.
    c. If the low-point of the ICAL curve is outside of the %RSD criteria:
        - Qualify detects in the associated samples with analyte concentrations in the non-linear range as estimated (J).
        - Detects in the associated samples with analyte concentrations within the calibration range should not be qualified.

  - For non-detects in the associated samples, use the lowest point of the linear portion of the ICAL curve to determine the new quantitation limit.

10. If the laboratory failed to provide adequate calibration information, contact the laboratory to request the necessary information. If the information is not available, use professional judgment to assess the data.
11. Annotate the potential effects on the reported data due to exceeding the ICAL criteria in the Data Review Narrative.

IV. Initial Calibration Verification

Review Items

Form 7A-OR, quantitation reports, and chromatograms

Objective

The objective is to ensure that the instrument is calibrated accurately to produce acceptable qualitative and quantitative data throughout each analytical sequence by the use of a second-source check standard.

Criteria

See criteria noted in Table 6 ICV Actions for Volatile and Semivolatile Analysis.

1. The accuracy of the calibration for each GC/MS system used for analysis must be verified at the frequency of one ICV standard analysis per initial calibration analytical sequence. The ICV is analyzed after the last ICAL standard analysis and prior to a blank, sample, or an applicable CCV analysis.
2. The ICV standard must contain all required target analytes, from an alternate source or a different lot than that used for the ICAL standards and the DMCs, at or near the mid-point concentration (CS3) of the ICAL.
3. For an ICV, the RRF for each target analyte and DMC must be ≥ the Minimum RRF value in Table 4A/B.
4. The Percent Difference (%D) between the ICAL mean RFF and the ICV RRF must be within the ICV/Opening CCV Maximum %D limits in Table 4A/B for each target analyte and DMC.

Evaluation

1. Verify that the ICV standard is analyzed at the specified frequency and sequence, and that it is associated with the correct ICAL. Also verify that the correct ICAL is represented in the data package and meets SOW criteria.
2. Verify that the concentrations of the target analytes and the DMCs in the ICV are at or near the mid-point standard CS3 from the ICAL.

3. Verify that the RRF and %D for each target analyte and DMC are reported on Form 7A-OR. Recalculate the RRF and %D for at least one target analyte and DMC associated with each internal standard, and verify that the recalculated values agree with the laboratory reported values on Form 7A-OR.
4. Verify that the RRFs for each target analyte and DMC in the ICV are ≥ Minimum RRF values in Table 4A/B.
5. Verify that the %Ds are within the ICV/Opening CCV Maximum %D limits in Table 4 for each target analyte and DMC.

Action

Note details on Data Review Summary (Appendix 1)

1. If the ICV is not performed at the specified frequency, use professional judgment to qualify detects and non- detects. Contact laboratory to request repeat analysis, if holding times have not expired and there are remaining sample vials. If reanalysis is not possible, carefully evaluate all other available information, including the quality of analyte peak shapes and mass spectral matches, the stability of internal standard Retention Times (RTs) and areas in each affected sample, and compare to the most recent calibration performed on the same instrument under the same conditions. Using this information and professional judgment, the reviewer may be able to justify unqualified acceptance of qualitative results.

2. If the ICV is not performed at the specified concentration, use professional judgment to qualify detects and non-detects. Special consideration should be given to sample results at the opposite extreme of the calibration range if this defect is noted.

3. If errors are detected in the calculations of either the RRF or the %D, perform a more comprehensive recalculation.
4. If the RRF in an ICV is < Minimum RRF value in Table 4 for any target analyte, carefully evaluate the qualitative data associated with positively identified analytes and use professional judgment to qualify detects as estimated (J) or unusable (R), and qualify non-detects as unusable (R).
    a. Take special note of any extreme deviation in the RRF and evaluate RT data, peak shapes, and areas of the target analytes and associated internal standards for inconsistencies that may indicate a chromatographic co-elution. If this is suspected, the contaminant may also be present in samples and blanks. Also review the documentation of the preparation of the ICV standard. Use professional judgment to qualify affected data appropriately.
5. If the RRF in an ICV is ≥ Minimum RRF value in Table 4A/B for any target analyte, detects and non-detects should not be qualified.

6. If the %D in an ICV is outside the ICV/Opening CCV Maximum %D limits in Table 4 for any target analyte, qualify detects as estimated (J) and non-detects as estimated (UJ).
7. If the %D in an ICV is within the inclusive range of the ICV/Opening CCV Maximum %D limits in Table 4 for any target analyte, detects and non-detects should not be qualified.
8. No qualification of the data is necessary based on the DMC RRF and/or %D alone. Use professional judgment to evaluate the DMC RRF and %D data in conjunction with the DMC recoveries to determine the need for data qualification.
9. If the laboratory has failed to provide adequate calibration information, contact the EPA Regional CLP COR, who may contact the laboratory to request the necessary information. If the information is not available, use professional judgment to assess the data.
10. Note the potential effects on the data due to ICV criteria exceedance in the Data Review Narrative.

V. Continuing Calibration Verification

Review Items

Form 7A-OR, quantitation reports, and chromatograms

Objective

The objective is to ensure that the instrument continues to meet the sensitivity and linearity criteria to produce acceptable qualitative and quantitative data throughout each analytical sequence.

Criteria

See criteria in Table 7. CCV Actions for Volatile and Semivolatile Analysis

1. The calibration for each GC/MS system used for analysis must be verified at the beginning and end of every 12-hour period of operation. The 12-hour period begins with the injection of BFB, followed by the injection of the opening CCV solution. After the injection of all samples and required blanks, and before the end of the 12-hour period, injection of the closing CCV is required. The closing CCV used to bracket the end of a 12-hour analytical sequence may be used as the opening CCV for a new 12-hour analytical sequence, provided that all technical acceptance criteria for an opening CCV are met.
2. The CCV standards must contain all required target analytes and DMCs at or near the mid-point concentration (CS3) of the ICAL.
3. For an opening or a closing CCV, the RRF for each target analyte and DMC must be ≥ the Minimum RRF value in Table 4.
4. The %D between the ICAL mean RRF and the opening CCV RRF must be within the ICV/Opening CCV Maximum %D limits in Table 4 for each target analyte and DMC.

5. For a closing CCV, the %D between the ICAL mean RRF and the CCV RRF must be within the Closing CCV Maximum %D limits in Table 4 for each target analyte and DMC.

Evaluation

1. Verify that the CCV is analyzed at the specified frequency and sequence, and that it is associated with the correct ICAL. Also verify that the correct ICAL is represented in the data package and meets SOW criteria, as described in Section III.
2. Verify that the mid-point standard CS3 from the ICAL is used as an opening or closing CCV.
3. Verify that the RRF and %D for each target analyte and DMC are reported on Form 7A-OR. Recalculate the RRF and %D for at least one target analyte and DMC associated with each internal standard, and verify that the recalculated values agree with the laboratory reported values on Form 7A-OR.
4. For an opening or a closing CCV, verify that the RRFs for each target analyte and DMC are
    a. ≥ Minimum RRF values in Table 4.
5. For an opening CCV, verify that the %Ds are within the ICV/Opening CCV Maximum %D limits in Table 4 for each target analyte and DMC.
6. For a closing CCV, verify that the %Ds are within the Closing CCV Maximum %D limits in Table 4 for each target analyte and DMC.

Action

Note details on Data Review Summary (Appendix 1)

1. If the CCV is not performed at the specified frequency, qualify detects and non-detects as unusable (R). Contact the EPA Regional CLP COR to request that the laboratory repeat the analysis, if holding times have not expired and there are remaining sample vials. If reanalysis is not possible, carefully evaluate all other available information, including the quality of analyte peak shapes and mass spectral matches, the stability of internal standard RTs and areas in each affected sample, and compare to the most recent calibration performed on the same instrument under the same conditions. Using this information and professional judgment, the reviewer may be able to justify unqualified acceptance of qualitative results and qualification of all quantitative results as estimated (J). Otherwise, qualify all detects and non-detects as unusable (R).
2. If the CCV is not performed at the specified concentration, use professional judgment to qualify detects and non-detects. Special consideration should be given to sample results at the opposite extreme of the calibration range if this defect is noted.
3. If errors are detected in the calculations of either the RRF or the %D, perform a more comprehensive recalculation.
4. For an opening or a closing CCV, if the RRF is < Minimum RRF value in Table 4 for any target analyte, carefully evaluate the qualitative data associated with positively identified

analytes and use professional judgment to qualify detects as estimated (J) or unusable (R), and qualify non-detects as unusable (R).

   a. Take special note of any extreme deviation in the RRF and evaluate RT data, peak shapes, and areas of the target analytes and associated internal standards for inconsistencies that may indicate a chromatographic co-elution. If this is suspected, the contaminant may also be present in samples and blanks. Also review the documentation of the preparation of the CCV standard. Use professional judgment to qualify affected data appropriately.

5. For an opening or a closing CCV, if the RRF is ≥ Minimum RRF value in Table 4 for any target analyte, detects and non-detects should not be qualified.
6. For an opening CCV, if the %D is outside the ICV/Opening CCV Maximum %D limits in Table 4 for any target analyte, qualify detects as estimated (J) and non-detects as estimated (UJ).
7. For a closing CCV, if the %D is outside the Closing CCV Maximum %D limits in Table 4 for any target analyte, qualify detects as estimated (J) and non-detects as estimated (UJ).
8. For an opening CCV, if the %D is within the inclusive range of the ICV/Opening CCV Maximum
%D limits in Table 4 for any target analyte, detects and non-detects should not be qualified.
9. For a closing CCV, if the %D is within the inclusive range of the Closing CCV Maximum %D limits in Table 4 for any target analyte, detects and non-detects should not be qualified.
10. No qualification of the data is necessary based on the DMC RRF and/or %D alone. Use professional judgment to evaluate the DMC RRF and %D data in conjunction with the DMC recoveries to determine the need for data qualification.
11. If the laboratory has failed to provide adequate calibration information, contact the EPA Regional CLP COR, who may contact the laboratory to request the necessary information. If the information is not available, use professional judgment to assess the data. Refer to E.1, above, for additional steps.
12. Note the potential effects on the data due to CCV criteria exceedance in the Data Review Narrative
13. If the CCV criteria are grossly exceeded, note this for EPA Regional CLP COR action.

VI. Blanks

Review Items

Form 1A-OR, Form 1B-OR, Form 4-OR, chromatograms and quantitation reports

Objective

The objective of a blank analysis results assessment is to determine the existence and magnitude of contamination resulting from laboratory (or field) activities.

Criteria

See details on Table 8. Blank Actions for Volatile and Semivolatile Analysis.

The criteria for evaluation of blanks should apply to any blank associated with the samples (e.g., method blanks, storage blank, field blanks, etc.). If problems with any blank exist, all associated data must be carefully evaluated to determine whether or not there is an inherent variability in the data or if the problem is an isolated occurrence not affecting other data. Use project specific requirements for Contract Required Quantitation Limits (CRQL) in Table 8.

1. Method blank analyses must be performed at the specified frequency and sequence. A method blank must be analyzed once every 12-hour period and prior to any sample analysis, and after all ICAL standards, the ICV, or the opening CCV (for volatile analysis). For semivolatile analysis, a method blank must be extracted per matrix each time samples are extracted. The number of samples extracted with each method blank shall not exceed 20 field samples.
2. The method blank must be analyzed on each GC/MS system used for sample analysis within an entire analytical sequence.
3. The method blank, like any other sample in the SDG, must meet the technical acceptance criteria for sample analysis.
4. For volatile analsyis:
    a. A storage blank analysis must be performed at the specified frequency and sequence. A storage blank must be prepared upon receipt of the first samples from an SDG, and stored with the samples until analysis. The storage blank must be analyzed once per SDG after all sample analyses within an SDG are completed.
    b. An instrument blank must be analyzed immediately after any sample that has target analytes exceeding the calibration range or non-target compounds exceeding 100 µg/L.
    c. The concentration of a target analyte in any blank must not exceed its Contract Required Quantitation Limit (CRQL) (2x CRQLs for Methylene chloride, Acetone, and 2-Butanone). TIC concentration in any blank must be ≤ 0.5µg/L (volatiles). For semivolatiles, TIC concentrations in any blanks must be < 5.0 ug/L for water (0.0050 mg/Lfor TCLP leachate) or 170 ug/kg for soil/sediment matrices.

Evaluation

1. Verify that method blanks are analyzed at the specified frequency and sequence. The Method Blank Summary (Form 4-OR) may be used to identify the samples associated with each method blank.

2. For volatile analysis: Verify that the instrument blank analysis has been performed following any sample analysis where a target analyte(s) is/are reported at high concentration(s).
3. Review the results of all associated blanks on the forms and raw data (chromatograms and quantitation reports) to evaluate the presence of target analytes and non-target compounds in the blanks.
4. Evaluate field or trip blanks in a manner similar to that used for the method blanks.

Action

Note details on Data Review Summary (Appendix 1)

1. If the appropriate blanks are not analyzed at the correct frequency, use professional judgment to determine if the associated sample data should be qualified. Obtain additional information from the laboratory, if necessary.
2. Action regarding unsuitable blank results depends on the circumstances and origin of the blank. Verify that data qualification decisions based on field quality control (QC) are supported by the project Quality Assurance Project Plan (QAPP) or EPA Regional Standard Operating Procedure (SOP). At a minimum, contamination found in field blanks should be documented in the Data Review Narrative. In instances where more than one blank is associated with a given sample, qualification should be based upon a comparison with the associated blank having the highest concentration of a contaminant. Do not correct the results by subtracting any blank value.
3. For any blank (including method blank), if a target analyte is detected, but is not detected in the sample, non-detects should not be qualified.
4. See Table 8 for Blank Actions for Volatile and Semivolatile Analysis exceeding CRQLs.
5. If an instrument blank is not analyzed following a sample analysis which contains analyte(s) at high concentration(s) exceeding the calibration range, evaluate the analyte(s) concentration(s) in the samples analyzed immediately after the sample with high analyte(s) concentration(s) for carryover. Use professional judgment to determine if instrument cross-contamination has affected any positive target analyte identification(s). Note if instrument cross-contamination is suggested and suspected of having an effect on the sample results or calibration performance.
6. If any analytes are detected in the storage, field, or trip blanks, the following is recommended:
    a. Review the associated method blank data to determine if the same analytes are also detected in the method blank.

- If the analytes are detected at comparable levels in the method blank, the source of the contamination may be in the analytical system. Apply the recommended actions for the method blank.
- If the analytes are not detected in the method blank, the source of contamination may be in the storage area or in the field, or contamination may have occurred during sample transport. Consider all associated samples for possible cross-contamination.
- For storage, field, or trip blanks, the sample result qualifications listed in Table 8 should apply.

7. If gross contamination exists with blank results that are > ICAL CS5 concentrations, qualify detects as unusable (R). If the contamination is suspected of having an effect on the sample results, note it accordingly.
8. For any blank (including method blank) reported with TICs (non-target compounds) concentrations that are > 0.5 µg/L and 170 ug/kg for soil/sediment matrices, use professional judgment to qualify sample results.
9. There may be instances where little or no contamination is present in the associated blanks, but qualification of the sample is deemed necessary. If it is determined that the contamination is from a source other than the sample, the data should be qualified or, in the case of field QC, should at least be documented in the Data Review Narrative. Contamination introduced through dilution water is one example. Although it is not always possible to determine, instances of this occurrence can be detected when contaminants are found in the diluted sample result, but are absent in the undiluted sample.

VII. Deuterated Monitoring Compound

Review Items

Form 2A-OR, Form 2B-OR, quantitation reports and chromatograms

Objective

The objective is to evaluate the DMC Percent Recovery (%R) to ensure that the analytical method is efficient.

Criteria

See criteria in Table 9 Volatile DMCs and Recovery Limits

See criteria in Table 9B Semivolatile DMCs and Recovery Limits

1. All samples and blanks are spiked with the DMCs listed in Table 9A/B, just prior to sample purging, to measure the DMC %R.
2. The %R for each DMC should be calculated correctly according to the method.
3. The %R for each DMC in samples and blanks must be within the limits in Table 9A/B.

Evaluation

1. Check the raw data (e.g., chromatograms and quantitation reports) to verify the recoveries on the Deuterated Monitoring Compound Recovery Form 2A-OR and Form 2B-OR.
2. Check for any calculation or transcription errors. Verify that the DMC recoveries were calculated correctly using the equation in the method and that the recalculated values agree with the laboratory reported values on Form 2A-OR and Form 2B-OR.
3. Whenever there are two or more analyses for a particular sample, use professional judgment to determine which analysis has the most acceptable data to report. Considerations include, but are not limited to:
    a. DMC recovery (marginal versus gross deviation).
    b. Technical holding times.
    c. Comparison of the target analyte results reported in each sample analysis.
    d. Other QC information, such as performance of internal standards.

Action

Note details on Data Review Summary (Appendix 1)

1. If a DMC was not added to the samples and blanks, or the concentrations of DMCs in the samples and blanks are not as specified, use professional judgment to qualify detects and non-detects. Contact the lab to arrange for reanalysis, if possible.
2. If errors are detected in the calculations of %R, perform a more comprehensive recalculation. It may be necessary to have the laboratory resubmit the data after making corrections.
3. If any DMC %R is outside the limits (Table 9A/B) in samples, qualify the associated target analytes listed in Table 11A/B considering the existence of interference in the raw data. See Table 10 for considerations and actions for DMC %R
4. If any DMC %R is outside the limits (Table 9A/B) in a blank, special consideration should be taken to evaluate the validity of the associated sample data. The basic concern is whether the blank problems represent an isolated problem with the blank alone, or whether there is a fundamental problem with the analytical process.

VIII. Matrix Spike/Matrix Spike Duplicate

Review Items

SDG Cover Page, Form 3A-OR, chromatograms, and quantitation reports

Objective

The objective of the Matrix Spike (MS)/Matrix Spike Duplicate (MSD) analysis is to evaluate the effect of each sample matrix on the sample preparation procedures and the measurement methodology.

Criteria

1. If requested, MS/MSD samples shall be prepared and analyzed at the specified frequency. One pair of MS/MSD samples should be analyzed per matrix or per SDG.
2. Samples identified as field blanks or Performance Evaluation (PE) samples cannot be used for spiked sample analysis.
3. The MS/MSD %R and the Relative Percent Difference (RPD) between MS and MSD results should be calculated according to the method.

4. The MS/MSD %R and RPD should be within the acceptance limits in Table 12A/B.

Evaluation

1. Verify that the requested MS/MSD samples were analyzed at the required frequency.
2. Verify that a field blank or PE sample was not used for MS/MSD analysis.
3. Verify that the recalculated MS/MSD %R and RPD values agree with the laboratory reported values on Form 3A-OR.
4. Inspect the MS/MSD %R and RPD on Form 3A-OR and verify that they are within the limits listed in Table 12.

Action

Note details on Data Review Summary (Appendix 1)

1. If requested MS/MSD samples were not analyzed at the specified frequency, use professional judgment to determine the impact on sample data, if any. Obtain additional information from the laboratory, if necessary. Record the situation in the Data Review Narrative and note it for EPA Regional CLP COR action. It is not likely that data qualification will be warranted if the frequency requirements are not met. Carefully consider all factors, known and unknown, about method performance on the matrix at hand, in lieu of MS/MSD data.
2. If errors are detected in the calculations of the MS/MSD %R or RPD, perform a more comprehensive recalculation.
3. If the MS/MSD %R or RPD is outside the acceptance limits in Table 12A/B qualify the detects and non-detects in the original sample to include consideration of the existence of interference in the raw data. See considerations for MS/MSD %R actions on Table 12A/B.

IX. Internal Standard

Review Items

Form 8A-OR, quantitation reports, and chromatograms

Objective

The objective is to evaluate the internal standard performance to ensure that GC/MS sensitivity and response are stable during each analysis.

Criteria

See criteria in Table 14 Internal Standard Actions for Volatile and Semivolatile Analysis

1. The internal standard solution must be added to all samples and blanks at the specified concentration. The internal standard solution must contain all internal standard compounds specified in the method.
2. The area response of each internal standard compound in all samples and blanks must be within the inclusive ranges of 50-200% of the area response of the same internal standard compound from the associated opening CCV or the mid-point standard CS3 from the associated ICAL.
3. The RT of the internal standard compound in the sample or blank must not vary more than ±10.0 seconds from the RT of the same internal standard compound in the associated opening CCV or mid-point standard CS3 from the associated ICAL.

Evaluation

1. Verify that all required internal standard compounds were added to sample and blank analyses at the specified concentrations.
2. Check the raw data (e.g., chromatograms and quantitation reports) to verify that the RT and area response of each internal standard compound in a sample or blank are reported on Form 8A-OR.
3. Verify that the RTs and area responses for all internal standard compounds are within the specified criteria. If internal standard RTs are significantly different from the associated CCV or ICAL midpoint (i.e., more than 10 seconds), the internal standard peak may have been misidentified, but most likely a change in the chromatographic system should be suspected. This could be an improper desorb/injection cycle, a leak in the purge/trap/GC system, or the effect of a highly contaminated matrix. Normally, the area counts will also suffer in this situation, but even if they appear unaffected, both quantitative and qualitative results should be considered highly suspect.
4. If there is a reanalysis for a particular sample, determine which analysis is the best data to report. Considerations include, but are not limited to:
    - Magnitude and direction of the internal standard area response shift.
    - Magnitude and direction of the internal standard RT shift.
    - Technical holding times.

- Comparison of the values of the target analytes reported in each method.
- Other QC information.

NOTE: For data obtained from the CLP, the preceding criteria are evaluated as part of the CCS process. Information regarding the noncompliant internal standard area response or RT can be obtained from the NFG reports and may be used as part of the evaluation process.

Action

Note details on Data Review Summary (Appendix 1)

If the required internal standard compounds were not added to a sample or blank, qualify detects and non-detects as unusable (R).

6. If the required internal standard compound was not analyzed at the specified concentration in a sample or blank, use professional judgment to qualify detects and non-detects.
7. If the area response of an internal standard compound in a sample or blank is < 20% of the area response of the same internal standard compound in the associated opening CCV or mid-point standard CS3 from the associated ICAL, qualify detects as estimated high (J+) and non-detects as unusable (R).
8. If the area response of an internal standard compound in a sample or blank is ≥ 20 % and < 50% of the area response of the same internal standard compound in the associated opening CCV or mid-point standard CS3 from the associated ICAL, qualify detects as estimated high (J+) and non-detects as estimated (UJ).
9. If the area response of an internal standard compound in a sample or blank is within the inclusive range of 50-200% of the area response of the same internal standard compound in the associated opening CCV or mid-point standard CS3 from the associated ICAL, detects and non-detects should not be qualified.
10. If the area response of an internal standard compound in a sample or blank is > 200% of the area response of the same internal standard compound in the associated opening CCV or mid-point standard CS3 from the associated ICAL, qualify detects as estimated low (J-). Non-detects should not be qualified.
11. If the RT shift between sample/blank and the associated opening CCV or mid-point standard CS3 from the associated ICAL of an internal standard compound is

\> 30.0 seconds, qualify detects and non-detects as unusable (R). The EPA Regional CLP COR should be contacted to arrange for reanalysis.

12. If the RT shift between sample/blank and the associated opening CCV or mid-point standard CS3 from the associated ICAL of an internal standard compound is < 30.0 seconds, detects and non-detects should not be qualified.
13. If the internal standard performance criteria are grossly exceeded, annotate the potential effects on the data in the Data Review Narrative.

X. Target Analyte Identification

Review Items

Form 1A-OR, quantitation reports, mass spectra, and chromatograms

Objective

The objective is to provide acceptable GC/MS qualitative analysis to minimize the number of erroneous analyte identifications.

Criteria

1. The mass spectrum of the analyte from the sample analysis must match that of the same analyte in the associated opening CCV or mid-point standard CS3 from the associated ICAL according to the following criteria:
    - All ions present in the calibration standard mass spectrum must be present in the sample spectrum at a relative intensity > 10%.
    - The relative intensities of these ions must agree within ±20% between the standard and sample spectra (e.g., for an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30-70%).
    - Ions present at > 10% in the sample mass spectrum, but not present in the standard spectrum, must be evaluated by a reviewer experienced in mass spectral interpretation.
2. The Relative Retention Time (RRT) for a positively identified target analyte must be within ±0.06 RRT units of the RRT for the same analyte in the associated opening CCV or mid-point standard CS3 from the associated ICAL.

Evaluation

1. Verify that the positively identified target analyte mass spectrum meets the specified criteria. If not, examine the sample target analyte spectra for the presence of interference at one or more mass fragment peaks. Although the presence of a co-eluting interfering may preclude positive identification of the analyte, the presumptive evidence of its presence may be useful information to include in the Data Review Narrative.
2. Verify that the RRT of the positively identified target analyte is within ±0.06 RRT units of the RRT for the same analyte in the associated opening CCV or mid-point standard CS3 from the associated ICAL.

3. Be aware of situations when sample carryover is a possibility and use professional judgment to determine if instrument cross-contamination has affected any positive analyte identification. An instrument blank must be analyzed after a sample containing target analytes with concentrations exceeding the ICAL range (20 µg/L for non-ketones, 200 µg/L for ketones), non-target compounds at concentrations > 100 µg/L, or saturated ions from an analyte (excluding the analyte peaks in the solvent front).
4. Verify that peaks are correctly identified as target analytes, TICs, DMCs, or internal standards on the chromatogram for samples and blanks.
5. Verify that there is no erroneous analyte identification, either false positive or false negative, for each target analyte. The positively identified target analytes can be more easily detected for false positives than false negatives. More information is available for false positives due to the requirement for submittal of data supporting positive identifications. Non-detected target analytes, on the other hand, are more difficult to assess. One example of the detection of false negatives is reporting a target analyte as a TIC.

Action

Note details on Data Review Summary (Appendix 1)

1. If the positively identified target analyte mass spectrum does not meet the specified criteria, qualify detect as unusable (R), or report the result at the CRQL and qualify as non-detect (U).
2. If the RRT for a positively identified target analyte is outside the specified RRT windows, qualify detect as unusable (R), or report the result at the CRQL and qualify as non-detect (U).
3. If it is determined that cross-contamination has occurred, use professional judgment to qualify detects. Annotate any changes made to the reported analytes due to either false positive or negative identifications, or concerns regarding target analyte identifications, in the Data Review Narrative.

XI. Target Analyte Quantitation and Reported Contract Required Quantitation Limit

Review Items

Form 1A-OR, sample preparation sheets, SDG narrative, quantitation reports and chromatograms

Objective

The objective is to ensure that the reported results and CRQLs for target analytes are accurate.

Criteria

Target analyte results and sample-specific CRQLs must be calculated according to the correct equations.

Target analyte RRF must be calculated using the correct associated internal standard, as listed in the method. Quantitation must be based on the quantitation ion (m/z) specified in the method for both the internal standards and target analytes. Target analyte result must be calculated using the mean RRF from the associated ICAL.

Evaluation

1. Verify that the results for all positively identified analytes are calculated and reported by the laboratory.
2. Verify that the CRQLs are calculated for the non-detects and reported accordingly.
3. Verify that the correct internal standard, quantitation ion, and mean RRF are used to calculate the reported results.
4. Verify that the same internal standard, quantitation ion, and mean RRF are used consistently.
5. Verify that the sample-specific CRQLs have been calculated and adjusted to reflect original sample mass/volume and any applicable dilutions.
6. For semivolatiles:
   a. Verify that the sample-specific CRQLs have been calculated and adjusted to reflect Percent Solids (%Solids), original sample mass/volume, and any applicable dilutions.
   b. For soil/sediment samples that are high in moisture (i.e., < 30% solids), evaluation of the presence of each analyte depends on the anticipated

interaction between the analyte and the total matrix, as well as how the sample was processed.

c. If the phases of a sample were separated and processed separately, no particular qualification on the grounds of matrix distribution is warranted.

d. If a soil/sediment sample was processed by eliminating most of the water, analytes that are highly water soluble under ambient conditions may be severely impacted such that their presence cannot be completely evaluated.

Action

Note details on Data Review Summary (Appendix 1)

1. If any discrepancies are found, contact the EPA Regional CLP COR, who may contact the laboratory to obtain additional information that could resolve any differences. If a discrepancy remains unresolved, use professional judgment to decide which value is the most accurate and to determine whether qualification of the data is warranted. Annotate the reasons for any data qualification in the Data Review Narrative.
2. If errors are detected in results and CRQL calculations, perform a more comprehensive recalculation.
3. If sample results are < CRQLs and ≥ MDLs, qualify as estimated (J).
4. Note numerous or significant failures to accurately quantify the target analytes, or to properly evaluate and adjust CRQLs, for EPA Regional CLP COR action.

XII. Tentatively Identified Compounds

Review Items

Form 1B-OR, chromatograms, library search printouts, and spectra for the TIC candidates

Objective

The objective is to provide tentative identifications to chromatographic peaks that are not identified as target analytes, DMCs, or internal standards.

Criteria

For each sample, the laboratory must conduct a mass spectral search of the National Institute of Standards and Technology (NIST) (2011 release or later), Wiley (2011 release or later), or equivalent mass spectral library, and report the possible identity for up to 30 of the largest peaks that are not DMCs, internal standards, or target analytes. The peak for a TIC should have an area or height > 10% of the area or height of the nearest internal standard. The estimated concentration for a TIC is calculated similarly to that for a target analyte, using total ion areas for the TIC and the internal standard, and assuming an RRF of 1.0.

Guidelines for tentative identification are as follows:

- Major ions (> 10% Relative Intensity) in the reference spectrum should be present in the sample spectrum.
- The relative intensities of the major ions should agree within ±20% between the sample and the reference spectra.
- Molecular ions present in the reference spectrum should be present in the sample spectrum.
- Non-target compounds receiving a library search match of 85% or higher are considered a "probable match". The compound should be reported unless the mass spectral interpretation specialist feels there is evidence not to report the compound as identified by the library search program. The laboratory should include the justification for not reporting a compound as listed by the search program in the SDG Narrative.
- If the library search produces more than one compound ≥ 85%, the compound with the highest percent match (report first compound if percent match is the same for two or more compounds) should be reported, unless the mass spectral interpretation specialist feels that the highest match compound should not be reported, or another compound with a lower match should be reported. The laboratory should include the justification for not reporting the compound with the highest spectral match within the SDG Narrative. DMCs, internal standards, and target analytes should not be reported as TICs.
- If the library search produces a series of obvious isomer compounds with library search matches ≥ 85%, the compound with the highest library search percent match (or the first compound if the library search matches are the same) should be reported. The laboratory should note in the SDG Narrative that the exact isomer configuration, as reported, may not be accurate.
- If the library search produces no match ≥ 85%, and in the technical judgment of the mass spectral interpretation specialist no valid tentative identification can be made, the compound should be reported as

"unknown". The mass spectral specialist should give additional classification of the unknown compound, if possible (e.g., "unknown aromatic", "unknown hydrocarbon", "unknown acid type", "unknown chlorinated compound"). If probable molecular weights can be distinguished, they should be included.

- The CAS registry number is simply an identifier which has no structural significance. Regardless of RTs, if the library search produces two or more compounds at or above 85% with the same CAS Number, the compound with the highest percent match (report first compound if the percent match is the same for two or more compounds) should be reported unless the mass spectral interpretation specialist feels there is just evidence not to report the compound with the highest match.
- If the library search produces only one and the same compound (i.e., the same CAS registry number) with the match at or above 85% at two different RTs, the compound having the highest percent match should be reported as TIC and the other one could be reported as unknown. If both TICs have the same percent match for the same compound, one of the TICs could be reported as unknown. Such justifications should be included in the SDG Narrative.
- Alkanes are not to be reported as TICs on Form 1B-OR. An alkane is defined as any hydrocarbon with the generic formula C_nH_{2n+2} (straight-chain or branched) or C_nH_{2n} (cyclic) that contains only C-H and C-C single bonds. When the preceding alkanes are tentatively identified, the concentration(s) should be estimated and the analytes reported as alkanes by class (i.e., straight-chain, branched, cyclic, as a series, or as applicable) in the SDG Narrative. Total alkanes concentration should be reported on Form 1B-OR.

Evaluation

1. Verify that the laboratory has generated a library search for all required peaks in the chromatograms for samples and blanks.
2. Verify that TIC peaks present in samples are not found in blanks. When a low-level, non-target compound that is a common artifact or laboratory contaminant is detected in a sample, a thorough check of blank chromatograms may require looking for peaks which are < 10% of the internal standard height, but present in the blank chromatogram at a similar RRT.

3. Verify that mass spectra for all reported TICs are present for every sample and blank.
4. Review ions present in the sample spectrum, but not in the reference spectrum, for possible background contamination, interference, or presence of coeluting compounds.
5. Review ions present in the reference spectrum, but not in the sample spectrum, for possible subtraction from the sample spectrum because of background contamination or coeluting compounds. Data system library reduction programs can sometimes create these discrepancies.
6. Consider all reasonable choices since TIC library searches often yield several candidate compounds having a close matching score.
7. Be aware of common laboratory artifacts/contaminants and their sources (e.g., Aldol condensation products, solvent preservatives, and reagent contaminants). These may be present in blanks and not reported as sample TICs.

Examples of volatile TICs:

a. Common laboratory contaminants include CO_2 (m/z 44), siloxanes (m/z 73), diethyl ether, hexane, certain freons, and phthalates at levels < 100 µg/L.

b. Solvent preservatives include cyclohexene (a methylene chloride preservative). Related by-products include cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorocyclohexanol.

c. Aldol condensation reaction products of acetone include 4-hydroxy-4-methyl-2-pentanone, 4-methyl-2-penten-2-one, and 5,5-dimethyl-2(5H)-furanone.

Examples of semivolatile TICs:

a. Common laboratory contaminants include CO2 (m/z 44), siloxanes (m/z 73), diethyl ether, hexane, certain freons, and phthalates at levels < 100 µg/L.

b. Solvent preservatives include cyclohexene (a methylene chloride preservative). Related by-products include cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorocyclohexanol.

c. Aldol condensation reaction products of acetone include 4-hydroxy-4-methyl-2-pentanone, 4-methyl-2-penten-2-one, and 5,5-dimethyl-2(5H)-furanone.

8. A target analyte may be identified by non-target library search procedures, even though it is not identified as a target analyte (false negative). If the total area quantitation method is used, request that the laboratory recalculate the result using the proper quantitation ion and RRF.
    a. A non-target compound may be incorrectly identified by the instrument's target analyte data processor as a target analyte (false positive). When this happens, the non-target library search procedure will not detect the false positive as a TIC. In this case, request that the laboratory properly identify the analyte as a TIC and recalculate the result using the total area quantitation method and an RRF of1.0.
    b. Evaluate other sample chromatograms and check for both false negatives and false positives to determine if the occurrence is isolated or systematic.
9. Verify that the TIC concentration is calculated using an RRF of 1.0.

Action

Note details on Data Review Summary (Appendix 1)

1. If the library search match for a TIC is ≥ 85%, qualify the TIC as tentatively identified with estimated concentration (NJ).
2. If the library search match for a TIC is < 85%, qualify the TIC as unknown with estimated concentration (J).
3. General actions related to the review of TIC results are as follows:
    - If it is determined that a tentative identification of a non-target compound is unacceptable, change the tentative identification to "unknown" or another appropriate identification, and qualify the result as estimated (J).
    - If a library search or proper calculation was not performed for all contractually-required peaks, the EPA Regional CLP COR may request the data from the laboratory.
    - Use professional judgment to determine whether a library search result for a TIC represents a reasonable identification. If there is more than one possible match, report the result as "either compound X or compound Y". If there is a lack of isomer specificity, change the TIC result to a non-specific isomer result (e.g., 1,3,5-trimethyl benzene to trimethyl benzene

isomer) or to a compound class (e.g., 2-methyl, 3-ethyl benzene to a substituted aromatic compound).

- Other Case factors may influence TIC judgments. If a sample TIC match is poor, but other samples have a TIC with a valid library match, similar RRT, and the same ions, infer identification information from the other sample TIC results.

4. Note any changes made to the reported data or any concerns regarding TIC identifications in the Data Review Narrative.

XIII. System Performance

Review Forms

Form 8A-OR and chromatograms

Objective

The objective is to ensure that the system is stable during the analytical sequence to produce quality data.

Criteria

There are no specific criteria for system performance.

Evaluation

1. Abrupt discrete shifts in the Reconstructed Ion Chromatogram (RIC) baseline may indicate a change in the instrument's sensitivity or in the zero setting. A baseline "shift" could indicate a decrease in sensitivity in the instrument or an increase in the instrument zero, possibly causing target compounds at or near the detection limit to miss detection. A baseline "rise" could indicate problems such as a change in the instrument zero, a leak, or degradation of the column.
2. Poor chromatographic performance affects both qualitative and quantitative results. Indications of substandard performance include:
    - High RIC background levels or shifts in absolute RTs of internal standards.
    - Excessive baseline rise at elevated temperature.
    - Extraneous peaks.
    - Loss of resolution.
    - Peak tailing or peak splitting that may result in inaccurate quantitation.
3. A drift in instrument sensitivity may occur during the 12-hour period and may be an indication of possible internal standard spiking problems. This could be discerned by examination of the internal standard area on Form 8A-OR for trends such as a continuous or near-continuous increase or decrease in the internal standard area over time.

Action

Note details on Data Review Summary (Appendix 1)

1. Use professional judgment to qualify the data if it is determined that system performance has degraded during sample analyses.
2. Note any degradation of system performance which significantly affected the data for EPA Regional CLP COR action.

XIV. Overall Assessment of Data

Review Items

Entire data package, data review results, and (if available) the QAPP and Sampling and Analysis Plan (SAP).

Objective

The objective is to provide the overall assessment on data quality and usability.

Criteria

1. Review all available materials to assess the overall quality of the data, keeping in mind the additive nature of analytical problems.
2. Reported analyte concentrations must be quantitated according to the appropriate equations, as listed in the method. All sample results must be within the linear calibration ranges per the methods.

Evaluation

Examine the raw data to verify that the correct calculation of the sample results was reported by the laboratory. Analysis logs, instrument printouts, etc., should be compared to the reported sample results recorded on the appropriate Organic Data Reporting Forms (Form 1A-OR through Form 8A-OR).

1. Evaluate any technical problems which have not been previously addressed.
2. Examine the raw data for any anomalies (e.g., baseline shift).
3. Verify that the appropriate method is used in sample analysis.
4. Verify that there are no transcription or reduction errors.
5. Verify that target analyte results fall within the calibrated ranges.
6. If appropriate information is available, use professional judgment to assess the usability of the data in order to assist the data user in avoiding inappropriate use of the data. Review all available information, including the QAPP (specifically the acceptance and performance criteria), SAP, and communication with the data user that concerns the intended use and desired quality of these data.

Action

Note details on Data Review Summary (Appendix 1)

1. Use professional judgment to determine if there is any need to qualify data which were not qualified based on the QC criteria previously discussed.
2. Use professional judgment to qualify sample results and non-detects if the MDL exceeds the CRQL.
3. If a sample is not diluted properly when sample results exceed the upper limit of the calibration range, qualify sample results as estimated (J).
4. Write a brief Data Review Narrative to give the user an indication of the limitations of the analytical data.
5. Note any inconsistency of the data with the SDG Narrative for EPA Regional CLP COR action. If sufficient information on the intended use and required quality of the data is available, include an assessment of the usability of the data within the given context. This may be used as part of a formal Data Quality Assessment (DQA).

4.0 REFERENCES

(1) U.S. EPA. November 2002. Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8).

(2) U.S. EPA. March 2006. Guidelines for Data Review of Contract Laboratory Program Analytical Services Volatile and Semivolatile Data Packages. Standard Operating Procedure 901, U.S. EPA Region 9.

(3) U.S. EPA Contract Laboratory Program. January 2017. National Functional Guidelines for Organic Superfund Data Review (U.S. EPA-540-R-2017-002).

APPENDIX 1: DATA REVIEW SUMMARY: VOLATILE AND SEMIVOLATILE ANALYSIS

SAMPLE NO.

SITE

LABORATORY

EVENT

LAB REPORT NO:

SAMPLE MATRIX

REVIEWER NAME

COMPLETION DATE

QC MANAGER CHECK

FOLLOW-UP

Review Criteria	**Criteria**	**Condition/Observation**	**Action**	**Qualifier**
Preservation and Holding Times				
GC/MS or GC/ECD Instrument Performance Check				
Initial Calibration				
Initial Calibration Verification				
Minimum RRF Criteria				
Blanks				
Deuterated Monitoring Compound or Surrogate Spikes				
Matrix Spike/Matrix Spike Duplicate				
Laboratory Control Sample				
Internal Standards				
GPC Performance Check				
Florisil Cartridge Performance Check				
Target Analyte Identification				
GC/MS Confirmation				
Target Analyte Quantitation and Reported CRQLs				
Tentatively Identified Compounds				
System Performance				
Overall Assessment of Data				

Table 1. Data Qualifiers and Definitions

Qualifier	Definition
U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
NJ	The analyte has been “tentatively identified” or “presumptively” as present and the associated numerical value is the estimated concentration in the sample.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
C	The target Pesticide or Aroclor analyte identification has been confirmed by Gas Chromatography/Mass Spectrometry (GC/MS).
X	The target Pesticide or Aroclor analyte identification was not confirmed when GC/MS analysis was performed.

Table 2A. Preservation and Holding Time Actions for Volatile Analysis

	Action	
	Detect	**Non-detect**
Sample temperature > 6°C but ≤ 10°C upon receipt at the laboratory	Use professional judgment	Use professional judgment
Sample temperature > 10°C upon receipt at the laboratory	Use professional judgment J*	Use professional judgment UJ
Sample not preserved but analyzed within the 7-day technical holding time	No qualification	No qualification
Samples not preserved and analyzed outside the 7-day technical holding time	J*	R
Sample properly preserved and analyzed within the 14-day technical holding time	No qualification	No qualification
Sample properly preserved but analyzed outside the 14-day technical holding time	J*	R
Holding time grossly exceeded	J*	R

*The true direction of any bias may be unknown in this case. Use caution in determining whether some detected analytes should be qualified as estimated low (J-) or as estimated high (J+), based on knowledge of individual analyte stability or interactions (i.e., dehydrohalogenation).

Table 2B. Preservation and Holding Time Actions for Semivolatile Analysis

Matrix	Preserved	Criteria	Action	
			Detect	Non-detect
Aqueous	No	≤ 7 days (for extraction) and ≤ 40 days (for analysis)	Use professional judgment	Use professional judgment
		TCLP/SPLP aqueous filtrate sample and TCLP/SPLP leachate sample extracted within the 7-day technical holding time		
	No	> 7 days (for extraction) and/or > 40 days (for analysis)	J	R
		TCLP/SPLP aqueous filtrate sample and TCLP/SPLP leachate sample not extracted within the 7-		
	Yes	≤ 7 days (for extraction) and ≤ 40 days (for analysis)	No qualification	No qualification
		TCLP/SPLP aqueous filtrate sample and TCLP/SPLP leachate sample extracted within the 7-day technical holding time		

Table 3A. Ion Abundance Criteria for BFB

Mass	Ion Abundance Criteria
50	15.0 - 40.0% of mass 95
75	30.0 - 80.0% of mass 95
95	Base peak, 100% relative abundance
96	5.0 - 9.0% of mass 95*
173	Less than 2.0% of mass 174
174	50.0% - 120% of mass 95
175	5.0 - 9.0% of mass 174
176	95.0 - 101% of mass 174
177	5.0 - 9.0% of mass 176

* All ion abundances must be normalized to m/z 95, the nominal base peak, even though the ion abundance of m/z 174 may be up to 120% that of m/z 95.

Table 3B. Ion Abundance Criteria for DFTPP

Mass	Ion Abundance Criteria
51	10.0 - 80.0% of mass 198
68	Less than 2.0% of mass 69
69	Present
70	Less than 2.0% of mass 69
127	10.0 - 80.0% of mass 198
197	Less than 2.0% of mass 198
198	Base peak, 100% relative abundance*
199	5.0 - 9.0% of mass 198
275	10.0 - 60.0% of mass 198
365	Greater than 1.0% of mass 198
441	Present, but less than mass 443
442	Greater than 50.0% of mass 198
443	15.0 - 24.0% of mass 442

*All ion abundances must be normalized to m/z 198, the nominal base peak, even though the ionabundance of m/z 442 may exceed that of m/z 198.

Table 4. RRF, %RSD, and %D Acceptance Criteria in Initial Calibration, ICV, and CCV for Volatile Analysis

Analyte	Minimum RRF	Maximum %RSD	ICV/Opening CCV Maximum %D[1]	Closing CCV Maximum %D
Dichlorodifluoromethane	0.010	30.0	±40.0	±50.0
Chloromethane	0.010	30.0	±30.0	±50.0
Vinyl chloride	0.010	30.0	±30.0	±50.0
Bromomethane	0.010	40.0	±30.0	±50.0
Chloroethane	0.010	30.0	±30.0	±50.0
Trichlorofluoromethane	0.010	30.0	±30.0	±50.0
1,1-Dichloroethene	0.020	30.0	±20.0	±25.0
1,1,2-Trichloro-1,2,2-trifluoroethane	0.010	30.0	±30.0	±50.0
Acetone	0.010	40.0	±40.0	±50.0
Carbon disulfide	0.010	20.0	±25.0	±25.0
Methyl acetate	0.010	40.0	±40.0	±50.0
Methylene chloride	0.010	40.0	±30.0	±50.0
trans-1,2-Dichloroethene	0.070	20.0	±20.0	±25.0
Methyl tert-butyl ether	0.010	30.0	±30.0	±50.0
1,1-Dichloroethane	0.100	20.0	±20.0	±25.0
cis-1,2-Dichloroethene	0.100	20.0	±20.0	±25.0
2-Butanone	0.010	40.0	±40.0	±50.0
Bromochloromethane	0.020	20.0	±20.0	±25.0
Chloroform	0.040	20.0	±20.0	±25.0
1,1,1-Trichloroethane	0.050	30.0	±20.0	±25.0
Cyclohexane	0.100	30.0	±25.0	±50.0
Carbon tetrachloride	0.020	20.0	±25.0	±50.0
Benzene	0.300	20.0	±20.0	±25.0
1,2-Dichloroethane	0.010	20.0	±25.0	±50.0
Trichloroethene	0.100	20.0	±20.0	±25.0
Methylcyclohexane	0.200	30.0	±25.0	±50.0
1,2-Dichloropropane	0.100	20.0	±20.0	±25.0
Bromodichloromethane	0.090	20.0	±20.0	±25.0
cis-1,3-Dichloropropene	0.100	20.0	±20.0	±25.0
4-Methyl-2-pentanone	0.010	30.0	±30.0	±50.0
Toluene	0.400	20.0	±20.0	±25.0
trans-1,3-Dichloropropene	0.010	30.0	±20.0	±25.0
1,1,2-Trichloroethane	0.040	20.0	±20.0	±25.0
Tetrachloroethene	0.100	20.0	±20.0	±25.0
2-Hexanone	0.010	40.0	±40.0	±50.0
Dibromochloromethane	0.050	20.0	±20.0	±25.0
1,2-Dibromoethane	0.010	20.0	±20.0	±25.0
Chlorobenzene	0.400	20.0	±20.0	±25.0
Ethylbenzene	0.500	20.0	±20.0	±25.0

Table 4. RRF, %RSD, and %D Acceptance Criteria in Initial Calibration, ICV, and CCV for Volatile Analysis

Analyte	Minimum RRF	Maximum %RSD	ICV/Opening CCV Maximum %D[1]	Closing CCV Maximum %D
m,p-Xylene	0.200	20.0	±20.0	±25.0
o-Xylene	0.300	30.0	±20.0	±25.0
Styrene	0.200	30.0	±20.0	±25.0
Bromoform	0.010	30.0	±30.0	±50.0
Isopropylbenzene	0.700	30.0	±25.0	±25.0
1,1,2,2-Tetrachloroethane	0.050	20.0	±25.0	±25.0
1,3-Dichlorobenzene	0.500	20.0	±20.0	±25.0
1,4-Dichlorobenzene	0.700	20.0	±20.0	±25.0
1,2-Dichlorobenzene	0.400	20.0	±20.0	±25.0
1,2-Dibromo-3-chloropropane	0.010	40.0	±40.0	±50.0
1,2,4-Trichlorobenzene	0.300	30.0	±30.0	±50.0
1,2,3-Trichlorobenzene	0.200	30.0	±40.0	±50.0
Deuterated Monitoring Compounds				
Vinyl chloride-d3	0.010	30.0	±30.0	±50.0
Chloroethane-d5	0.010	30.0	±30.0	±50.0
1,1-Dichloroethene-d2	0.010	30.0	±25.0	±25.0
2-Butanone-d5	0.010	40.0	±40.0	±50.0
Chloroform-d	0.010	20.0	±20.0	±25.0
1,2-Dichloroethane-d4	0.010	20.0	±25.0	±25.0
Benzene-d6	0.030	20.0	±20.0	±25.0
1,2-Dichloropropane-d6	0.100	20.0	±20.0	±25.0
Toluene-d8	0.200	20.0	±20.0	±25.0
trans-1,3-Dichloropropene-d4	0.010	30.0	±25.0	±25.0
2-Hexanone-d5	0.010	40.0	±40.0	±50.0
1,1,2,2- Tetrachloroethane-d2	0.010	20.0	±25.0	±25.0
1,2-Dichlorobenzene-d4	0.060	20.0	±20.0	±25.0

[1] If a closing CCV is acting as an opening CCV, all target analytes must meet the requirements for an opening CCV

Table 4B. RRF, %RSD, and %D Acceptance Criteria in Initial Calibration, ICV, and CCV for Semivolatile Analysis

Semivolatile Analysis	Minimum RRF	Maximum %RSD	ICV/Opening CCV Maximum %D1	Closing CCV Maximum %D
1,4-Dioxane	0.010	40.0	±40.0	±50.0
Benzaldehyde	0.100	40.0	±40.0	±50.0
Phenol	0.080	20.0	±20.0	±25.0
Bis(2-chloroethyl) ether	0.100	20.0	±20.0	±25.0
2-Chlorophenol	0.200	20.0	±20.0	±25.0
2-Methylphenol	0.010	20.0	±20.0	±25.0
3-Methylphenol	0.010	20.0	±20.0	±25.0
2,2'-Oxybis-(1-chloropropane)	0.010	20.0	±25.0	±50.0
Acetophenone	0.060	20.0	±20.0	±25.0
4-Methylphenol	0.010	20.0	±20.0	±25.0
N-Nitroso-di-n-propylamine	0.080	20.0	±25.0	±25.0
Hexachloroethane	0.100	20.0	±20.0	±25.0
Nitrobenzene	0.090	20.0	±20.0	±25.0
Isophorone	0.100	20.0	±20.0	±25.0
2-Nitrophenol	0.060	20.0	±20.0	±25.0
2,4-Dimethylphenol	0.050	20.0	±25.0	±50.0
Bis(2-chloroethoxy) methane	0.080	20.0	±20.0	±25.0
2,4-Dichlorophenol	0.060	20.0	±20.0	±25.0
Naphthalene	0.200	20.0	±20.0	±25.0
4-Chloroaniline	0.010	40.0	±40.0	±50.0
Hexachlorobutadiene	0.040	20.0	±20.0	±25.0
Caprolactam	0.010	40.0	±30.0	±50.0
4-Chloro-3-methylphenol	0.040	20.0	±20.0	±25.0
2-Methylnaphthalene	0.100	20.0	±20.0	±25.0
Hexachlorocyclopentadiene	0.010	40.0	±40.0	±50.0
2,4,6-Trichlorophenol	0.090	20.0	±20.0	±25.0
2,4,5-Trichlorophenol	0.100	20.0	±20.0	±25.0
1,1'-Biphenyl	0.200	20.0	±20.0	±25.0
2-Chloronaphthalene	0.300	20.0	±20.0	±25.0
2-Nitroaniline	0.060	20.0	±25.0	±25.0
Dimethylphthalate	0.300	20.0	±20.0	±25.0
2,6-Dinitrotoluene	0.080	20.0	±20.0	±25.0
Acenaphthylene	0.400	20.0	±20.0	±25.0
3-Nitroaniline	0.010	20.0	±25.0	±50.0
Acenaphthene	0.200	20.0	±20.0	±25.0
2,4-Dinitrophenol	0.010	40.0	±50.0	±50.0
4-Nitrophenol	0.010	40.0	±40.0	±50.0
Dibenzofuran	0.300	20.0	±20.0	±25.0
2,4-Dinitrotoluene	0.070	20.0	±20.0	±25.0
Diethylphthalate	0.300	20.0	±20.0	±25.0

Table 4B. RRF, %RSD, and %D Acceptance Criteria in Initial Calibration, ICV, and CCV for Semivolatile Analysis

Semivolatile Analysis	Minimum RRF	Maximum %RSD	ICV/Opening CCV Maximum %D[1]	Closing CCV Maximum %D
1,2,4,5-Tetrachlorobenzene	0.100	20.0	±20.0	±25.0
4-Chlorophenyl-phenylether	0.100	20.0	±20.0	±25.0
Fluorene	0.200	20.0	±20.0	±25.0
4-Nitroaniline	0.010	40.0	±40.0	±50.0
4,6-Dinitro-2-methylphenol	0.010	40.0	±30.0	±50.0
4-Bromophenyl-phenyl ether	0.070	20.0	±20.0	±25.0
N-Nitrosodiphenylamine	0.100	20.0	±20.0	±25.0
Hexachlorobenzene	0.050	20.0	±20.0	±25.0
Atrazine	0.010	40.0	±25.0	±50.0
Pentachlorophenol	0.010	40.0	±40.0	±50.0
Phenanthrene	0.200	20.0	±20.0	±25.0
Anthracene	0.200	20.0	±20.0	±25.0
Carbazole	0.050	20.0	±20.0	±25.0
Di-n-butylphthalate	0.500	20.0	±20.0	±25.0
Fluoranthene	0.100	20.0	±20.0	±25.0
Pyrene	0.400	20.0	±25.0	±50.0
Butylbenzylphthalate	0.100	20.0	±25.0	±50.0
3,3'-Dichlorobenzidine	0.010	40.0	±40.0	±50.0
Benzo(a)anthracene	0.300	20.0	±20.0	±25.0
Chrysene	0.200	20.0	±20.0	±50.0
Bis(2-ethylhexyl) phthalate	0.200	20.0	±25.0	±50.0
Di-n-octylphthalate	0.010	40.0	±40.0	±50.0
Benzo(b)fluoranthene	0.010	20.0	±25.0	±50.0
Benzo(k)fluoranthene	0.010	20.0	±25.0	±50.0
Benzo(a)pyrene	0.010	20.0	±20.0	±50.0
Indeno(1,2,3-cd)pyrene	0.010	20.0	±25.0	±50.0
Dibenzo(a,h)anthracene	0.010	20.0	±25.0	±50.0
Benzo(g,h,i)perylene	0.010	20.0	±30.0	±50.0
2,3,4,6-Tetrachlorophenol	0.040	20.0	±20.0	±50.0

Table 4B. RRF, %RSD, and %D Acceptance Criteria in Initial Calibration, ICV, and CCV for Semivolatile Analysis

Semivolatile Analysis	Minimum RRF	Maximum %RSD	ICV/Opening CCV Maximum %D[1]	Closing CCV Maximum %D
Selective Ion Monitoring				
Naphthalene	0.600	20.0	±25.0	±25.0
2-Methylnaphthalene	0.300	20.0	±20.0	±25.0
Acenaphthylene	0.900	20.0	±20.0	±25.0
Acenaphthene	0.500	20.0	±20.0	±25.0
Fluorene	0.700	20.0	±25.0	±50.0
Phenanthrene	0.300	20.0	±25.0	±50.0
Anthracene	0.400	20.0	±25.0	±50.0
Fluoranthene	0.400	20.0	±25.0	±50.0
Pyrene	0.500	20.0	±30.0	±50.0
Benzo(a)anthracene	0.400	20.0	±25.0	±50.0
Chrysene	0.400	20.0	±25.0	±50.0
Benzo(b)fluoranthene	0.100	20.0	±30.0	±50.0
Benzo(k)fluoranthene	0.100	20.0	±30.0	±50.0
Benzo(a)pyrene	0.100	20.0	±25.0	±50.0
Indeno(1,2,3-cd)pyrene	0.100	20.0	±40.0	±50.0
Dibenzo(a,h)anthracene	0.010	25.0	±40.0	±50.0
Benzo(g,h,i)perylene	0.020	25.0	±40.0	±50.0
Pentachlorophenol	0.010	40.0	±50.0	±50.0
Deuterated Monitoring Compounds				
1,4-Dioxane-d8	0.010	20.0	±25.0	±50.0
Phenol-d5	0.010	20.0	±25.0	±25.0
Bis-(2-chloroethyl) ether-d8	0.100	20.0	±20.0	±25.0
2-Chlorophenol-d4	0.200	20.0	±20.0	±25.0
4-Methylphenol-d8	0.010	20.0	±20.0	±25.0
4-Chloroaniline-d4	0.010	40.0	±40.0	±50.0
Nitrobenzene-d5	0.050	20.0	±20.0	±25.0
2-Nitrophenol-d4	0.050	20.0	±20.0	±25.0
2,4-Dichlorophenol-d3	0.060	20.0	±20.0	±25.0
Dimethylphthalate-d6	0.300	20.0	±20.0	±25.0
Acenaphthylene-d8	0.400	20.0	±20.0	±25.0
4-Nitrophenol-d4	0.010	40.0	±40.0	±50.0
Fluorene-d10	0.100	20.0	±20.0	±25.0
4,6-Dinitro-2-methylphenol-d2	0.010	40.0	±30.0	±50.0
Anthracene-d10	0.300	20.0	±20.0	±25.0
Pyrene-d10	0.300	20.0	±25.0	±50.0
Benzo(a)pyrene-d12	0.010	20.0	±20.0	±50.0
Fluoranthene-d10 (SIM)	0.400	20.0	±25.0	±50.0
2-Methylnaphthalene-d10 (SIM)	0.300	20.0	±20.0	±25.0

[1] If a closing CCV is acting as an opening CCV, all target analytes must meet the requirements for an opening CCV.

Table 5. Initial Calibration Actions for Volatile and Semivolatile Analysis

Criteria	Action	
	Detect	**Non-detect**
Initial Calibration not performed at the specified frequency and sequence	Use professional judgment R	Use professional judgment R
Initial Calibration not performed at the specified concentrations	J	UJ
RRF < Minimum RRF for target analyte	Use professional judgment J+ or R	R
RRF ≥ Minimum RRF for target analyte	No qualification	No qualification
%RSD > Maximum %RSD for target analyte	J	Use professional judgment
%RSD ≤ Maximum %RSD for target analyte	No qualification	No qualification

Table 6. ICV Actions for Volatile and Semivolatile Analysis

Criteria for ICV	Action	
	Detect	**Non-detect**
ICV not performed at the specified frequency and sequence	Use professional judgment	Use professional judgment
ICV not performed at the specified concentration	Use professional judgment	Use professional judgment
RRF < Minimum RRF for target analyte	Use professional judgment J or R	R
RRF ≥ Minimum RRF for target analyte	No qualification	No qualification
%D outside the ICV/Opening CCV Maximum %D limits for target analyte	J	UJ
%D within the inclusive ICV/Opening CCV Maximum %D limits for target analyte	No qualification	No qualification

Table 7. CCV Actions for Volatile and Semivolatile Analysis

Criteria for Opening CCV		Action	
		Detect	Non-detect
CCV not performed at the specified frequency and sequence	CCV not performed at the specified frequency	Use professional judgment J or R	Use professional judgment UJ or R
CCV not performed at the specified concentration	CCV not performed at the specified concentration	Use professional judgment	Use professional judgment
RRF < Minimum RRF for target analyte	RRF < Minimum RRF for target analyte	Use professional judgment J or R	R
RRF ≥ Minimum RRF for target analyte	RRF ≥ Minimum RRF in Table 4 for target analyte	No qualification	No qualification
%D outside the ICV/Opening CCV Maximum %D limits for target analyte	%D outside the Closing CCV Maximum %D limits for target analyte	J	UJ
%D within the inclusive ICV/Opening CCV Maximum %D limits for target analyte	%D within the inclusive Closing CCV Maximum %D limits for target analyte	No qualification	No qualification

Table 8. Blank Actions for Volatile and Semivolatile Analysis

Blank Type	Blank Result	Sample Result	Action
Method, Storage, Field, Trip, Instrument*	Detect	Non-detect	No qualification
	< CRQL	< CRQL	Report at CRQL and qualify as non-detect (U)
		≥ CRQL or ≥ 2x Blank Result for Methylene chloride, Acetone, and 2-Butanone	Use professional judgment
	≥C RQL	< CRQL	Report at CRQL and qualify as non-detect (U)
		≥ CRQL but < Blank Result	Report at sample result and qualify as non-detect (U) or unusable (R)
		≥ CRQL and ≥ Blank Result or ≥ 2x Blank Result for Methylene chloride, Acetone, and 2-Butanone	Use professional judgment
	Gross contamination	Detect	Report at sample result and qualify as unusable (R)
	TIC > 0.5 µg/L	Detect	Use professional judgment

* Qualifications based on instrument blank results affect only the sample analyzed immediately after the sample that has target analyte concentration exceeding the calibration range or TICs concentration exceeding 100 µg/L.

Table 9A. Volatile DMCs and Recovery Limits

DMC	Recovery Limits (%)
Vinyl chloride-d3	40 - 130
Chloroethane-d5	65 - 130
1,1-Dichloroethene-d2	60 - 125
2-Butanone-d5	40 - 130
Chloroform-d	70 - 125
1,2-Dichloroethane-d4	70 - 130
Benzene-d6	70 - 125
1,2-Dichloropropane-d6	60 - 140
Toluene-d8	70 - 130
trans-1,3-Dichloropropene-d4	55 - 130
2-Hexanone-d5	45 - 130
1,1,2,2-Tetrachloroethane-d2	65 - 120
1,2-Dichlorobenzene-d4	80 - 120

Table 9B. Semivolatile DMC Recovery Limits

DMC	%R For Water Sample	%R For Soil/Sediment Sample
1,4-Dioxane-d8	40 - 110	40 - 110
Phenol-d5	10 - 130	10 - 130
Bis(2-chloroethyl) ether-d8	25 - 120	10 - 150
2-Chlorophenol-d4	20 - 130	15 - 120
4-Methylphenol-d8	25 - 125	10 - 140
4-Chloroaniline-d4	1 - 146*	1 - 145*
Nitrobenzene-d5	20 - 125	10 - 135
2-Nitrophenol-d4	20 - 130	10 - 120
2,4-Dichlorophenol-d3	20 - 120	10 - 140
Dimethylphthalate-d6	25 - 130	10 - 145
Acenaphthylene-d8	10 - 130	15 - 120
4-Nitrophenol-d4	10 - 150	10 - 150
Fluorene-d10	25 - 125	20 - 140
4,6-Dinitro-2-methylphenol-d2	10 - 130	10 - 130
Anthracene-d10	25 - 130	10 - 150
Pyrene-d10	15 - 130	10 - 130
Benzo(a)pyrene-d12	20 - 130	10 - 140
Fluoranthene-d10 (SIM)	30 - 130	30 - 130
2-Methylnaphthalene-d10 (SIM)	30 - 130	20 - 140

* Limits are advisory

Table 10. DMC Actions for Volatile and Semivolatile Analysis

Criteria	Action	
	Detect	Non-detect
%R < 10%	J-	R
10% ≤ %R < Lower Acceptance Limit	J-	UJ
Lower Acceptance Limit ≤ %R ≤ Upper Acceptance Limit	No qualification	No qualification
%R > Upper Acceptance Limit	J+	No qualification

Table 11A. Volatile DMCs and the Associated Target Analytes

Vinyl chloride-d3 (DMC-1)	**Chloroethane-d5 (DMC-2)**	**1,1-Dichloroethene-d2 (DMC-3)**
Vinyl chloride	Dichlorodifluoromethane	trans-1,2-Dichloroethene
	Chloromethane	cis-1,2-Dichloroethene
	Bromomethane	1,1-Dichloroethene
	Chloroethane	
	Carbon disulfide	
2-Butanone-d5 (DMC-4)	**Chloroform-d (DMC-5)**	**1,2-Dichloroethane-d4 (DMC-6)**
Acetone 2-Butanone	1,1-Dichloroethane Bromochloromethane Chloroform Dibromochloromethane Bromoform	Trichlorofluoromethane 1,1,2-Trichloro-1,2,2-trifluoroethane Methyl acetate Methylene chloride Methyl-tert-butyl ether 1,1,1-Trichloroethane Carbon tetrachloride 1,2-Dibromoethane 1,2-Dichloroethane
Benzene-d6 (DMC-7)	**1,2-Dichloropropane-d6 (DMC-**	**Toluene-d8 (DMC-9)**
Benzene	Cyclohexane Methylcyclohexane 1,2-Dichloropropane Bromodichloromethane	Trichloroethene Toluene Tetrachloroethene Ethylbenzene o-Xylene m,p-Xylene Styrene Isopropylbenzene
trans-1,3-Dichloropropene-d4 (DMC-10)	**2-Hexanone-d5 (DMC-11)**	**1,1,2,2-Tetrachloroethane-d2 (DMC-12)**
cis-1,3-Dichloropropene trans-1,3-Dichloropropene 1,1,2-Trichloroethane	4-Methyl-2-pentanone 2-Hexanone	1,1,2,2,-Tetrachloroethane 1,2-Dibromo-3-chloropropane
1,2-Dichlorobenzene-d4 (DMC-13)		
Chlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene 1,2-Dichlorobenzene 1,2,4-Trichlorobenzene 1,2,3-Trichlorobenzene		

Table 11B. Semivolatile DMCs and the Associated Target Analytes

1,4-Dioxane-d8 (DMC-1)	**Phenol-d5 (DMC-2)**	**Bis(2-Chloroethyl) ether-d8 (DMC-3)**
1,4-Dioxane	Benzaldehyde Phenol	Bis(2-chloroethyl) ether 2,2'-Oxybis(1-chloropropane) Bis(2-chloroethoxy) methane
2-Chlorophenol-d4 (DMC-4)	**4-Methylphenol-d8 (DMC-5)**	**4-Chloroaniline-d4 (DMC-6)**
2-Chlorophenol	2-Methylphenol 3-Methylphenol 4-Methylphenol 2,4-Dimethylphenol	4-Chloroaniline
Nitrobenzene-d5 (DMC-7)	**2-Nitrophenol-d4 (DMC-8)**	**2,4-Dichlorophenol-d3 (DMC-9)**
Acetophenone N-Nitroso-di-n-propylamine Hexachloroethane Hexachlorocyclopentadiene Nitrobenzene 2,6-Dinitrotoluene 2,4-Dinitrotoluene N-Nitrosodiphenylamine 3,3'-Dichlorobenzidine	Isophorone 2-Nitrophenol	2,4-Dichlorophenol Hexachlorobutadiene 4-Chloro-3-methylphenol 2,4,6-Trichlorophenol 2,4,5-Trichlorophenol 1,2,4,5-Tetrachlorobenzene *Pentachlorophenol 2,3,4,6-Tetrachlorophenol
Dimethylphthalate-d6 (DMC-10)	**Acenaphthylene-d8 (DMC-11)**	**4-Nitrophenol-d4 (DMC-12)**
Caprolactam 1,1'-Biphenyl Dimethylphthalate Diethylphthalate Di-n-butylphthalate Butylbenzylphthalate Bis(2-ethylhexyl) phthalate Di-n-octylphthalate	*Naphthalene *2-Methylnaphthalene 2-Chloronaphthalene *Acenaphthylene *Acenaphthene	2-Nitroaniline 3-Nitroaniline 2,4-Dinitrophenol 4-Nitrophenol 4-Nitroaniline
Fluorene-d10 (DMC-13)	**4,6-Dinitro-2-methylphenol-d2 (DMC-14)**	**Anthracene-d10 (DMC-15)**
Dibenzofuran *Fluorene 4-Chlorophenyl-phenylether 4-Bromophenyl-phenylether Carbazole	4,6-Dinitro-2-methylphenol	Hexachlorobenzene Atrazine *Phenanthrene *Anthracene

Table 11B. Semivolatile DMCs and the Associated Target Analytes

Pyrene-d10 (DMC-16)	**Benzo(a)pyrene-d12 (DMC-17)**	
*Fluoranthene *Pyrene *Benzo(a)anthracene *Chrysene	*Benzo(b)fluoranthene *Benzo(k)fluoranthene *Benzo(a)pyrene *Indeno(1,2,3-cd)pyrene *Dibenzo(a,h)anthracene *Benzo(g,h,i)perylene	

Semivolatile SIM DMCs and the Associated Target Analytes

Fluoranthene-d10 (DMC-1)	**2-Methylnaphthalene-d10 (DMC-2)**
Fluoranthene	Naphthalene
Pyrene	2-Methylnaphthalene
Benzo(a)anthracene	Acenaphthylene
Chrysene	Acenaphthene
Benzo(b)fluoranthene	Fluorene
Benzo(k)fluoranthene	Pentachlorophenol
Benzo(a)pyrene	Phenanthrene
Indeno(1,2,3-cd)pyrene	Anthracene
Dibenzo(a,h)anthracene	
Benzo(g,h,i)perylene	

Table 12. MS/MSD %R and RPD Limits for Volatile Analysis

Analyte	%R	RPD
1,1-Dichloroethene	61 - 145	0 - 14
Benzene	76 - 127	0 - 11
Trichloroethene	71 - 120	0 - 14
Toluene	76 - 125	0 - 13
Chlorobenzene	75 - 130	0 - 13

Table 12B. MS/MSD %R and RPD Limits for Semivolatile Analysis

Compound	%R for Water Sample	RPD for Water Sample	%R for Soil/Sediment Sample	RPD for Soil/Sediment Sample
Phenol	12 - 110	0 - 42	26 - 90	0 - 35
2-Chlorophenol	27 - 123	0 - 40	25 - 102	0 - 50
N-Nitroso-di-n-propylamine	41 - 116	0 - 38	41 - 126	0 - 38
4-Chloro-3-methylphenol	23 - 97	0 - 42	26 - 103	0 - 33
Acenaphthene	46 - 118	0 - 31	31 - 137	0 - 19
4-Nitrophenol	10 - 80	0 - 50	11 - 114	0 - 50
2,4-Dinitrotoluene	24 - 96	0 - 38	28 - 89	0 - 47
Pentachlorophenol	9 - 103	0 - 50	17 - 109	0 - 47
Pyrene	26 - 127	0 - 31	35 - 142	0 - 36

Table 13. MS/MSD Actions for Volatile and Semivolatile Analysis

Criteria	Action	
	Detect	Non-detect
Volatile Analysis		
%R < 20%	J	R
20% ≤ %R< Lower Acceptance Limit	J	UJ
Lower Acceptance Limit ≤ %R or RPD ≤ Upper Acceptance Limit	No qualification	No qualification
%R or RPD > Upper Acceptance Limit	J	No qualification
Semivolatile Analysis		
%R < 10% (excluding spiked analyte with %R lower limit of 10% or less)	J	R
10% ≤ %R (excluding spiked analyte with %R lower limit of 10% or less) < Lower Acceptance Limit	J	UJ
Lower Acceptance Limit ≤ %R or RPD ≤ Upper Acceptance Limit	No qualification	No qualification
%R or RPD > Upper Acceptance Limit	J	No qualification

Table 14. Internal Standard Actions for Volatile and Semivolatile Analysis

Criteria	Action	
	Detect	Non-detect
Area response < 20% of the opening CCV or mid-point standard CS3 from ICAL	J+	R
20% ≤ Area response < 50% of the opening CCV or mid-point standard CS3 from ICAL	J+	UJ
50% ≤ Area response ≤ 200% of the opening CCV or mid-point standard CS3 from ICAL	No qualification	No qualification
Area response > 200% of the opening CCV or mid-point standard CS3 from ICAL	J-	No qualification
RT shift between sample/blank and opening CCV or mid-point standard CS3 from ICAL > 10.0 seconds	R	R
RT shift between sample/blank and opening CCV or mid-point standard CS3 from ICAL < 10.0 seconds	No qualification	No qualification

APPENDIX: ORGANIC DATA REVIEW SUMMARY

SAMPE NO.		SITE	
LABORATORY		EVENT	
LAB REPORT NO:	DATE	SAMPLE MATRIX	
REVIEWER NAME		COMPLETION DATE	
QC MANAGER CHECK		FOLLOW-UP	

Review Criteria	**Method**				
	TRACE VOC	**LOW/MED VOC**	**HIGH VOC**	**SVOC**	**Other:**
Preservation and Holding Times					
GC/MS or GC/ECD Instrument Performance Check					
Initial Calibration					
Initial Calibration Verification					

Review Criteria	**Method**				
	TRACE VOC	**LOW/MED VOC**	**HIGH VOC**	**SVOC**	**Other:**
Continuing Calibration Verification					
Blanks					
Deuterated Monitoring Compound or Surrogate Spikes					
Matrix Spike/Matrix Spike Duplicate					
Laboratory Control Sample					
Regional QA/QC					

Review Criteria	Method				
	TRACE VOC	LOW/MED VOC	HIGH VOC	SVOC	Other:
Internal Standards					
GPC Performance Check					
Florisil Cartridge Performance Check					
Target Analyte Identification					
GC/MS Confirmation					
Target Analyte Quantitation and Reported CRQLs					
Tentatively Identified Compounds					

Review Criteria	**Method**				
	TRACE VOC	**LOW/MED VOC**	**HIGH VOC**	**SVOC**	**Other:**
System Performance					
Overall Assessment of Data					

Attachment : Data Review Assessment Report (Manual Review) Example

Attachment 4 Data Review Assessment Report (Manual Review)

Data Quality Assessment Record (DQAR)

Review Date: ________ Analyses: ____________ Matrix: ______ Project #: ________

SDG /Lab File: ________________

Laboratory : ____

Site Name: ____

Check One: EPA ____ ESAT ______ CLP ______ Other (specify) ____________

Signature:

Reviewer ________________________

Sample Numbers:

I. SUMMARY OF PROBLEMS AND COMMENTS:

A summary of deficiencies noted for the method used to generate data for this project is presented below. For the purposes of this review, the QC limits specified in the analytical method have been applied to the data. Data qualifiers recommendations are made in accordance with the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic and Organic Data Review* (Functional Guidelines), and the Region 4 SOP, *Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services* (R4DVSOP), Rev. 2.1.

II. Data Quality Assessment (An explanation for any "no" answer must be provided)

? = see remarks

1. Summary:

	Yes	N/A	No
Were all requested analyses performed?			
Were all required QC checks performed?			
Were all required documents present?			
Were requested detection limits met?			

Remark:

2. Holding Times:

	Yes	N/A	No
VOA/BNA/PEST prepared within 14 days of sampling (7 days for VOA aromatics in non-preserved samples)?			
PCDD/PCDF extracted within 30 days of sampling?			
Extracts analyzed within 40 days of extraction?			
Were all samples/extracts properly preserved?			
For TCLP: Were RCRA TCLP holding times met?			

Remark:

3. GC/MS Tuning:

	Yes	N/A	No
Were PFK/DFTPP/BFB criteria met?			
Pesticides: Were standards run in proper sequence?			
Combined DDT/Endrin Breakdown acceptable?			
Retention time windows defined?			

Remark:

4.1 Initial Calibration:	Yes	N/A	No
Were %RSDs acceptable?			
Were RRFs acceptable?			
Was S/N acceptable?			
Were PCDD/PCDF ion ratios acceptable?			

Remark:

4.2 Continuing Calibration:	Yes	N/A	No
Were %RSDs acceptable?			
Were RRFs acceptable?			
Were PEST cont. calib. factors met?			
Was PCDD/PCDF S/N acceptable?			
Were PCDD/PCDF ion ratios acceptable?			

Remark:

5. Spikes:	Yes	N/A	No
Was a method spike analysis performed?			
Were matrix spike/m.s. duplicate analyses performed?			
Were acceptable recoveries obtained?			
Was acceptable precision obtained?			

Remark:

6. Blanks:	Yes	N/A	No
Were blank analyses performed?			
Were any contaminants noted?			
If yes, were blank rules applied to the data?			

Remark:

7. Performance Evaluation Sample:	Yes	N/A	No
Was a P.E. Sample analyzed with the samples?			
If yes, were acceptable results obtained?			

Remark:

8. Internal Standard / PCDD/PCDF Recovery Standards:	Yes	N/A	No
Were peak areas acceptable?			

Remark:

9. Surrogates / PCDD/PCDF Internal Standards:	Yes	N/A	No
Were peak areas acceptable?			

Remark:

10. Compound Identification / Quantification:	Yes	N/A	No
Were all positive results confirmed?			
Was supporting documentation included?			
Was a check of the calculations performed?			
If yes, were results acceptable?			
PCDD/PCDF ion ratios acceptable?			

Remark:

	Yes	N/A	No
11. Tentatively Identified Compounds?			
Were TICs requested for these analyses?	______	______	______
If yes, were results provided?	______	______	______

Remark:

III. Data Summary

Acceptable except as noted.

DATA QUALIFIER EXPLANATIONS

Sample	Compound(s)	Laboratory Flag	ESAT Flag	Reason

ENVIRONMENTAL WORKS SCIENCE. SAFETY. GRIT. INGENUITY.	**Version 1.1**	**SOP No. 18. Investigative Waste Management**
Standard Operating Procedures (SOP)		**Responsible Department: Remediation** **Page 1 of 15**

1.0 OBJECTIVE/APPLICABILITY

This standard operating procedure (SOP) delineates the process for characterizing and managing wastes generated during corrective action activities conducted by Environmental Works, Incorporated (EWI), and their subcontractors.

This procedure is limited to the planning, implementation, and management activities for all wastes generated by the project, and the preparation, approval, and retention of all required documentation associated with waste generation, management, and disposal. The project manager should assume that wastes generated during an investigation will require compliance with federal requirements for generation, storage, transportation, or disposal. In addition, there may be state regulations that govern the disposal action.

The work plan for a site investigation must include a description of control procedures for contaminated materials. This plan should assess the type of contamination, estimate the amounts that would be produced, describe containment equipment and procedures, and delineate storage or disposal methods. Adequate budget must be allocated for these purposes. As a general policy, it is wise to select investigation methods that minimize the generation of contaminated materials. The handling and the disposing of potentially hazardous materials are expensive; however, the consequences and penalties for improper handling are significant.

2.0 DEFINITIONS

- **Accumulation date** – the date a hazardous waste is first generated, or the date that hazardous waste collected in a satellite accumulation area exceeds: (a) 55 gallons of hazardous waste, or (b) 1 kilogram of acute hazardous waste, or (c) 100 kilograms of any residue or contaminated soil, waste, or other debris resulting from the cleanup of a spill, into or onto any land or water of any acute hazardous waste.
- **Acute hazardous waste** – Environmental Protection Agency (EPA) hazardous waste number designated with an (H) in the "hazard code" column of Title 40, Code of Federal Regulations (40 CFR) 261.31-33.
- **Area of contamination (AOC)** – A certain discrete area of generally dispersed contamination which is considered to be equivalent to a RCRA unit. Because an AOC is equated to a RCRA unit, consolidation or treatment within the AOC does not create a new point of hazardous waste generation for purposes of RCRA.
- **Bill of Lading** - legal document between generator, transporter, and disposal facility stating type, quantity, and description of waste being transported

- **By-product material** – Radioactive material resulting from producing or processing nuclear materials.
- **Code of Federal Regulations (CFR)** – The CFR is a codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the federal government. The CFR is divided into 50 "titles", which represent broad areas subject to federal regulation. Each title is divided into chapters, which usually bear the name of the issuing agency.
- **Commercial Chemical Product** – A chemical substance that is manufactured or formulated for commercial or manufacturing use.
- **Committed dose equivalent** – The predicted dose equivalent to a tissue or organ over a 50-year period after an intake of a radionuclide into the body. It does not include dose contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or sievert).
- **Committed effective dose equivalent (CEDE)** – The sum of the committed dose equivalents to various organs or tissues in the body from radioactive material taken into the body, each multiplied by the tissue-specific weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert).
- **Construction and demolition debris** – Materials generally considered to be not water-soluble and non-hazardous in nature, including, but not limited to, steel, glass, brick, concrete, asphalt roofing materials, pipe, gypsum wallboard, lumber, and other materials discarded during the construction or destruction of a structure or project. Construction and demolition debris also includes rocks, soil, tree remains, trees, and other vegetative matter that normally results from land clearing.
- **Department of Transportation (DOT)** – Federal agency that oversees all national transportation systems and regulates the transport of hazardous materials.
- **Environmental media** – Borehole cuttings and core, soil, rock, sediments, surface water, and groundwater that are displaced during corrective action.
- **Hazardous constituent (hazardous waste constituent)** – (1) a constituent that causes the administrative authority to list the hazardous waste in 40 CFR Part 261, Subpart D, or a constituent listed in Table 1 of 40 CFR Part 261.24; (2) According to the March 1, 2005, Compliance Order of Consent (Consent Order), any constituent identified in Appendix VIII of Part 261.

- **Hazardous waste** – 1) solid waste (as defined in 40 CFR 261.2 and incorporated by 20.3.1.200 NMAC) that is not excluded from regulation as a hazardous waste and is a listed waste (as provided in 40 CFR Part 261, Subpart D) or a waste that exhibits any of the characteristics of hazardous waste (i.e. ignitability, corrosivity, reactivity, or toxicity, as provided in 40 CFR Part 261, Subpart D).
- **High-level waste** – A highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste that contains fission products in sufficient concentrations, and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.
- **Incompatible waste** – A waste that can cause corrosion or decay of containment materials or is unsuitable for comingling with another waste or material because a dangerous reaction might occur. See 40 CFR Part 265, Appendix V for more examples.
- **Industrial waste** – Solid waste generated by manufacturing or industrial processes that is not hazardous waste regulated under Subtitle C of RCRA.
- **Investigative-derived waste (IDW)** – Solid or hazardous waste that was generated as a result of investigation and/or characterization corrective action activities. IDW may include drilling muds, cuttings, and purge water from test put and well installation; purge water, soil, and other materials from collection of samples; residues from testing of treatment technologies and pump and treat systems; contaminated personal protective equipment (PPE), and solutions (aqueous or otherwise) used to decontaminate non-disposable PPE (EPA Office of Solid Waste and Emergency Response, Publication 9345.3-03FS, January 1992).
- **Large Quantity Generator** – A business that generates (or accumulates in Missouri) more than 2,200 lbs (1,000 kg) per month of hazardous waste.
- **Low-level waste** – Radioactive waste that is not classified as high-level waste, spent nuclear fuel, transuranic (TRU) waste, by-product material (as defined in section 11e(c) of the Atomic Energy Act of 1954, as amended), or naturally occurring and accelerator-produced radioactive material.
- **Safety Data Sheet (SDS)** – Chemical manufacturers and importers prepare detailed technical bulletins called Safety Data Sheets about the hazards of each chemical they produce and import. Suppliers must send an SDS at the time of the first shipment of the chemical and any time the SDS is updated with new and significant information about the hazards. SDSs include information about components and contaminants, including exposure limits, physical data, fire and explosion hazards, toxicity, and health hazard

data. It also discusses emergency and first aid procedures and information about storage and disposal and spill or leak procedures.

- **Mixed waste** – Any waste containing both hazardous waste and source, special nuclear, or by-product materials subject to the Atomic Energy Act of 1954.
- **Naturally occurring and accelerator-produced radioactive material –** Radioactive materials that are considered either naturally occurring and are not source, special nuclear, or by-product material or are produced in a charged particle accelerator.
- **Non-radioactive waste** – Waste that meets the ISD 121-1.0, Table 14-2 release criteria for both surface and volume contamination.
- **Polychlorinated biphenyl (PCB)** – Any chemical substance that is limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances which contains such substance.
- **PCB remediation waste** – Waste containing PCBs as a result of a spill, release, or other unauthorized disposal, at the following concentrations:
    - Materials disposed of prior to April 18, 1978, that are currently at concentrations where the original source was greater than or equal to 500 parts per million (ppm) PCBs, regardless of the concentration of the original spill;
    - Materials that are currently at any volume or concentration where the original source was greater than or equal to 500 ppm PCBs beginning on April 18, 1978, or greater than or equal to 50 ppm beginning on July 2, 1979; and,
    - Materials that are currently at any concentration if the PCBs are spilled or released from a source not authorized for use under 40 CFR Part 761.
    - PCB remediation waste means soil, rags, and other debris generated as a result of any PCB spill cleanup, including, but not limited to:
        - Environmental media containing PCBs, such as soil and gravel; dredge materials (e.g., sediments); settled sediment fines; and aqueous decantate from sediment;
        - Sewage sludge containing less than 50 ppm PCBs and that is not a use regulated by 40 CFR Parts 257, 258, and 503;
        - PCB sewage sludge;

    - Commercial or industrial sludge contaminated as the result of a spill of PCBs including sludges located in or removed from any pollution control device or aqueous decantate from an industrial sludge;
    - Building or other man-made structures (such as concrete floors, wood floors, or walls contaminated with a leaking PCB or PCB-contaminated transformer), porous surfaces, and non-porous surfaces.

- **Publicly Owned Treatment Works (POTW)** – A municipal wastewater treatment plant that receives wastewater through the public sewer from households, office buildings, factories, industrial facilities, and other places where people live and work.
- **Radioactive waste** – solid, liquid, or containerized gaseous material that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended, and is of negligible economic value, considering costs of recovery. Radioactive waste has radioactive surface contamination or volume contamination in excess of the ISD 121-1.0 Table 14-2 release criteria.
- **Radiological controlled area (RCA)** – Any area to which access is managed to protect individuals from exposure to radiation or radioactive materials.
- **Recycled** – A material that is used, reused, or reclaimed.
- **Reclaimed** – A material that is processed to recover usable products or is regenerated.
- **Satellite accumulation area** – A designated space for accumulating hazardous and mixed waste where the volume of waste shall not exceed 55 gallons or the volume of acutely hazardous/mixed waste shall not exceed 1 kilogram (40 CFR 262.34).
- **Segregate** – To separate wastes that can be managed together based on similar characteristics and ultimate handling approach (such as radioactively contaminated vs. non-radioactive waste).
- **Site-Specific Health and Safety Plan (SSHASP)** – A health and safety plan that is specific to a site or ER-related field activity that has been approved by an ER health and safety representative. This document contains information specific to the project, including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g. PPE) and hazard mitigation.
- **Solid waste** – Any garbage, refuse, sludge, from a waste treatment plant, water supply treatment plant, or air pollution control facility or other discarded material including

solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities.

- **Spent material** – Any material that has been used and, as a result of contamination, can no longer serve the purpose for which it was produced without first processing it.
- **Small Quantity Generator (SQG)** – A business that generates (or accumulates in Missouri) between 220 and 2,200 lbs (100 and 1,000 kg) per month of hazardous waste.
- **Sludge** – Any solid, semi-solid, or liquid waste generated from a municipal, commercial, or industrial waste-water treatment plant, water supply treatment plant, or air pollution control facility, exclusive of the treated effluent from a wastewater treatment plant.
- **Treatment, Storage, and Disposal Facility (TSDF)** – Refers to a facility that treats, stores, or disposes of hazardous waste; TSDFs have specific requirements under RCRA.
- **Very Small Quantity Generator (VSQG**) – A business that generates (or accumulates in Missouri) 220 lbs (100 kg) or less per month of hazardous waste or 2.2 lbs (1kg) or less of acutely hazardous waste.
- **Volatile Organic Compounds (VOCs)** – VOCs are highly evaporative organic gases that can be produced during the manufacture or use of chemicals such as paints, solvents, and cleaners.
- **Waste generator** – Any person, by site, whose act or process produces hazardous waste or whose act first causes a hazardous waste to become subject to regulation (40 CFR 260.10).

Note: The definition above is specific to hazardous waste because it is defined in the hazardous waste management regulations. In this SOP "any person" means EWI personnel or their sub-contractors.

3.0 SCOPE

Wastes generated by personnel of EWI, and their sub-contractors, include hazardous waste, mixed hazardous waste, industrial waste, and municipal solid waste. Environmental media (e.g. soil, rock, and groundwater) may fall into any of the above regulatory classifications.

Waste management activities are implemented in the field through a site-specific work plan. Documentation and characterization requirements beyond those described in this procedure may exist for treatment, storage, and disposal (TSD) facilities.

The procedures for the different categories of investigation derived waste (IDW) described in this document are to be used by EWI personnel to manage the IDW generated during site investigations. On the occasion that EWI personnel determine that any of the procedures described in this SOP are inappropriate, inadequate, or impractical and that another procedure must be used to manage IDW generated at a particular site, the variant procedure will be documented in the field logbook and final report, along with a description of the circumstances requiring its use.

4.0 PERSONNEL QUALIFICATIONS AND RESPONSIBILITIES

Personnel of EWI, by the requirements of their job descriptions and through ongoing training, are qualified to perform the task required by this procedure.

Project Manager

The Project Manager provides the Field Manager with a site-safety plan (see Appendix A) for waste management and the Equipment Manager with a checklist of equipment needed for the procedure (see Appendix A). The Project Manager oversees the on-site safety of the field crew and completion of the waste management.

Field Manager

The Field Manager works with the Project Manager to schedule the waste management procedure.

Equipment Manager

The Equipment Manager gathers the equipment needed for the waste management procedure and troubleshoots problems with the equipment.

Field Technician

The field technician follows the guidance of the Project Manager in the proper management of waste disposal.

5.0 TYPES OF INVESTIGATION DERIVED WASTE (IDW)

Materials that may become IDW include, but are not limited to:

1. PPE – This includes disposable coveralls, gloves, booties, respirator canisters, splash suits, etc.;
2. Disposable equipment and items – this includes plastic ground and equipment covers, aluminum foil, conduit pipe, composite liquid waste samplers (COLIWASAs), Teflon® tubing, broken or unused sample containers, sample container boxes, tape, etc.;
3. Soil and/or rock cuttings from drilling or hand augering;

4. Drilling mud or water used for mud or water rotary drilling;
5. Trash;
6. Groundwater obtained through well development or well purging;
7. Cleaning fluids such as spent solvents and wash water; and,
8. Packing and shipping materials.

Table 1.0 (see Appendix B) lists the types of IDW commonly generated during field investigations and the current disposal practices for these materials.

For the purpose of determining the ultimate disposition of IDW, it is typically distinguished as being either hazardous or non-hazardous. This determination is based on either clear regulatory guidance or by subsequent analysis. This determination and subsequent management is the responsibility of the Project Manager.

6.0 SOURCES OF CONTAMINATED MATERIALS AND CONTAINMENT METHODS

6.1 Decontamination Solutions

Decontamination solutions and rinses must be assumed to contain the chemicals associated with the site, which could either be hazardous or non-hazardous. The solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment requires cleaning.

6.1.1 Decontamination Solutions containing Hazardous Waste(s)

Small amounts of rinse solutions, such as those generated by the personnel decontamination station (PDS), are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility. As a rule of thumb, use of a temporary PDS will generate 55 to 110 gallons of decontamination solution per day for every five persons using it. If the amounts generated by a PDS exceed one or two 55-gallon drums each day, a larger capacity above ground storage vessel, such as a fiberglass tank or collapsible rubber bladder, should be considered. If individual drums are used, they should be marked with sufficient information so that personnel can determine what contaminants may be present. This information should be based on analytical results from the sampling campaign.

Larger equipment, such as backhoes and tractors, must be decontaminated in an area that has a method of controlling and collecting the spent fluids. A decontamination area for large equipment can consist of a shallow depression lined with plastic which is covered with clean sand or gravel, or the area may be a bermed concrete pad with a floor drain leading to a holding tank. The amounts generated by typical equipment cleaning devices usually exceed 500 gallons per cleaning; efforts should be made to manually remove as much solid waste from the equipment as practical prior to decontamination to help minimize spent fluids,. Spill prevention and containment measures should be implemented for larger fluid containers, or if many drums of fluid are left on-site. Protection from vandals is also needed.

6.2 Disposable Equipment

6.2.1 Disposable Equipment containing Hazardous Waste(s)

Disposable equipment that could be contaminated during a site investigation typically includes tools, rubber gloves, boots, broken sample containers, and chemically resistant clothing. These items are small and can easily be contained in 55-gallon drums with removable lids. Containers should be sealed at the end of each work day and upon project completion. Additionally, containers are labeled in accordance with the applicable Department of Transportation (DOT) regulations on hazardous materials under 49 CFR 172.304. Adequate protection from vandals, theft, and adverse must be provided for all containers.

6.2.2 Disposal Equipment containing Non-Hazardous Waste(s)

EWI personnel should follow procedures outlined in section 6.2.1 for disposing of equipment containing non-hazardous waste, except this waste is not regulated under 49 CFR 172.304.

6.3 Drilling Muds and Well-Development Fluids

Drilling muds and well development fluids are materials used when installing groundwater monitoring wells. Their use could result in the surface accumulation of contaminated liquids and solids that require containment. Monitoring wells are often placed in uncontaminated areas to determine if hazardous chemicals have migrated below ground. Materials from these wells require especially careful management since they threaten contamination of otherwise clean property.

The volume of drilling and well-development fluids requiring containment will depend on the number of wells, diameters and depths, groundwater characteristics, and geologic formations. There are no simple mathematical formulas available for accurately predicting these volumes. It is best to rely on the experience of hydrogeologists and/or reputable well drillers who are familiar with the local conditions and the well installation techniques selected. These individuals should be able to estimate the volume of contaminated fluid to be contained.

Drilling fluid (mud) is mixed and stored in a container commonly referred to as a mud pit. This mud pit consists of a suction section from which drilling fluid is withdrawn and pumped through hoses down the drill pipe to the bit and then back up the hole to the settling section of the mud pit. In the settling section, the fluid velocity is reduced by a screen and by several flow-restriction devices, thereby allowing the well cuttings to settle out of the fluid.

The mud pit may be either a portable aboveground tank, commonly made of steel, or a stationary/pit that is in the ground. The aboveground tanks have a major advantage over pits in the ground because the tanks isolate the contaminated fluids from the surface environment. The tanks are also portable and can usually be cleaned easily.

As the well is drilled, the sediments that accumulate in the settling section must be removed. Removal is best done by shoveling sediments into drums or other similar containers. When the drilling is complete, the contents of the above ground tank are likewise shoveled or pumped into drums, and the tank is cleaned and made available for reuse.

If in-ground pits are used, they shall not extend into the natural water table. They shall also be lined with a bentonite-cement mixture followed by a layer of flexible impermeable material such as plastic sheeting. To maintain its impermeable seal, the material used must be nonreactive with the contaminants. An advantage of the in-ground pit is that well cuttings do not necessarily have to be removed periodically during drilling because the pit can be made deep enough to contain them. Depending on site conditions, the in-ground pit may have to be totally re-excavated and refilled with uncontaminated natural soils when the drilling operation is complete.

When the aboveground tank or the in-ground pit is used, a reserve tank or pit should be located at the site as a backup for leaks, spills, and overflows. In either case, drainage shall be such that any excess fluid can be controlled within the immediate area of the drill site. In-ground pits must also be barricaded and lighted to prevent accidents.

The containment procedure for well-development fluids is similar to that for drilling fluids. The volume and weight of contaminated fluid will be determined by the method of development. When a new well is bailed to produce clear water, substantially less volume and weight of fluid will result, than when backwashing or pumping is used; well development methodology should be selected based on site-specific conditions (see EWI SOP #7).

6.4 Spill-contaminated Materials

A spill is always possible when a site investigation involves opening and moving containers of liquids. Contaminated sorbents and soils resulting from spills will have to be contained and cleaned up. Small quantities of spill-contaminated materials are usually best contained in drums while larger quantities can be placed in rolloff boxes or other impermeable structures. In some cases, onsite containment may not be feasible and immediate transport to an approved disposal site will be required.

7.0 MANAGEMENT OF NON-HAZARDOUS IDW

Disposal of non-hazardous IDW should be addressed during a pre-work briefing between the Project Manager and field personnel.

If the waste is from an active facility, permission should be sought from the operator of the facility to place the non-hazardous PPE, disposable equipment, and/or paper/cardboard into the facilities' dumpsters.. These materials may also be taken to a nearby permitted landfill. On larger projects, a covered rolloff box may be stationed at the site during the field activities.

Non-hazardous IDW such as drill cuttings, purge or development water, decontamination wash water, drilling mud, etc., should be placed into a unit with an environmental permit, such as a landfill or sanitary sewer. These materials must not be placed into dumpsters.

The minimum requirements for this subsection are:

- Under no circumstances should monitoring well purge water be placed back into the well from which it came. The water should be disposed of accordingly.
- Soap and water decontamination fluids and rinsates of such cannot be placed in any water bodies and must be collected for proper disposal.
- The collection, handling, and proposed disposal method must be specified in the work plan or scope of work. Soil or water samples will likely be warranted to characterize the waste for profiling & disposal. These samples should be collected while onsite; it is the Project Manager and Field Manager's responsibility to know what analysis is warranted based on the disposal facility and type of contaminants. IDW containers left onsite while awaiting analytical results should be labeled with "Contents Under Test" decal in addition to any other required placarding.
- Efforts should be made to work with the disposal facility and lab to obtain the waste profile and approval to haul as expeditiously as possible to minimize the amount of time IDW must remain onsite.

7.1 Bill of Lading

A bill of lading (available in Appendix A) must accompany each shipment of waste for disposal, recycling, or reuse. EWI will fill out Generator, Origin, Transporter, and Destination. Each section must be signed by the respective representative.

Information also included on a bill of lading is type, quantity, and description of the waste. Type is for the type of container used: poly drum, steel drum, tote bag, etc. Quantity is numerical.

Because this is used for nonhazardous waste, EPA waste codes are not applicable in the description. Description should contain enough information to adequately describe the waste.

8.0 MANAGEMENT OF HAZARDOUS IDW

8.1 Defining Hazardous Waste(s)

A waste is any solid, liquid, or contained gaseous material that is discarded by being disposed of, burned or incinerated, or recycled (there are some exceptions for recycled materials). It can be the by-product of a manufacturing process or simply a commercial product that is used in a business (e.g. cleaning fluid or battery acid).

Hazardous waste can be one of two types:

1. Listed waste. Waste is considered hazardous if it appears on one of four lists published in the Code of Federal Regulations (40 CFR Part 261). Currently, more than 500 wastes are listed. Wastes are listed as hazardous because they are known to be harmful to human health and the environment when not managed properly. Even when managed properly, some listed wastes are so dangerous that they are called acutely hazardous wastes. Examples of acutely hazardous wastes include wastes generated from pesticides and that can be fatal to humans even in low doses.
2. Characteristic waste. If the waste does not appear on one of the hazardous waste lists, it still might be considered hazardous if it demonstrates one or more of the following characteristics:
    - It catches fire under certain conditions. This is known as ignitable waste. Testing for this is done by using an open cup test. The open cup test records the flash point of a material. If the flash point is less than 140°F, it is considered ignitable. Examples are paints and certain degreasers and solvents.
    - It corrodes metals at a rate of 5 mm per year or more or has a very high or low pH; 2.0 and below or 12.5 and above. This is known as a corrosive waste. Examples are rust removers, acid or alkaline cleaning fluids, and battery acid.
    - It is unstable and explodes or produces toxic fumes, gases, and vapors when mixed with water or under other conditions such as heat or pressure. This is known as a reactive waste. There are no specific tests recommended by EPA to determine reactivity; therefore, generator knowledge must be used. Examples are certain cyanides or sulfide-bearing wastes.
    - It is harmful or fatal when ingested or absorbed, or it leaches toxic chemicals into the soil or groundwater when disposed of on land. This is known as a toxic

waste. Toxicity Characteristic Leaching Procedure (TCLP) is a laboratory test used to determine toxicity. Examples are wastes that contain high concentrations of heavy metals, such as cadmium, lead, or mercury.

8.2 Accumulating Waste On-Site

Accumulating hazardous waste on-site can pose a threat to human health and the environment, so it can only remain for a short time without a permit. Sites that are small quantity generators (SQGs) can accumulate no more than 13,228 lbs (6,000 kg) of hazardous waste on-site for up to 180 days without a permit. The amount of time can increase to 270 days if the generator must transport it more than 200 miles away for recovery, treatment, or disposal.

On-site hazardous waste must be accumulated in storage tanks and containers and managed according to EPA requirements summarized below:

1. Label each container appropriately (see the hazardous waste EWI specialist to obtain proper labeling information);
2. Use a container made of, or lined with, a material that is compatible with the hazardous waste to be stored;
3. Keep all containers holding hazardous waste closed during storage, except when adding or removing waste. Do not open, handle, or store (e.g. stack) containers in a way that might rupture them, cause them to leak, or otherwise fail; and,
4. Do not mix incompatible wastes or materials, including mixing non-hazardous waste with hazardous waste.

8.3 Shipping Waste Off-Site

All hazardous waste has to be sent to a regulated Treatment, Storage, and Disposal Facility (TSDF) or recycler. Most regulated TSDFs and recyclers will have a permit fro the state or EPA. Some, however, may operate under other regulations that do not require a permit. Check with the appropriate state authorities to be sure the facility you select has any necessary permits. All TSDFs and recyclers must have EPA identification numbers.

Project Manager's must ensure that waste is properly packaged, labeled, marked hazrdous, and shipped in a vehicle placard for hazardous waste following Department of Transportation (DOT) regulations. For additional information, consult the DOT regulations (49 CFR Parts 172 and 173) or call the DOT hazardous materials information line at 202-366-4488 or 1-800-467-4922.

8.4 Preparing Hazardous Waste Manifests

The Hazardous Waste Manifest System is a set of forms, reports, and procedures designed to seamlessly track hazardous waste from the time it leaves the generator until it reaches the off-site waste management facility that will store, treat, or dispose of the hazardous waste. The system allows the waste generator to verify that its waste has been properly delivered and that no waste has been lost or unaccounted for in the process.

The key component of this system is the Uniform Hazardous Waste Manifest, which is a multipart form prepared by most generators that transport hazardous waste for off-site treatment, recycling, storage, or disposal. The manifest is required by both the DOT and EPA. When completed, it contains information on the type and quantity of the waste being transported, instructions for handling the waste, and signatures of all parties involved in the off-site treatments, recycling, storage, or disposal process. Each party also must retain a copy of the manifest. This process ensures critical accountability in the transportation and disposal process. Once the waste reaches its destination, the receiving facility returns a signed copy of the manifest to the generator, confirming that the waste has been received. An example of a hazardous waste manifest is included as Appendix C. All hazardous waste shipments must be accompanied by a hazardous waste manifest.

9.0 SAFETY

Acute or chronic exposure to petroleum-contaminated soil could result in bodily injury. Routes of exposure include inhalation, ingestion, and dermal contact. Consult the appropriate chemical safety data sheet (SDS) before the initiation of soil sampling if an active facility, or process knowledge of the Project Manager for non-active sites (example, petroleum constituents at a former gas station).

Conduct an on-site safety meeting each day before the start of the project. Review safety hazards (e.g. high-traffic areas, exposure to chemicals, alertness to heavy equipment). Have all personnel sign the Site Safety Meeting log (see Appendix A) each day before the start of the project. Take appropriate action if personnel are injured on-site.

When working with potentially hazardous substances, follow the United States Environmental Protection Agency (US EPA), Occupational Safety and Health Administration (OSHA), or EWI Corporate Health and Safety Plan.

10.0 REFERENCES

- "Corporate Health and Safety Plan" Environmental Works, Incorporated.
- "Memorandum: Clarification Regarding Use of SW-846 Methods" http://clu-in.org/goto.cfm?link=%2Fproducts%2Fregs%2Fsw846.htm

- SW-846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods." https://www.epa.gov/hw-sw846
- SW-846 "Test Method 1311: Toxicity Characteristic Leaching Procedure" https://www.epa.gov/hw-sw846/sw-846-test-method-1311-toxicity-characteristic-leaching-procedure

11.0 VERSION HISTORY

This document is subject to periodic review and updates as technologies, methodologies, and industry-standard practices change. The table below summarizes updates to this SOP.

Version Number	Date	Changes Made	Edited By
1.0	8/1/08	Original Version	April Brennan
1.1	8/17/21	SDS Information, waste characterization sampling, Bill of Lading, VSQG, Updates to references	Kay Kincannon

APPENDIX A

Forms

PROJECT ASSIGNMENT FORM

Project Name: ____________________ # __________
Personnel: ____________________ Completion Date: __________
Purpose: ____________________

Scope of Work	Supplies & Equipment
Site: ____________________	

Question & Info. Contact= ____________________

Return this form with the progress logs

ENVIRONMENTAL WORKS

BILL OF LADING – SHORT FORM – NOT NEGOTIABLE

Date ________________

LADING/PROJECT NUMBER:__________________________ Page ____ of ____

GENERATOR:	**ORIGIN:**
Signature:	Signature:
TRANSPORTER:	**DESTINATION:**
Signature:	Signature:

CARRIER INFORMATION

Type	Quantity	Lading Description

MISSOURI DEPARTMENT OF NATURAL RESOURCES
SOLID WASTE MANAGEMENT PROGRAM

SPECIAL WASTE DISPOSAL REQUEST

Reset Form

SECTION I GENERAL INFORMATION (TO BE COMPLETED BY THE GENERATOR AND LANDFILL OPERATOR)

DISPOSAL FACILITY	WASTE GENERATOR
NAME City of Springfield Noble Hill Sanitary Landfill	NAME
ADDRESS 3545 West FR 34	ADDRESS
CITY, STATE, ZIP CODE Willard, MO 65781	CITY, STATE, ZIP CODE
TELEPHONE NUMBER (417) 864-2031 or (417) 742-9843 FAX NUMBER (417) 864-1906	TELEPHONE NUMBER FAX NUMBER
PERMIT NO. 107704	N/A
CONTACT PERSON Austin Evans or Sonny Decker	CONTACT PERSON CONTACT FAX/EMAIL

SECTION II WASTE CHARACTERIZATION (TO BE COMPLETED BY THE GENERATOR)

A. NAME OF WASTE

B. DESCRIPTION OF GENERATION PROCESS

C. (CHECK ONE)

(1.) ☐ SOLID (2.) ☐ SLUDGE (20% OR GREATER SOLIDS) ☐ (3.) SLURRY (20% OR LESS SOLIDS)

(4.) ☐ LIQUID (5% OR LESS SOLIDS) (5.) ☐ OTHER - SPECIFY ______

(INDICATE) % SOLIDS BY WEIGHT______;

SPECIFIC GRAVITY______; PUMPABLE: ☐ YES ☒ NO; ODOR: ☒ YES ☐ NO; FREE FLUID: ☐ YES ☒ NO;

pH______; FLASHPOINT ______

D. WAS THE WASTE EVER CLASSIFIED OR LISTED HAZARDOUS? ☐ YES ☐ NO IF YES, SPECIFY THE EPA WASTE NUMBER ______

E. LIST BELOW THE CHEMICAL COMPOSITION (ATTACH ANY ADDITIONAL ANALYSIS)

MAJOR COMPONENTS	% BY WEIGHT
1.	
2.	
3.	
4.	

F. SOURCE OF CHEMICAL DATA

SECTION III GENERATION RATE/DISPOSAL FREQUENCY* (TO BE COMPLETED BY GENERATOR)

A. AVERAGE GENERATION RATE (CUBIC YARDS PER WEEK, POUNDS PER MONTH, ETC.) ______

B. DISPOSAL REQUEST [COMPLETE (1) OR (2)]:

(1) ☐ Continual (or intermittent)

If disposal is to be made on a continual or intermittent basis, indicate the **quantity** and **frequency** of disposal______(cubic yards per week, pounds per month, etc.)

Indicate the quantity available for immediate disposal, if applicable ______

(2) ☐ One-time only

If one-time only, indicate the total amount to be disposed of ______

***NOTE ➓** INDICATE APPROPRIATE UNITS (TONS, GALLONS, POUNDS, CUBIC YARDS, ETC.)

SECTION IV TRANSPORTATION (TO BE COMPLETED BY GENERATOR OR LANDFILL OPERATOR)

A. CONTAINERS USED FOR TRANSPORTATION (CHECK ONE)

(1) ☐ BULK (______CU. YD.); (2) ☐ METAL DRUMS (______GAL.); (3) ☐ CASES, CARTONS (SIZE______);

(4) ☐ FIBER DRUMS (______GALS.); (5) OTHER - SPECIFY ______

B. TYPE OF VEHICLE

(1) ☐ TRACTOR-TRAILER; (2) ☐ ROLL-OFF/LUGGER; (3) ☐ DUMP TRUCK; (4) ☐ (OTHER) ______

SECTION V DISPOSAL TECHNIQUES (TO BE COMPLETED BY THE LANDFILL OPERATOR)

A. ☐ SEPARATE TRENCH BURIAL

(1) LOCATION ON LANDFILL SITE ____________________

(2) TRENCH DESIGN PREVIOUSLY APPROVED BY DNR? ☐ YES ☐ NO IF NOT, ATTACH REQUEST FOR APPROVAL

B. ■ CO-DISPOSAL WITH MUNICIPAL WASTE ON ACTIVE FILL FACE

1. AVERAGE DAILY QUANTITY OF MUNICIPAL SOLID WASTE 950 TPD (SPECIFY TONS OR CUBIC YARDS)

2. SPECIAL WASTE TO BE UNLOADED AT: ☐ TOE OF WORKING FACE

☑ TOP OF WORKING FACE

C. ☐ OTHER DISPOSAL PROCEDURES - SPECIFY ____________________

SECTION VI HANDLING PROCEDURES (TO BE COMPLETED BY GENERATOR)

Safety precautions during handling: Provide handling information supplied by product manufacturer, waste generator, or from other sources, describing the necessary measures that should be taken to protect personal safety, to control dusting, or to ensure fixed placement of waste. This should include a description of materials not compatible with this waste.

ATTN: Note that any drums or barrels must have the lids removed during disposal.

SECTION VII CERTIFICATION (TO BE COMPLETED BY GENERATOR AND LANDFILL OPERATOR)

I, the undersigned, submit this request to dispose of the named waste and certify that the information supplied by me herein is correct. I understand approval to dispose of the waste may be suspended if false information has been submitted or if the disposal operation is not performed in a proper and legal manner.

SIGNATURE OF LANDFILL OPERATOR OR AUTHORIZED REPRESENTATIVE	
PRINT NAME/TITLE	DATE

I, the undersigned, submit this request to dispose of the named waste and certify that the waste named herein, to the best of my knowledge, is not a hazardous waste as defined by the Missouri Waste Management Law and rules, and that the information supplied by me is correct.

SIGNATURE OF WASTE GENERATOR OR AUTHORIZED REPRESENTATIVE	
PRINT NAME/TITLE	DATE

ADDITIONAL COMMENTS

REQUEST EXPIRES:

PAYMENT INFORMATION (to be filled out by generator):

Company name to be billed: ____________________

Landfill Voucher Account # (if known, it's a 4 digit #, can call Diana Young to find out at (417) 864-1905): ____________________

INSTRUCTIONS FOR COMPLETION OF THE SPECIAL WASTE DISPOSAL FORM

As a **generator**, you should complete all or part of sections I, II, III, IV, VI, and VII.

As a **landfill operator**, you should complete all or part of sections I, IV, V and VII.

The following instructions correspond with the numbering system on the disposal form:

I. GENERAL INFORMATION

This may be completed by the generator or the landfill operator. Please be certain to include the disposal-area permit number and the person we could contact if questions should arise.

II. WASTE CHARACTERIZATION (To be completed by the generator)

A. Provide the name of the waste, i.e., fly ash, paint sludge, etc.

B. Describe the process or activity that produced the waste.

C. Indicate the physical state of the waste by checking one of the numbered blanks 1 through 5. Also include the pH, the percentage of solids by weight and other information as requested.

D. Indicate whether this waste was **ever** classified or listed as hazardous. If so, and your firm was the generator, give the previous EPA waste identification number for the waste (D001, D002, etc.).

E. List the components of the waste and their percentage of the total weight of the waste. If a lab report or analysis is available, attach a copy to the form.

F. Indicate the source of the data listed in this section, such as your firm’s lab, an independent laboratory, or manufacturer’s specifications.

III. GENERATION RATE/DISPOSAL FREQUENCY (To be completed by the generator)

A. Indicate the average **generation** rate for the waste.

B. Indicate if the request is for a **one-time** disposal or for **continuous** disposal, by completing (1) or (2).

(1) Indicate the quantity of waste and the frequency with which it will be taken to the landfill for disposal. In addition, indicate the amount of any waste which has been stored and will immediately be taken to the landfill for disposal.

OR

(2) Indicate the total amount of waste for a one-time disposal.

IV. TRANSPORTATION (To be completed by transporter or landfill operator)

A. Check one of the five options to indicate the type of containers to be used in transporting the waste to the disposal site. Also indicate the size of an individual container of that type.

B. Check one of the four options to indicate the mode of transportation to be used for the waste.

V. DISPOSAL TECHNIQUES (To be completed by the landfill operator)

A. If the waste is to be buried in a trench separate from the other wastes, indicate that by checking this blank.

1. Describe where the separate disposal area is located on the landfill.

2. Indicate whether the separate trench design has been approved by DNR, either during the original permit approval or by later amendments to your operating procedure.

B. If the waste is to be combined with municipal wastes and deposited on the active working face, indicate by checking this blank.

1. Also show the average daily quantity of municipal solid waste received at the disposal facility.

2. Indicate whether the waste is to be deposited at the top or the toe of the working face.

C. If neither trench burial nor co-disposal is to be used, describe the proposed alternative disposal method.

VI. HANDLING PROCEDURES (To be completed by the generator)

Describe the precautions necessary to safely handle the waste. Also list other materials that should be isolated from the waste.

VII. CERTIFICATION (To be completed by generator and landfill operator)

Read the certification statement carefully, then sign and date the form. Print or type your name below your signature.

We encourage you to make any suggestions or comments you may wish in the space provided or by attaching additional sheets.

APPENDIX B

Table 1.0

TABLE 1.0
DISPOSAL OF INVESTIGATION DERIVED WASTE

TYPE	HAZARDOUS	NON-HAZARDOUS
PPE-Disposable	Containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of the site operator.	Place waste in trash bag. Place in dumpster with permission of the site operator, otherwise return to the office for disopsal in the dumpster.
PPE-Reusable	Deconmtaminate as per EWI SOP #3, if possible. If the equipment cannot be decontaminated, containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with the permission of the site operator.	Decontaminate as per EWI SOP #3.
Spent Solvents	Containerize in original containers. Clearly identify contents. Leave on-site with permision of the site operator and arrange for proper disposal.	N/A
Soil Cuttings	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of the site operator, otherwise arrange with the Project Manager for testing and disposal.	Containerize in a 55-gallon steel drum with tight-fitting lid. Identify and leave on-site with permission of the site operator, otherwise arrange with the Project Manager for testing and disposal.
Groundwater	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of the site operator, otherwise arrange with the Project Manager for testing and disposal.	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of the site operator, otherwise arrange with the Project Manager for testing and disposal.
Decontamination Water	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of the site operator, otherwise arrange with the Project Manager for testing and disposal.	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of the site operator, otherwise arrange with the Project Manager for testing and disposal.
Disposal Equipment	Containerize in DOT-approved container or 5-gallon plastic bucket with tight-fitting lid. Identify and leave on-site with permission of the site operator, otherwise arrange with the Project Manager for testing and disposal.	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of the site operator, otherwise arrange with the Project Manager for testing and disposal.
Trash	N/A	Place waste in trash bag. Place in dumpster with permission of the site operator, otherwise return to the office for disopsal in the dumpster.

APPENDIX C

Hazardous Waste Manifest

Please print or type. Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST	1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	**4. Manifest Tracking Number** 022111952 **JJK**

GENERATOR

5. Generator's Name and Mailing Address
Generator's Site Address (if different than mailing address)
Generator's Phone:

6. Transporter 1 Company Name
U.S. EPA ID Number

7. Transporter 2 Company Name
U.S. EPA ID Number

8. Designated Facility Name and Site Address
U.S. EPA ID Number
Facility's Phone:

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers		11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes		
		No.	Type					
	1.							
	2.							
	3.							
	4.							

14. Special Handling Instructions and Additional Information

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name | Signature | Month | Day | Year

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name | Signature | Month | Day | Year
Transporter 2 Printed/Typed Name | Signature | Month | Day | Year

DESIGNATED FACILITY

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:

18b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:

18c. Signature of Alternate Facility (or Generator) | Month | Day | Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)

1.	2.	3.	4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name | Signature | Month | Day | Year

DESIGNATED FACILITY TO EPA's e-MANIFEST SYSTEM

Appendix D

ITRC 2020 Incremental Sampling Methodology Guidance, Section 4.6: Sample Handling and Mass Reduction

from: https://ism-2.itrcweb.org/regulatory-context-field-implementation-sample-collection-and-preparation/#4_6

4.6 Sample Handling and Mass Reduction

It is recommended that all ISM sample processing be performed in a controlled laboratory setting to minimize sampling errors

ISM sample processing techniques, such as milling and representative subsampling, are designed to ensure the (typically small) mass of sample analyzed by the laboratory is representative of the DU or SU from which it was collected. These techniques reduce data variability as compared with conventional sample handling and processing approaches, but they also introduce some amount of sampling error. It is recommended that all ISM sample processing be performed in a controlled laboratory setting to minimize these sampling errors; discussion of detailed ISM sample processing is reserved for Section 5. However, there are certain projects that may warrant field sampling processing step(s).

When dealing with contaminants that have been deposited as solid particulates (such as energetics, metals at firing ranges, and so on), field subsampling is not recommended. Studies on energetics have shown that representative subsampling prior to grinding is problematic and likely not possible (Hewitt et al. 2009). However, depending on site logistics, type of soil, total number and/or mass of ISM samples, and so on, sample processing can be initiated in the field for some contaminants (SVOCs, pesticides, PCBs, and metals) with appropriate cautions as noted below. Limitations of the field processing of ISM samples include the following:

- Field processing is not recommended for contaminants deposited as solid particulates (energetics, metals at firing ranges, and so on) because subsampling solid particulates without properly grinding the sample mass may lead to samples that are not representative of site conditions.
- There is a lack of commercially available and correct subsampling tools (16-mm flat-bottom scoop with sides) for proper field processing procedures.
- Sample processing requires a controlled environment to air-dry, sieve, and subsample, if necessary, to minimize the potential loss or introduction of contaminants of concern (COCs) during sample processing.
- Additional subsampling replicates are needed to be collected and analyzed in a laboratory setting to evaluate analytical precision. This requires more knowledgeable and trained personnel.
- Moist samples may need to be air-dried to facilitate sieving in an appropriate dust-free location where temperatures and ultraviolet (UV) light are controlled. This requires an indoor location or job trailer.

Samples with little vegetation and composed mostly of sands and silts that naturally have a very low moisture content and soils that have been air-dried can be sieved in the field to remove pebbles and vegetative debris. Prior to air-drying, sieving, or both, the field-moist sample weight should be recorded. Additionally, field sieving is an option that allows the user to calculate the mass of a bulk ISM sample that will go to a laboratory to ensure that the adequate volume is submitted. It also allows the sampler to control the particle size of the sample to meet DQO requirements. Unless field subsampling will be performed, the entire sieved ISM sample fraction should be submitted to the laboratory for appropriate processing and subsampling.

If ISM processing and/or subsampling is performed in the field, subsampling replicates are recommended to evaluate precision.

Finally, if ISM sample processing and subsampling is performed in the field, it is recommended that at a minimum three replicate subsamples be collected and submitted to the laboratory for analysis. The subsampling process (as described above) is repeated on oneISM sample to form replicates, and the replicate results are then used to evaluate the precision of the field processing and subsampling. Note that the subsampling replicates should be collected in addition tothe ISM field replicates described in Section 5.3.5.

Mass reduction is another form of sampling handling that is important to ensure that manageable sample volumes are collected and submitted to a laboratory. Simply dividing an ISM sample (sieved or not) into separate volumes and placing each volume into separate sample containers or selecting a targeted sample volume from a larger ISM sample for analysis is not an acceptable method of mass reduction. Likewise, manually mixing samples to “homogenize” them in the field or laboratory may just serve to further segregate different particle sizes as the particles may settle in layers by weight or size during mixing. It is imperative that an entire ISM sample volume (the total increment) be submitted for ISM processing/laboratory analysis. The ability to submit appropriate sample sizes is controlled through proper sample design and the sample mass reduction techniques further described in the following subsections.

4.6.1 Sample handling and mass reduction for non-volatile analysis

Ideally an entire soil core would be submitted to the laboratory for processing, however due to storage limitations of the laboratories this is not practical. To resolve this issue the following techniques can be implemented during sample collection in the field so representative samples can be provided to the laboratory for analysis.

4.6.1.1 Wedge sampling

Subsurface ISM increment collection techniques in recommended order are as follows:
Collect entire core interval
Core wedge subsample
Core Plug subsample
Core slice subsample

One option for collecting a representative subsample from a subsurface core increment for non-volatile contaminants is to collect a core wedge sample. The simplest approach is to split the core in half vertically along the axis, reducing the increment mass by half. Alternatively, a smaller wedge of soil (say, one-third of the core) can be taken from the entire length of the targeted depth interval. Removing a wedge of soil across the length of a larger core to encompass the entire depth interval rather than collecting the entire core depth interval as a whole reduces the mass of an individual increment of an ISM sample (see Figure 4-3) while still representing the entire depth. Individual wedges from 30 or more separate DU cores are then combined to form the complete subsurface ISM sample. ISM field replicates require completely separate incremental (that is, core) locations and collection of replicates using multiple wedges from the same core cannot be used as a measure of DU or overall sampling and analysis variability. ISM field replicates are discussed in Section 3.1.5.5. Core wedge replicates (i.e., wedge replicates from the same core) may also be collected when COPCs require separate laboratory processing procedures (see Section 3.1.5.3 and Section 5.2).

Figure 4-3. Examples of wedge sampling.
Source: ITRC ISM Update Team, 2020.

Replicates can be collected from the same core, combined with other wedge increments, and submitted as separate ISM samples to assess the precision of this subsampling strategy. This process reduces the total number of borings required to collect replicates (30 borings compared to 90 for replicates). However, core wedge replicates are not the same as ISM field replicates because ISM field replicates require completely separate incremental (that is, core) locations. Thus, core wedges should not be used as a measure of DU or overall sampling and analysis variability. Core wedge replicates evaluate only the variability in the subsampling process as opposed to collecting the entire core interval as the increment. ISM field replicates, on the other hand, provide information on spatial variability and the variance in the estimate of the mean without specifically separating out the contribution of field and/or laboratory sample processing/subsampling from other sources of variance. ISM field replicates are discussed in Section 3.1.5.5. Core wedge replicates may also be collected when COPCs require separate laboratory processing procedures (see Section 3.1.5.3 and Section 5.2).

4.6.1.2 Plug subsampling

Figure 4-4. Examples of plug sampling.
Source: ITRC ISM-1 Team, 2012.

One option that is less preferred than wedge sampling but more practical in certain soil types is a plug sampler (Figure 4-4). Using this method, a designated number of plugs is collected from the desired increment length, from 30 or more separate cores, and then combined to form the complete subsurface ISM sample. This method is considered inferior to wedge sampling because unlike wedge sampling, where the entire length of the core is represented in the increment, only the randomly selected plug locations represent the increment – other portions of the interval are excluded. However, as some soil types prohibit cutting the soil wedge, the plug approach is increasingly practical.

Replicates can be collected from the same core, combined with other plugs, and submitted as separate ISM samples to assess the precision of this subsampling strategy. Similarly to wedge sampling, this process reduces the number of borings (30 borings compared to 90 for separate replicates), but it does not assess the overall DU variability.

4.6.1.3 Core slice

The least preferred option for subsampling individual subsurface cores for non-volatile contaminants is to collect a core slice from the targeted DU layer (Figure 4-5). In this approach, a randomly selected perpendicular slice from within the larger targeted depth interval is collected as the ISM increment. For example, if the targeted depth interval was 2 ft in length (8 to 10 ft bgs), a 4-in perpendicular slice would be randomly selected from within the targeted depth interval of each individual core and collected as the ISM increment. Individual, randomly selected core slices from 30 or more separate cores would then be combined to form the complete subsurface ISM sample. This option introduces more bias than the whole core increment or core wedge approaches, but by reducing the increment mass, it addresses some of the logistical issues associated with handling the full core or the wedge increments. That said, this is the least recommended approach for subsurface ISM core sampling because it is the least likely to accurately represent the complete vertical length of the targeted DU layer.

Replicates can again be collected from the same core by selecting another slice of the same thickness, thereby reducing the total overall number of borings needed to collect replicates. It is important to prepare a sorting scheme for these increments so as not to bias one replicate as shallower/deeper than another. Similar to core wedge replicates, core slice replicates are not the same as ISM field replicates because ISM field replicates require completely separate incremental (that is, core) locations. Thus, core slice replicates should not be used as a measure of DU or overall sampling and analysis variability.

Figure 4-5. Examples of core slice sample.
Source: Illinois EPA LUST FAQ and BIOTREE websites.

4.6.2 Sample handling and mass reduction for volatile analysis

The core wedge and slice approaches are not appropriate when VOCs are of concern since they can be quickly lost from an exposed surface (Hewitt, Jenkins, and Grant 1995). For VOCs, multiple plugs representative of the desired core depth are collected and immediately preserved in methanol (see Section 4.3.5).

When sampling for VOCs, the core may be subsampled by collecting numerous, small (say, 5-g) plugs at regularly spaced intervals along the targeted DU depth interval of the subsurface core. As with VOC sampling of any exposed soil, the plugs are immediately placed in a sampling bottle containing a predetermined volume of methanol. Nominal 5-g plugs of soil can be collected across the core using a VOC coring device (see Figure 5-10). The spacing interval of the VOC plugs along the core interval should be determined during the SPP but may require adjustment in the field based on core recovery in the case of subsurface ISM sampling. The syringe (or other coring device) used to collect the increments should be filled completely so that each increment has the same volume of soil. Additionally, the ISM sampler should be aware of potential volatile loss once the core is opened. As with any VOC soil sample, ISM VOC increments should be collected and preserved as quickly as possible to minimize potential loss. Potential loss of COPCs due to volatilization during collection of ISM increments is expected to be similar to discrete sample collection by USEPA SW-846 Method 5035A for the same sample density across a subsurface core (USEPA 2007).

Note that an unpublished study from Hawaii using a large bottle with methanol-preserved VOCs was stored in the sun and repeatedly opened over the course of the day to simulate increment additions, and VOC recovery was better than 80% for all analytes except dichlorodifluoromethane.

4.6.3 Sample storage

The primary concern for sample storage is acknowledging larger sample volumes, which will require more storage space and additional coolers.

Processed, labeled samples ready for packaging and shipment to the laboratory are typically stored in a cooler on ice, which for the larger ISM volumes means greater quantities of wet ice and more coolers. For bulk samples stored prior to mass reduction, larger ice receptacles may be constructed by using storage bins for regularly shaped containers (buckets) or form-boards and plastic sheeting for long or irregularly shaped bulk samples.

4.6.4 Sample shipping

The primary consideration for shipping ISM samples is the weight of large volumes (larger than traditional discrete samples) and the required storage and shipment temperatures. The increased weight should be considered when estimating shipping costs (see Section 3.4).

When sampling for volatiles by ISM, the shipment of large volumes of solvent to and from the sampling activity can be problematic. When possible, methanol should be transported to the field via a surface transport to avoid or mitigate the volume limitations common in air transport. Guidelines for the transportation of a solvent such as methanol can be found in 49 CFR §172, “Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans” (DOT 2011). Shipments via air transport may also be required to adhere to International Air Transport Association Dangerous Goods Regulations (IATA 2011).

4.6.5 Sample chain of custody

Typical laboratory chains of custody are not set up to indicate ISM processing and the specific steps requested for a specific project. It is thus important to communicate project-specific requirements to the laboratory and devise a means for requesting ISM processing (and the appropriate steps) in the chain of custody to ensure that the requirements are clearly communicated to the laboratory. Additionally, there are instances where multiple laboratories may be performing different analyses from the same ISM sample, but the ISM sample should not be split between two or more laboratories for separate ISM processing. Because the ISM sample can only be processed by one of multiple laboratories, one laboratory must be selected to perform the processing, and the means of transferring aliquots for analytical analysis to any other laboratory must be coordinated. It is important to ensure that this additional step in the chain of custody is documented. Sample holding times should also be considered in the logistics during field planning. Certain hold times can run short in considering the date of collection, the time to deliver samples to the lab, processing time (especially for wet samples that require extended dry time), transfer to a second laboratory, and laboratory extraction.

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[1] Methanol preservation is discussed herein as the most common VOC preservative for soil, but there are other volatile preservatives that can be similarly utilized to preserve specific compounds. The methodology and considerations presented would remain the same.