Remedial Action Work Plan

MCA Barracks Site Area (HAA-15)

Hunter Army Airfield, Georgia

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Version: Final

Prepared for

U.S. Army Environmental Command
2450 Connell Road, Building 2264
Fort Sam Houston, Texas 78234-7664
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And

Hunter Army Airfield
Directorate of Public Works
1550 Veterans Parkway Building 1137
USAG Fort Stewart, Georgia 31314

Prepared by

KEMRON Environmental Services, Inc.
1359A Ellsworth Industrial Blvd.
Atlanta, GA 30318
404-636-0928

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Acronyms

Acronym	Definition
µg/L	Micrograms per Liter
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
COC	Contaminant of Concern
CVOC	Chlorinated Volatile Organic Compound
DCE	Dichloroethene
DI	Deionized
DO	Dissolved Oxygen
DoD	Department of Defense
DPT	Direct Push Technology
DPW	Department of Public Works
ELAP	Environmental Laboratory Accreditation Program
ERD	Enhanced Reductive Dechlorination
EVO	Emulsified Vegetable Oil
ft	Foot or Feet
FYR	Five Year Review
GA EPD	Georgia Environmental Protection Division
GEOS	Georgia EPD Online System
HAA	Hunter Army Airfield
IDW	Investigation Derived Waste
IRZ	In-situ Reduction Zone
IWTP	Industrial Wastewater Treatment Plant
KEMRON	KEMRON Environmental Services, Inc.
LUC	Land Use Controls
LUCIP	LUC Implementation Plan
LSASD	Laboratory Services and Applied Science Division
MCA	Military Construction Army
MCL	Maximum Contaminant Level
MIP	Membrane Interface Probe
MNA	Monitored Natural Attenuation
MS/MSD	Matrix Spike/ Matrix Spike Duplicate
O.C.G.A.	Official Code of Georgia Annotated
ORP	Oxidation/Reduction Potential
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	Polyaromatic Hydrocarbon
PCB	Polychlorinated biphenyls
PCE	Perchloroethene
PPE	Personal Protective Equipment

Acronym	Definition
psi	pounds per square inch
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/ Quality Control
QSM	Quality Systems Manual
RACR	Remedial Action Completion Report
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SESD	Science and Ecosystem Support Division
SOF	Special Operations Forces
SOP	Standard Operating Procedure
SSHP	Site-Specific Health and Safety Plan
SVOC	Semi Volatile Organic Compound
TCE	Trichloroethene
TOC	Total Organic Carbon
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
UU/UE	Unrestricted Use/ Unrestricted Exposure
VC	Vinyl Chloride
VOC	Volatile Organic Compound

Certification Statement

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: ______________________ Date: 03/11/2022

Printed Name: Robyn T. Brody, PG
Georgia Registration Number: 1113

Seal: ROBYN T. BRODY GEORGIA REGISTERED PROFESSIONAL GEOLOGIST No. 1113

1 PROJECT SUMMARY

KEMRON Environmental Services, Inc. (KEMRON) has prepared this Remedial Action Work Plan (RAWP) for Hunter Army Airfield (HAA) for the Georgia Environmental Protection Division (GA EPD). HAA-15, the Site, is an Operable Unit (OU) within HAA, managed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) by the Army with regulatory oversite by the GA EPD. This RAWP serves as the work plan to implement the State of Georgia approved Selected Remedy for the Site as outlined in the Record of Decision ([ROD] KEMRON, 2021).

Investigations from 1993 through 2017 have identified a plume of volatile organic compounds (VOCs) and chlorinated solvents in groundwater under the Site, and lead, arsenic, and poly aromatic hydrocarbons (PAHs) in soil in the Old Hospital Area. Contaminants of Concern (COCs) in groundwater include trichloroethene (TCE), cis-1,2-dichloroethene (DCE), vinyl chloride (VC), benzene, and 1,1-DCE. COCs in soil include lead, arsenic, and benzo(a)pyrene. Hangar Building 811, where TCE was used as a cleaner and solvent, the aircraft wash racks and former Industrial Wastewater Treatment Plant (IWTP) adjacent to Building 850 have been identified as source areas for TCE.

The approved remedy for remediating chlorinated VOCs (CVOC) impacts to groundwater and soil impacts around the Old Hospital Area are:

Groundwater:

- Enhanced Reductive Dechlorination (ERD)
    - Injections in zones of high TCE concentrations around Hangar Building 811 and the former wash rack and former IWTP
        - 22 injection wells in three lines with 30-foot (ft) spacing in higher concentrations zone near Hangar Building 811
        - Four injection wells in the higher concentration zone near the former IWTP
    - Annual injections of emulsified vegetable oil (EVO) until performance monitoring demonstrates an in-situ reduction zone (IRZ) has been established
    - Installation of seven additional performance monitoring wells to supplement existing monitoring network
        - Five wells to characterize treatment within the main plume near Hangar Building 811
        - Two wells to characterize the secondary hot spot near the former IWTP
    - Performance monitoring to monitor ongoing effectiveness of the IRZ and determine if additional injections are required.
- Monitored Natural Attenuation (MNA)
    - Performance monitoring of selected wells to monitor the overall effectiveness of MNA in achieving remedial goals
- Land Use Controls (LUCs)
    - Onsite LUCs enforced by HAA will prohibit installation of water wells within or downgradient to the source area.
- CERCLA five-year reviews

Soil

- Excavation and Disposal
    - Excavation of impacted surface soil
    - Offsite disposal at an approved landfill under manifest
    - Backfill with confirmed clean soil

This RAWP is intended to act as the work plan for the implementation of these remedies. Cost estimates to complete the GA EPD approved remedy are included and summarized within this report.

2 SITE HISTORY, DESCRIPTION, AND BACKGROUND

2.1 Site Description

HAA is an active military installation located in Savannah, Georgia that contains areas of industrial, commercial, and temporary residential properties. The Site, HAA-15, is located in the northeastern portion of HAA and includes the Special Operations Forces (SOF) Facility, Military Construction Army (MCA) Barracks Area, Retention Pond 29, Hangar Buildings 811 and 813, the former IWTP, and the Old Hospital Area. A Site Location map is shown on **Figure 2-1**, and a Site Features map is shown on **Figure 2-2**.

Investigations at HAA-15 from 1996 through 2017 have identified CVOCs to be the primary COCs in groundwater at the Site. Based on historical operations, Sitewide investigations, and observed concentrations, Hangar Building 811, and the former wash racks and the former IWTP where TCE was used as a cleaner/solvent, are considered the primary sources of CVOCs at HAA-15.

Pre-construction investigations at the SOF Facility and MCA Barracks Area in 1996 and 1998, respectively, identified TCE and perchloroethene (PCE) and TCE, (respectively) above Maximum Contaminant Levels (MCLs) in groundwater. Subsequent investigations from 1998 to 2006 attempted to delineate impacts in soil and groundwater. In 2005-2006, soil sampling, groundwater sampling, and monitoring well installation and sampling were performed across HAA-15 The investigation was expanded to include the aircraft hangars, aircraft wash racks, former IWTP, Old Hospital Area, Georgia Air Guard Motor Pool, the Motor Repair Shop, and Pond 29.

Investigations were performed from 2009 to 2017 to delineate the sources and extent of impacts to groundwater at HAA-15, focusing primarily on TCE. This investigation was Site-wide across HAA-15, included a tracer study, Membrane Interface Probe (MIP) investigations, soil and groundwater sampling, soil vapor sampling, and surface water assessments. This investigation culminated in the completion of a Remedial Investigation/Feasibility Study (RI/FS; Arcadis 2019).

2.2 Current Site Use

HAA-15 includes administrative buildings and commercial/industrial use buildings. The space around the 10-acre retention pond, Pond 29, includes a landscaped, maintained area of oak trees and green space designated for recreational use. HAA-15 will remain a commercial/industrial use property, with no current plans for future conversion of the site for permanent residential use (US Army, 2017).

3 ENVIRONMENTAL SETTING

3.1 Physical Site Setting

HAA is an active military installation located in Savannah, Georgia that contains areas of industrial, commercial, and temporary residential properties. HAA-15 is located in the northeastern portion of HAA and includes an active airfield and a 10-acre man-made stormwater retention pond. A site map showing where HAA-15 is located within HAA is shown as **Figure 2-1**, and the investigation areas comprising HAA-15 are shown on **Figure 2-2**.

3.2 Geology

HAA is located within the Southern Coastal Plain physiographic province. The Coastal Plain is characterized by a wedge of gently southeast dipping clastic sediments, primarily sand, silt, and clay, overlying crystalline metamorphic basement rock. The unconsolidated sediment wedge thickens to the east, reaching a maximum thickness of approximately 7,500 ft, with a total thickness of sediments in the Savannah, Georgia area of over 2,000 ft. The metamorphic basement complex ranges from Precambrian to Triassic in age, and dips coastward at about 30 ft per mile from the Fall Line, near Macon and Augusta, GA, to the Savannah, GA area. The depositional environment at HAA has been characterized as that of a former barrier island system, with coarsening-upward sequences of sands, transitioning from characteristic former shallow open ocean deposits (fine, reworked sands) in the east, to a beach environment (fine to medium well sorted sands), to marsh and bay environments west of the airfields (silts and clays with some sand interbeds).

Previous investigations at or near the Site show the subsurface to be primarily sands with little clay and silt. Subsurface soils are categorized into two general strata, an upper zone soil and a lower zone soil. The upper zone soils extend from ground surface to approximately 30-35 ft below ground surface (bgs) and are typically yellow, grey, to brown, fine- to medium- grained sands with occasional interbedded layers of clays and silts. The lower zone soils extend from approximately 35 ft bgs to approximately 100 ft bgs and are typically interbedded silty clays and silty sands, fining downwards toward the Hawthorne clay.

3.3 Hydrogeology

The regional hydrogeology of the HAA area is characterized by two aquifers separated by a thick confining unit. The uppermost aquifer system is the surficial aquifer in the Savannah area. It is underlain by two thick, continuous clays of the Hawthorne Group. Around HAA, the clay units extend from approximately 60 ft to 285 ft bgs. These clays separate the surficial aquifer from the deeper Floridian aquifer.

The Floridian aquifer is regionally extensive, serving as the primary water supply aquifer in the Coastal Plain, with approximately 800 ft of Oligocene to Eocene aged porous limestones. HAA Potable Water supply wells HAA Well #1 and HAA Well #2 are installed in the Floridian Aquifer with open intervals from 259 to 504 ft bgs to 260 to 555 ft bgs, respectively.

Groundwater in the upper aquifer at HAA-15 flows north-northwest, away from the runway complex. The average shallow zone gradient was calculated to be 0.0085 ft/ft. Deep zone upper aquifer groundwater flow is also generally to the north-northwest with an average gradient calculated to be 0.012 ft/ft. The observed depth to groundwater in December 2014 ranged from 2.59 to 23.70 ft across HAA-15. Potentiometric surface maps are included in the shallow zone in **Figure 3-1** and the deep zone in **Figure 3-2**.

Pond 29, a 10-acre man-made pond, and drainage canals at the site appear to be discharge boundaries for the shallow unconfined groundwater. Pond 29 appears to have a minimal effect on flow direction, although it is believed to be a discharge point for shallow groundwater and representative of the shallow groundwater level when groundwater levels are high. Lamar Canal, in the northwest of HAA-15, is a major local waterway and a possible shallow groundwater discharge boundary (Pika/Arcadis 2019).

4 PRELIMINARY ACTIVITIES

4.1 Permitting

KEMRON will prepare an Underground Injection Control (UIC) Permit under the GA EPD rules for underground injection control, Chapter 391-3-6-.13 Georgia Water Quality Control Act Official Code of Georgia Annotated (O.C.G.A) 12-5-20 et.seq. The permit will be submitted by the Army through the GA EPD Online System (GEOS). The UIC Permit application will include an overview of the proposed injection, injection well construction data, injection system data, specifics of the injection, engineering layout of the system, approved corrective action plans, and certification with local land use plan and zoning requirements. A draft UIC Permit is included in Appendix B.

4.2 Health and Safety Plan

Prior to beginning field work, KEMRON will prepare a Site-Specific Health and Safety Plan (SSHP) in accordance with Occupational Safety and Health Administration (OSHA) and U.S. Environmental Protection Agency (USEPA) requirements and general industry (29 Code of Federal Regulations [CFR] 1910) and construction (29 CFR 1926) standards, and KEMRON corporate health and safety standards. The SSHP will provide project-specific safety and health requirements. The SSHP will address all definable features of work and associated safety protocols to ensure a safe and healthful environment for workers, subcontractors, and visitors when entering the Site. The SSHP will incorporate site-specific conditions as appropriate, and hazard analyses for each major task involved in the scope of work. For the duration of on-Site activities, safety meetings will be held at least daily, and at the start of new activities, during which relevant sections of the SSHP will be reviewed.

4.3 Utility Locate

Georgia public utilities protection center (Georgia 811) will be notified at least 48 hours prior to initiation of field activities when intrusive activities are scheduled, in order to have the on-site utilities located. For sensitive and potentially complex areas, KEMRON will also utilize a private utility locator to supplement the 811-utility locating service.

KEMRON personnel will be responsible for notifying the HAA environmental office of planned intrusive activities at least two weeks prior of the initiation of field activities. A 50-foot radius will be marked around each boring location, and the Department of Public Works (DPW) will accept responsibility for accuracy of locates pertaining to gas and fuel lines, water lines, electrical lines (including secondary electricity), airfield lighting, low voltage lines, fire systems, sewer lines, roof drain lines, storm drain lines, industrial waste lines, chilled water lines, high temperature water lines, irrigation systems, and DPW non-fiber computer lines. The field team leader will check the proposed drilling, sampling, and excavation locations for marked underground utilities other underground structures, and above-ground utilities (e.g. power lines).

5 GROUNDWATER REMEDIATION

The selected remedy for groundwater at HAA-15 is ERD, MNA, and LUCs. ERD and MNA are discussed in this section, and LUCs are discussed in Section 7.

5.1 Baseline Sampling

Prior to the injection, a baseline sampling event will be performed within the treatment zone. Sampling will include selected wells in the performance monitoring network and will be completed in accordance with procedures outlined in Section 8. The baseline monitoring will establish initial contaminant concentrations and geochemical conditions. This information will be used to monitor changes to the geochemical conditions during injection and to contaminant concentrations and geochemical conditions over post-injection performance monitoring events. Additionally, the final injection design may be adjusted, if needed, pending the results of baseline sampling.

- Baseline Sampling of 13 wells for VOCs, TOC, Light Gases
  - H15-MW-01C, H15-MW-02C, H15-MW-02D, H15-MW-03C, H15-MW-04C, H15-MW-05C, H15-MW-06C, H15-MW-10C, H15-MW-13C, H15-MW-15C, H15-MW-20E, HGL-6C, HGL-7C

5.2 Injection

Remediation will consist of ERD to enhance mass removal associated with CVOCs near Hangar Building 811 and former wash rack/former IWTP area, MNA for remaining contaminants, onsite LUCs preventing installation of potable wells within or downgradient to the source areas, and CERCLA five-year reviews.

5.3 Injection Design

The ERD remediation system will include 22 injection points installed in three transects to reduce site contamination levels by treatment of the source zone. The injection points will be spaced across the three transects and positioned perpendicular to groundwater flow to achieve coverage, as shown on **Figure 5-1**. There will be an additional four injection points in the IRZ area.

A direct-push technology (DPT) rig will be used to install borings into which a reductive carbon substrate based on EVO will be injected. EVO is mixture of quick release and slow-release organic carbon providing a long-lasting source of organic carbon. The remedial injection fluid will be mixed utilizing tanks inside an enclosed injection trailer and then pumped into the formation using air-driven, chemically resistant pumps. The rate, pressure, and volume will be monitored using an electronic flow meter. The DPT rig will be operated by a Georgia licensed driller.

Injection rates will be monitored to create cones of impression. Cones of impression will allow the treatment chemistry to influence the smear zone, enabling desorption and subsequent recovery of contaminant held in the smear zone. This will allow for the injectate to contact the largest area possible enabling more efficient treatment.

Approximately 22 DPT borings will be installed in locations of highest chlorinated contaminants, with an additional four installed in the IRZ area. Horizontal spacing of 30-ft centers for injections across the site were based on the hydraulic conductivity derived in the RI/FS. The vertical extent of distribution will extend from approximately 40-50 ft bgs. Based on the data, it appears that the highest contamination corresponds to the smear zone resulting from groundwater table fluctuations.

5.4 Injection System

The injection wells will be installed using conventional DPT techniques in areas currently used as parking lots or grass fields. Injection wells were designed on 30-ft centers, however, due to obstructions exact well locations will be determined during installation. Final injection well design and locations will be determined in the field based on boring logs and depth to water measurements from existing wells adjacent to the injection well locations.

The injection system will consist of a potable water supply, the electron donor reservoir, an inline chemical feed pump, mixing tanks, a well injection manifold, injection distribution hoses, and injection wellheads. A stainless-steel manifold system equipped with pressure monitoring/relief devices will be used to ensure safe and accurate mixing, and controlled injection of the reagents to maximize distribution within the treatment zones. Well head injection pressures should be kept between 7 to 10 pounds per square inch (psi).

Potable water will be supplied via a potable water source located near the site. Temporary piping and hoses will be used to transfer the potable water from the supply to a portable 2,000-gallon tank. The water in the tank will be mixed with sodium bicarbonate for pH control. Batch process mixing will be completed by recirculating the solution through the tank using a high-volume pump. A submersible pump will be placed into the tank to supply the sodium bicarbonate solution to the electron donor addition system. A bottom-up injection approach will be implemented at each DPT location using injection tooling designed for horizontal distribution of reagents throughout the targeted treatment intervals. The treatment interval is estimated to be 40-50 feet below ground surface.

5.5 Injection Monitoring

All injections will be performed under direct supervision of the KEMRON. Data collection will be performed using a laptop in real-time. Injection flow rates, pressures, total volumes, reagent tracking, and field notes will be recorded at regular intervals. Water supply lines, injection system, and injection wells will be monitored for leaks.

Flow rate and pressure during the DPT injections will be closely monitored to ensure optimal distribution of the injectate. Monitoring wells will to be used for verification to ensure daylighting does not occur. If daylighting of injectate occurs, the pressure used will be reduced. If a lower pressure does not curtail the daylighting, the location of the injection point will be reconsidered and either relocated, or the excess injectate will be applied to nearby locations.

5.6 Installation of Additional Monitoring Wells

During the injection mobilization, seven additional monitoring wells will be installed to supplement the performance monitoring network. Five new wells are anticipated to be added to the main plume area around Hangar Building 811, and two additional wells be installed in the former IWTP hot spot area. These wells will be installed to total depths of approximately 45-50 ft bgs with 10-ft screens in the deep surface aquifer. Proposed well locations are shown on Figure 5-1, actual installation locations will be adjusted based on access and utility clearance. Monitoring wells will be installed in accordance with EPA Region 4 Science and Ecosystem Support Division (SESD) SESDGUID-001-R2: Design and Installation of Monitoring Wells.

5.7 Performance Monitoring and LTM

Performance monitoring wells will include a subset of the existing wells at the site to representatively cover the treatment and downgradient area. The selected wells will contain wells within the plume treatment area and immediate downgradient areas to determine if an adequate carbon source is present and if the groundwater requires EVO replenishment. Sampling will include collection of groundwater for analysis of VOCs to determine contaminant trends, Total Organic Carbon (TOC) to calculate EVO loading and for monitoring organic carbon consumption from ERD, and Light Gases (methane, ethane, and ethene [MEE]) to monitor the formation of dissolved gases from the ERD. Additionally, during the first performance monitoring event, KEMRON will collect samples for dissolved iron, manganese, and sulfate to evaluate the presence of native electron acceptors. Sampling methodology is described in Section 8.

The performance monitoring will continue at the site as an evaluation mechanism for the ERD injections. It is anticipated that quarterly performance monitoring will directly transfer into semi-annual, and later, annual MNA. The selected remedy for the site includes MNA to monitor the reduction of chlorinated VOC levels from the continued degradation of chlorinated VOCs through ERD as evidenced in the generation of daughter products and formation of dissolved gasses.

5.7.1 Monitoring Program

Quarterly sampling will continue for one year, with semiannual sampling continuing through year five. Sampling is then anticipated to transition to annual sampling for 25 years. Quarterly, semiannual, and annual sampling will be conducted in accordance with Table 5-1 below.

Table 5-1: Monitoring Program

Quarter	Well Network	Analytes
Quarter 1	• Performance Monitoring (20 Wells): H15-MW-01C, H15-MW-02C, H15-MW-02D, H15-MW-03C, H15-MW-04C, H15-MW-05C, H15-MW-06C, H15-MW-10C, H15-MW-13C, H15-MW-15C, H15-MW-20E, HGL-6C, HGL-7C, 7 Newly installed wells	• VOCs, TOC, MEE, dissolved iron, manganese, sulfate

Quarter	Well Network	Analytes
Quarter 2 /Semi-Annual 1	• Performance Monitoring -Second Quarterly: H15-MW-01C, H15-MW-02C, H15-MW-02D, H15-MW-03C, H15-MW-04C, H15-MW-05C, H15-MW-06C, H15-MW-10C, H15-MW-13C, H15-MW-15C, H15-MW-20E, HGL-6C, HGL-7C, 7 Newly installed wells • Semiannual Monitoring: H15-MW-11C, H15-MW-14C, HGL-8C, H15-MW-02B, H15-MW-15B, H15-MW-19B, HGL-6B, HGL-7B, XX-15, XX-19	• VOCs, TOC, MEE, dissolved iron, manganese, sulfate • VOCs
Quarter 3	• Performance Monitoring -Third Quarterly: H15-MW-01C, H15-MW-02C, H15-MW-02D, H15-MW-03C, H15-MW-04C, H15-MW-05C, H15-MW-06C, H15-MW-10C, H15-MW-13C, H15-MW-15C, H15-MW-20E, HGL-6C, HGL-7C, 7 Newly installed wells	• VOCs, TOC, MEE
Quarter 4/ Semi-Annual 2/ Annual 1	• Performance Monitoring: H15-MW-01C, H15-MW-02C, H15-MW-02D, H15-MW-03C, H15-MW-04C, H15-MW-05C, H15-MW-06C, H15-MW-10C, H15-MW-13C, H15-MW-15C, H15-MW-20E, HGL-6C, HGL-7C, 7 Newly installed wells • Semiannual Monitoring: H15-MW-11C, H15-MW-14C, HGL-8C, H15-MW-02B, H15-MW-15B, H15-MW-19B, HGL-6B, HGL-7B, XX-15, XX-19 • Annual Monitoring Event (70 wells): H15-MW-02B, H15-MW-03B, H15-MW-05B, H15-MW-15B, H15-MW-17B, H15-MW-18B, H15-MW-19B, HGL-11B, HGL-6B, HGL-7B, HGL-8B, XX-12, XX-13, XX-14, XX-15, XX-26 (1-S), H15-MW-01B, H15-MW-03B, H15-MW-07B, H15-MW-14B, H15-MW-16B, HGL-11B, HGL-1B, HGL-2B, HGL-4B, HGL-5B, HGL-MW-22B, XX-04, XX-05, XX-06, XX-07, XX-09, XX-10, XX-25, XX-08, H15-MW-11C, H15-MW-14C, HGL-8C, XX-18, XX-19, XX-21, XX-26 (3-D), H15-MW-02E, H15-MW-07C, H15-MW-08C, HGl-11C, HGL-1C, HGL-2C, HGL-4C, HGL-5C	• VOCs, TOC, MEE • VOCs • VOCs

6 SOIL REMEDIATION

The selected remedy for soil at HAA-15 is excavation and disposal.

6.1 Excavation and Disposal

Approximately 340 cubic yards of Semi Volatile Organic Compounds (SVOC) and metals-impacted surface soils near the Old Hospital Area will be excavated and disposed of off-site. The excavation is planned for an approximately 4,600 square foot area to two ft bgs. The soils are anticipated to be non-hazardous, however based on concentrations of lead in some soils observed during the RI/FS, a portion of the excavated soil may require treatment prior to non-hazardous classification. Soils will be physically removed and transported to an offsite permitted landfill. All soils will be profiled with the landfill, with the Army as generator, and transported under manifest. KEMRON will identify a “clean” borrow source and collect VOC, SVOC, polychlorinated biphenyls (PCB), and Resource Conservation and Recovery Act (RCRA) Metals Samples from that location. The backfill will be graded to match the existing surroundings and regionally and seasonally appropriate vegetation will be established for erosion control. The planned excavation extent is shown in **Figure 6-1**.

6.2 Confirmation Sampling

KEMRON will collect confirmation samples from the wall and floor of the excavation area. Confirmation sample analysis includes benzo(a)pyrene, lead, mercury, and arsenic.

The removal action will be documented in the remedial action completion report (RACR). This report will include the methodology utilized, sample results, and executed waste manifests.

6.3 Backfilling

KEMRON will identify a “clean” borrow source and collect VOC, SVOC, polychlorinated biphenyls (PCB), and Resource Conservation and Recovery Act (RCRA) Metals Samples from that location. The backfill will be graded to match the existing surroundings and regionally and seasonally appropriate vegetation will be established for erosion control. The planned excavation extent is shown in **Figure 6-1**.

7 LUCS

The selected remedy for HAA-15 includes onsite LUCs.

7.1 Groundwater

Based on CVOC impacts to groundwater, onsite LUCs will be put in place to prohibit installation of potable water wells or consumption of groundwater within or downgradient to the source area at HAA-15 until COC concentrations in site groundwater are at levels that allow Unrestricted Use / Unrestricted Exposure (UU/UE). These restrictions will be included in the HAA Base Master Plan.

LUCs prohibiting the use of groundwater at HAA-15 as a potable source will be maintained as long as COCs remain over applicable screening levels. Screening levels were outlined in the Record of Decision (KEMRON 2021) as:

- Bromodichloromethane – 0.13 µg/L;
- Chloroform – 0.22 µg/L;
- Cis-1,2-DCE – 70 µg/L;
- Ethylbenzene – 700 µg/L;
- Methylene chloride – 5 µg/L;
- TCE – 5 µg/L; and
- VC – 2 µg/L.

7.2 Annual Inspections

LUCs are enforced and their effectiveness evaluated through annual inspections that are documented and maintained in the project record. At a minimum, LUC inspections will be conducted annually. The inspections will be performed with documentation of any non-compliance and the condition of any engineering controls, if applicable.

During inspection, a LUC inspection form will be completed with, at a minimum, the date and time of the inspection, the name of the inspector, a notation of the observations made, what maintenance (if any) is required, and the date and nature of any repairs or other remedial actions taken.

The purpose of the inspections is to assess each LUC and engineering control, including signage (if present) and groundwater use restrictions to determine if the controls are being maintained. HAA will be notified if any changes in land use are discovered.

Annual LUC Inspections will be submitted to the Army for submittal to GA EPD.

7.3 Five Year Reviews

Pursuant to CERCLA Section 121, this facility will be subject to Five-Year Review (FYR) to evaluate the implementation and performance of the remedy in order to determine whether the remedy is or will be protective of human health and the environment. The FYR process will begin five years following completion of the remedial action and will be conducted in accordance with the USEPA Comprehensive Five-Year Review Guidance.

8 SAMPLING METHODOLOGY

This Section provides the overall approach to sample collection methodology during remedial activities at the Site. All sampling will also be conducted in accordance with the existing base-wide and site-specific Quality Assurance Project Plans (QAPP)s.

8.1 Groundwater Sample Collection Methodology

Groundwater sampling and field measurement for these performance sampling events will be performed utilizing low-flow sampling techniques in accordance with EPA Region 4 SESD Standard Operating Procedures (SOPs), and KEMRON Corporate SOPs as follows:

- SESDGUID-101-R2: Design and Installation of Monitoring Wells
- SESDPROC-105-R3: Groundwater Level and Well Depth Measurement
- SESDPROC-301-R4: Groundwater Sampling
- SESDPROC-106-R4: Field DO Measurement
- SESDPROC-100-R4: Field pH Measurement
- SESDPROC-113-R2: Field Measurement of ORP
- SESDPROC-205-R3: Field Equipment Cleaning and Decontamination
- SESDPROC-209-R3: Packing, Marking, Labeling and Shipping of Environmental Samples
- SESDPROC-202-R3: Management of Derived Waste.

The condition of each monitoring well, depth to groundwater, and measurement of field parameters including temperature, pH, dissolved oxygen (DO), conductivity, salinity, oxidation/reduction potential (ORP), and turbidity will be assessed. Collection of water samples will be logged on Water Sample data sheets, included in Appendix A.

8.2 Soil Sample Collection Methodology

Soil sampling for confirmation samples during soil excavation will be performed in accordance with SESD SOPs and KEMRON Corporate SOPs as follows:

- SESDPROC-300-R3: Soil Sampling
- SESDPROC-205-R3: Field Equipment Cleaning and Decontamination
- SESDPROC-209-R3: Packing, Marking, Labeling and Shipping of Environmental Samples
- SESDPROC-202-R3: Management of Derived Waste.

Soil samples will be logged on sample collection data sheets, and the lithology described through visual observations using the Unified Soil Classification System (USCS) for description and identification of soils. Descriptions will include major soil type and percentage, composition of the soil, moisture, texture, color, and any other pertinent observed characteristics. A soil log sheet is included in Appendix A

8.3 Sample Identification, Packing, and Shipping

Sampling procedures are conducted in accordance with the Region 4 USEPA Operating Procedure for Packing, Marking, Labeling, and Shipping of Environmental and Waste Samples (SESDPROC-209-R3), dated February 4, 2015. Each sample is assigned a unique identifying name and the date the sample was taken to ensure all samples are discrete. All logbooks, sample labels or tags, custody seals, representative sampling documents, and chain-of-custody documents are completed using these unique sample designations.

8.4 Quality Assurance/Quality Control (QA/QC) Samples

To monitor both sampling and laboratory performance, the following types of field QA/QC samples will be collected:

- Field Duplicates
    - At a rate of one per 20 samples, or one per event if fewer than 20 samples are to be collected.
    - Are to be assigned identification numbers that do not indicate they are duplicates.
- Matrix Spike/Matrix Spike Duplicates (MS/MSD)
    - One set per analytical batch of less than or equal to 20 samples collected during a sampling event.
- Trip Blanks
    - Required at a rate of one per cooler containing samples that will be submitted for analysis of VOCs.
- Rinsate Blanks
    - To be collected immediately after equipment decontamination at a frequency of one per 20 samples and submitted for all analyses requested in the sampling event.

8.5 Field Documentation

A bound field logbook is used to document all field operations and contains sufficient data and information to reconstruct field activities for a specific day. Pages in the logbook are bound and numbered. All entries are recorded legibly in indelible ink. At the end of each day, the last page is signed and dated by the author(s) and a line drawn through the remainder of the page. At a minimum, the daily log contains:

- Date and time the field work started;
- Names and titles of sampling personnel;
- Purpose of the sampling;
- Location and description of the sample and sample site;
- Date and time each sample was collected;
- Any deviations from the Work Plan;
- Meteorological conditions at the start of sampling and changes in these conditions;
- Record of any field measurements observed;
- The number and type of samples collected and the sample numbers;

- Packaging information; and
- Sample destination.

Errors on field documents are corrected by drawing a line through the error and entering the correct information. Errors on a field document are corrected by the person who made the original entry, and the erroneous information should not be obliterated. All corrections are initialed and dated.

8.6 Decontamination Procedures

All tools, equipment, personnel and sampling devices that come into contact with contaminated media are properly decontaminated. Personal protective equipment (PPE) and disposable sampling supplies are disposed of properly. General decontamination is conducted in accordance with the Region 4 USEPA Operating Procedure for Field Equipment Cleaning and Decontamination, Revision 3, dated December 18, 2015 (SESDPROC-205-R3).

- Reusable non-dedicated sampling equipment decontamination are performed before and after sample collection. All sampling equipment will be decontaminated as follows:
- Remove debris clinging to the equipment with a dry brush;
- Clean with phosphate-free surfactant using a brush if necessary to remove particulate matter and surface films, and rinse in tap water or distilled water;
- Rinse a final time with deionized (DI) water and allow to air dry;
- Completely wrap sampling equipment in aluminum foil, shiny side out, to prevent contamination during transportation;
- Clean, disposable gloves will be worn while handling sampling equipment during the final stages of decontamination. DI water will be stored in glass or Teflon containers and applied via Teflon squeeze bottles;
- Equipment or materials not used immediately after decontamination will be placed on a plastic sheet, covered with plastic to avoid site dust settling on air drying equipment, and secured to avoid potential contamination.

8.7 Analytical Laboratory

All groundwater samples collected will be analyzed by a certified Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) laboratory for the analyses. All analytical data will undergo data validation. Data validation procedures will be conducted in accordance with USEPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review (EPA-540-R-014-002, and EPA-540-R-013-001) including Region-specific amendments), with the DoD QSM version 5.3 and analytical method procedures (Test Methods for Evaluating Solid Waste Physical/Chemical Methods SW-846, Third Edition as amended by Update III).

8.8 Analytical Method Requirements

Samples will be preserved according to the selected analytical method. Specific method preservation requirements, size and type of sample containers to be used, and holding times for each parameter are listed in the Site-Wide QAPP (Pika/Arcadis, 2014).

8.9 Investigation Derived Waste Management

Investigation Derived Waste (IDW) including soil and waste cuttings and decontamination, development, and purge water will be collected and characterized and managed in accordance with the site-wide QAPP and the USEPA Laboratory Services and Applied Science Division (LSASD) Procedure 202-R4 and any other base-specific requirements regarding IDW.

Specific disposal methods will be considered on a site-by-site basis pending the waste characterization sampling results. Disposal methods will conform to applicable installation, local, state, and federal requirements.

9 REPORTING

This section outlines the reporting requirements for this project.

9.1 Annual Groundwater Monitoring Reports

KEMRON will prepare an Annual Groundwater Monitoring Report to document groundwater monitoring following implementation of the remedial technology for the Site. The Annual Report will document the performance monitoring and will be submitted following the fourth quarterly (or second semi-annual) performance monitoring event. The annual report will include data from the performance monitoring groundwater sampling events, laboratory analytical results, field measurements and observations, an exit/ramp down strategy (if applicable), and remedial alternative optimizations.

9.2 Annual LUC Inspection Reports

An Annual LUC Inspection Report will be prepared that summarizes the LUC implementation, compliance and effectiveness of LUC mechanisms and identifies LUC restriction violations, if any. It will include annual LUC field inspection documentation (including but not limited to completed checklists and photographs from site inspection, verification of LUC elements, signage verification if applicable, etc.) per the established LUC SOP and LUC Implementation Plan (LUCIP).

9.3 Remedial Action Completion Report

Upon completion of the remedial action implementation at each site, a RACR will be prepared to document the approach, to explain deviations from the RAWP, and to provide a record of the field activities. The RACR will include the EVO and reagent information (type, manufacturer, and actual quantities of the injected materials), maps showing RA features (excavation areas, injection points, and any new wells), results from the baseline and initial performance monitoring groundwater sampling events, laboratory analytical results, field measurements and observations, copies of any permits and other documentation, and significant difficulties encountered while performing the fieldwork. A RACR will be completed for this Site following relevant EPA guidance documents, including Close Out Procedures for National Priorities List Sites, Occupational Health and Safety Administration (OSWER) Directive 9320.2-22, May 2011.

9.4 CERCLA 5 Year Reviews

CERCLA 5-year reviews are required for this project, until such time as COCs at the site are at levels that allow UU/UE.

10 COST SUMMARY

The following provides a summary of the costs for implementation of the remedial action presented in this report. Tables 10-1 and 10-3 summarizes specific tasks required for completion of the remedial action for groundwater and soil, respectively, and Tables 10-2 and 10-4 project estimated costs for groundwater and soil, respectively, for the site duration of 30 years. Costs updated from HAA-15 (MCA Barracks Site) Remedial Investigation/Feasibility Study (Pika/Arcadis 2019).

Table 10-1: Groundwater Remedial Action Tasks

Remedial Action Task Description	Estimated Cost
UIC Permit and Baseline Sampling	$35,000.00
Injection Point Installation	$219,000.00
Injection Event	$313,000.00
Institutional Controls	$30,000.00
MNA Monitoring (per event)	$37,000.00
Performance Monitoring (per event)	$26,000.00

Table 10-2: Groundwater Remedial Action Cost Estimate Totals

Cost Type	Year	Cost Per Year	Total Cost
Capital Cost	0-1	$597,000.00	$597,000.00
Quarterly Performance Monitoring	0-1	$148,000.00	$148,000.00
Semi-Annual MNA	1-5	$74,000.00	$296,000.00
Annual MNA	6-30	$37,000.00	$925,000.00
Total Cost			$1,966,000.00

Table 10-3: Soil Remedial Action Tasks

Remedial Action Task Description	Estimated Cost
Excavation and Disposal Activity	$151,000.00
Oversight and Sampling	$27,000.00
Annual LUC Inspection	$6,000.00
Administrative Controls, LUCIP	$21,000.00
5-Year Review, Administrative Controls, LUCIP	$27,000.00

Table 10-4: Soil Remedial Action Cost Estimate Totals

Cost Type	Year	Cost Per Year	Total Cost
Capital Cost	0-1	$199,000.00	$199,000.00
Annual LUC Inspection	0-30	$6,000.00	$162,000.00
Periodic Cost	5, 10, 15, 20, 25, & 30	$27,000.00	$162,000.00
Total Cost			$523,000.00

11 REFERENCES

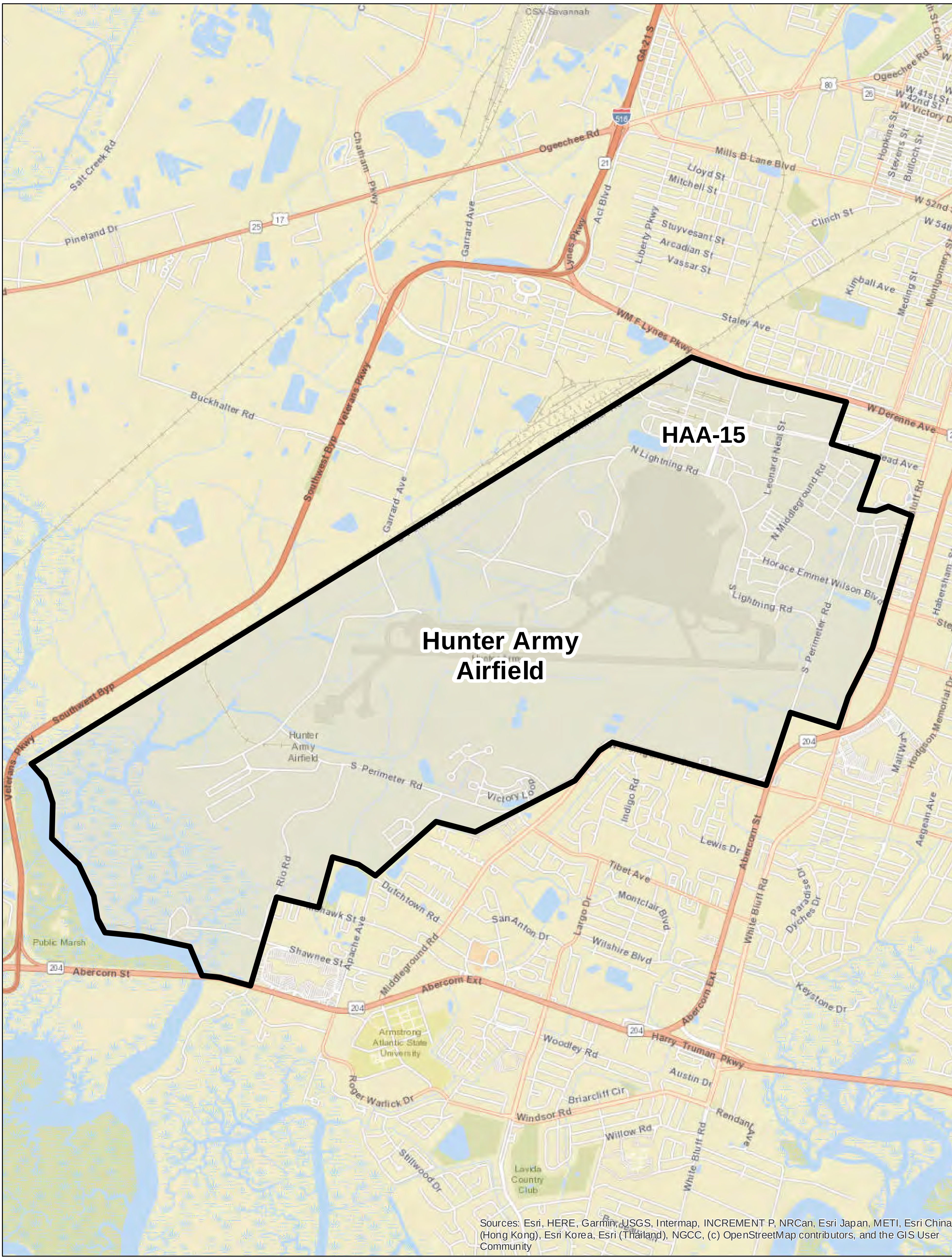
KEMRON. 2021. Record of Decision, MCA Barracks Site Area (HAA-15), Hunter Army Airfield, Georgia. Draft Final. October.

Pika/Arcadis. 2014. Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP), Hunter Army Airfield, Georgia. September.

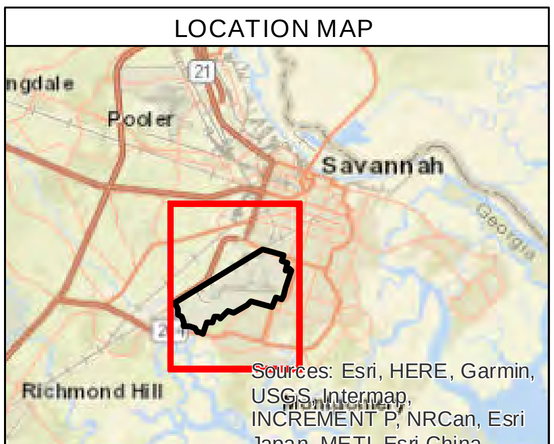
Pika/Arcadis. 2019. HAA-15 (MCA Barracks Site) Remedial Investigation/Feasibility Study. Hunter Army Airfield, Savannah, Georgia. June.

U.S. Army. 2017. Fort Stewart – Hunter Army Airfield Area Development Plan, Fort Stewart Department of Public Works, September.

FIGURES



LOCATION MAP



0 2,000 4,000
Feet

NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17 N (feet)

LEGEND

Installation Boundary

TITLE

Hunter Army Airfield
MCA Barracks Site HAA-15
Site Location Map

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

DRAWING DATE: 7/24/2020

Drawn by:	Reviewed by:
CJ	MSC

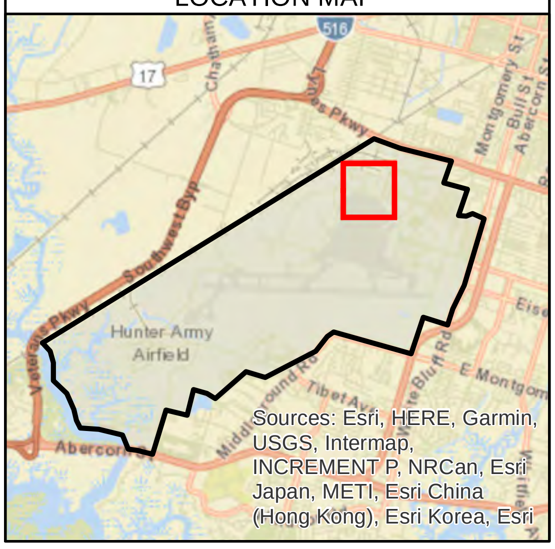
N

FIGURE

2-1

Document Path: L:\GIS_Databases\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Hunter Army Airfield\MXDs\HAA-15\Site_Location.mxd

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17 N (feet)

LEGEND

Installation Boundary

0 400 800
Feet

TITLE

Hunter Army Airfield
MCA Barracks Site HAA-15
Site Layout

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

DRAWING DATE: 7/21/2020

Drawn by:	Reviewed by:
CJ	MSC

N

FIGURE
2-2

Document Path: L:\GIS_Databases\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Hunter Army Airfield\MXDs\HAA-15\Site_Layout.mxd

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PROJECT: 10153001.0001 PATH: Z:\GISPROJECTS_ENV\HAAF_PIKA\MAPDOCS\H15\2017\H15 RIFS\F3-3A H15_RIFS 201412 POT S DSIZE.MXD SAVED: 7/7/2017

PROJECTION: NAD_1983_StatePlane_Georgia_East_FIPS_1001_Feet
REFERENCE: SAGIS (2008).

LEGEND

- Monitoring Well (shallow)
- (NM) Not Measured
- (26.03) Water-Level Elevation (ft amsl) Measured December 8-9, 2014
- Groundwater Contour Line (ft amsl)
- (inferred where dashed)
- Direction of Groundwater Flow

NOTE: The shallow zone of the upper aquifer consists of wells with screened intervals between ground surface and 30 ft bgs.

HUNTER ARMY AIRFIELD, GEORGIA

MCA BARRACKS SITE (HAA-15)
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Potentiometric Surface Map for the Shallow Zone of the Upper Aquifer (December 2014)

From Pika/Arcadis 2019

FIGURE **3-1**

CITY: (KNOXVILLE) DIV/GROUP: (ENV/GIS) LD: (B.ALTOM) PIC: (T.TALELE) PM: (S.GIBBONS) TM: (D.LIPIK) BY: KIVES
PROJECT: 10153001.0001 PATH: Z:\GISPROJECTS_ENV\HAAF_PIKA\MAPDOCS\H15\2017\H15 RIFS\F3-3B H15_RIFS 201412 POT D DSIZE.MXD SAVED: 7/5/2017

PROJECTION: NAD_1983_StatePlane_Georgia_East_FIPS_1001_Feet
REFERENCE: SAGIS (2008).

LEGEND

- Monitoring Well (deep)
- (NM) Not Measured
- (26.03) Water-Level Elevation (ft amsl) Measured December 8-9, 2014
- (9.95*) Water-Level Elevation Not Used to Construct Contours (Well screened in different interval)
- Groundwater Contour Line (ft amsl)
- (inferred where dashed)
- Direction of Groundwater Flow

NOTE: The deep zone of the upper aquifer consists of wells with screened intervals between 30 and 50 ft bgs.

HUNTER ARMY AIRFIELD, GEORGIA

MCA BARRACKS SITE (HAA-15)
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

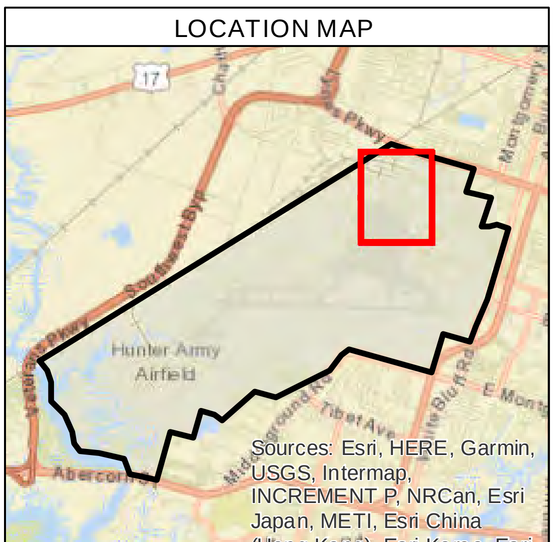
Potentiometric Surface Map for the Deep Zone of the Upper Aquifer (December 2014)

From Pika/Arcadis 2019

FIGURE
3-2

Notes:
All Concentrations in micrograms per liter (ug/L)
Results shown are for locations analyzed for the target compound during the December 2014 event.
Tapwater Regional Screening Level (RSL) for Trichloroethylene (TCE) is 0.49 ug/L.
Maximum Contaminant Level (MCL) for TCE is 5.0 ug/L
"J" Values are approximated
"<" Values were not detected at the Method Detection Limit (listed)
Bracketed "[ ] " concentrations represent duplicate sample results.
Wells H15-MW-02E and H15-MW-20E are screened at 120-125 ft below ground surface and were not used to generate these contours.

LOCATION MAP



LEGEND

Monitoring Well (Deep)
Installation Boundary
1.0 TCE Concentration (ug/L)
Groundwater Flow Direction
Proposed Injection Line
Proposed Injection Area

TCE Concentration (Deep Wells)

0.49 - 4.9 ug/L
5.0 - 49.9 ug/L
50 - 499.9 ug/L
50 - 499.9 ug/L
< 500 ug/L

WGS 1984, UTM Zone 17 N (feet)

0 600 1,200
Feet

TITLE

MCA Barracks Site HAA-15
Planned Injection Areas

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

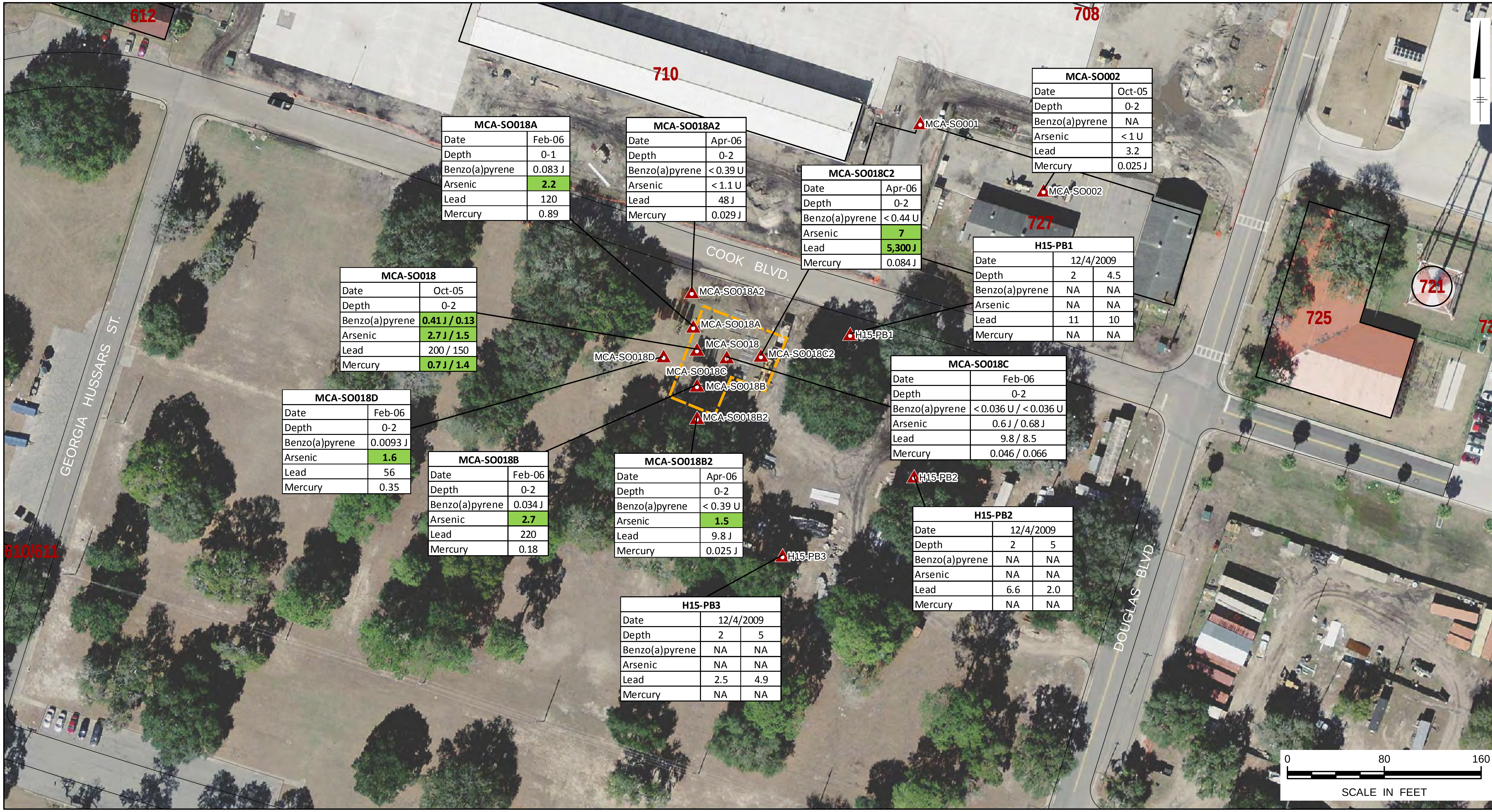
DRAWING DATE: 7/24/2020

Drawn by:	Reviewed by:
CJ	MSC

N

FIGURE
5-1

Document Path: L:\GIS_Databases\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Hunter Army Airfield\MXDs\HAA-15\Proposed_Injection.mxd



MCA-SO018A	
Date	Feb-06
Depth	0-1
Benzo(a)pyrene	0.083 J
Arsenic	**2.2**
Lead	120
Mercury	0.89

MCA-SO018A2	
Date	Apr-06
Depth	0-2
Benzo(a)pyrene	< 0.39 U
Arsenic	< 1.1 U
Lead	48 J
Mercury	0.029 J

MCA-SO018C2	
Date	Apr-06
Depth	0-2
Benzo(a)pyrene	< 0.44 U
Arsenic	**7**
Lead	**5,300 J**
Mercury	0.084 J

MCA-SO002	
Date	Oct-05
Depth	0-2
Benzo(a)pyrene	NA
Arsenic	< 1 U
Lead	3.2
Mercury	0.025 J

H15-PB1		
Date	12/4/2009	
Depth	2	4.5
Benzo(a)pyrene	NA	NA
Arsenic	NA	NA
Lead	11	10
Mercury	NA	NA

MCA-SO018	
Date	Oct-05
Depth	0-2
Benzo(a)pyrene	**0.41 J / 0.13**
Arsenic	**2.7 J / 1.5**
Lead	200 / 150
Mercury	**0.7 J / 1.4**

MCA-SO018C	
Date	Feb-06
Depth	0-2
Benzo(a)pyrene	< 0.036 U / < 0.036 U
Arsenic	0.6 J / 0.68 J
Lead	9.8 / 8.5
Mercury	0.046 / 0.066

MCA-SO018D	
Date	Feb-06
Depth	0-2
Benzo(a)pyrene	0.0093 J
Arsenic	**1.6**
Lead	56
Mercury	0.35

MCA-SO018B	
Date	Feb-06
Depth	0-2
Benzo(a)pyrene	0.034 J
Arsenic	**2.7**
Lead	220
Mercury	0.18

MCA-SO018B2	
Date	Apr-06
Depth	0-2
Benzo(a)pyrene	< 0.39 U
Arsenic	**1.5**
Lead	9.8 J
Mercury	0.025 J

H15-PB2		
Date	12/4/2009	
Depth	2	5
Benzo(a)pyrene	NA	NA
Arsenic	NA	NA
Lead	6.6	2.0
Mercury	NA	NA

H15-PB3		
Date	12/4/2009	
Depth	2	5
Benzo(a)pyrene	NA	NA
Arsenic	NA	NA
Lead	2.5	4.9
Mercury	NA	NA

PROJECTION: NAD_1983_StatePlane_Georgia_East_FIPS_1001_Feet
REFERENCE: SAGIS (2008).

LEGEND

- Soil Boring
- Approximate Extent of Proposed Excavation
- 710 Building Number

MCA-SO018C		
Date	Feb-06	Sample Date
Depth	0-2	Sample Interval (ft bgs)
Lead	9.8 / 8.5	Lead Concentration / duplicate

Soil Boring ID

NOTES:
1) All soil concentrations reported in milligrams per kilogram (mg/kg).
2) **BOLD** concentration exceeds the applicable 2018 United States Environmental Protection Agency Regional Screening Level for Residential Soil for soil samples collected between ground surface and 2 feet below grade.
3) Concentrations shown are those detected above the method detection limit (MDL).
4) J values are estimated.
5) < 1 U - constituent was not detected above the indicated MDL.
6) NA - Not Analyzed.

From Approved RI/FS, Figure 5-4, Pika/Arcadis 2019

HUNTER ARMY AIRFIELD, GEORGIA
MCA BARRACKS SITE (HAA-15)
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Old Hospital Area
Concentrations in Soil

KEMRON ENVIRONMENTAL SERVICES

Planned Excavation Area

FIGURE 6-1

CITY: Citrix DIV/GROUP: IMDV LD: (B.ALTOM) PIC: (T.TALELE) PM: (S.GIBBONS) TM: (S.BOSTIAN) BY: acarlone
PROJECT: 10153001.0001.EE015 PATH: Z:\GISProjects_ENV\PIKA\HAAF_PIKA\MapDocs\H15\2018\H15 RIFS\F5-4 H15_CAP HOSP AREA SOIL.mxd SAVED: 6/11/2018

APPENDIX A:
Sampling and Inspection Forms

KEMRON ENVIRONMENTAL SERVICES

1359-A Ellsworth Industrial Boulevard Atlanta, GA 30318 Telephone (404) 636-0928 FAX (404) 636-7162 http://www.kemron.com

Site Name: ____________________ Well ID: ____________________

Site Location: ____________________ Sample ID: ____________________

Date: ____________________ Page: ____________________

Well Diameter: ____________________ Purge Method: ____________________

Well Capacity (gal/ft): ____________________ Purge Initiated At: ____________________

Total Depth of Well (ft): ____________________ Purge Ended At: ____________________

Static Depth to Water (ft): ____________________ Sampling Method: ____________________

Water Column (ft): ____________________ Sampling Initiated At: ____________________

Well Volume (gal): ____________________ Sampling Ended At: ____________________

Purge Volume (Well Volume x 3): ____________________ Field Decontaminated: Yes No

Sampled By (Sign & Print): ____________________ Field Filtered: Yes No

____________________ Duplicate: Yes No

Time	Purge Volume (gallons)	Cumul. Purge Volume (gallons)	Purge Rate (gpm)	Depth to Water	Depth to Pump Inlet	pH	Temp (^{o}C)	Cond. (ms/sec)	D.O. (mg/L)	Turbitidy (NTUs)	Color	Odor

Sample and Container Information					
Analysis	Container Type	Volume	Preservation	No. of Containers	Remarks

Well Capacity: 1" = 0.041 gal/ft, 2" = 0.163 gal/ft, 4" = 0.653 gal/ft, 6" = 1.469 gal/ft

HUNTER ARMY AIRFIELD
LAND USE CONTROL (LUC) INSPECTION FORM

ADDRESSES SITES UNDER CORRECTIVE MEASURE IMPLEMENTATION (CMI), INTERIM REMEDIAL ACTION (IRA), LONG TERM MANAGEMENT (LTM), or ANNUAL GROUNDWATER MONITORING

<table>
<tr><th colspan="2">I. SITE INFORMATION</th></tr>
<tr><td>Site Name:</td><td>Date Of Inspection:</td></tr>
<tr><td>Permit Holder:</td><td>EPA ID # for facility in which LUCs are required:</td></tr>
<tr><td>Permit Holder Address:</td><td>Weather/Temperature:</td></tr>
<tr><td colspan="2">Corrective Action Includes: (Check all that apply)
☐ Land Use Controls ☐ Phytoremediation
☐ Landfill cover/containment ☐ Monitored natural attenuation
☐ Groundwater pump and treatment
☐ Other: ____</td></tr>
<tr><td colspan="2">LUC Performance Objectives: (Include all that apply)</td></tr>
<tr><td colspan="2">Type of Inspection: Walkthrough / Administrative Review

Frequency: Annual

Agency, office, or company conducting the inspection: Red Oak Environmental on behalf of KEMRON Environmental Services, Inc.

Contact:

____
Name Title Phone no.

____
Signature Date

Attachments: (e.g. Inspection team roster attached, Site map attached, Photographs attached)</td></tr>
</table>

II. INTERVIEWS

1. Site Manager:

____
Name Title Date

Interviewed: ☐ at site ☐ at office ☐ by phone ☐ Other Phone no._________________

Present at time of inspection: ☐ Yes ☐ No

Problems/Suggestions:

Reports attached:

2. Staff:

____
Name Title Date

Interviewed: ☐ at site ☐ at office ☐ by phone ☐ Other Phone no. __________________

Present at time of inspection: ☐ Yes ☐ No

Problems/Suggestions:____

Reports attached:____

3. Local Regulatory Authorities/Agencies
(e.g. State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.)
Fill in all that apply.

Agency: ____

Contact: ____
Name Title Date

Present at time of inspection: ☐ Yes ☐ No

Problems/Suggestions:

Reports attached:

Agency: ____

Contact:____
Name Title Date

Present at time of inspection: ☐ Yes ☐ No

Problems/Suggestions: ____

Reports attached: ____

4. Other Interviews (Summary attached): ☐ Yes ☐ No

III. LAND USE CONTROLS (LUCs) – Check all that apply

☐ Applicable ☐ N/A

**If deficiencies are noted, the locations should be documented on a site map and with photos.*

A. <u>Engineering Controls</u> ☐ Applicable ☐ N/A

1. Fencing ☐ Yes ☐ No ☐ N/A
Are they secured? ☐ Yes ☐ No

Remarks:____

2. Barriers ☐ Yes ☐ No ☐ N/A
Are they in place? ☐ Yes ☐ No

Remarks:____

3. Signs ☐ Yes ☐ No ☐ N/A
Are they damaged? ☐ Yes ☐ No

Remarks:____

B. <u>Prohibitive Directive</u> ☐ Applicable ☐ N/A

1. Signs and other Security Measures ☐ Yes ☐ No ☐ N/A
Are they damaged? ☐ Yes ☐ No

Remarks:____

2. Well Installation ☐ Yes ☐ No ☐ N/A
Were wells installed? ☐ Yes ☐ No

Remarks:____

3. Digging/Excavation ☐ Yes ☐ No ☐ N/A
Did excavation occur? ☐ Yes ☐ No

Authorization/Dig Permit # ______________________________

Remarks:____

4. Other ☐ Yes ☐ N/A

Remarks:____

C. <u>Institutional Controls</u> ☐ Applicable ☐ N/A

1. Deed and Restrictive Covenant ☐ Yes ☐ N/A
Readily Available? ☐ Yes ☐ No

Remarks:____

2. Other ☐ Yes ☐ No ☐ N/A

Remarks: <u>Recorded in Master Planning and applicable GIS Data.</u>

3. Local Land Use Changes ☐ Yes ☐ No ☐ N/A
Do the changes in land use potentially affect the corrective action? ☐ Yes ☐ No

Remarks:____

4. **Land Use Changes Off Site** ☐ Yes ☐ No ☐ N/A
Do the changes in land use potentially affect the corrective action? ☐ Yes ☐ No

Remarks:____

V. SITE CONDITIONS

**If deficiencies are noted, the locations should be documented on a site map and with photos.*

1. **Provide general description (i.e. roads, buildings, etc.)**

VI. LAND COVERS

☐ Applicable ☐ N/A

**If deficiencies are noted, the locations should be documented on a site map and with photos.*

A. <u>Vegetative Cap Surface</u>

1. **Settlement** (Low spots) ☐ Yes ☐ No
Areal extent ___________________________ Depth _______________________________
Photograph Attached ☐ Yes ☐ No
Corrective measures implemented to rectify settlement ☐ Yes ☐ No ☐ N/A

Remarks ____

2. **Cracks** ☐ Yes ☐ No
Lengths _________________ Widths _________________ Depth __________________
Photograph Attached ☐ Yes ☐ No
Corrective measures implemented to rectify settlement ☐ Yes ☐ No ☐ N/A

Remarks:____

3. **Erosion** ☐ Yes ☐ No
Areal extent___________________________ Depth______________________________
Photograph Attached ☐ Yes ☐ No
Corrective measures implemented to rectify erosion ☐ Yes ☐ No ☐ N/A

Remarks:____

4. **Holes** ☐ Yes ☐ No
Areal extent___________________________ Depth________________________________

Photograph Attached ☐ Yes ☐ No
Corrective measures implemented to rectify holes ☐ Yes ☐ No ☐ N/A

Remarks:____

5. Vegetative Cover ☐ Yes ☐ No

Type (grass, trees, etc.) trees, shrubs, low ground cover
Cover properly established ☐ Yes ☐ No
Has vegetation damaged cover? ☐ Yes ☐ No
Photograph Attached ☐ Yes ☐ No
Corrective measures implemented to rectify cover ☐ Yes ☐ No ☐ N/A

Remarks:____

6. Alternative Cover (armored rock, etc.) ☐ Yes ☐ No
Has cover been damaged? ☐ Yes ☐ No
Photograph Attached ☐ Yes ☐ No
Corrective measures implemented to rectify cover ☐ Yes ☐ No ☐ N/A

Remarks:____

7. Wet Areas/Water Damage ☐ Yes ☐ No

Wet areas Areal extent

Ponding Areal extent

Seeps Areal extent

Soft subgrade Areal extent

Other Areal extent
Photograph Attached ☐ Yes ☐ No
Corrective measures implemented to rectify conditions ☐ Yes ☐ No ☐ N/A

Remarks:____

VII. GROUNDWATER/SURFACE WATER REMEDIES

☐ Applicable ☐ N/A

**If deficiencies are noted, the locations should be documented on a site map and with photos.*

A. <u>Groundwater Wells, Pumps, and Pipelines</u> ☐ Applicable ☐ N/A

1. Monitoring Wells

Properly secured/locked? ☐ Yes ☐ No
Damaged? ☐ Yes ☐ No
Maintenance Needed? ☐ Yes ☐ No
All required wells located ☐ Yes ☐ No
Routinely Sampled? ☐ Yes ☐ No
Abandoned well(s) ☐ Yes ☐ No

List abandoned well(s)____

Remarks:____

B. <u>Surface Water Collection Structures, Pumps, and Pipelines</u> ☐ Applicable ☐ N/A

1. Collection Structures, Pumps, and Electrical

Damaged? ☐ Yes ☐ No ☐ N/A

Remarks:____

2. Surface Water Collection System Pipelines, Valves, Valve Boxes and Other Appurtenances

Damaged? ☐ Yes ☐ No ☐ N/A

Remarks:____

C. <u>Groundwater Monitoring</u> ☐ Applicable ☐ N/A

1. Monitoring Data

Is routinely submitted on time ☐ Readily available ☐ Up to date ☐ N/A
Is of acceptable quality ☐ Readily available ☐ Up to date ☐ N/A

Remarks:____

2. Groundwater Monitoring Record ☐ Readily available ☐ Up to date ☐ N/A

Remarks:____

3. Monitoring data suggests:

Groundwater plume is effectively contained ☐ Yes ☐ No ☐ N/A
Contaminant concentrations ☐ Increasing ☐ Decreasing ☐ N/A
Plume has moved offsite ☐ Yes ☐ No ☐ N/A
Other ☐ Yes ☐ No ☐ N/A

Remarks: ____

VIII. OTHER REMEDIES

☐ Applicable ☐ N/A

**If deficiencies are noted, the locations should be documented on a site map and with photos.*

If there are remedies applied at the sites, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the corrective action. An example would be soil vapor extraction.

Remarks: ____

____

____

____

____

____

____

____

____

IX. OVERALL SITE OBSERVATIONS

A. Implementation of the Corrective Action

Describe issues and observations relating to whether the corrective action is effective and functioning as designed. Begin with a brief statement of what the corrective action is to accomplish (e.g., to contain plume, minimize infiltration and gas emissions).

Remarks:

B. Adequacy of O&M

Do you think the corrective action is effective? ☐ Yes ☐ No

Remarks:____

C. Evaluation of Land Use Controls (LUCs) ☐ Applicable ☐ N/A

1. **Implementation and Enforcement**

Site conditions imply LUCs not properly implemented ☐ Yes ☐ No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☐ No ☐ N/A

Remarks:____

D. Reporting

Reporting is up-to-date? ☐ Yes ☐ No ☐ N/A
Has there been a property conveyance since last inspection? ☐ Yes ☐ No

If yes, attach copy of property conveyance documents

Reports are verified by the lead agency?	☐ Yes	☐ No	☐ N/A
Specific requirements in deed or decision documents met?	☐ Yes	☐ No	☐ N/A
Violations have been reported?	☐ Yes	☐ No	☐ N/A

Other problems or suggestions:____

Report attached:____

E. Early Indicators of Potential Corrective Action Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unexpected repairs, which suggest that the protectiveness of the corrective action may be compromised in the future.

Remarks:
____

____

____

____

____

____

X. CONTACT INFORMATION
A. Inspector **Name (print)** ______________________________ **Signature** ______________________________ **Date** ______________________________
B. Responsible Party **Name (print)** ______________________________ **Signature** ______________________________ **Date** ______________________________

KEMRON ENVIRONMENTAL SERVICES

1359-A Ellsworth Industrial Boulevard Atlanta, GA 30318 Telephone (404) 636-0928 FAX (404) 636-7162 http://www.kemron.com

Soil/Sediment Sampling Log

Site Name:

Site Location:

Date:/ Time:

Weather Conditions:

Water Depth above sample (ft):

Water Flow/Parameters:

Sample ID:

Sample Location:

Cove/Water Body:

Sample Coordinates:

Sampled By (Sign & Print):

Sample Type (circle): Grab Composite Incremental Other:

MS/MSD: Yes No MS/MSD ID:

Duplicate: Yes No Duplicate ID:

Depth		Collection Device/Sampling Method	Soil/Sediment Classification (Color, Texture, Odor, pH, etc.)	Remarks
From	To			

Sample and Container Information					
Analysis	Container Type	Volume	Preservation	No. of Containers	Remarks

Collection Device/Sampling Method: HA=Hand Auger, GS=Grab Sampler, CS=Core Sampler

Container Type: CG = Clear Class, AG = Amber Glass

APPENDIX B:
UIC Permit

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

For EPD Use Only
Permit No.:___________

Wastewater Regulatory Program
New Facility

SECTION I. PERMIT TYPE	
Please check the applicable box	
Domestic/Municipal Wastewater	**Industrial Wastewater**
Individual Permit	**Individual Permit**
☐ 2A – Municipal Domestic Wastewater Discharge	☐ 2B – Concentrated Animal Feeding Operation (CAFO) and Aquatic Animal Production
☐ 2E – Non-Process Sanitary/Domestic Wastewater	☐ 2D – New Sources & New Dischargers
☐ Domestic/Municipal Land Application System	☐ Industrial Pretreatment
	☐ Industrial Land Application System
General Permit	**General Permit**
☐ Land Application System GP for Large Community Systems (Permit No. GAG278000)	☐ NPDES GP for Settlement Pond Discharge from Sand & Gravel Dredgers (Permit No. GAG100000)
☐ NPDES GP for Private and Institutional Development Water Pollution Control Plant Activities (Permit No. GAG550000)	☐ NPDES GP for Once-Through Non-Contact Cooling Water with No Additives (Permit No. GAG200000)
☐ NPDES GP for Reclaimed Water Discharges Associated with the City of Pooler, Georgia (Permit No. GAG600000)	☐ NPDES GP for Mining and Processing Facilities (Permit No. GAG300000)
☐ Land Application System GP for Land Disposal of Domestic Septage (Permit No. GAG620000)	☐ CAFO General Permit for LAS Medium: 301-1000 AU (Permit No. GAG920000)
☐ NPDES GP for Drinking Water Treatment Plant Filter Backwash (Permit No. GAG640000)	☐ NPDES-CAFO General Permit for Individual Discharge (Permit No. GAG930000)
☐ NPDES GP for Discharges of Pesticide Applications to Waters of the State (Permit No. GAG820000)	☐ CAFO General Permit for LAS: Large >1000 AU (Permit No. GAG940000)
Underground Injection Control	
☑ Class V Injection Well Permit	☐ Class V Mixed Waste Nondomestic Septic System

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

SECTION II. APPLICANT & FACILITY INFORMATION

Applicant Organization/Legal Name: Directorate of Public Works, Environmental Prevention & Compliance Branch

Applicant Mailing Address: 1550 Veterans Parkway, Bldg 1137

City: USAG Fort Stewart	State: GA	Zip Code: 31314	County: Liberty

Facility Name: HAA-15, Hunter Army Airfield, MCA Barracks Site Area

Facility Address: 1550 Veterans Parkway, Building 1137

City: USAG Fort Stewart	State: **GA**	Zip Code: 31314	County: Liberty

Facility Site Coordinates (ex. 34.545263, -84.885404): 32deg01'31"N, 81deg08'06"W

River Basin: Little Ogeechee River

If there are any other wastewater permits associated with this facility provide the corresponding permit no. and check the applicable box(s).

Associated Permit No.:

☐ Switched to an individual permit ☐ Effluent trade partner ☐ Other
☐ Switched from a Land Treatment System ☐ Switched to a General Permit

SIC Code(s) in order of priority:
1. 9711 2. 3. 4.

NAICS Code(s) in order of priority:
1. 928110 2. 3. 4.

SECTION III. CONTACT INFORMATION

Contact Affiliation Type:
☑ Owner Contact ☐ Contractor ☐ Permit Contact ☐ Engineer ☐ Project Contact ☐ Unknown

First Name: Tavy	Last Name: Wade	Title: Remediation Section Leader

E-mail Address: tavy.j.wade.civ@mail.mil	Phone No.: 912-315-5144

SECTION IV. LIST ADDITIONAL PERMITS ISSUED BY EPD

Provide the name and permit nos. for all permits issued to this facility

Name of Permit	Permit No.

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

SECTION V. NATURE OF BUSINESS

1. Describe the nature of your business:

HAA-15 currently includes administrative buildings, commercial/industrial use buildings, and a 10-acre retention pond (Pond 29). The area around Pond 29 includes a maintained area of oak trees and green space designated for recreational use. HAA-15 will remain a commercial/industrial use property, with no current plans for future conversion to permanent residential use. Environmental Investigations at HAA-15 identified chlorinated volatile organic compounds (CVOCs) in groundwater and lead, arsenic, and poly aromatic hydrocarbons (PAHs) in soil. Remediation at HAA-15 will consist of Enhanced Reductive Dechlorination (ERD) to enhance mass removal associated with CVOCs, MNA for remaining contaminants, onsite land use controls (LUCs) preventing installation of potable wells within or downgradient to the source areas, and CERCLA five-year reviews.

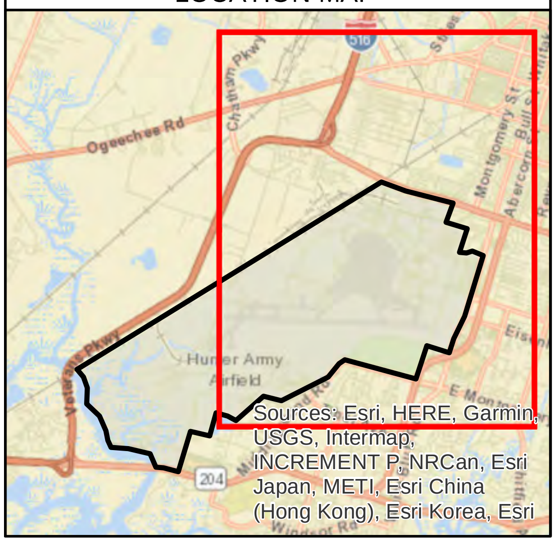
2. Describe the wastewater treatment process (if known):

Not Applicable

3. Additional information:

HAA-15 is an Operable Unit (OU) within HAAF, managed under CERCLA by the Army with regulatory oversight by the GA EPD.

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17 N (feet)

LEGEND

Installation Boundary

HAA-15

0 1,000 2,000 3,000 4,000

Feet

TITLE

Hunter Army Airfield
MCA Barracks Site HAA-15
Site Location

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

DRAWING DATE: 10/18/21

Drawn by:	Reviewed by:
CJ	JB

N

FIGURE

1

Document Path: L:\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Hunter Army Airfield\MXDs\HAA-15\UIC-topo-HAA15.mxd

APPENDIX C:
SOPs

Technical Procedure: FSOP-002
Revision: 02

STANDARD OPERATING PROCEDURE FOR FIELD QUALITY CONTROL

KEMRON Environmental Services, Inc.
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Leland Meadows, Technical Advisor — 08/27/2019 Date

John Dwyer, President — 08/27/2019 Date

VERSION CONTROL

Version	Changes	Affects Section	Effective Date
00	NA	Entire Document	08 November 2004
01	Review for content, technology and methods, and quality control.	Entire Document	October 2014
02	Review for content, technology and methods, and quality control.	Entire Document	26 August 2019

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LIST OF APPENDICES

1 POLICY

KEMRON personnel will follow this procedure in conjunction with both project specific guidance and field procedures to determine which quality control samples are necessary and technical collection procedures.

1.1 Precautions

Proper safety precautions must be observed when collecting environmental samples. Refer to the KEMRON Corporate Environmental Health and Safety (EHS) Manual and any site-specific Health and Safety Plans (HASP) or Accident Prevention Plan (APP) for guidelines on safety precautions.

2 PURPOSE

Following this procedure will ensure that the quality control samples collected will be collected in a consistent manner.

3 SCOPE

This SOP provides basic procedures for collecting various types of quality control samples. This SOP applies to KEMRON personnel and subcontractors collecting quality control samples for KEMRON projects. Client, federal, or state requirements, or project-specific requirements may dictate specific types of equipment or procedures to be used when applying this SOP to a particular project. Deviations from this SOP to accommodate site-specific requirements shall be documented in project planning documents and Appendix A and approved by the KEMRON Quality Assurance / Quality Control (QA/QC) Manager or client representative where applicable, prior to the performance of work

4 RESPONSIBILITY

Project Manager Responsibilities
The KEMRON Project Manager ensures that any project specific deviations from this procedure will be provided to the Field Staff.

Field Staff Responsibilities
The KEMRON field staff will follow procedures specified in this SOP unless written site-specific protocol is provided by the Project Manager.

5 DEFINITIONS

- **Background Sample**: A sample (usually a grab sample) collected from an area, water body, or site similar to the one being studied, but located in an area known or thought to be free from pollutants of concern.

- **Construction water blanks**: A sample of the water used to mix or hydrate construction materials such as monitoring well grout.

- **Control Sample**: A sample with pre-determined characteristics which undergoes sample processing identical to that carried out for test samples and that is used as a basis for comparison with test samples. Examples of control samples include reference materials, spiked test samples, method blanks, dilution water (as used in toxicological testing), and control cultures (i.e., samples of known biological composition).

- **Deionized Water Blank**: A sample collected from a field deionized water generating system. The purpose of the deionized water blank is to measure positive bias from sample handling variability due to possible localized contamination of the deionized water generating system or contamination introduced to the sample containers during storage at the site.

- **Duplicate Samples**: One of two samples taken from the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are independent samples which are collected as close as possible to the same point in space and time (co-located). They are two separate samples taken from the same source, stored in separate containers, and analyzed independently. These duplicates are useful in documenting the precision of the sampling process.

- **Equipment Field Blank**: An equipment field blank is used to determine if contaminants have been introduced by contact of the sample medium with sampling equipment. Equipment field blanks are often associated with collecting rinse blanks of equipment that has been decontaminated.

- **Field Blank**: A sample that is prepared in the field to evaluate the potential for contamination of a sample by site contaminants from a source not associated with the sample collected (for example air-borne dust or organic vapors which could contaminate a soil sample).

- **Filter Pack Blanks**: A sample of the material used to create an interface around the screened interval of a monitoring well.

- **Grout Blanks**: Grout blanks are a sample of the material used to make seals around the annular space in monitoring wells.

- **Material Blank**: A sample of sampling materials (e.g., material used to collect wipe samples, etc.), construction materials (e.g., well construction materials), or reagents (e.g., deionized water generated in the field, water from local water supplies used to mix well grout, etc.) collected to measure any positive bias from sample handling variability. Commonly collected material blanks are listed below:

- **Preservation Blank**: A preservation blank is a sample that is prepared in the field and used to determine if the preservative used during field operations was contaminated, thereby causing a positive bias in the contaminant concentration.

- **Quality Control (QC) Samples**: Samples are collected during field studies for various purposes which include the isolation of site effects (control samples), define background conditions (background sample), evaluate field/laboratory variability (spikes and blanks, trip blanks, duplicate or replicate samples, split samples).

- **Replicate Samples**: Multiple samples taken within each combination of time, location, and any other controlled variables. The purpose of collecting replicate samples is to obtain precision (i.e., the special and temporal variations, plus variance introduced by sampling and analytical procedures). If the area sampled has a large-scale environmental pattern, it should be broken up into relatively homogeneous sub-areas, and sample collections should be proportioned according to the size of each sub-area. Replicate samples of three or more are most commonly collected during incremental sampling, which is intended to provide a more precise population mean in cases of heterogeneous contamination. Incremental field replicates are collected from the same decision unit (DU) during the same sample time interval. However, incremental replicates are not co-located and may be collected in the following fashions: systematic random (serpentine fashion), random within grids, or simple random within the DU.

- **Spikes**: Spikes, also known as proficiency test (PT) samples, are a sample with known concentrations of contaminants. Spike samples are often packaged for shipment with other samples and sent for analysis. Sample containers must remain closed before they reach the laboratory. Spiked samples are used to measure bias due to sample handling or analytical procedures.

- **Split Sample**: Split samples are obtained by dividing one sample into two or more identical sub-samples. If analyzed at the same laboratory, they are used to check on the reproducibility of the method or the laboratory performing the analyses. If analyzed at different laboratories they are used to ensure units from the two laboratories are comparable. Obtaining accurate splits from non-homogeneous or multi-layered samples is often very difficult and must be done with great care to ensure splits of equal composition.

- **Temperature Blank**: A temperature blank is a container of water shipped with each cooler of samples requiring preservation by cooling to ≤ 6°C (ice). The temperatures of the blanks are measured at the time of sample receipt by the laboratory.

- **Trip Blanks**: A trip blank is prepared at the time of the sample kit preparation (by lab or field office) and remains unopened until analysis. Trip blanks indicate if volatile contamination in the environment of container / sample handling is affecting the associated volatile samples.

- **Wipe Sample Blanks**: A sample of the material used for collecting wipe samples

6 PREPARATION OF FIELD QUALITY CONTROL (QC) SAMPLES

The following procedures are basic procedures, should be used in conjunction with the field SOP and may not apply to a particular project. Project documents will specify what types of QC are necessary.

6.1 Control Sample

- Collect the control sample in the same way a study sample is collected, i.e., composite, grab, etc. and using the same equipment.
- Handle the control sample in the same way a study sample is collected, i.e., container, labeling, preservation.

6.2 Background Sample

- Collect the background sample in the same way a study sample is collected, i.e., composite, grab, etc. and in the area prescribed by the project documents.
- Handle the background sample in the same way a study sample is collected, i.e., container, labeling, preservation.

6.3 Split Sample

- Collect a study sample which is approximately double in size than what is normally used.
- Homogenize the sample.
- Split the sample into two portions.
- Aliquot each portion in the appropriate sample containers with the appropriate preservation.

- Ship one portion of the split sample with the batch of samples to the laboratory prescribed in the project documents and ship the second portion to a second laboratory as prescribed in the project documents.

Note: Split samples are not collected for volatiles.

6.4 Duplicate or Replicate Sample

- Collect additional study sample(s) from the same location / area / bucket in the same manner as that of the study sample.
- Handle the control sample in the same way a study sample is collected, i.e., container, labeling, preservation.
- If incremental samples are being collected, all replicate sample increments should be collected in the same decision unit and in the same manner. However, increments collected as a part of separate replicate samples should not be co-located. See Section 5 of the Interstate Technology Regulatory Counsel's (ITRC) Incremental Sampling Guidance for examples of increment collection methodologies.

6.5 Trip Blank

Trip blanks are prepared at the time of sample kit preparation which may occur at the laboratory or the field office.

- Fill a VOA vial full with deionized water, cap and ensure that there are no air bubbles.
- Transport the unopened trip blank with the sample kit to the field.
- Transport the unopened trip blank with the samples to the laboratory for analysis

Note: The trip blank is analyzed for volatile organic compounds.

6.6 Spikes

Spikes are generally prepared at the laboratory prior to analysis; however, there are occasions where the project may require field prepared spike samples.

- Purchase or prepare a spike or proficiency test sample as stated in the project documents. Prepare a spike sample by fortifying a background sample with the target analytes of interest. Prepare an unfortified background sample also.
- Submit the spike sample, and background sample as necessary, to the laboratory for analysis as a "blind" sample.
- Evaluation occurs upon receipt of the sample results.

6.7 Equipment Blanks

- Bring extra deionized water to the field.
- Pour deionized water over the sampling equipment following equipment cleaning and collect in an appropriate sample container.
- Handle the sample container in the same fashion as an aqueous sample is handled, i.e. container, preservation, etc.
- Collect enough equipment blanks to analyze for all the target analytes of interest or as stated in the project documents.
- Transport the sample to the laboratory for analysis with the samples.

6.8 Temperature Blanks

- Fill a small container with water. (Sample kits should already contain a temperature blank).
- Transport the temperature blank with the samples to the laboratory.
- Provide a temperature blank with each cooler or sample transport container.

6.9 Preservative Blanks

- Prepare a preservative blank at the appropriate stage and in the frequency as stated in the project documents.
- Bring extra deionized water to the field.
- Fill the same type bottle used for sample collection with deionized water
- Add the appropriate type and amount of chemical preservative.
- Transport the sample to the laboratory with the samples.

6.10 Field Blanks

- Bring extra deionized water to the field.
- Pour the water into the appropriate sample containers at pre-designated locations at the site, according to project documents.
- Collect in dusty environments and/or from areas where volatile organic contamination is present in the atmosphere and originating from a source other than the source being sampled.
- Add the appropriate chemical preservative according to the analysis.
- Transport the sample to the laboratory with the samples.

6.11 Wipe Sample Blanks

- Bring extra wipe samples to the site.
- Handle, package and transport unused wipe material as that for wipes used for sampling.

6.12 Grout Blanks

- Take a sample of the grout used to seal the monitoring well.
- Place in a suitable container and transport to the laboratory.

6.13 Filter Pack Blanks

- Take a sample of the filter pack used in assembling of the monitoring well.
- Place in a suitable container and transport to the laboratory.

6.14 Construction Water Blanks

- Take a sample of the water used in preparing construction materials.
- Place in a suitable container and transport to the laboratory.

6.15 Deionized Water Blanks

- Take a sample of the water generated from the field deionized water source at the end of sampling activities or in intervals as stated in the project documents.
- Take the sample in clean environment so external conditions are not affecting the sample.
- Place in a suitable container and transport to the laboratory.

7.0 REFERENCES

- Operating Procedures for Field Sampling Quality Control, SESD-PROC-011-R4, USEPA, Region 4, February 2013.
- Interstate Technology Regulatory Counsel, Incremental Sampling Guidance, February 2012.

Appendix A: Request for Deviations

Deviation to FSOP-002: STANDARD OPERATING PROCEDURE FOR FIELD QUALITY CONTROL

Description of Deviation
1.
2.
Need for Deviation
1.
2.
Corrective Action Taken
1.
2.

Approved by:

Name: Signature:
KEMRON Project Manager Date

Name: Signature:
KEMRON QA/QC Manager Effective Date

- OR -

Name: Signature:
Client Representative Effective Date

Appendix B: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Standard Operating Procedures

Technical Procedure: FSOP-200
Revision: 02

STANDARD OPERATING PROCEDURE FOR FIELD DOCUMENTATION

KEMRON Environmental Services, Inc.
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Leland Meadows

Leland Meadows, Corporate QA/QC Manager — 08/15/19 Date

John Dwyer, President — 08/15/19 Date

VERSION CONTROL

Version	Changes	Affects Section	Effective Date
00	N/A		08 November 2004
01	Review for content, technology and methods, and quality control.	Entire Document	08 November 2014
02	Review for content, technology and methods, and quality control.	Entire Document	19 August 2019

TABLE OF CONTENTS

LIST OF APPENDICES

1 POLICY

This standard operating procedure (SOP) discusses the documentation of KEMRON field activities. The extent of the documentation is such that activities can be recreated either through real time note taking or through reference to other documents and/or logbooks. Logbooks shall have the KEMRON home office address and phone number, toll free if available written on the inside of the front cover. Appendix B contains a sign-off sheet documenting each employee's review of the SOP.

2 PURPOSE

This SOP establishes the field documentation procedures required at KEMRON.

3 SCOPE

The technical documentation addressed in this procedure applies to field activities that KEMRON directly participates in or where project over-site is provided by KEMRON. Client, federal, or state requirements, or project-specific requirements may dictate specific types of equipment or procedures to be used when applying this SOP to a particular project. Deviations from this SOP to accommodate site-specific requirements shall be documented in project planning documents and Appendix A as approved by the KEMRON Quality Assurance / Quality Control (QA/QC) Manager or client representative where applicable, prior to the performance of work.

4 RESPONSIBILITY

Project Manager Responsibilities
The KEMRON Project Manager ensures that a specific field investigation is performed in accordance with this procedure and project-specific requirements.

Site Manager Responsibilities
Designated by the Project Manager, the Site Manager is to be responsible for and present during activities related to the collection of samples by a specific sampling team.

Field Technician Responsibilities
The KEMRON field technician(s) follow the applicable steps as stated in this procedure, in the site specific Health and Safety Plan, and as directed by the Project Manager.

Subcontractors
Subcontractors are secured under contract and required to meet local, state, and federal requirements (i.e., 29 CFR 1910.333(c)(3); 29 CFR 1926.550(a)(15)(i), (ii), (iii)).

5 FIELD DOCUMENTATION

The two types of field documentation routinely completed at KEMRON include bound notebooks and field data sheets. Specific types of field data sheets may be required by the client. If so, those forms are used in place of any generic field sheets used by KEMRON.

5.1 Bound Field Logbooks

Bound field logbooks are assigned to the job or job tasks for larger/multiphase work. The front of each logbook will state "KEMRON", book number, project name, project number, and start/end dates for the logbook. The spine of the logbook will contain the following minimally: project number and start and end dates. Field notes recorded in bound notebooks will be recorded with a ball point pen, on all- weather bound environmental field notebooks with consecutively numbered pages. See section 7 for information to be recorded. Upon completion of the field effort and data entry and entry review (see section 7.3) the logbooks should be copied or scanned and are immediately placed in a central project location for retrieval by other KEMRON personnel. Typically this would be the project file in the office.

5.2 Field Data Sheets

When field data sheets are used a reference to the frequency of site visits is established by either of the following: (1) client/work agreement (i.e., take data every month); or (2) the data sheets are referenced in a bound logbook. When referenced in a bound notebook, the date, time, number of pages and description of the content of the field data sheets is included. Recorded notes are made with a ball point pen. If multiple field data sheets are used for any given site visit, the pages are numbered using the following format: "page 1 of 3, page 2 of 3, page 3 of 3" in a conspicuous location on each data sheet. Ensure correct study area designation and sample numbers; date and time (24-hour system recordings); and ensure that any unused portion of the data sheet and/or bound logbook is lined out, initialed and dated.

6 QA/QC OF FIELD DOCUMENTATION

6.1 Making Corrections

If an entry is in need of a correction, the erroneous information is crossed out with a single strike mark and initialed and dated, where the correction is recorded as near to the error as possible.

6.2 Field Staff

The field staff who collected the data signs and dates the daily entry in the bound notebook or field data sheet(s). This is completed the day the data is entered.

6.3 Independent Reviewer

Each set of collected data is reviewed and signed by an independent reviewer. The review is completed as soon as possible following data collection. At a minimum, documentation and validity of the following items should be verified (will be dependent on type of field activity): correct study area designation and sample numbers; date and time (24-hour system recordings); and ensure that any unused portion of the data sheet and/or bound logbook is lined out, initialed and dated.

7 TYPES OF FIELD DOCUMENTATION AND PROCEDURES

7.1 General Field Documentation

Field log books or documentation forms must include, at a minimum, the following information:

a. Page heading to include location, date, project/client (for easy reference when copying)
b. Name of individuals and contractors on-site
c. Purpose of the sampling event
d. Time onsite and offsite
e. Parties involved (list individuals and companies)
f. Vehicle (type, function, etc.)

g. Weather and site conditions (to include temperature, humidity, barometer, wind dir/speed, rainfall)
h. Documented review of Health and Safety Plan and any specific topics discussed
i. Detailed descriptions of sample locations that identify the area of concern (make references to maps, GPS location, redlines, manmade objects, terrain, site history, etc.)
j. Any field equipment used, including make/model and calibration documentation
k. Any equipment decontamination and maintenance completed in the field and reference to who completed the decontamination and field maintenance if other than the field staff and when it was completed
l. Collected field measurements (PID /OVA, pH, temperature, etc.). If data is recorded on a field form, the logbook should reference that field measurements are documented in on the field form
m. Sample number, samplers signature, fractions sampled, date sampled, time (military format) sampled and preservation method for each sample
n. Identification and types of QC samples collected
o. Photographic information
p. Reference to and summary of information on any field data sheets
q. Carrier number used for shipping (e.g. FedEx number), if applicable
r. Cross through any remaining empty portions of page(s) at conclusion of entries with initials in crossed area
s. A daily summary at the end of each field day documenting the samples collected on that day
t. Number pages and sign

7.2 Sample Identification

The method for determining the sample identification may be specified in a site-specific Sampling Analysis Plan (SAP) or Quality Assurance Project Plan (QAPP). If one of these documents exists for a given project, then sample identification should follow the identification procedure specified in those documents. If a sampling identification scheme is not provided in a site-specific document, such as a SAP/QAPP or a Work Plan, then the following guidelines should be followed:

Every sample will be given a unique sample designation for identification purposes. The numbering system will be coordinated with the Field Team Leader and the Field Staff to ensure that the proposed sample identifiers are discrete. The sample identification will be a series of letters and numbers consisting of three (3) or four (4) character strings, identifying the specific sample as follows:

The following is an example sample numbering system:

NN-#-SD-MMDDYY

Where:

- NN is the media, well or boring ID, such as
  - SS = surface soil,
  - SB = subsurface soil,
  - SED = sediment,
  - SW = surface water, or
  - Site-specific boring or well ID as specified in project plans (e.g. B-1)
- # = the location number of the sample
- SD is the depth of the sample below ground surface
- MMDDYY is the date of sample collection (month/day/year)

For example: Sample No. SD-801-1-081519

This is a sediment sample from location number 801. This is the surficial sample taken to a depth of approximately 0 -1 ft. collected the 8th of August, 2019.

Logbooks, sample labels or tags, custody seals, representative sampling documents, and chain-of-custody documents will be completed using these sample designations. QC samples will be assigned unique sample designations in the same way as field samples. A two (2)-character designation will be added at the end of the sample number to identify the QC samples in the field logbook as described below:

QC = Quality Control sample (MS/MSD);
RB = Rinsate Blank sample;
FB = Field Blank; and
TM = Temperature Blank.

The additional two (2)-character QC designation will not be placed on the sample jars or the Chain-of-Custody Record; therefore, the QC samples will not be identified as such to the laboratory.

Trip blank samples will be included in each cooler container volatile organic analysis samples and will be identified as follows:

TB-MMDDYY-#

Where:

- TB = Trip Blank
- MMDDYY is the date of sample collection (month/day/year)
- # = sequential number when multiple trip blanks are submitted in one day

7.3 Sample Labels

A sample label will be attached to each sample container and completed legibly with indelible ink. The sample labels will be affixed to the sample bottles. The labels will identify the name and initials of the sample collector, date and time of sample collection, place of collection, sample number, analysis required, preservatives added; and designation between grab and composite samples. Grab samples are individual soil samples and duplicate samples collected from one (1) location at one (1) time. Composite samples are grab samples that are combined and homogenized representing several locations collected at different times.

7.4 Laboratory Analytical Test Methods

The laboratory analytical test method may have multiple versions that indicate a slight variation in the analytical test method, such as the limit of detection. It is the responsibility of the Field Team Leader to ensure the Field Sample Custodian records the proper analytical test methods in the log book, sample label, and chain of custody. The specific method number version is identified in the project SAP/QAPP or Work Plan.

7.5 Chain of Custody

Chain-of-custody procedures include the following key functions: 1) maintaining custody of samples, and 2) documentation of the chain-of-custody. A sample is considered in Custody when it is in the possession of the sampler, in view of the sampler, or placed in a secured area where the samples cannot be tampered.

The Chain-Of-Custody Record (COC) is used to ensure sample integrity and to document the samples were maintained by the sampler. The COC documents transfer of sample custody from the field sample custodian to another person, to the laboratory or other organizational elements. The COC also serves as a sample logging mechanism for the laboratory sample custodian. A separate COC should be completed for each final destination or laboratory used during the investigation and for each cooler of samples.

The Field Sample Custodian must pay particular attention to the number of samples per COC to ensure samples listed on the COC can fit into the cooler, once packed with ice. Once the Field Sample Custodian has determined that no additional samples can be placed into a cooler, then a new COC should be prepared for the next cooler shipment. The COC is completed when samples are packaged in the cooler for transfer. The COC number should be cross-referenced in the field logbook.

The COC should have a unique ID and include the following information (an example COC is included in Appendix B):

- Project and Contact Information
  - Project No./Phase/Task Code
  - Project Name
  - Project Location
  - Project Contact (PM or Chemist)
  - Sampler(s)
- Laboratory Information
  - Laboratory Name
  - Lab Location
  - Lab Contact
  - Subcontract Agreement No.
- Sample and Analysis Information
  - Sample ID
  - Sample date
  - Sample time
  - Sample Type – Matrix, Grab or Composite
  - Container quantity and preservative
  - Analysis Requested
  - MS/MSD designation
  - Turnaround time (TAT)
- Sample Transfer
  - Carrier/Courier
  - Airbill No.
  - Date Shipped
  - Relinquished by/Received by sign offs

Whenever possible, a secondary review of the COC versus the sample labels should be completed to verify proper sample ID, date, time and analysis are recorded on the COC.

7.5.1 Sample Packing and Transfer Chain-of-Custody

Prior to sample collection, bags of ice should be purchased and place within the cooler so that once a sample has been collected and recorded in the logbook and on the COC, it is placed in the chilled cooler. Samples collected during field investigations or in response to a hazardous materials incident are classified prior to shipment, as either environmental or hazardous materials samples. Please refer to the SOP for Sampling Packing and Shipping (FSOP-300) for specific details. Once the samples are properly packaged, the samples are taken to a facility for shipment to the analytical laboratory.

All samples will be accompanied by the laboratory copy of the COC. If pre-printed forms are used, the white and pink sheets will be sent with the samples and the white sheet will be kept. When shipping samples via common carrier, such as FedEx, the "Relinquished By" box should be filled in and the "Received By" box should be left blank. The laboratory receiving staff will be responsible for receiving the custody of the samples and will fill in the "Received By" section of the COC, once the shipment arrives at the laboratory. After samples have been received and accepted by the laboratory, a sample receipt notification (SRN) will be emailed to the Project Manager to review the samples received by the laboratory. The field personnel should ensure the Project Manager obtains the field copy of the COC and field notes so that the SRN from the laboratory can be reviewed.

7.6 Equipment Maintenance and Calibration Logbooks

For KEMRON-owned equipment, each piece of equipment has an assigned logbook which remains at the central facility (regional office or site office). The equipment serial number cross-references the equipment with the logbook. Maintenance and calibration information is included in the logbook(s). Any maintenance and/or calibration that are completed in the field is recorded first in the field log and then transcribed to the equipment maintenance & calibration logbook upon returning to the office / site office.

7.7 Survey Documentation

7.7.1 Laser Level and Rod Surveying

For surveying well heads, the following are examples of what can be recorded:

a. The benchmark can be a true known elevation or an assumed elevation of 100.0 labeled as TBM (Temporary Benchmark).
b. The Back Sight (BS) is the rod reading taken from the known benchmark or the arbitrary benchmark established as 100.0'.
c. The Back Sight rod reading is simply added to the benchmark elevation to establish the Height of Instrument.
d. The Fore Sight (FS) rod readings are those rod readings taken from unknown elevation points.
e. Establish the elevations of previously unknown points by subtracting the FS rod readings from the HI.
f. A Turning Point (TP) is a newly surveyed point that becomes a new benchmark once the instrument is moved.
g. The above example shows MW-3 becoming a Turning Point (TP 1) as the instrument needed moved to get a line of site on the final two points.
h. Once the instrument is moved a new HI is established by simply taking a rod reading (BS) on your TP.

The above information can be recorded in columns in the logbook with the following column headers: Station ID, BS (+) Rod Reading, HI (height of Instrument), FS (-) Rod Reading, and Elevation.

Station ID	BS (+) Rod Reading	HI (Height of Instrument)	FS (-) Rod Reading	Elevation
Benchmark (BM)	4.5	673.15		668.65
MW-1			4.70	668.45
MW-2			5.25	667.90
MW-3			3.50	669.65
Turning Point (TP 1)	6.5	676.15		669.65
MW-4			5.65	670.50

MW-5			5.50	670.65

7.7.2 Surveying Using GPS

The GPS unit models range in accuracy and the appropriate model will be selected by the Project Manager.

The Project Manager will identify the GPS unit model, coordinate system, datum, and units to be used for a specific project. The GPS user will verify that the information is correctly stored in the GPS unit. If the Project Manager has specific points that need to be located in the field, waypoints may need to be loaded into the GPS. Prior to leaving for the site, make sure the waypoint file is loaded into the GPS unit and is correct. Configure GPS per manufacturer instructions.

After collecting information in the field and before leaving, make sure the information collected in the GPS unit is correct and can be viewed in the Map tab. Recheck that the GPS configuration correct. Close the file on the GPS unit. Download GPS files to a computer after each day of data collection. On multiple day projects, make sure to email the Project Manager the file after every day of work.

7.8 Photographic Records

Digital photographs will be maintained in digital files and/or a photo record book in the project file. Film photographs will be maintained in the project file. The number and subject of photographs (digital and film) will be recorded in the field logbook(s) and, if necessary, cross-referenced to the photographic logbook, which may be used for larger projects. The entries identify the photographs with the following information:

- The project #, date, time, and location of the photograph, including direction facing;
- The name of the photographer
- The signature of the photographer.

Appendix A: Request for Deviations

Deviation to FSOP-200: STANDARD OPERATING PROCEDURE FOR FIELD DOCUMENTATION

Description of Deviation
1.
2.
Need for Deviation
1.
2.
Corrective Action Taken
1.
2.

Approved by:

Name: Signature:
KEMRON Project Manager Date

Name: Signature:
KEMRON QA/QC Manager Effective Date

- OR -

Name: Signature:
Client Representative Effective Date

Appendix B: Example Chain-of Custody Record

KEMRON

CHAIN-OF-CUSTODY RECORD

1 COC NUMBER:

2 PROJECT NAME:	5 PROJECT NUMBER:	8 LAB NAME AND CONTACT:	11 FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 1 (Name and Company)	14 RECIPIENT 1 (Address, Tel No., and Fax No.):
3 PROJECT PHASE/SITE/TASK:	6 CTO OR DO NUMBER:	9 LAB PO NUMBER:	12 FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 2 (Name and Company)	15 RECIPIENT 2 (Address, Tel No., and Fax No.):
4 PROJECT CONTACT:	7 PROJECT TEL NO AND FAX NO:	10 LAB TEL NO AND FAX NO:	13 FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 3 (Name and Company)	16 RECIPIENT 3 (Address, Tel No., and Fax No.):

17 ITEM	18 SAMPLE IDENTIFIER	19 SAMPLE DESCRIPTION/LOCATION	20 MATRIX (see codes on SOP)	21 DATE COLLECTED	22 TIME COLLECTED	23 DATA PKG LEVEL (see codes on SOP)	24 TAT (calendar days)	25 ANALYSES REQUIRED (Include Method Numbers)	26 SAMPLE TYPE (see codes on SOP)	27 COMMENTS/ SCREENING READINGS	28 LAB ID (for lab's use)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

29 SAMPLER(S) AND COMPANY: (please print)	30 COURIER AND SHIPPING NUMBER:	31 SAMPLES TEMPERATURE AND CONDITION UPON RECEIPT (for lab's use):

32 RELINQUISHED BY	DATE	TIME	33 RECEIVED BY	DATE	TIME
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		

Distribution: [ ] Original - Laboratory (To be returned with Analytical Report); [ ] Copy 1 - Project File; [ ] Copy 2 - PMO

Appendix C: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Kemron Standard Operating Procedures

Technical Procedure: FSOP-300
Revision: 02

STANDARD OPERATING PROCEDURE FOR SAMPLE PACKAGING AND SHIPPING

KEMRON Environmental Services, Inc.
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Leland Meadows

Leland Meadows, Technical Advisor — 08/16/2019 Date

John Dwyer, President — 08/16/2019 Date

VERSION CONTROL

Version	Changes	Affects Section	Effective Date
00	N/A	Entire Document	08 November 2004
01	Review for content, technology and methods, and quality control.	Entire Document	23 October 2014
02	Review for content, technology and methods, and quality control.	Entire Document	19 August 2019

TABLE OF CONTENTS

LIST OF APPENDICES

1 POLICY

Samples collected during field investigations or in response to a hazardous materials incident are classified prior to shipment, as either environmental or hazardous materials samples.

2 PURPOSE

The purpose of this technical procedure is to provide information and additional instruction regarding procedures for the classification and shipment of materials by KEMRON personnel. KEMRON employees shall maintain copies of chain-of-custodies and shipping paperwork in the event of an audit or problem during shipment. Requirements for field documentation are presented in FSOP-200. During the course of normal project activities, KEMRON personnel may be required to ship materials including samples, wastes, chemicals, supplies, calibration solutions/gases, etc.

Certain materials which meet specific definitions under US Department of Transportation (DOT) regulations are considered "hazardous materials" and are subject to restrictive shipping requirements including employee training, packaging, labeling, and documentation. Such materials, when shipped by air, may be classified as "dangerous goods' and be subject to further regulatory requirements and/or shipping restrictions

The purpose of this procedure is to ensure consistent sample packaging and shipping at KEMRON in accordance with Federal regulations. The Department of Transportation (US DOT) and the International Air Transport Authority (IATA) promulgates the regulations for packing, marking, labeling, and shipping of dangerous goods by air transport. The US DOT regulations fall under 49 CFR, Subchapter C, Hazardous Materials Regulations. This document describes procedures, methods and considerations to be used by KEMRON employees when packing, marking, labeling and shipping environmental and waste samples to ensure that shipments are in compliance with the above regulations and guidance.

2.1 Precautions

Proper safety precautions must be observed when packing, marking, labeling, and shipping environmental or waste samples. Field Staff are directed to refer to the KEMRON Corporate Environmental Health and Safety Manual and any pertinent site-specific Health and Safety Plans (HASPs) or Accident Prevention Plans (APPs) for guidelines on safety precautions.

3 SCOPE

This procedure addresses the packaging of samples and proper shipping protocol and identifying when a material is considered hazardous or dangerous, according to the DOT. The following guidelines will be used by KEMRON personnel in determining if materials being offered for shipment are classified as hazardous under DOT regulations. Shipments of hazardous materials by KEMRON must conform to DOT requirements and be prepared and offered for shipment ONLY by personnel who have documented training in accordance with regulatory requirements. ALL shipments of hazardous materials must be approved/authorized by Program/Regional Management.

The following materials are considered hazardous by DOT and must be shipped in accordance with DOT HMT requirements:

- Materials designated as hazardous by listing in the Hazardous Materials Table (49 CFR 172.101);
- Hazardous wastes requiring manifesting;
- Hazardous substances listed in Appendix A to 49 CFR Part 172.101, and shipped in a quantity in one package in excess of the listed RQ;

- Mixtures or solutions of hazardous substances exceeding concentration limits corresponding to RQs as listed in table in 49 CFR Part 171.8;
- Substances or samples of substances meeting the defining criteria of any DOT hazard class or division (see Appendix B);
- Other specifically listed DOT regulated hazardous materials such as marine pollutants and elevated temperature materials.

Client, federal, or state requirements, or project-specific requirements may dictate specific types of equipment or procedures to be used when applying this SOP to a particular project. Deviations from this SOP to accommodate site-specific requirements shall be documented in project planning documents and Appendix A and approved by the KEMRON Quality Assurance / Quality Control (QA/QC) Manager or client representative where applicable, prior to the performance of work.

4 RESPONSIBILITY

Project Manager
The KEMRON Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOP and the project-specific work plan. The KEMRON Project Manager ensures field staff have reviewed and signed off on this SOP prior to beginning field work. A sign-off sheet covering SOPs related to the project will be prepared and filed with project documents.

Field Staff
The KEMRON field staff prepares, organizes, and inspects the equipment required for the sampling event prior to the initiation of sampling activities. The field sampler and shipper are responsible for initiating, maintaining, and transferring chain-of-custody. Upon completion of the sampling event, the field staff returns the equipment to the designated storage area ensuring that the equipment is decontaminated and in a condition ready for reuse. KEMRON field staff are required to follow procedures specified in this SOP, or approved project-specific SOP, prior to initiating the sampling event. Field staff are required to sign off that they have read and understand this SOP prior to beginning fieldwork (Appendix F).

5 DEFINITIONS

- **Dangerous Goods**: US DOT classified Hazardous Materials may be classified as Dangerous Goods when shipped by air and be subject to further regulatory requirements and/or shipping restrictions than that stated for Hazardous Materials. According to the International Air Transportation Association (IATA), Dangerous Goods are articles or substances which are capable of posing a risk to health, safety, property or the environment and which are shown in the list of dangerous goods (IATA Section 4.2) or which are classified according to IATA Regulations.

- **Environmental Sample**: A sample of solid waste, water, soil, sediment, or air which is collected for the sole purpose of testing to determine characteristics or composition and are not subject to 40 CFR Part 262 through 268 (including use of hazardous waste manifests), if certain conditions of shipment are met. Refer to USEPA Region 4 Science and Ecosystem Support Division Standard Operating Procedure for Packing, Marking, Labeling and Shipping of Environmental and Waste Samples, SESD-PROC-209-R2) (https://www.epa.gov/sites/production/files/2015-06/documents/Shipping-Environmental-and -Waste-Samples.pdf) dated February 2015 (Appendix D). .

- **Hazardous Materials**: Materials which meet specific definitions under US DOT regulations which are subject to restrictive shipping requirements including employee training, packaging, labeling, and documentation.

6 SHIPPING HAZARDOUS MATERIALS

For purposes of DOT, a material is Hazardous if a material which is subject to the Hazardous Waste Manifest Requirements under USEP A regulations contained in 40 CFR Part 262. Per 40 CFR Part 261.4, samples of solid waste, water, soil, or air which are collected for the sole purpose of testing to determine characteristics or composition, are not subject to 40 CFR Part 262 through 268 (including use of hazardous waste manifests), if certain conditions of shipment are met.

Many samples shipped by KEMRON will meet the RCRA criteria for exemption from provisions of 40 CFR Parts 262 through 268, including hazardous waste manifesting, and will therefore, not meet the DOT definition of a hazardous waste.

This does not mean that all environmental samples are exempt from DOT requirements. Your shipment must pass ALL the definitional tests in order be excluded by definition. Ask the following questions about the shipment.

- Is it designated in the HM table (49 CFR 172.101)?
- Is it a hazardous waste requiring manifesting?
- Is it a hazardous substance (listed in Appendix A to 49 CFR Part 172.101) in a quantity in one package which exceeds the RQ?
- If it is a hazardous substance mixture or solution, is it in a concentration by weight that exceeds the corresponding RQ of the material as listed in the table found in 49 CFR Part 171.8 Hazardous Substance (3)(ii)?
- Does it meet the defining criteria of any DOT hazard class or division as defined in Appendix B?
- Is it specifically listed as a marine pollutant?
- Does it meet the definition of an elevated temperature material?

If the answer to any of these questions is yes, the shipment is regulated by DOT as a hazardous material and subject to specific shipping requirements. Consult with your management to assure that properly trained personnel prepare and offer the shipment and that the shipment meets regulatory requirements.

7 SHIPMENT OF DANGEROUS GOODS (BY AIR)

The Project Manager is responsible for determining if samples collected during a specific field investigation meet the definitions for hazardous materials and/or dangerous goods. When shipping dangerous goods by air, samples must be packaged by a trained and certified employee. Check with the air shipping carrier to ensure the carrier shipping requirements are met. For additional information, see the IATA Manual.

8 SHIPMENT OF ENVIRONMENTAL SAMPLES

Samples determined by the Project Manager to be environmental samples are shipped using the following protocol, developed jointly between USEPA, OSHA, and DOT. This procedure is documented in the "Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples"

Untreated wastewater and sludge from POTW's are considered to be "diagnostic specimens" (not environmental laboratory samples). However, because they are not considered to be etiologic agents (infectious) they are not restricted and may be shipped if not deemed hazardous material.

It is important to use the proper package delivery service/carrier account number (such as FedEx) when shipping samples. Most of the time the carrier account of the laboratory is used, however some projects or laboratories will require the use of KEMRON's carrier account. The Project Manager should review the proper carrier account for the project with the field staff prior to sample shipment.

8.1 Shipping Environmental Samples by Commercial Carrier (Air or Ground)

Environmental samples should be packed prior to shipment using the following procedures and in compliance with the carrier requirements:

1. Allow a small amount of headspace in the bottles (except VOC containers with a septum seal) to compensate for any pressure and temperature changes.
2. Be sure the lids on each of the bottles are tight (will not leak). Lids may be taped or sealed with custody seals as added protection or as required.
3. Place bottles in separate and appropriately sized plastic bags and seal the bags with tape.
4. Include one temperature blank per cooler.
5. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape.
6. Line the cooler with a large heavy duty plastic bag.
7. Place an appropriate amount of bubble wrap in the bottom of the cooler and then place the bottles in the cooler with sufficient space to allow for the addition of bubble wrap between the bottles and cans.
8. Put "double bagged" ice (in heavy duty plastic bags and properly sealed) on top of and/or between the samples. Fill the remaining space between the bottles or cans with bubble wrap.
9. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).
10. Place the completed Chain-of-Custody Record (COC) into a plastic bag, and tape the bag to the inner side of the cooler lid. Refer to FSOP-200 for field documentation including COC completion.
11. Close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut.
12. Chain-of-custody seals should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.
13. Shipping containers must be marked "THIS END UP", and arrow labels which indicate the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper should be placed on the outside of the container. Labels used in the shipment of hazardous materials (e.g., Cargo Only Air Craft, Flammable Solids, etc.) are not permitted to be on the outside of containers used to transport environmental samples.

8.2 Hand Delivery of Samples to Laboratory (by Employee or Courier)

1. Bottles can be filled completely with sample (required for VOC containers with a septum seal).
2. Be sure the lids on the bottles are tight (will not leak).
3. Place bottles in a sturdy cooler with sufficient space to allow for the addition of bubble wrap between the bottles.
4. Include one temperature blank per cooler.
5. Put "double bagged" ice (in heavy duty polyethylene bags and properly sealed) on top of and/or between the samples.
6. Place Chain-of-Custody (COC) in plastic bag and tape to the inside of the cooler lid, close lid, seal with custody seals and transfer the courier. If delivering the cooler in person, close the cooler lid and hand deliver the cooler with COC.

9 Asbestos Shipping

See Appendix C.

1. Place each asbestos sample in a small Ziploc bag.
2. Place the bags of asbestos samples in a large Ziploc bag, as needed.
3. Place in a sturdy box for shipping (such as a FedEx box)
4. Use bubble wrap to prevent the sample(s) from moving around in the box.
5. Insert COC in the box.
6. Seal box and place “Danger” stickers on the box.
7. Affix chain-of-custody seals to the top and sides of the box within any securing tape so that the box cannot be opened without breaking the seal.

10 Air Quality Sample Shipping

1. Place air samples in a sturdy box suitable for the type of sampling media (i.e., tenax tubes, tedlar bags, summa canisters)
2. Use bubble wrap to prevent the sample(s) from moving around in the box.
3. Insert COC in the box
4. Seal box
5. Affix chain-of-custody seals to the top and sides of the box within any securing tape so that the box cannot be opened without breaking the seal.

11 References

1. Dangerous Goods Regulations, International Air Transport Authority (IATA). Current Edition.
2. EPA Order 1000.18, February 16, 1979.
3. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), US-EPA, April 13, 1981.
4. 40 CFR 136.3. July 1, 2001. See Table 11, Footnote 3.
5. Operating Procedures for Packing, Marking, Labeling and Shipping of Environmental and Waste Samples, SESD-PROC-209-R2, USEPA, Region 4, April 2011.

Appendix A: Request for Deviations

Deviation to FSOP-300: STANDARD OPERATING PROCEDURE FOR SAMPLE PACKAGING AND SHIPPING

Description of Deviation
1.
2.
Need for Deviation
1.
2.
Corrective Action Taken
1.
2.

Approved by:

Name: Signature:
KEMRON Project Manager Date

Name: Signature:
KEMRON QA/QC Manager Effective Date

- OR -

Name: Signature:
Client Representative Effective Date

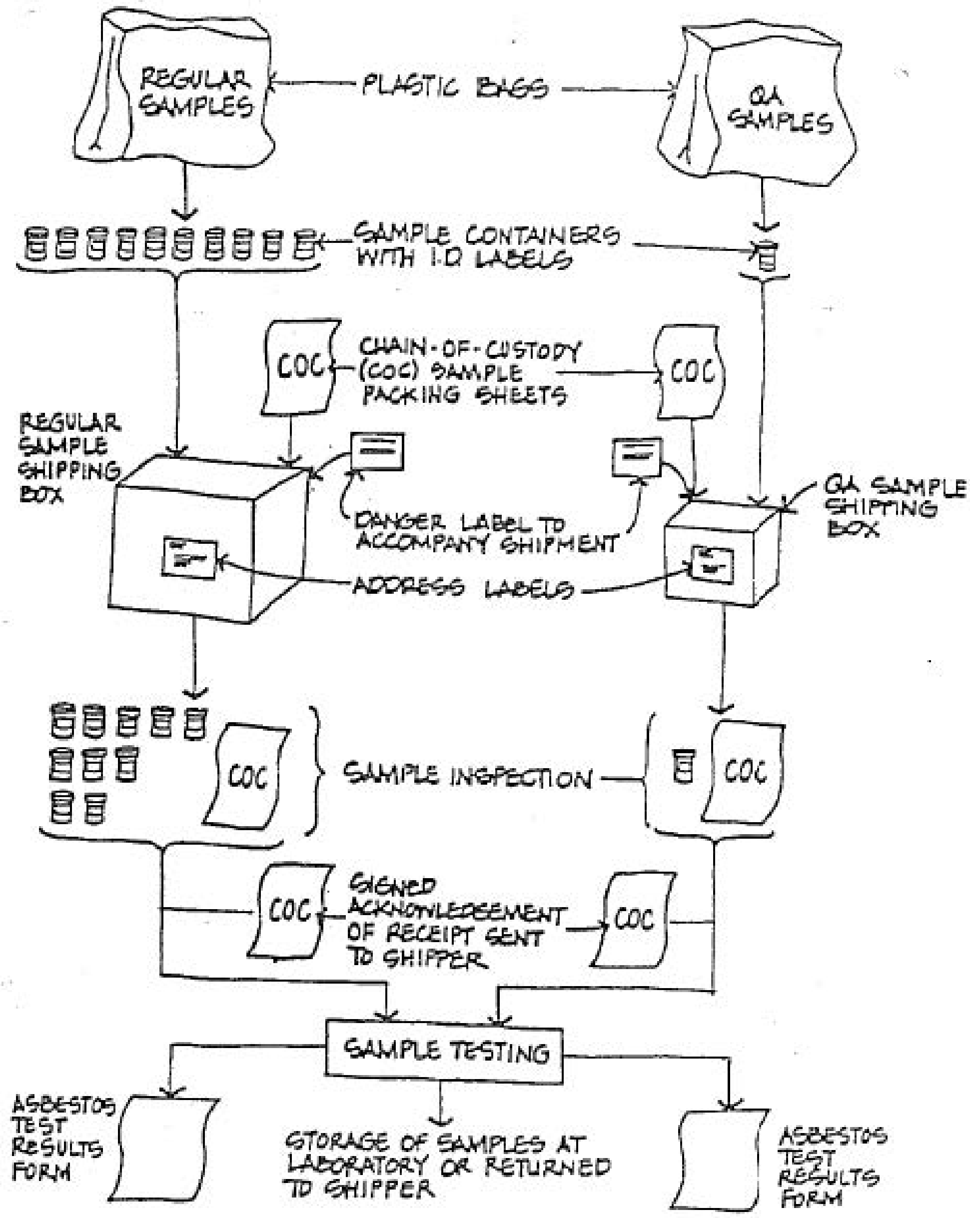
Appendix B: Definition of Hazardous Materials

DOT Definition of Hazardous Material:
A hazardous material is defined as any substance or material that could adversely affect the safety of the public, handlers, or carriers during transportation.

Class	Name of class or division	49 CFR reference for definitions
1	**Explosives**	
	1.1 with a mass explosion hazard	173.50
	1.2 with a projection hazard	173.50
	1.3 with predominately a fire hazard	173.50
	1.4 with no significant blast hazard	173.50
	1.5 Very insensitive explosives; blasting agents	173.50
	1.6 Extremely insensitive detonating substances	173.50
2	**Gases**	
	2.1 Flammable gas	173.115
	2.2 Non-flammable compressed gas	173.115
	2.3 Poisonous gas	173.115
3	**Flammable and combustible liquid** Flammable- flash point below 141° Combustible- flash point 141° - 200°	173.120
4	**Flammable Solids**	
	4.1 Flammable solid	173.124
	4.2 Spontaneously combustible material	173.124
	4.3 Dangerous when wet material	173.124
5	**Oxidizers and Organic Peroxides**	
	5.1 Oxidizer	173.127
	5.2 Organic peroxide	173.128
6	**Toxic Materials**	
	6.1 Poisonous materials	173.132
	6.2 Infectious substance (Etiologic agent)	173.134
7	**Radioactive material**	173.403
8	**Corrosive material**	173.136
9	**Miscellaneous hazardous material**	173.140
None	Other regulated material: ORM-D	173.144

Appendix C: Asbestos Sample Packaging Procedures

EXHIBIT K-2
SAMPLE HANDLING PROCEDURES



Appendix D: EPA Standard Operating Procedure (SOP)

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Region 4 **U.S. Environmental Protection Agency** **Science and Ecosystem Support Division** **Athens, Georgia**
OPERATING PROCEDURE
Title: **Packing, Marking, Labeling and Shipping of Environmental and Waste Samples**

Effective Date: February 4, 2015	**Number:** SESDPROC-209-R3

Authors
Name: Art Masters Title: Environmental Scientist, Regional Expert Signature: [signature] Date: 2/4/2015
Approvals
Name: John Deatrick Title: Chief, Field Services Branch Signature: [signature] Date: 2/2/15
Name: Hunter Johnson Title: Field Quality Manager, Science and Ecosystem Support Division Signature: [signature] Date: 2/4/2015

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Revision History

The top row of this table shows the most recent changes to this controlled document. For previous revision history information, archived versions of this document are maintained by the SESD Document Control Coordinator on the SESD local area network (LAN).

History	Effective Date
SESDPROC-209-R3, *Packing, Marking, Labeling and Shipping of Environmental and Waste Samples*, replaces SESDPROC-209-R2. **Cover Page:** Changes made to reflect reorganization of SESD from two field branches to one: John Deatrick listed as the Chief, Field Services Branch. The FQM was changed from Liza Montalvo to Hunter Johnson. **Revision History:** Changes were made to reflect the current practice of only including the most recent changes in the revision history.	February 4, 2015
SESDPROC-209-R2, *Packing, Marking, Labeling and Shipping of Environmental and Waste Samples*, replaces SESDPROC-209-R1.	April 20, 2011
SESDPROC-209-R1, *Packing, Marking, Labeling and Shipping of Environmental and Waste Samples*, replaces SESDPROC-209-R0.	November 1, 2007
SESDPROC-209-R0, Packing, Marking, Labeling and Shipping of Environmental and Waste Samples, Original Issue	February 05, 2007

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1 General Information

1. Purpose

Regulations for packing, marking, labeling, and shipping of dangerous goods by air transport are promulgated by Department of Transportation under 49 CFR, Subchapter C, Hazardous Materials Regulations, and the International Air Transport Authority (IATA), which is equivalent to United Nations International Civil Aviation Organization (UN/ICAO). Transportation of hazardous materials (dangerous goods) by EPA personnel is covered by EPA Order 1000. This document describes general and specific procedures, methods and considerations to be used and observed by SESD field investigators when packing, marking, labeling and shipping environmental and waste samples to ensure that all shipments are in compliance with the above regulations and guidance.

2. Scope/Application

The procedures contained in this document are to be used by field personnel when packing, marking, labeling, and shipping environmental samples and dangerous goods by air transport. Samples collected during field investigations or in response to a hazardous materials incident must be classified prior to shipment, as either environmental or hazardous materials (dangerous goods) samples.

In general, environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, biological specimens, or any samples not expected to be contaminated with high levels of hazardous materials. Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods.

Government employees transporting samples or hazardous materials (i.e., preservatives or waste samples) in government vehicles are not subject to the requirements of this section in accordance with 49 CFR 171.1(d)(5). EPA contractors, however, are not covered by this exemption and may not transport these materials without full compliance with 49 CFR.

Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use.

3. Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

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4. References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version.

Title 40 Code of Federal Regulations (CFR), Pt. 136.3, Identification of Test Procedures, July 1, 2001. See Table II, Footnote 3.

Title 49 CFR, Pt. 171.1(d)(5), Applicability of Hazardous Materials Regulations (HMR) to Persons and Functions.

United States Department of Transportation (US DOT). 2003. Letter from Edward T. Mazzullo, Director, Office of Hazardous Materials Standards, to Henry L. Longest II, Acting Assistant Administrator, USEPA, Ref No. 02-0093, February 13, 2003.

US Environmental Protection Agency (US EPA) Order 1000.18, February 16, 1979.

US EPA. 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA.

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version.

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version.

5. General Precautions

1.5.1 Safety

Proper safety precautions must be observed when packing, marking, labeling, and shipping environmental or waste samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional.

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2 Shipment of Dangerous Goods

The project leader is responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample is collected of a material that is listed in the Dangerous Goods List, Section 4.2, IATA, then that sample must be identified, packaged, marked, labeled, and shipped according to the instructions given for that material. If the composition of the collected sample(s) is unknown, and the project leader knows or suspects that it is a regulated material (dangerous goods), the sample may not be offered for air transport. If the composition and properties of the waste sample or highly contaminated soil, sediment, or water sample are unknown, or only partially known, the sample may not be offered for air transport.

In addition, the shipment of pre-preserved sample containers or bottles of preservatives (e.g., NaOH pellets, HCL, etc.) which are designated as dangerous goods by IATA is regulated. Shipment of nitric acid is strictly regulated. Consult the IATA Dangerous Goods Regulations for guidance. ***Dangerous goods must not be offered for air transport by any personnel except SESD's dangerous goods shipment designee or other personnel trained and certified by IATA in dangerous goods shipment.***

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3 Shipment of Environmental Samples

Guidance for the shipment of environmental laboratory samples by personnel is provided in a memorandum dated March 6, 1981, subject "Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Laboratory Samples". By this memorandum, the shipment of the following unpreserved samples is not regulated:

- Drinking water
- Treated effluent
- Biological specimens
- Sediment
- Water treatment plant sludge
- POTW sludge

In addition, the shipment of the following preserved samples is not regulated, provided the amount of preservative used does not exceed the amounts found in 40 CFR 136.3 or the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version. This provision is also discussed in correspondence between DOT and EPA (Department of Transportation, Letter from Edward T. Mazzullo, Director, Office of Hazardous Materials Standards, to Henry L. Longest II, Acting Assistant Administrator, USEPA, Ref No.: 02-0093, February 13, 2003). It is the shippers' (individual signing the air waybill) responsibility to ensure that proper amounts of preservative are used:

- Drinking water
- Ambient water
- Treated effluent
- Biological specimens
- Sediment
- Wastewater treatment plant sludge
- Water treatment plant sludge

Samples determined by the project leader to be in these categories are to be shipped using the following protocol, developed jointly between USEPA, OSHA, and DOT. This procedure is documented in the "Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples."

Untreated wastewater and sludge from Publicly Owned Treatment Works (POTWs) are considered to be "diagnostic specimens" (not environmental laboratory samples). However, because they are not considered to be etiologic agents (infectious) they are not restricted and may be shipped using the procedures outlined below.

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Environmental samples should be packed prior to shipment by air using the following procedures:

1. Allow sufficient headspace (ullage) in all bottles (except VOA containers with a septum seal) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).

2. Ensure that the lids on all bottles are tight (will not leak).

3. Place bottles in separate and appropriately sized polyethylene bags and seal the bags. If available, the use of Whirl-Pak bags is preferable, if unavailable seal regular bags with tape (plastic electrical tape).

4. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape inside and outside. Line the cooler with a large heavy duty plastic bag.

5. Place cushioning/absorbent material in the bottom of the cooler and then place the containers in the cooler with sufficient space to allow for the addition of cushioning between the containers.

6. Put "blue ice" (or ice that has been "double bagged" in heavy duty polyethylene bags and properly sealed) on top of and/or between the containers. Fill all remaining space between the containers with absorbent material.

7. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).

8. Place the Chain-of-Custody Record or the CLP Traffic Report Form (if applicable) into a plastic bag, and tape the bag to the inner side of the cooler lid.

9. Close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. Chain-of-custody seals should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

Appendix E: Example Chain-of-Custody

CHAIN-OF-CUSTODY RECORD

Kemron

1 COC NUMBER:

2 PROJECT NAME:	5 PROJECT NUMBER:	8 LAB NAME AND CONTACT:	11 FAX AND MAIL REPORTS/EDD TO: RECIPIENT 1 (Name and Company)	14 RECIPIENT 1 (Address, Tel No., and Fax No.):
3 PROJECT PHASE/SITE/TASK:	6 CTO OR DO NUMBER:	9 LAB PO NUMBER:	12 FAX AND MAIL REPORTS/EDD TO: RECIPIENT 2 (Name and Company)	15 RECIPIENT 2 (Address, Tel No., and Fax No.):
4 PROJECT CONTACT:	7 PROJECT TEL NO AND FAX NO:	10 LAB TEL NO AND FAX NO:	13 FAX AND MAIL REPORTS/EDD TO: RECIPIENT 3 (Name and Company)	16 RECIPIENT 3 (Address, Tel No., and Fax No.):

25 ANALYSES REQUIRED (Include Method Numbers)

17 ITEM	18 SAMPLE IDENTIFIER	19 SAMPLE DESCRIPTION/LOCATION	20 MATRIX (see codes on SOP)	21 DATE COLLECTED	22 TIME COLLECTED	23 DATA PKG LEVEL (see codes on SOP)	24 TAT (calendar days)												26 SAMPLE TYPE (see codes on SOP)	27 COMMENTS/ SCREENING READINGS	28 LAB ID (for lab's use)
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					

29 SAMPLER(S) AND COMPANY: (please print)	30 COURIER AND SHIPPING NUMBER:	31 SAMPLES TEMPERATURE AND CONDITION UPON RECEIPT (for lab's use):

32 RELINQUISHED BY	DATE	TIME	33 RECEIVED BY	DATE	TIME
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		

Distribution: [ ] Original - Laboratory (To be returned with Analytical Report); [ ] Copy 1 - Project File; [ ] Copy 2 - PMO

Appendix F: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Technical Procedure: FSOP-500
Revision: 02

STANDARD OPERATING PROCEDURE FOR DESIGN AND INSTALLATION OF MONITORING WELLS

KEMRON Environmental Services, Inc.
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Leland J Meadows

Leland Meadows, Corporate QA/QC Manager — 08/26/19 Date

John Dwyer, President — 08/26/19 Date

VERSION CONTROL

Version	Changes	Affects Section	Effective Date
00	N/A	Entire Document	18 December 2014
01	Review for content, technology and methods, and quality control.	Entire Document	15 March 2015
01	Review for content, technology and methods, and quality control.	Entire Document	26 August 2019

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LIST OF APPENDICES

1 POLICY

KEMRON personnel will follow procedures established in this SOP for designing and installing a monitoring well (MW) unless specified in a site-specific work plan (WP), or contract requirement. Furthermore, this procedure provides field documentation and oversight requirements during the installation of MW. Personnel will follow Health and Safety procedures as directed by the Corporate Health and Safety Plan and the Site Specific Health and Safety Plan.

2 PURPOSE

The purpose of this SOP is to provide the methods and considerations that should be followed by KEMRON personnel when designing and or performing oversight of the installation of permanent or temporary groundwater monitoring wells to be used for collection of groundwater samples.

2.1 Precautions

Refer to the site-specific Health and Safety Plans (HASPs) or Accident Prevention Plans (APPs) for guidelines on safety precautions during drilling and sampling operations. As required in these plans, ensure the following:

- When conducting decontamination using laboratory detergent, safety glasses with splash shields or goggles, and latex or nitrile gloves will be worn.
- No eating, smoking, drinking, chewing, or any hand to mouth contact should be permitted when handling soil or groundwater samples.
- Any on-site personnel under the direction of KEMRON must review, sign and adhere to the site-specific safety procedures
- Manage IDW in accordance with the site-specific plans

3 SCOPE

This procedure is to be used by field personnel when designing, constructing and or installing groundwater monitoring wells. If field personnel determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used for any aspect of the design, construction and/or installation of a groundwater monitoring well, the deviation from this procedure must be approved by the Project Manager and will be documented in the field log book, along with a description of the circumstances requiring its use.

4 RESPONSIBILITY

Project Manager Responsibilities

The KEMRON Project Manager provides the project specific MW design and ensures the field staff understand any project specific requirements that may be provided in a WP or contract.

Field Staff Responsibilities

KEMRON Field Staff are required to follow this SOP unless a written site-specific WP or contract specifications are provided by the Project Manager. Deviations from this SOP require prior written approval from the KEMRON Project Manager or his designated alternate where such deviations are determined necessary. Field staff must properly document the quantity and type of MW materials, the methods used to install the material and the interval of each material placed during construction.

5 DEFINITIONS

- **Annular Space:** The space between two concentric tubes or casings, or between the casing and the borehole wall. This would include the space(s) between multiple strings of tubing/casings in a borehole installed either concentrically or multi-cased adjacent to each other.

- **Borehole:** A circular open or uncased subsurface hole created by drilling.

- **Bridge:** An obstruction within the annulus which may prevent circulation or proper placement of annular materials.

- **Casing:** A pipe, finished in sections with either threaded connections or beveled edges to be field welded, which is installed temporarily or permanently to counteract caving, to advance the borehole, and/or to isolate the zone being monitored.

- **Casing, Protective:** A section of larger diameter pipe that is placed over the upper end of a smaller diameter monitoring well riser or casing to provide structural protection to the well and restrict unauthorized access into the well.

- **Grout:** A low permeability material placed in the annulus between the well casing or riser pipe and the borehole wall (in a single-cased monitoring well), or between the riser and casing (in a multi-cased monitoring well), to maintain the alignment of the casing and riser and to prevent movement of groundwater or surface water within the annular space.

- **Multi-cased well:** A well constructed by successively smaller diameter casings with depth.

- **Filter Pack:** A clean silica sand or sand and gravel mixture of selected grain size and gradation that is installed in the annular space between the borehole wall and the well screen, extending an appropriate distance above the screen, for the purpose of retaining and stabilizing the particles from the adjacent strata.

- **Permanent Monitoring Well:** Permanent monitoring wells are wells used for routine collection of groundwater samples and/or other data.

- **Riser:** The pipe extending from the well screen to or above the ground surface.

- **Rock Quality Designation (RQD):** A calculation to determine the rock mass integrity. RQD is calculated by dividing the length of recovered rock core larger than 4 inches i by the total length cored on any give rock core run (typically 5 foot runs). This is used during NQ core size or larger rock core.

- **Soil plug:** A plug which naturally forms at the bottom of the hollow-stem auger while drilling. This soil plug must be removed when sampling or installing well casings. Plug removal can occur by washing out the plug using a side discharge rotary bit, or augering out the plug with solid-stem auger bit sized to fit into the hollow-stem auger.

- **Tamper:** A heavy cylindrical metal section of tubing that is operated on a wire rope or cable. It slips over the riser and fits inside the casing or borehole annulus. It is generally used to tamp annular sealants or filter pack materials into place and prevent bridging

- **Tremie:** A method used to place well construction material into the borehole from the bottom to the top by pressure grouting or positive displacement. The filter pack and grout are typically placed using this method during well construction activities.

- **Temporary Monitoring Well:** Temporary monitoring wells (TMW's) are wells used for collecting groundwater samples for screening purposes

- **Tremie Pipe:** A pipe used to deliver filter pack or grout from the surface to specific depths. Use of the tremie pipe is recommended when there is a bridge potential.

- **Well Development:** Well development serves to remove the finer grained material from the well screen and filter pack that may otherwise interfere with water quality analysis, restore groundwater properties disturbed during the drilling process and to improve the hydraulic characteristics of the filter pack and hydraulic communication between the well and the hydrologic unit adjacent to the well screen.

- **Well Screen:** A filtering device used to retain the primary or natural filter pack; usually a cylindrical pipe with openings of a uniform width, orientation, and spacing.

6 GENERAL

- Wells will be installed by a properly licensed driller or well installation contractor, where applicable.

- Required state and local permits must be obtained prior to beginning the work.

- Submit any required well installation documents to the local regulatory agencies (this may be done by the drilling form).

- Equipment, tools, materials, etc. will be properly decontaminated, prior to site arrival and prior to each well installation, to prevent possible introduction of contaminants in the wells during construction. If the area is known, or believed, to be contaminated, a decontamination solution appropriate for the contaminant of concern will be used. Decontamination waste will be properly managed.

- In most cases, hollow stem augers should be used for the installation of permanent or temporary monitoring wells. However in some cases it may be necessary to use air or mud rotary or direct push technology (DPT) or hand auger to install the wells.

- The monitoring wells will be properly developed. After the grout has been allowed to cure, the development of the wells can be completed by surging, over-pumping, surge-blocking, or some other approved method. The monitoring wells should be developed until it yields water that is free of sediment.

- Well development water and/or drill cuttings impacted by a contaminant must be properly managed to prevent further spread of contamination.

- The completed monitoring wells shall be surveyed at the top of the casing at marked location and concrete pad with reference to either the National Geodetic Vertical Datum (N.G.V.D) or local bench mark.

- Document well construction. Typical Well Construction Diagrams are attached.

7 PERMANENT MONITORING WELL DESIGN

The design and installation of permanent monitoring wells involves drilling into various types of subsurface geologic conditions that may require different drilling methods and installation procedures. The drilling methods and installation procedures should be based on field data, if available, or existing data (geologic literature search). In most cases, the design of the monitoring wells has been performed in the WP. The WP will typically include the following information:

a. Known or suspected geology at site
b. Known or suspected depth to water (DTW) at well locations
c. Proposed well locations
d. Proposed well construction details:
    i. Total depth of well
    ii. Borehole diameter
    iii. Screen length
    iv. Diameter of well (and other casing, if applicable)
    v. Well screen material (PVC, SS, etc.) and construction
    vi. Filter pack size
    vii. Screen slot size
    viii. Filter pack seal (fine sand, bentonite, etc.)
    ix. Depth of filter pack
    x. Depth of seal
    xi. Method of grouting
    xii. Depth of outer casing if applicable
    xiii. Surface completion (flush-mount, stick-up, etc.)
e. Surface conditions at proposed well locations (concrete, asphalt, gravel, etc.)
f. Provision for field adjustment of proposed well locations
g. Method of well installation
h. Permits required
i. Traffic conditions at site
j. Health and Safety concerns (vapors, traffic)
k. Special circumstances such as sands, bedrock, perched water, confining layer, etc.

In the event that a WP does not exist, or does not provide the information specified above, this information must be gathered for proper well design. The following sections include a general discussion of drilling methods. This information is useful to Project Managers and other employees when designing monitoring wells, or to field staff when needing to modify a drilling technique in the field.

7.1 Drilling Methods

There are several drilling methods that can be used to install monitoring wells under various subsurface conditions. A brief description of the drilling methods is provided below for general knowledge and guidance when selecting a drilling method. The drilling method chosen should be based on the subsurface geology and site-specific requirements.

It should be noted that before any subsurface drilling is initiated, hand augering or post hole must be initiated for the top four (4) feet below the land surface, in order to determine if utilities are present at the location of the drilling.

7.1.1 Auger Methods

Augering is one of the most common drilling types and most commonly consists of a hollow stem in environmental applications; however, solid stems augers can be used as well. The auger consists of a steel stem with a continuous, spiraled steel flight, welded onto the exterior. This drilling technique is used in soils conditions where drilling is limited to the upper 100 feet (maximum 150 feet) below ground surface. The end of the auger contains a drill bit that has welded carbide teeth, which break apart the soil when rotated during drilling. The outer spiral flights on the auger transport the cuttings to the surface during drilling. During Hollow Stem Auger (HSA) drilling, the soil can be logged from the soil cuttings off the augers, through split-spoon sampling, or from a sampler (such as a CME sampler). Soil classification and logging should be in accordance with ASTM standards and/or in accordance with WP.

Once the borehole has been advanced to the total depth, a monitoring well can be installed inside of hollow-stem augers without soils caving into the borehole. The auger can contain a bottom plug, or pilot bit to keep out most of the soils and/or water that have a tendency to enter the bottom of the augers during drilling. If drilling below the water table in a sandy soil condition, potable water or polymer, if allowed, may be poured into the augers during drilling to equalize pressure to reduce the inflow of formation materials.

If soil sampling or screening is not being performed during drilling, a bottom plug can wedged into the bottom of the auger bit and is knocked out at when the boring has advanced to the total depth prior to well installation. The use of wood bottom plugs is not acceptable. The type of bottom plug, trap door, or pilot bit assembly proposed for the drilling activity should be approved by a senior field geologist prior to drilling operations.

7.1.2 Rotary Methods

Rotary drilling methods are also commonly used in environmental applications in soils or soft rock. Rotary methods can utilize water, air or mud during rotary drilling. Rotary drilling consists of a drill pipe or drill stem with a rotating bit (typically a tricone bit) that cuts through the soils. The soil cuttings from the drilling bit are transported to the surface by drilling fluids (water or mud) or air by forcing the drilling fluids or air down through the drill pipe, and out through the bottom of the drilling bit. The cuttings are then lifted to the surface between the borehole wall and the drill pipe. In general, the drilling fluids themselves hold the borehole open during drilling through hydrostatic pressure.

Special consideration should be made when considering this drilling technique at sites with potential contamination in soil or water due to the potential to create a large volume of IDW, or cross-contamination between zones. Also, introducing potable water could possibility introduce trace contamination of halogenated compounds when municipal water supplies are used (trihalomethanes). Mud rotary can be useful in unconsolidated sediments where environmental impacts are not anticipated. This drilling technique is more successful than auger drilling when the subsurface conditions alternate between soil and partially weathered rock or contain a substantial amount of gravel layers (karst).

Air rotary methods are commonly used in drilling in through bedrock. Air rotary requires high air velocities, and a large air volume are required. The bit on the end of the drill stem will consist of a down-hole percussion hammer when drilling through rock. The air hammer is used to drive the air stream to rapidly penetrate bedrock materials and bring rock chips to the surface. This drilling technique can be difficult in karst bedrock where large voids prevent re-circulation of the air. Air rotary drilling is extremely successful in identifying water-bearing fractures in bedrock.

During rotary drilling, soil and/or rock can only be logged by the materials brought to the surface by the air, water or mud. Contacts between different materials are typically identified through the field personnel logging the penetration rates of each foot of drilling, the behavior of the rig during drilling, presence of water in the cuttings, the driller's observations, and characteristics cuttings observed at the surface. Therefore, the field personnel must log the information mentioned above to develop a proper drill log during rotary drilling.

7.1.3 Sonic Methods

Sonic drilling methods can be performed in soil, and shallow weathered rock conditions. Sonic drilling consists of concentric hollow drill stems using rotation in conjunction with axial vibration of the drill stem. The drill stem is typically advanced in 5 or 10 foot sections and the inner string is removed with a core of drill cuttings while the outer drill stem remains in-place to maintain an open borehole. There are no cuttings generated during this drilling technique. The only material generated is within the inner barrel and preserves most soil and rock structures to allow for detailed identification of structures and the depths of contact and/or depth of contamination. This drilling method is useful in a wide variety of materials, such as unconsolidated and/or flowing sands, semi-consolidated soil and to a lesser extent bedrock. In the event of flowing sands, the drill stem can be pressurized with water, similar to augers or rotary methods. However, the depth of penetration and quality of the sample in competent rock is limited.

In the event that a surface casing is required, a larger diameter temporary casing to be set into a confining layer while sonic drilling proceeds into the deeper soils. The casing is then removed during the grouting operation of well installation. Once the total depth of the boring is achieved, the inner casing is removed and the well is installed inside the outer casing. Centralizers are recommended in most cases to facilitate centering of the well inside the casing, especially in cases where deep PVC wells are being installed.

7.2 Borehole Construction

In general, the annular space between the borehole wall and the well should be approximately 2-inches to allow the even distribution of well materials around the screen and riser pipe, as well as to allow room for the tremie pipes and well materials. For example, a 2-inch diameter well casing would require a 6-inch diameter borehole. For hollow stem augers and sonic method drill casing, a 4-1/4inch ID auger or sonic drill stem should be the minimum size used for placement of 2-inch well and 8-1/4-inch ID for 4-inch well.

It should be noted that on occasion, well construction may be designed to allow for the construction of a well sump at the bottom of a well to allow for the accumulation of suspended sediment or silt. The sumps typically consist of a 5-foot section of PVC riser pipe at the bottom of the well. The sumps are installed at sites where there is known elevated turbidity in the formation.

In general a filterpack should be place in the bottom 6-inches of the well, and should extend up to 2-feet above the top of the screened interval. The filterpack should be placed using tremie or positive displacement methods. If hollow stem augers are being used, the augers can be used as a tremie to place the filterpack around the well screen by slowly removing the augers as the filterpack is being placed around the well screen.

Following the installation of the filterpack, the bentonite seal should be placed and hydrated in the well. Bentonite pellet seals should be placed in a minimum of two-foot thickness of dry pellets. The bentonite pellets must be hydrated with water that extends above the height of the seal. The pellets should be hydrated for eight hours, or the manufacturer's recommended hydration time, whichever is greater. Where the water table is temporarily below the pellet seal, potable water should be added repeatedly to hydrate the pellets prior to grouting.

7.3 Standard Well Construction Techniques

Once the boring has been advanced to the total depth, the well casing will be installed into the borehole. The well casings should be secured to the well screen by flush-jointed threads and placed into the borehole. Glue of any type should not be used to secure casing joints. If necessary, centralizers can be placed on the casing prior to installation. It should be noted that centralizers should be placed so that the placement of the filter pack, bentonite pellet seal, and annular grout will not be hindered. In general, most monitoring wells will not require centralizers. If centralizers are used, it would be in a well over 50 feet deep and would be placed either below the well screen, or above the bentonite seal. The specific placement intervals should be identified in the WP and will be designed based on site conditions.

Once the well has been placed inside the augers or drill stem (if appropriate), the augers/drill stem will be slowly lifted as the filterpack, and bentonite seal are placed around the screen and riser pipe. A clean weighted tape measure should be used to monitor the level of the well construction materials to confirm the proper placement and bridging does not occur. If well construction is within an open borehole, the filter pack sand should be installed by tremie methods, using water to wash the sand through the pipe to the depth of placement.

Following the placement of the filterpack to the designed depth, the bentonite seal (unhydrated) should be place to a minimum thickness of two feet. The bentonite seal must be hydrated with water, unless the water level is above the bentonite seal material. The seal should be allowed to hydrate a for eight hours, unless otherwise specified in a site-specific WP.

Following the hydration period of the bentonite seal, the grout should be placed in the well using the tremie method. Grout should pumped into the annular space around the casing and allowed to set for 24 hours before the surface pad and protective casing are installed.

After the surface pad and protective casing are installed, bumper guards should be installed around stick-up wells (if required). The bumper guard should extend above the ground surface a sufficient height to protect the well (2- 3 feet) with the total length of each bumper guard being 5 feet in length.

The wells should be permanently marked with the well number, top of casing elevation, and a measurement point for measuring water levels.

7.4 Double-Cased Walls

Double cased wells are used to seal off two subsurface zones, such as a surficial aquifer from a bedrock aquifer, for a well installed below a confining unit, and/or when there is extensive surface contamination. Double cased wells are also useful if flowing sands are encountered. Initially, a large borehole (8 inches or greater) is advanced through the overburden or shallow zone and one to two feet into a confining clay, bedrock, or non-contaminated zone. Then an outer casing typically 6-inches or 8-inches in diameter) is set into the borehole and grouted into place. The exact size and depth of the outer casing should be specified in a site-specific WP or approved by a licensed geologist. The outer casing should be tremie grouted, or similar method to place the grout from the bottom of the casing to the top. The ground should consist of a neat cement, cement/bentonite, cement/sand, or a 30% solids bentonite grout. Once the grout has been allowed to cure for 24 hours, drilling can begin inside the casing using a smaller diameter drilling technique. Once the total depth is achieved, well installation will follow the methods described in Section 7.1.3 Sonic Wells.

7.5 Bedrock Wells

Bedrock wells can be installed using the following techniques:

7.5.1 Open-Hole Well

Follow the procedures described in Section 7.4 to set the surface casing. If detailed logging of lithology, fractures and rock quality designation (RQD) is required, then rock coring is the preferred drilling technique in competent rock. Other methods include roller cone bits (soft rock) or air hammer drilling (Section 7.1.2) to advance the boring into rock. Regardless of the technique, care should be taken to minimize damage to the grout seal from cracking or eroding away due to excessive pressure or force. When the total depth is achieved, the drilling stem will be removed and the well will be completed as an open borehole from the ground surface to the bottom of the well. The well will consist only of the outer surface casing that is installed down into bedrock and extends above the ground surface as the outer protective casing. It should be noted that on CERCLA or RCRA sites, pre-approval of an open-hole well completion should be obtained through approval of a site-specific WP, or similar document. This well design is typically used in scenarios where cavernous limestone precludes the installation of well construction materials, or in highly fractured bedrock settings.

7.5.2 Double Cased Well

This method follows the procedures described in Section 7.4 to set the surface casing, followed by the installation of an inner well casing with well construction materials. In some cases, installation of a filter pack may not be required. This well installation method is most ideal because it allows for the isolation of fractures/monitoring zone(s).

7.6 Well Development

Well development serves to remove the finer grained material from the well screen and filter pack that may otherwise interfere with water quality analysis, restore groundwater properties disturbed during the drilling process and to improve the hydraulic characteristics of the filter pack and hydraulic communication between the well and the hydrologic unit adjacent to the well screen. Well development should not be initiated until the well construction materials have been in-place for 24 hours following surface pad or grout installation. In general, monitoring wells should be developed until the water is free of visible sediment, and there are stable pH, temperature, turbidity, and specific conductivity. In cases where all parameters are stable except for turbidity, contact the PM for guidance. If the goes dry during well development, then allow for the water table to the static water level, and then begin development again.

Well development is typically performed using pumping, and a surge-block. However, under certain conditions, a bailer or air lifting may be appropriate. Sampling can be performed once the ground water has re-equilibrated to static conditions, is free of visible sediment, and the water quality parameters have stabilized. As a general guideline, it is common to wait 24 hours after development to sample a monitoring well. A field record must be maintained to document the volume of water removed, the water quality parameters and the behavior of the well during development. This information must be recorded on a Well Development Log.

7.7 Well Decommissioning (Abandonment)

The methods to perform well abandonment will vary at each site. A site-specific WP should specify the methods for well abandonment. A summary of well abandonment techniques are provided below, in the event that a WP doesn't specify well abandonment techniques.

7.7.1 Overdrilling

Using a HSA drill rig, drill over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. Once completed, the borehole should be grouted. If the well is over 6-inches in diameter, a solid stem auger may be necessary.

7.7.2 Pulling the Well

Using the wench on a drill ring, the casing will be pulled from the ground. If the casing breaks, or cannot be pulled, the well will be grouted in place.

7.7.3 Grout in-Place

Some state regulations allow wells to be grouted in place. In instances where this is permissible, the pad should be demolished and the area around the casing excavated. The casing should be sawn off at a depth of three feet below ground surface and the screen and riser should be tremie grouted with a 30% solids bentonite grout. If necessary, a cement grout can be used above the saturated zone to assist with long term resistance to desiccation of the grout.

8 TEMPORARY MONITORING WELL DESIGN

Temporary wells are used at sites instead of permanent monitoring wells, especially for due diligence purposes. Following any of the drilling techniques previously described, a temporary well can be installed in the borehole to collect a groundwater sample. Temporary wells can also be installed from a borehole advanced using a hand auger, power auger, or direct push technology. Once the wells are sampled, the screen and riser pipe are removed and the borehole is backfilled with material, such as soil cuttings, bentonite pellets or grout. Below are examples temporary well designs that can be used to collect groundwater samples.

8.1 No Filterpack Temporary Well

This tends to be the most common temporary well. After the borehole is advanced to the total depth, the casing and screen are simply inserted into the open borehole and groundwater sampling is performed. This method has the lowest cost and is the fastest method for temporary well installation. However, because there is no filterpack, there can be elevated turbidity. Care should be taken to not disturb the casing during purging and sampling.

8.2 Pre-packed Filterpack Temporary Well

This is a less common method, but allows for some filtering of the sediment using a filterpack. During the well construction, a pre-packed well screen is used, which comes assembled with a filterpack already assembled with the well screen and the sand extends 6 to 12 inches above the screened interval. This will help reduce the turbidity of the sample in clay environments.

8.3 Traditional Filterpack Temporary Well

This temporary well includes the methods used to place the filter pack of a permanent monitoring well. This type temporary well construction can be effective in aquifers where fine silts or clays predominate. This construction technique takes longer to implement and uses more filter pack material than others previously discussed.

8.4 Double Filterpack Temporary Well

The borehole is advanced to the desired depth. A pre-packed the well screen is filled with filter pack material and the well screen and casing inserted until the top of the filter pack is at least 6 inches below the water table then filter pack material is poured into the annular space around the well screen.

8.5 Temporary Monitoring Well Installation Using the Geoprobe® Screen Point 15/16 Groundwater Sampler

A Geoprobe® drill rig has a Screen Point 15/16 Groundwater Sampler that can be attached to the probe rods to collect groundwater from a discrete interval. The sampler is pushed to the desired sampling depths in saturated, unconsolidated materials, then the screen is opened and groundwater can be sampled. It should be noted that the Screen Point® 15/16 sampler is available in stainless steel and PVC.

Typically, a peristaltic pump is used to collect the groundwater sample. However, if the waters levels are greater than 25 feet, other techniques, such as a manual bladder pump, a micro bailer, may have to be utilized to collect the sample.

9 FIELD RECORDS

9.1 Field Logbook

Examples of specific well installation documentation include the following:

- Site Name
- Date and time of arrival
- Weather conditions, including ambient air temperature and/or miscellaneous observations
- Location
- Date and time drilling
- Drilling location and boring ID
- Well depth
- Physical characteristics, to include the general soil type (sand, silt, clay, and organic/other matter such as wood chips, as determined using the Unified Soil Classification System (USCS)), approximate grain size (fine, medium, coarse), presence of observable biota, odor, color, layers, depth of layer changes
- Plan and section view sketches of well construction
- Pertinent field observations and comments
- Names of individuals on site

10 REFERENCES

KEMRON FSOP-100 Sampling Equipment and Container Decontamination
KEMRON FSOP-200 Field Documentation
KEMRON FSOP-800 Soil Sampling
USEPA, Design and Installation of Monitoring Wells, EPA 542-S-02-001, May 2002.
USEPA, Region 4, Design and Installation of Monitoring Wells Guidance (SESDGUID-101-R1), January 2013

Appendix A: Request for Deviations

Deviation to FSOP-500: STANDARD OPERATING PROCEDURE FOR DESIGN AND INSTALLATION OF MONITORING WELLS

Description of Deviation
1.
2.
Need for Deviation
1.
2.
Corrective Action Taken
1.
2.

Approved by:

Name: Signature:
KEMRON Project Manager Date

Name: Signature:
KEMRON QA/QC Manager Effective Date

- OR -

Name: Signature:
Client Representative Effective Date

Appendix B: Permanent MW Installation Oversight (via Hollow-Stem Auger, Solid Stem Auger, Rotary Drilling, Sonic Drilling, etc.)

Pre-Mobilization Procedure

- Field staff review and understand WP
- Field staff or PM to contact drillers: Set up meeting time, and review drilling specifications (borehole diameter and approximate depth, casing diameters, screen slot size, and surface completion requirements)
- Utility Clearance implemented (per KEMRON FSOP-001)
- Site owner is informed of the work date
- HASP is prepared
- Field staff gathers mobilization equipment, supplies, truck, etc. Examples: field book, site map, directions to the site, HASP, WP, surveying equipment, IP, sampling and well development supplies, markers, measuring tape or wheel, safety equipment and cones, and tools.

Pre-Installation Procedure

- Check-in with site owner / personnel
- H&S review with on-site personnel and HASP signing
- Verify utility markings (per utility clearance SOP)
- Mark off proposed well locations per WP
- Posthole dig each well location (per Utility Clearance SOP)
- Check drill rig for safety issues (missing bolts, damaged cables, etc.) and environmental issues (leaking oil, equipment not cleaned from previous sites, etc.)
- Brief drillers on location; equipment decon; and excluding the use of oils, petroleum based lubricants, solvents and PVC cement / glue; and IDW containment

MW Installation Procedure

Per WP or SOP observe / ensure the following:

- generation of a stable and straight borehole of specified diameter
- measurement of depth to water to be sure screened area will bracket the water table
- plug removal (hollow-stem augering only)
- screen, riser, and casing are correct construction and specification
- filter pack installation
- assembly of the correct lengths of screens and risers
- perpendicular installation
- assembly does not float
- riser extends to a correct height relative to the ground surface
- riser is finished evenly so groundwater measurements are consistent
- placement of a temporary cap for the remainder of the installation
- filling and tamping of annular space with filter pack material
- addition of any hydrating material
- depth to filter pack meets installation specifications
- installation of a seal above the filter pack
- seal material meets the installation specifications
- application and tremie of grout mixture and that materials meet specifications
- installation of multi-cased wells, if specified
- leak-proof installation of protective casing and manhole/vault
- installation of a sloping concrete pad at or above the ground level and installation of the outer protective casing
- cuttings and purge fluids are properly contained
- Mark the name of the well in the wet concrete or on the well vault

- Lock the outer protective casing
- Specified time intervals between hydrating bentonite, grout placement, and well development are followed.
- Installation of weep holes in stick-up surface completion, if applicable.

Well Development

Develop the well as stated in the WP or SOP and document as required (see Appendix E for sample form).

Documentation

Document in field book and Well Installation Log the date, drilling company, drillers names, KEMRON employees on site, others present on site, weather conditions, initial groundcover per well location, document observations / drillers comments during each drilling event (i.e., competency, blow counts, circulation, etc.), borehole diameter, screen and riser lengths, depth to filter pack, depth, surface completion details and thickness of seal

Appendix C: Temporary MW Installation (via Hand Augering or Direct Push)

Pre-Mobilization Procedure

- Field staff review and understand WP
- Field staff or PM to contact drillers: Set up meeting time, and review drilling specifications (borehole diameter and approximate depth, casing diameters, screen slot size, and surface completion requirements)
- Utility Clearance implemented (per KEMRON FSOP-001)
- Site owner is informed of the work date
- HASP is prepared
- Field staff gathers and mobilization equipment, supplies, truck, etc. Examples: field book, site map, directions to the site, HASP, WP, surveying equipment, IP, sampling and well development supplies, markers, measuring tape or wheel, safety equipment and cones, and tools.

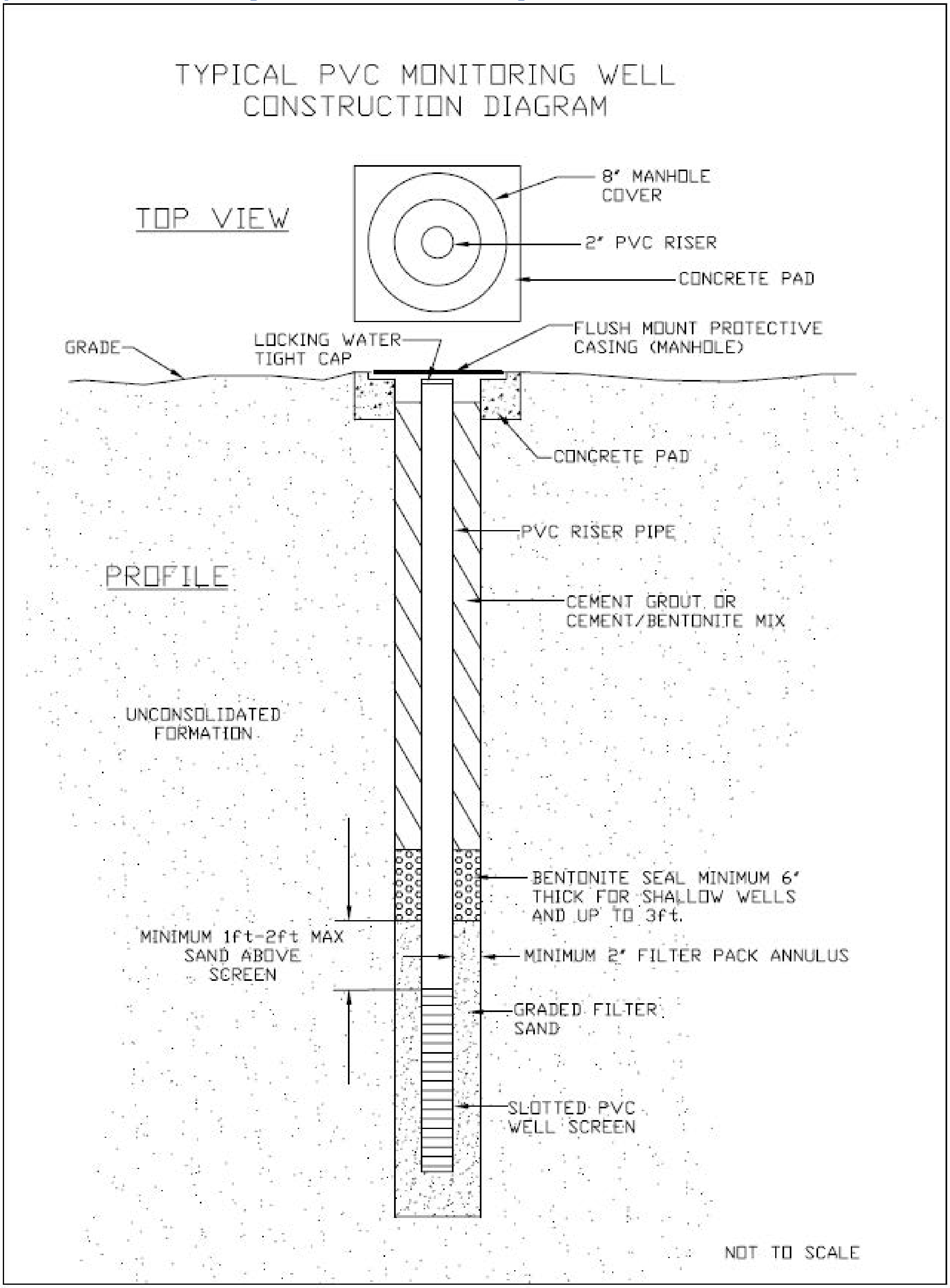
Pre-Installation Procedure

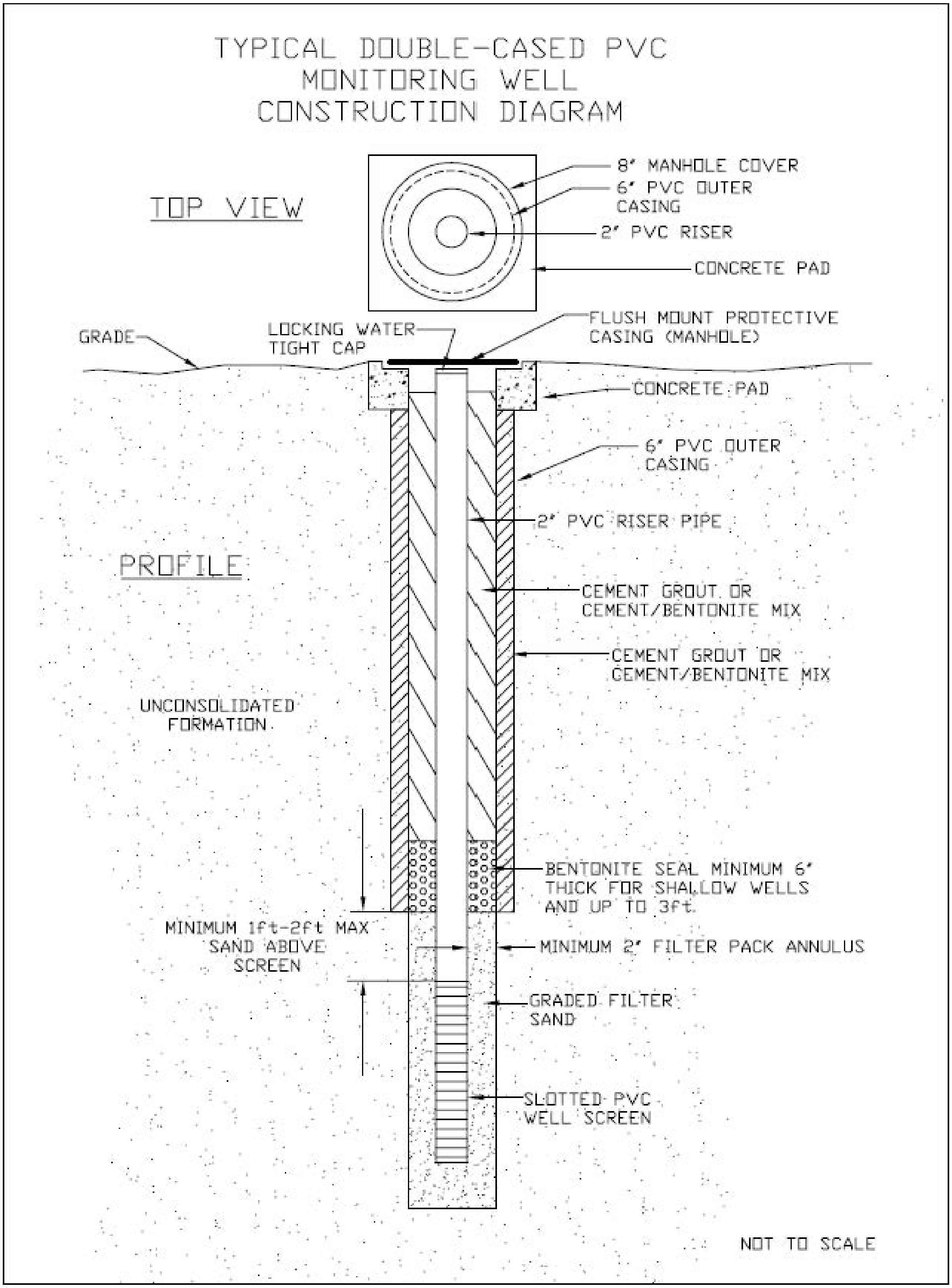
- Check-in with site owner / personnel
- Verify utility markings (per utility clearance SOP)
- Mark off proposed well locations per WP
- Posthole dig each well location (per Utility Clearance SOP)
- H&S tailgate meeting with driller and HASP signing
- Brief drillers on location; equipment decon; and excluding the use of oils, petroleum based lubricants, solvents and PVC cement / glue; and IDW containment

MW Installation Procedure per WP

- Ensure/generate a stable and straight borehole
- Measure DTW to be sure screened area will bracket the water table
- Install filter pack
- Assemble the correct lengths of screens and risers
- Ensure perpendicular installation
- Ensure assembly does not float
- Place a temporary cap for the remainder of the installation
- Add any hydrating material, if necessary
- If specified, apply grout mixture where materials meet specifications
- Install a temporary well cover
- Cuttings and purge fluids are properly contained
- Following groundwater sample collection, remove well materials and properly abandon the borehole.

Appendix D: Monitoring Well Installation Diagrams




TYPICAL DOUBLE-CASED PVC
MONITORING WELL
CONSTRUCTION DIAGRAM
TOP VIEW
8" MANHOLE COVER
6" PVC OUTER CASING
2" PVC RISER
CONCRETE PAD
GRADE
LOCKING WATER TIGHT CAP
FLUSH MOUNT PROTECTIVE CASING (MANHOLE)
CONCRETE PAD
6" PVC OUTER CASING
2" PVC RISER PIPE
PROFILE
CEMENT GROUT OR CEMENT/BENTONITE MIX
CEMENT GROUT OR CEMENT/BENTONITE MIX
UNCONSOLIDATED FORMATION
BENTONITE SEAL MINIMUM 6" THICK FOR SHALLOW WELLS AND UP TO 3ft.
MINIMUM 1ft-2ft MAX SAND ABOVE SCREEN
MINIMUM 2" FILTER PACK ANNULUS
GRADED FILTER SAND
SLOTTED PVC WELL SCREEN
NOT TO SCALE

Appendix E: Well Development Log

KEMRON ENVIRONMENTAL SERVICES

1359-A Ellsworth Industrial Boulevard Atlanta, GA 30318 Telephone (404) 636-0928 FAX (404) 636-7162 http://www.kemron.com

Site Name:	Well ID:
Site Location:	Sample ID:
Date:	Page:
Well Diameter:	Develop Method:
Well Capacity (gal/ft):	Development Initiated At:
Total Depth of Well (ft):	Development Ended At:
Static Depth to Water (ft):	Field Decontaminated:
Water Column (ft):	
Well Volume (gal):	
Development Volume (Min. Well Volume x 3):	
Developed By (Sign & Print):	

Time	Purge Volume (gallons)	Cumul. Purge Volume (gallons)	Purge Rate (gpm)	Depth to Water	Depth to Pump Inlet	pH	Temp (°C)	Cond. (ms/sec)	D.O. (mg/L)	ORP (mV)	Turbitidy (NTUs)	Color	Odor

Well Capacity: 1" = 0.041 gal/ft, 2" = 0.163 gal/ft, 4" = 0.653 gal/ft, 6" = 1.469 gal/ft

Appendix F: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Technical Procedure: FSOP-600
Revision: 02

STANDARD OPERATING PROCEDURE FOR GROUNDWATER SAMPLING

KEMRON Environmental Services, Inc.
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Leland J Meadows

Leland Meadows, Corporate QA/QC Manager — 08/19/19 Date

John Dwyer, President — 08/19/19 Date

VERSION CONTROL

Version	Changes	Affects Section	Effective Date
00	N/A	Entire Document	08 November 2004
01	Review for content, technology and methods, and quality control.	Entire Document	06 October 2014
02	Review for content, technology and methods, and quality control.	Entire Document	19 August 2019

TABLE OF CONTENTS

LIST OF APPENDICES

1 PURPOSE

The objectives of this procedure are to ensure valid and representative samples of groundwater are collected from monitoring wells that meet project requirements and to prevent deterioration and contamination of samples before laboratory analysis. By complying with procedures specified in this Standard Operating Procedure (SOP), KEMRON will ensure that the following are successfully completed:

- Proper well purging
- Proper sampling
- Prevention of contamination or cross-contamination of groundwater samples during collection, containerization, transit and storage
- Obtain and record accurate and complete sampling data
- Preparation of complete and correct sample labels
- Preparation and filing of sample chain of custody
- Communication of adequate instruction to the laboratory

1.1 Safety

Safety precautions must take place during groundwater sampling. Groundwater sampling may involve chemical hazards associated with the materials being sampled. Adequate health and safety measures must be taken to protect project-sampling personnel from potential chemical exposures or other hazards. These measures must be addressed in the project Health and Safety Plan (HASP). This plan must be approved by the project health and safety officer before work commences, must be distributed to personnel performing sampling, and must be adhered to as field activities are performed.

1.2 Precautions

The following precautions should be made during groundwater sampling:

- Store samples in a secure location and avoid storing samples in an environment that could alter the properties of the samples.
- Sample from the anticipated cleanest to most contaminated location to minimize the opportunity for cross-contamination.
- Collected samples must remain in the custody of the sampler until relinquished to another party.
- Documentation of field sampling is done on a Groundwater Sample Collection Form and bound logbook.
- Shipping documents shall be retained by the Project Manager and placed in the project files.

2 SCOPE

This SOP provides technical guidance on groundwater sampling including decontamination procedures, and types and uses of sampling equipment. This SOP applies to KEMRON personnel and subcontractors collecting groundwater samples for KEMRON projects. Client, federal, or state requirements, or project-specific requirements may dictate specific types of equipment or procedures to be used when applying this SOP to a particular project. Deviations from this SOP to accommodate site-specific requirements shall be documented in project planning documents and Appendix A and approved by the KEMRON Quality Assurance / Quality Control (QA/QC) Manager or client representative where applicable, prior to the performance of work.

3 RESPONSIBILITIES

Project Manager Responsibilities
The KEMRON Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOP and the project-specific work plan. The KEMRON Project Manager ensures field staff have reviewed and signed off on this SOP prior to beginning field work. A sign-off sheet covering the SOPs related to the project will be prepared and filed with project documents.

Field Staff Responsibilities
The KEMRON field staff prepares, organizes, and inspects the equipment required for the sampling event prior to the initiation of sampling activities. The field sampler and shipper are responsible for initiating, maintaining, and transferring chain-of-custody. Upon completion of the sampling event, the field staff returns the equipment to the designated storage area ensuring that the equipment is decontaminated and in a condition ready for reuse. KEMRON field staff are required to follow procedures specified in this SOP, or approved project-specific SOP, prior to initiating the sampling event. Field staff are required to sign off that they have read and understand this SOP prior to beginning field work.

4 DEFINITIONS

Bailer: A bailer is used to sample wells. A bailer may be of stainless steel, Teflon®, polyethylene or other appropriate construction and may be composed of a reel system equipped with a Teflon-coated stainless steel suspension cord, a disposable monofilament line or disposable braided filament line. A bailer can be dedicated or non-dedicated to a specific well and disposable or reusable.

Chain-of-Custody: An unbroken trail of accountability that ensures the physical security of samples, data, and records. The chain-of-custody documentation shows times, dates, and names of the individuals relinquishing and receiving the samples identified on the record.

Custody: Physical control of an object, in this case of an environmental sample.

Dedicated: Equipment (bailer or pump) dedicated to a particular well which remains associated only with the assigned well until the work/project is completed.

Depth to Water: The depth to water is the depth from the top of the well casing to the surface of the groundwater. An established point (typically the surveyed top of the well casing) is utilized as a reference point for measuring the depth to water.

Diffusion Sampler: A passive sampler, also known as equilibrium sampler, this device relies on diffusion of the analytes to reach equilibrium between the sampler fluid and the well water. Samples are time-weighted toward conditions at the sampling point during the latter portion of the deployment period. The degree of weighting depends on analyte and device-specific diffusion rates. Typically, conditions during only the last few days of sampler deployment are represented (ITRC, 2006). Depending upon the contaminant of concern, equilibration times range from a few days to several weeks (ITRC, 2006). They are less versatile than grab samplers because they are not generally effective for all chemical classes. Like grab samplers, they can be stacked to obtain multiple depths within a well screen or open hole boring.

Evacuation of Well: Removal of standing volume of water in a well by pumping or bailing.

Equipment Blank: An equipment field blank is used to determine if contaminants have been introduced by contact of the sample medium with sampling equipment. Equipment field blanks are often associated with collecting rinse blanks of equipment that has been decontaminated**.**

Field Blank: A field blank sample undergoes the full handling and shipping process of an actual sample. It is designed to detect sample contamination that can occur during field operation or during shipment. Field blanks are prepared using certified clean water preserved in the same manner as the other collected samples, and then submitted to the laboratory for analysis.

Flow Rate: A measurement taken of the water flowing from the well when a pump is used. The flow rate is in units of volume per time.

Free Product Measurement: A measurement taken using an oil-water interface probe to determine the presence and thickness of free-phase product within a well. Measure the depth to the top and bottom of the free phase in reference to the water level measurement reference at the top of the casing. For light non-aqueous phase liquids (LNAPL), this would be on top of the water column; in dense non-aqueous phase liquids (DNAPL), this would occur at the bottom of the well.

Investigation Derived Waste (IDW): IDW includes waste generated during groundwater sampling, such as decontamination solutions, disposable equipment, and water from groundwater monitoring well development and purging. IDW consists of waste materials that are known or suspected to be contaminated with hazardous waste substances through the actions of sample collection or personnel and equipment decontamination. Management and disposal of IDW will be detailed in the site-specific Work Plan, SAP or QAPP.

Low-Flow Purge (tubing in screened interval): Per EPA guidance, low-flow purging is purging at a rate of 50-500 mL/min to have minimal drawdown of the water table and minimize disruption of the water column. Low-flow purging is accomplished using low-flow purge equipment at the mid-point of the screened interval and is used to avoid generating large quantities of IDW and for time management.

Traditional Low-Flow Purge (multi-volume purge): Per EPA guidance, multi-volume purging uses a minimum of three, maximum of five well volumes purged prior to sampling. The well can be sampled once water quality parameters have stabilized. The tubing or pump in take is placed at the top of the water column during purging and sampling.

Non-Dedicated: Equipment (bailer or pump) not dedicated to a particular well. Non-dedicated equipment is decontaminated between use or if for one-time use (bailers) then properly disposed of after use.

Passive (no purge) samplers: There are three types of passive samplers, including the following: thief (grab) samplers, diffusion (equilibrium) samplers, and integrating (kinetic) samplers. Any of the three types can be deployed down a well to the desired depth within the screened interval or open borehole to obtain a discrete sample without using pumping or a purging technique (ITRC 2006). Most can be stacked to obtain samples at multiple depths. Some samplers can also be used to measure contaminants in groundwater as it enters a surface water body.

Purging: The process of removing stagnant water from a monitoring well (water in the screen, well casing, and saturated annulus) immediately prior to sampling, causing its replacement by groundwater from the adjacent formation, which is representative of actual aquifer conditions.

Recharged Well: A well is considered recharged when the water level recovers to at least 80% of the static water level.

Slow Recovery Wells: Slow recovery wells are wells that require more than 6 hours to recharge after purging.

Stabilized Well: Well stabilization is achieved following well purging when water level and field measurements are observed to be consistent between measurements and within project work plan requirements.

Thief Sampler: Passive sampler designed to obtain an instantaneous grab (point) groundwater sample at the depth to which they are lowered. Thief samplers are activated either by pulling up or using an up and down motion to force water into the sampler (e.g. HydraSleeve™) or by a triggering device at the well head (e.g. Snap™, Discrete Interval, Kemmerer). They are effective for collecting any type of chemical species; however, collecting a sufficient quantity of water to enable testing for all chemicals of concern may be an issue.

Trip Blank: Unlike field blanks, the trip blanks are used for VOCs analysis only. In addition, trip blanks are prepared prior to going into the field by filling containers (VOC vials) with clean water. The samples are kept closed, handled, transported to the field, and then returned to the laboratory in the same manner as the other samples. Trip blanks are used to evaluate error associated with shipping and handling, and analytical procedures. They are used in conjuncture with field blanks to isolate sources of sample contamination already noted in previous field blanks.

Unrecoverable Wells: Wells that have not sufficiently recovered within 24 hours.

Water Column Height: Well depth minus the depth to water.

Water Level Measurement Reference: The point on the well head where water levels are measured (typically the high point of the casing). This point is marked and surveyed as soon as practical after well installation to ensure consistent measurement.

Water Quality Measurements: Groundwater chemistry measurements used to establish the quality of groundwater. Measurements may include: temperature, pH, conductivity, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity.

Well Stability: Stability is achieved as specified in the project work plan. The following are provided as a reference.

- Change in groundwater chemistry measurements is within a specified range (indicating stability) by the end of the third well volume purged; or
- Stabilization is considered complete after five well volumes are purged even if field parameters have not met specified range (range established to indicate stability); or
- Stabilization is complete when well is fully evacuated. Using these criteria, measurements are taken to verify the evacuation. Allow well to recharge prior to sampling.

Well Volume Calculation: The standing water volume for typical well diameters is below:

1" Casing = .041 gal/ft
2" Casing = .163 gal/ft
4" Casing = .653 gal/ft
6" Casing = 1.469 gal/ft

or can be calculated using the following formula:

Water Volume (gallons) = .041 (d^2) h
d = inside well casing radius (in inches)
h = height (in feet) of the water column in the well

5 PLANNING AND PRECAUTIONS

The Project Manager provides written instructions of any project-specific information for the sampling crew. The written instructions can be as simple as a sampling requirements report or as detailed as a Sampling and Analysis Plan (SAP). Items in written sampling instructions may include the following:

a) Purging method;
b) Criteria for a complete purge;
c) Criteria for stabilized well;
d) Wells to sample;
e) Method of sampling;
f) Analytical parameters;
g) Applicable regulations for handling purged water;
h) Volume to purge;
i) Sample containers to be used for each analysis;
j) Preservative for each analysis; and
k) Instructions for samples to be field filtered or lab filtered for dissolved metals, if appropriate.

Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific SAP/Quality Assurance Project Plan (QAPP). Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements typically suggest the collection of a sufficient quantity of quality control (QC) samples such as field duplicate, equipment and/or field blank, and matrix spike/matrix spike duplicate (MS/MSD) samples. These requirements should be outlined in the SAP/QAPP.

Information regarding the sample containers, preservation techniques and holding times for groundwater samples will be described in the project specific SAP/QAPP.

6 SAMPLE COLLECTION EQUIPMENT AND PROCEDURES

The tables in this section provide a description of equipment and sampling procedures for different groundwater sampling methods. The project work plan will specify the method and any site-specific requirements. Once the groundwater is sampled, the sample will be aliquoted in the following sequence or as stated in the project-specific planning documents: Field Parameters, Volatile Organic Compounds (VOCs); Semi-volatile Organic Compounds (SVOCs), Pesticides, Herbicides, Polychlorinated Biphenyls (PCBs), Metals, Radiological Contaminants, and Wet chemistry parameters.

Groundwater sampling objectives may vary significantly between projects. Project objectives should be defined within the project-specific planning documents. The list of required materials below identifies the types of equipment which may be used for a range of groundwater sampling applications. The various types of sampling equipment which may be used include:

Well Purging Equipment

- Bailers
- Bladder pumps
- Submersible pumps
- Peristaltic pumps
- Centrifugal Pumps
- Waterra™ pumps

Field Instruments
- Individual or multi-parameter meter(s) to measure temperature, pH, specific conductance, DO, ORP, and/or turbidity
- Flow through cell
- Water level measuring device(s) (bring one extra)
- Interface probe or product detection paste

Sampling Equipment
- Reusable or disposable bailers
- Bladder Pump
- Electric Submersible Pump
- Suction Lift Pumps (Peristaltic)
- Passive Samplers (See Attachment C)

Sample Preparation Equipment
- Filtration equipment
- Intermediate containers
- Sample kit (i.e., bottles, labels, preservatives, custody records, cooler)

General Equipment
- Well keys
- Ratchet Set
- Project-specific sampling plans (SAP, QAPP, HASP) including map of wells to be sampled
- Sample collection records
- Field notebook/pen
- Waterproof marker pens
- Deionized water dispenser bottler
- Sample cup
- Buckets
- Coolers, or sample shuttles (fill coolers with ice before sampling starts)
- Instrument calibration solutions
- Power source (e.g. generator and/or battery)
- Equipment decontamination supplies
- Health and safety supplies (PPE, etc)
- First-Aid kit
- Tool box (e.g. bolt cutter, turkey baster, etc.)
- 55-gallon drum for collecting purge water
- Graduated cylinder (determine flow)
- Flow controller for submersible pump
- 55-gallon drums for IDW
- Bailer retrieval/extraction tools (e.g. large treble hook)
- IDW Labels

Expendable Materials
- Deionized or distilled water supply
- Disposable bailer string (nylon or polypropylene)
- 0.45 micron filters
- Paper towels
- Plastic sheeting
- Aluminum Foil
- Ice/blue ice for sample preservation

- Disposable latex powder-free glove liners
- Disposable nitrile gloves
- Plastic trash bags
- Ziploc® bags
- Decontamination supplies (Alconox, isopropyl alcohol)

This equipment list was developed to aid in field organization and should be used in preparation for each sampling event. Depending on the site-specific sampling plan, additional material and equipment may be necessary and should be determined before the scheduled sampling event. Similarly, not all of the items shown in this list may be necessary for any one sampling event.

See Appendices for Sampling Procedures.

Special Considerations

In the event that free-phase product is present in monitoring wells, the site-specific work plan should be consulted on whether or not the monitoring well should be sampled. In some cases, groundwater sampling should not be performed at a well where greater than 1/8-inch of free-product is present in the well. If the site-specific work plan did not anticipate the presence of free-product, the field staff should immediately contact the project manager. If LNAPL is encountered in a well the thickness should be verified visually utilizing a clear bailing device to eliminate false thickness readings from instrumentation identifying high dissolved contaminant concentrations as LNAPL.

Groundwater samples for VOC analysis must be collected in 40 ml glass vials with Teflon® septa. The vial may be either preserved with concentrated hydrochloric acid or they may be unpreserved. It may be necessary to use the unpreserved vials if the groundwater has a high amount of dissolved limestone, i.e., is highly calcareous, there will most likely be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles. This will render the sample unacceptable. In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

The samples should be collected with as little agitation or disturbance as possible. The vial should be filled so that there is a meniscus at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus.

Care should be taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected.

Samples for VOC analysis must be collected using either stainless steel or Teflon® equipment, such as:

- Bailers constructed of stainless steel or Teflon®. Polyethylene bailers may be allowed on a case by case basis. Site specific documents will dictate if polyethylene bailers are acceptable for sampling.
- RediFlo2® submersible pumps equipped with Teflon® sample delivery tubing. Polyethylene tubing may be allowed on a case by case basis. Site specific documents will dictate if polyethylene tubing is acceptable for sampling.
- Peristaltic pump/vacuum jug assemblies outfitted with Teflon® tubing from the water column to the transfer cap, which should also be constructed of Teflon®. Peristaltic pumps may also utilize a vacuum apparatus at the sampling jar to collect water samples before the pump head.

7 FIELD MEASUREMENTS

Unless specified otherwise in the project documents, the following measurements will be taken and evaluated for acceptability:

Parameter	Acceptable Range for establishing stability*
Temperature*	10% of reading
pH	±0.2 standard units
Conductivity	±3% of readings
Dissolved oxygen	±10% of reading
Redox potential(ORP or Eh)**	±20 mV
Turbidity***	≤5 NTU or ±10% reading, whichever is greater

* Groundwater temperature is subject to rapid changes when collected for parameter measurements and may vary due to ambient conditions. In some instances, the well may be adequately purged without stable temperature measurements.

** ORP should be measured and recorded and only used to determine well stability if required by project documents.

*** Three consecutive acceptable measurements for parameters typically establish water quality.

8 FIELD RECORDS

Field Logbook

See the Field Documentation FSOP-200, for generic documentation items. Examples of specific groundwater sampling documentation include the following:

a. Facility name;
b. Date and time of arrival;
c. Weather conditions, including ambient air temperature and/or miscellaneous observations;
d. Location;
e. Well designation;
f. Well sequence number;
g. Static water level;
h. Total depth of well;
i. Depth to water;
j. Casing diameter;
k. Well volume or one-half well screen volume;
l. Method of purging;
m. Start time of purging;
n. Total volume of water evacuated from well;
o. Evacuation completion time;
p. Sampling strategy (bailer manual, bailer automated, low-flow);
q. Flow rate recorded (if applicable);
r. Field equipment calibration check;
s. Water quality measurements;
t. Water level at time of sample collection;
u. Date and time sample collected;
v. Sample sequence number;
w. Sample Equipment ID;
x. Other pertinent observations of water samples (color, turbidity, odor, etc.);
y. Fractions sampled and preservation method;
z. Signature of sampler(s) and date; and

aa. Miscellaneous information, i.e. well was purged dry prior to taking three (3) evacuation volumes.

Chain of Custody
Completed chain-of-custody (COC) forms are maintained for samples. A sample COC form is included as an Appendix J. The original form is sent to the laboratory with the samples and signed by the lab upon receipt. Original completed COC forms are returned to KEMRON with the analytical report. A copy of the COC will be retained by the field crew and kept with field records.

9 DECONTAMINATION

The equipment taken to the field will be clean. Decontamination of equipment is performed:

- During a sampling event for multiple uses of equipment,
- At the conclusion of equipment use at the site, and
- At the onset of equipment use. This does not apply for dedicated equipment.

The following procedures, or those specified in the site-specific documents, are completed for reusable non-dedicated equipment:

1. Hand wash, or flush / pump through automatic samplers/equipment, with a non-phosphate laboratory detergent dissolved in tap water;
2. Rinse with tap water;
3. Rinse thoroughly with deionized water;
4. Allow to air dry;
5. Wrap in aluminum foil and a plastic bag, if needed, and store in a clean, dry area;

Decontamination solvent such as isopropanol, acetone or hexane may be used for equipment exposed to high levels of organics (e.g., NAPL). Use of specific decontamination solvents should be addressed in project-specific planning documents and the waste solvents managed and disposed in accordance with applicable regulations.

10 SHIPPING

Equipment decontamination chemicals may need to be shipped to the site and samples may need to be shipped to the laboratory. Shipping is completed in accordance with the current federal and international regulations (DOT, EPA, IATA). Shipping stipulations are to be included in the project documents, but should you have any questions regarding shipping of any materials to and from the site, contact the authorized shipping representative in your home office.

11 ASSOCIATED SOPS

- Field Documentation FSOP-200
- Design and Installation of Monitoring Wells FSOP-500

12 REFERENCES

ITRC, Technology Overview of Passive Sampler Technologies, March 2006.

USEPA, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA 542-S-02-001, May 2002.

USEPA, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedure, EPA 540-S-95-504, April 1996.

USEPA, RCRA Groundwater Monitoring, Draft Technical Guidance, November 1992.

USEPA, Potential Source of Error in Groundwater Sampling at Hazardous Waste Sites, EPA 540-S-92-019, August 1992.

USEPA, Region 4, Groundwater Sampling Operating Procedure (SESDPROC-301-R4), April 2017.

Appendix A: Request for Deviations

Deviation to FSOP-600: STANDARD OPERATING PROCEDURE FOR GROUNDWATER SAMPLING

Description of Deviation
1.
2.
Need for Deviation
1.
2.
Corrective Action Taken
1.
2.

Approved by:

Name: Signature:
KEMRON Project Manager Date

Name: Signature:
KEMRON QA/QC Manager Effective Date

- OR -

Name: Signature:
Client Representative Effective Date

Appendix B: Purging and Sampling by Bailer

Purging & Sampling Equipment:
The Bailer system can be dedicated or non-dedicated.

- Bailer: pre-cleaned closed-top Teflon® or stainless steel bailer or a disposable polyethylene bailer.
- When sampling for VOCs, Teflon® or stainless steel bailers should be the default bailer type. Polyethylene bailers are only allowed when sampling in areas of known source material with expected high VOC concentrations, when sampling for BTEX, Metals, Radiological Contaminants, or if site-specific documents permit.
- Either of the following:
    - New braided nylon or polypropylene cords, one per well (disposable).
    - Reusable lanyards (monofilament, stainless steel, or Teflon-coated) for bailer systems.

Sampling Procedure
Prior to sampling, obtain sample containers from laboratory (or laboratories). Ensure presence of preservatives in bottles as appropriate.

Before opening the well, a clean working surface shall be set up around the well head using a clean plastic sheet. Prior to opening the well, the required health and safety gear (as specified in the HASP) shall be donned. This, at a minimum, usually means wearing gloves to limit the potential for exposure to contaminants as well as reduce the potential for handling-induced contamination of sampling equipment.

Preliminary Measurements: Inspect the monitoring well casing to determine if the well is vented. If the well is not vented, remove the well cap and allow the monitoring well sufficient time to equilibrate before measuring the water level. The time required for equilibration is dependent upon site geology. A general rule of thumb is to allow a minimum of two hours for equilibration of a water level. Measure the depth to water at the pre-marked well casing reference point (notch or other visible mark). To obtain a water level measurement, lower the probe of a water level measuring device into the well until the audible sound of the unit is detected or the light on an electronic sounder illuminates. At this time the precise measurement should be determined (to nearest 0.01 feet) by repeatedly raising and lowering the tape to converge on the exact measurement. Obtain the reading from the top of casing (TOC) measuring point. The water level measurement should be entered on the Groundwater Sample Collection Record or in the field log book. Next, turn off the audible sound on the unit and allow the instrument to unwind to the total depth of the well. Note the total depth of the well and if the bottom of the well feels “soft” (indicating sedimentation) on the Groundwater Sample Collection Record or in the field log book. The measurement device must be decontaminated immediately after use with a non-phosphatic detergent and rinsed with distilled water. Generally, only that portion of the tape which enters the water table should be cleaned. It is important that the measuring tape should not be placed directly on the ground surface or allowed to become kinked. Measuring devices, including interface probes, which come into contact with free product, will likely require more thorough decontamination.

Calculate the water level (water column height) and volume of water in casing. Note: Following water-level measurement, if free phase product is suspected, measure the product thickness with an interface probe as specified in the work plan. If measurable quantities of product are encountered do not sample and notify the Project Manager immediately. Wells containing free product are generally not used for groundwater sampling, since the concentration of contaminants present in the free product can adversely affect the quality of the water sample, lending to a non-representative water sample.

Purge Well: Note: If non-dedicated equipment is used for purging, at least one equipment blank (or as specified in the work plan) will be collected from the decontaminated / cleaned purge equipment.

1. Slowly and gently, lower the bailer into the top of the standing water column. Keeping the bailer at the top of the water column is crucial throughout purging especially at the end of purging.

2. If resistance or drag is encountered the bailer could be become lodged.
3. Allow bailer to fill and remove from the well. Bailer rope should not be allowed to touch the ground surface at any time during the purge routine.
4. Collect purged water in a graduated bucket, etc. to determine the number of well volumes purged.
5. Following each well volume purged, take water level and field parameter measurements. Purge should be continued until 3 well volumes have been purged and parameters are stabilized.
6. Containerize the purged water unless specified otherwise in the project work plan.

Purging a well dry may occur under some low-yield conditions. When the well recovers, a cascading effect may occur within the screened zone which can volatilize some organic compounds. This may be considered inappropriate by regulatory agencies when VOCs are the target analyte of interest. Purging a well dry, then sampling after it has recovered may be acceptable for other target analytes, however. Under low yield conditions, low-flow sampling pumps such as bladder pumps may be required for VOC sample collection.

Sampling

1. Sample wells:
    a. Per the Site Work Plan, SAP or QAPP, and
    b. Within six hours of purging unless it is a slow recovery well or
    c. As soon as sufficient recharge water is available or up to 24 hours after purging for slow-recovery wells or wells that purge completely dry.
2. Use one pre-cleaned or disposable bailer per well.
3. Attach new nylon rope or other appropriate cord to the bailer.
4. Slowly immerse the bailer into the top of the water column to reduce agitation and splashing.
5. Fill bailer and promptly remove from well.
6. Record sample observations in field log book and/or on sample collection form.

Aliquot Sample: Aliquot the sample into the containers necessary for both laboratory analysis and any further field measurements. For laboratory analysis, include initials, date and time of sample collection, sample ID, preservative and analysis required on sample container label. Place in cooler and cool to 4^{o} Celsius (C) with wet ice.

If groundwater samples require dissolved metals analysis, then a peristaltic pump must be used to filter the samples. Groundwater samples collected for total dissolved metals analyses will be field filtered (unless specified otherwise in project documents) prior to being placed in sample containers and properly preserved. Groundwater filtration will be performed using a peristaltic pump and a 0.45-micron in-line water filter, or project specific filtering requirements. Disposable filters are commonly available in 0.45-micron size. Low-capacity or high-capacity cartridges are available and may be selectively used based on sample turbidity.

The filtration of groundwater samples shall be performed either directly from the pump discharge line or from laboratory-supplied intermediate containers. In either case, well purging shall be performed first. Fresh groundwater shall then be filtered directly into sample containers.

Post-Sampling Activities

Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to:

- Ensuring that the field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing the sample paperwork, including copies provided to laboratory.
- Compiling the field data for site records.
- Manage and store and label IDW in accordance with Site-specific documents.

- Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure the appropriate sample analyses has been returned to sampler.

Appendix C: Pump Assisted Purging and Bailer Sampling

Purge Equipment:
Motor-driven centrifugal lift pump

Sampling Equipment:

- The bailer system can be dedicated or non-dedicated.
- Bailer: pre-cleaned closed-top Teflon® or stainless steel bailer or a disposable polyethylene bailer.
- Either of the following:
  - New braided nylon or polypropylene cords, one per well (disposable);
  - Reusable lanyards (monofilament, stainless steel, or Teflon-coated) for dedicated bailer systems.

Sampling Procedure:
Before opening the well, a clean working surface shall be set up around the well head using a clean plastic sheet. Prior to opening the well, the required health and safety gear (as specified in the HASP) shall be donned. This, at a minimum, usually means wearing gloves to limit the potential for exposure to contaminants as well as reduce the potential for handling-induced contamination of sampling equipment.

Preliminary Measurements: Measure the depth to water at the pre-marked well casing reference point (notch or other visible mark) and calculate the water level (water column height) and volume of water in casing. Note: Following water-level measurement, if free phase product is suspected, measure the product thickness with an interface as specified in the work plan. If measurable quantities of product are encountered do not sample and notify the Project Manager immediately. Ensure that water level meter / interface probes are probes are decontaminated after each use. If multiple wells are to be sampled, work from cleanest to most contaminated based on analytical data and/or field observations made during soil boring / well installation.

Purge well: Note: If non-dedicated equipment is used for purging, at least one equipment blank (or as specified in work plan) will be collected from the decontaminated / cleaned purge equipment. It is important not to operate petroleum fueled power sources or related equipment near the sampling location. The well should not be pumped dry during low-flow purging.

1. Lower the pump / hose assembly into the top of the standing water column. Keep assembly towards top of water column so that the purging will evacuate water from the formation into the screened area of the well and up through the casing to remove the entire static volume.
2. Begin purging the water and calculate flow rate.
3. Determine the time necessary to purge one-half the well screen volume or that specified in the work plan. Take field parameters, depth to water, and flow-rate measurements every five to ten minutes (or more frequently depending on the time necessary to purge one-half the well screen volume).
4. Stop purging when necessary well volume has been removed and parameters have stabilized.
5. Containerize the purged water unless specified otherwise in the project work plan.

Stabilize well: Measure and record water level until 80% static water level is achieved (well fully recharged). Measure and record field parameters until groundwater chemistry stability is achieved as specified in the project work plan.

Sampling:

1. Sample well within six hours of purging unless it is a slow recovery well or as soon as sufficient recharge water is available or up to 24 hours after purging for slow-recovery wells or wells that purge completely dry.
2. Use one pre-cleaned or disposable bailer per well.
3. Attach new nylon rope or other appropriate cord to the bailer.
4. Slowly immerse the bailer into the top of the water column to reduce agitation and splashing.

5. Fill bailer and promptly remove from well.
6. Record sample observations in field log book.
7. Containerize, manage, label and store IDW in accordance with site-specific documents.

Aliquot Sample: Aliquot the sample into the containers necessary for both laboratory analysis (and for any further field measurements. For laboratory analysis, include initials, date and time of sample collection, sample ID, preservative and analysis required on sample container label. Place in cooler and cool to 4º Celsius (C) with wet ice.

Decontamination: After sampling a well, decontaminate reusable equipment and samplers prior to future use.

Appendix D: Volumetric Purge (multi-volume purge) and Sample Collection

Purging and Sampling Strategy:
Traditional Low-Flow Purge Collection Method with pump is a standard multi-volume purging technique that requires purging a minimum of three well volumes along with stable parameters prior to sampling.

The use of a peristaltic pump requires water levels to be maintained above the limit of suction. For wells where the water level is below the limit of suction (approximately 25' to 30', and/or where there is a large volume of water to be purged), the variable speed electric submersible pump would be a more appropriate pump of choice.

Purge and Sampling Equipment:
Dedicated or non-dedicated equipment may be used.
Low-Flow Purge System includes submersible or non-submersible pump, tubing, and suspension cable.

Note: Tubing may be Teflon®, Teflon® line or polyethylene. The type of tubing will be specified in site-specific documents.

Sampling Procedure:
Pump Installation and Set-up:
1. Open the well and allow water level to equilibrate before taking a water level measurement.
2. Measure the depth to water at the pre-marked well casing reference point (notch or other visible mark) and calculate the water level (water column height) and volume of water in casing.
3. Set submersible pump or pump tubing just below the surface of the water column (within 6-inches for a peristaltic pump or 3 feet for a submersible pump).
4. Set-up associated equipment (generator, compressor, tubing, etc.)

Preliminary Measurements: Ensure well is fully recharged after pump / tubing installation by taking a water level measurement. Note: Following water-level measurement, if free phase product is suspected, measure the product thickness with an interface probe if and as specified in the work plan. If measurable quantities of product are encountered do not sample and notify the Project Manager immediately.

Purge and Stabilize Well: Note: If non-dedicated equipment is used for purging, at least one equipment blank per day (or as specified in the SAP and/or work plan) will be collected from the decontaminated / cleaned purge equipment. Operate petroleum fueled power sources or related equipment downwind from the sampling location. The intent of low flow purging is to minimize drawdown, but the pump intake or tubing should be adjusted, if drawdown in the well occurs. It should be noted that purging rates should be equal to the rate or recharge of the aquifer, but in some conditions, the well may be purged dry, even with the lowest purging rate.
1. Lower the pump inlet as the well is purged.
2. Calculate Flow Rate of purged groundwater (acceptable range is 200 - 500 ml per minute).
3. Flow rate may be adjusted at this point but flow-rate should not exceed the recharge rate of the aquifer. Monitor by measuring the top of the water column with a water level recorder or similar device while purging. Continue to measure the water level flow-rate until stability is achieved.
4. Take field parameters, depth to water, and flow-rate measurements every 5–10 minutes (or more frequently depending on the time necessary to purge one-half the well volume).
5. In the event that the well is purged dry using low flow techniques, the groundwater sample should be collected as soon as the well has recharged enough for sample collection,
6. Containerize the purged water unless specified otherwise in the project work plan.
7. Sampling occurs after the groundwater chemistry parameters are stable and a minimum of three well volumes have been purged from the well as specified in this SOP or in project work plans.

Sampling:

1. Reduce the flow to a low level to minimize sample disturbance, if necessary, and collect sample directly from the discharge tubing connected to the pump. Discharge tubing should not contact the inside of the sample containers.
2. The “straw-method” should be used when sampling for VOCs from a peristaltic pump. Groundwater should be allowed to be pumped up to the pump head, then the end of the tubing should be crimped or plugged with a gloved finger. The tubing should then be removed from the well and groundwater allowed to gravity feed from the tubing into the VOA vials.
3. Aliquot samples according to the number and analysis type as specified in the work plan and include initials, date and time of sample collection, sample ID, preservative and analysis required on sample container label.
4. Place in cooler and cool to 4º Celsius (C) with wet ice.
5. Record sample observations in field log book and Sample Collection Form.
6. Containerize, label, manage and store IDW in accordance with site-specific documents.

Decontamination: After sampling, decontaminate the low-flow purge equipment prior to further use.

Appendix E: Low Flow Purge (tubing-in-screened interval) and Sample Collection

Purging and Sampling Strategy
Low-Flow Purge (tubing in screened interval) Collection Method with pump is used primarily when calculated well volumes are excessive and create issues for time management or management of IDW. This purging and sampling technique does not require a minimum purge volume, only stabilized parameters prior to sampling.

The use of a peristaltic pump requires water levels to be maintained above the limit of suction. For wells where the water level is below the limit of suction (approximately 25' to 30', and/or where there is a large volume of water to be purged), the variable speed electric submersible pump would be a more appropriate pump of choice

Purge and Sampling Equipment
Dedicated or non-dedicated equipment may be used.
Low-Flow Purge System includes submersible or non-submersible pump, tubing, and suspension cable.
Note: Tubing may be Teflon®, Teflon® line or polyethylene. The type of tubing will be specified in site-specific documents.

Sampling Procedure
Pump Installation and Set-up:
1. Open the well and allow water level to equilibrate before taking a water level measurement (minimum of two hours).
2. Measure the depth to water at the pre-marked well casing reference point (notch or other visible mark) and calculate the water level (water column height) and volume of water in casing.
3. Set submersible pump or pump tubing at the mid-point of the screened interval.
4. Set-up associated equipment (generator, compressor, tubing, etc.)

Preliminary Measurements: Ensure well is fully recharged after pump / tubing installation by taking a water level measurement. Note: Following water-level measurement, if free phase product is suspected, measure the product thickness with an interface probe if and as specified in the work plan. If measurable quantities of product are encountered do not sample and notify the Project Manager immediately.

Purge and Stabilize Well: Note: If non-dedicated equipment is used for purging, at least one equipment blank per day (or as specified in SAP and/or work plan) will be collected from the decontaminated / cleaned purge equipment. Operate petroleum fueled power sources or related equipment downwind from the sampling location. The intent of low flow purging is to minimize drawdown. There should only be a slight and stable drawdown (less than 0.3 feet drawdown) of the water column. If this cannot be met by adjusting the purging rate to equal the recharge of the aquifer, then other methods should be employed to sample the well.

1. Lower the pump inlet as the well is purged.
2. Calculate Flow Rate of purged groundwater (acceptable range is 200 - 500 ml per minute).
3. Flow rate may be adjusted at this point but flow-rate should not exceed the recharge rate of the aquifer. Monitor by measuring the top of the water column with a water level recorder or similar device while purging. Continue to measure the water level flow-rate until stability is achieved.
4. A maximum of a 0.3 foot draw down produced by the pump is allowed.
5. Take field parameters, depth to water, and flow-rate measurements every 5–10 minutes (or more frequently depending on the time necessary to purge one-half the well screen volume).
6. Containerize the purged water unless specified otherwise in the project work plan.
7. Sampling occurs after the water level and groundwater chemistry parameters are stable as specified in this SOP or in project work plans.

Sampling

1. Reduce the flow to a low level to minimize sample disturbance, if necessary, and collect sample directly from the discharge tubing connected to the pump. Discharge tubing should not contact the inside of the sample containers.
2. The “straw-method” should be used when sampling for VOCs from a peristaltic pump. Groundwater should be allowed to be pumped up to the pump head, and then the end of the tubing should be crimped or plugged with a gloved finger. The tubing should then be removed from the well and groundwater allowed to gravity feed from the tubing into the VOA vials.
3. Aliquot samples according to the number and analysis type as specified in the work plan and include initials, date and time of sample collection, sample ID, preservative and analysis required on sample container label.
4. Place in cooler and cool to 4º Celsius (C) with wet ice.
5. Record sample observations in field log book and Sample Collection Form.
6. Containerize, label, manage and store IDW in accordance with site-specific documents.

Decontamination: After sampling, decontaminate the low-flow purge equipment prior to further use.

Appendix F: Passive Sampling Using the Snap Sampler™

Purging and Sampling Strategy
Passive Sampling using the Snap Sampler™ is a no purge sampling technique. The Snap Sampler™ utilizes specialty double-ended bottles are closed while submerged in the well. The in-well closure feature eliminates transferring sample to laboratory-prepared containers at the well head. It should be noted that this technique requires agency approval prior to use at a site.

Purge and Sampling Equipment
This is a no purge sampling technique. Equipment includes the Snap Sampler™ volatile organic analysis (VOA) vial, which is similar to standard-sized 40 mL glass VOA vials but has double end openings. A 125 mL polyethylene bottle is also available for larger sample volume. Both bottle types have two Snap Caps™ made of perfluoroalkoxy (PFA) Teflon® that seal water within the Snap Sampler™ VOA vial with an internal closure spring. The closure spring is made of stainless steel coated with PFA Teflon®. The sampler is lowered using a trigger cable. The trigger consists of a movable internal cable surrounded by a fixed-length sheath.
Once connected, the sampler is installed in the well.

Sampling Procedure
Installation and Set-up:

1. Open the well and allow water level to equilibrate (a minimum of two hours) before taking a water level measurement. Take measurements at 15 minute intervals to verify equilibration has occurred.
2. Measure the depth to water at the pre-marked well casing reference point (notch or other visible mark) and calculate the water level (water column height) and volume of water in casing.
3. Place a Snap Sampler™ inside the Snap Sampler™ and the Snap Caps™ are attached in an open position to the sampler's trigger mechanism. Up to four Snap Samplers™ can be attached in series to collect up to four sample bottles with one trigger.
4. The Snap Sampler™ is lowered into its deployment position by the trigger, which consists of high density polyethylene (HDPE) tubing with an internal stainless steel trigger cable coated with fluorinated ethylene propylene (FEP) Teflon®. The trigger tubing is fixed at the surface at a specialized well head docking station. Allow for adequate equilibration period prior to passive sampling (may be as little as 24 hours or up to 90 days, depending on well flow-through conditions and data objectives).

Sampling
To collect samples, the trigger cable is manually pulled at the well head to activate the sampler release mechanism. The mechanism releases the Snap Caps™, which close on the Snap Sampler™ bottle. The sampler is then retrieved from the well with the closed bottles. Acid preservative can be added to a specially-sized cavity in one of the Snap Caps™, and standard septa screw caps are placed on each end of the bottle. Field personnel are required to remove the bottles from the Snap Sampler™, and without opening the vials, trim the Snap Caps™ and place septa caps on the bottles. If field preservation is needed, preservative is added through a cavity in one of the Snap Caps™ before securing the septa cap. The vial can then be labeled and transported to the laboratory in the same fashion as standard VOA vials. The Snap Sampler™ VOA vial can be used directly in common laboratory auto sampler equipment, so samples are not exposed to ambient air during retrieval, field preparation, or analysis at the lab unless manual dilutions or reanalyses are required.

Place in cooler and cool to 4° Celsius (C) with wet ice.

Record sample observations in field log book and sample collection form.

Decontamination: The Snap Sampler™ is intended for redeployment in the same well from which it came, so extensive decontamination is not required for redeployment. When deployed and redeployed in the same well from sampling event to sampling event, the Snap Sampler™ needs only to be cleaned to the extent that objects, sediment, or other debris is removed from the sampler trigger mechanism to operate properly.

In the event that the Snap Sampler™ is to be moved between wells for sampling, decontamination is accomplished by disassembling the sampler and washing the individual parts. The trigger tube and wire are not intended to be used between wells.

Appendix G: Passive Sampling Using HydraSleeve™

Purging & Sampling Equipment
The HydraSleeve™ can be used to sample a wide spectrum of analytes including but not limited to the following: VOCs, semi-volatile organics, metals, radiological contaminants, major cations and anions, dissolved trace metals, dissolved sulfide, dissolved gases (methane/ethene/carbon dioxide), total dissolved solids, dissolved organic carbon, dissolved silica, explosive compounds, and perchlorate. It should be noted that this technique requires agency approval prior to use at a site.

The HydraSleeve™ consists of three basic components: a reusable weight; a long, flexible, lay-flat sample sleeve (usually made of polyethylene); and a self-sealing valve. The bottom of the flexible tube is sealed and the weight is attached to it. The valve is located at the top of the lay-flat sample sleeve and includes an attachment point for the suspension line.

The HydraSleeve™ are sized to fit in 2-inch or 4-inch wells. The standard sampler is for a 2-inch well and is has a 1.5-inch outside diameter (OD) by 36-inches long sleeve and the sleeve for a 4-inch well as a 2.5-inch OD by 24-inches long sleeve. The standard 1.5-inch sampler holds 1-liter and the 2.5-inch sampler holds 2-liters of sample. HydraSleeve™ samplers can be custom fabricated in varying lengths and diameters for specific volume requirements.

Sampling Procedure
Prior to sampling, obtain sample containers from laboratory (or laboratories). Ensure presence of preservatives in bottles as appropriate.

Before opening the well, a clean working surface shall be set up around the well head using a clean plastic sheet. Prior to opening the well, the required health and safety gear (as specified in the HASP) shall be donned. This, at a minimum, usually means wearing gloves to limit the potential for exposure to contaminants as well as reduce the potential for handling-induced contamination of sampling equipment.

Preliminary Measurements
Inspect the well casing to determine if the monitoring well is vented. If the well is not vented, allow sufficient time (ideally two hours) for the water level to equilibrate prior to water level measurement. Measure the depth to water at the pre-marked well casing reference point (notch or other visible mark). To obtain a water level measurement, lower the probe of a water level measuring device into the well until the audible sound of the unit is detected or the light on an electronic sounder illuminates. At this time the precise measurement should be determined (to nearest 0.01 feet) by repeatedly raising and lowering the tape to converge on the exact measurement. Obtain the reading from the top of casing (TOC) measuring point. The water level measurement should be entered on the Groundwater Sample Collection Record or in the field log book. The measurement device shall be decontaminated immediately after use with a non-phosphatic detergent and rinsed with distilled water. Generally, only that portion of the tape which enters the water table should be cleaned. It is important that the measuring tape should not be placed directly on the ground surface or allowed to become kinked. Measuring devices, including interface probes, which come into contact with free product, will likely require more thorough decontamination.

Calculate the water level (water column height) and volume of water in casing. Note: Following water-level measurement, if free phase product is suspected, measure the product thickness with an interface probe as specified in the work plan. If measurable quantities of product are encountered do not sample and notify the Project Manager immediately. Wells containing free product are generally not used for groundwater sampling, since the concentration of contaminants present in the free product can adversely affect the quality of the water sample, lending to a non-representative water sample.

Purge Well: Note: There in no purging performed prior to sampling using the HydraSleeve™.

Sampling:

Sampler placement
Attach the reusable weight to the HydraSleeve™. The HydraSleev^{eTM} is lowered and placed at the desired position in the well screen. In-situ water pressure keeps the reed valve closed, preventing water from entering the sampler. Monitor the water level until the water level has returned to equilibrium.

Sample collection
Open the reed valve to allow filling when the sampler is moved upward faster than 1 foot per second, either in one continuous upward pull or by cycling the sampler up and down to sample a shorter interval. There should be no change in water level, and only minimal agitation during collection.

Sample retrieval
When the flexible sleeve is full, the reed valve closes and the sampler can be recovered without entry of overlying fluids. Once the sampler has been returned to the ground surface, puncturing the sleeve with the pointed discharge tube and drain the contents from the sleeve into sample containers or field filtration equipment.

Aliquot Sample: Aliquot the sample into the containers necessary for both laboratory analysis and any further field measurements. For laboratory analysis, include initials, date and time of sample collection, sample ID, preservative and analysis required on sample container label. Place in cooler and cool to 4° Celsius (C) with wet ice.

Groundwater samples collected for total dissolved metals analyses will be field filtered prior to being placed in sample containers and properly preserved. Groundwater filtration will be performed using a peristaltic pump and a 0.45-micron in-line water filter. Disposable filters are commonly available in 0.45-micron size. Low-capacity or high-capacity cartridges are available and may be selectively used based on sample turbidity.

The filtration of groundwater samples shall be performed from laboratory-supplied intermediate containers. In either case, well purging shall be performed first. Fresh groundwater shall then be filtered directly into sample containers.

Post-Sampling Activities: Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to:

- Ensuring that the field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing the sample paperwork, including copies provided to laboratory.
- Compiling the field data for site records.
- Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure the appropriate sample analyses has been returned to sampler.
- Containerize, label, manage and store IDW in accordance with site-specific documents.

Appendix H: Passive Sampling Using Polyethyle Diffusion Bags™

Purging & Sampling Equipment
Polyethylene Diffusion Bags™ (PDBs) can be used to sample VOCs and is a passive sampling technique that does not require purging prior to sampling.

The PDB consists of low density polyethylene (typically 4mils thick) film which serves as a semi-permeable membrane. The membrane is formed into the shape of a tube to create a sample chamber which is filled with de-ionized water and sealed. Various configurations are commercially available either pre-filled and sealed at both ends at the factory, or with a fill port and plug for filling at the factory, in the field, or at the user's lab. PDB samplers are typically 18 to 24 inches long and 1.25 to 1.75 inches in diameter to fit into a 2-inch diameter and larger monitoring wells. Typically uses a stainless steel hanging assembly to install and hold sampler in place within well. It should be noted that this technique requires agency approval prior to use at a site.

Sampling Procedure:
1. Prior to sampling, obtain sample containers from laboratory (or laboratories). Ensure presence of preservatives in bottles as appropriate.

2. Before opening the well, a clean working surface shall be set up around the well head using a clean plastic sheet. Prior to opening the well, the required health and safety gear (as specified in the HASP) shall be donned. This, at a minimum, usually means wearing gloves to limit the potential for exposure to contaminants as well as reduce the potential for handling-induced contamination of sampling equipment.

Preliminary Measurements
Inspect the well casing to determine if the monitoring well is vented. If the well is not vented, allow sufficient time (minimum two hours) for the water level to equilibrate prior to water level measurement. Measure the depth to water at the pre-marked well casing reference point (notch or other visible mark). To obtain a water level measurement, lower the probe of a water level measuring device into the well until the audible sound of the unit is detected or the light on an electronic sounder illuminates. At this time the precise measurement should be determined (to nearest 0.01 feet) by repeatedly raising and lowering the tape to converge on the exact measurement. Obtain the reading from the top of casing (TOC) measuring point. The water level measurement should be entered on the Groundwater Sample Collection Record or in the field log book. The measurement device shall be decontaminated immediately after use with a non-phosphatic detergent and rinsed with distilled water. Generally, only that portion of the tape which enters the water table should be cleaned. It is important that the measuring tape should not be placed directly on the ground surface or allowed to become kinked. Measuring devices, including interface probes, which come into contact with free product, will likely require more thorough decontamination.

Purge Well
Note: There in no purging performed prior to sampling using PDBs.

Sampling
1. Sampler placement: Deployment consists of attaching the PDB sampler to a carefully measured, weighted suspension cord and lowering the PDB to the exact predetermined location within the screened interval of the well. It is generally recommended that the samplers are left in place a minimum of two weeks to allow the well to resume normal flow and stratification and for equilibration.

2. Sample collection: Pull the sampler out of the well and transferring the contents to VOA vials. Transfer should be made within minutes of removal from submersion to prevent loss of volatiles to the air.

For laboratory analysis, include initials, date and time of sample collection, sample ID, preservative and analysis required on sample container label. Place in cooler and cool to 4^{o} Celsius (C) with wet ice.

Post-Sampling Activities
Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to:

- Ensuring that the field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing the sample paperwork, including copies provided to laboratory.
- Compiling the field data for site records.
- Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure the appropriate sample analyses has been returned to sampler.
- The PDB is a disposable groundwater sampler. Only the reusable stainless steel weight and suspension cord need to be decontaminated if moved from well to well.
- Containerize, label, manage, and store IDW in accordance with site-specific documents.

Appendix I: Direct Push Groundwater Sample Collection

Purging and Sampling Strategy:
The use of direct push groundwater sampling is contingent upon the existing conditions at the project site. For a particular site investigation, the work plan will identify the appropriate drilling method and method of groundwater sampling, along with proposed sampling depths and intervals and any special procedures or methods. Procedures used to purge temporary ground water monitoring wells differ from permanent wells because temporary wells are installed for immediate sample acquisition. Wells of this type may include standard well screen and riser placed in boreholes created by hand augering, power augering, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15/16 sampler or a Hydropunch® sampler.

Purge and Sampling Equipment:

- Direct push Unit
- Groundwater sampling system consisting of expendable sampling tips, well screen with protective sleeve, connector assembly, probe rods (riser pipe), drive cap, grab sampling devices (bailers, if used), sample tubing and check valve assembly (if used), and sampling pump (if used);
- Auxiliary tools for handling, assembling, and disassembling tools and probe rods
- Containers to manage investigation-derived material per site-specific documents.

Sampling
Procedure:
Probe Advancement and Set-up: Install the sampling assembly to the probe rod, and advance the assembled sampler using the drill rigs hydraulic rams (smooth quasi static push) or the drill rig hammer (percussive driving), or both. If appropriate, a leakage test will be conducted by checking for the presence of water inside the riser with an electronic water level meter. If no leakage is observed, then sampling may proceed. If water is present in the riser pipe from an unknown source, it should be purged before sampling; otherwise the sampling effort should be abandoned. Extension rods are used to hold the screen in position as the casing puller assembly is used to retract the probe rods. Groundwater sampling may be completed once the well screen is fully exposed. The extension rods are then removed and polyethylene or Teflon® tubing with a check valve is then inserted inside the probe rods to the bottom of the screen.

Sampling:

1. The sampling tube assembly may then be oscillated up and down to bring water to the surface for sample collection. Collect sample directly from the discharge tubing. Discharge tubing should not contact the inside of the sample containers.
2. Alternatively, if permitted by the sampling plan, a sampling pump (e.g., peristaltic) may be connected to the tubing to draw in the sample. The “straw-method” should be used when sampling for VOCs from a peristaltic pump. Groundwater should be allowed to be pumped up to the pump head, and then the end of the tubing should be crimped or plugged with a gloved finger. The tubing should then be removed from the well and groundwater allowed to gravity feed from the tubing into the VOA vials.
3. In lieu of using sampling tubing, a small diameter bailer may be lowered inside the probe rods to the interval of the screen to collect a grab sample of groundwater.
4. Aliquot samples according to the number and analysis type as specified in the work plan and include initials, date and time of sample collection, sample ID, preservative and analysis required on sample container label.
5. Place in cooler and cool to 4^{o} Celsius (C) with wet ice.
6. Record sample observations in field log book and Sample Collection Form.
7. Containerize, label, manage and store IDW in accordance with site-specific documents.

Decontamination: After sampling, decontaminate the low-flow purge equipment prior to further use.

Appendix J: Example Chain-of-Custody

Kemron

CHAIN-OF-CUSTODY RECORD

[1] COC NUMBER:

[2] PROJECT NAME:	[3] PROJECT NUMBER:	[8] LAB NAME AND CONTACT:	[11] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 1 (Name and Company)	[14] RECIPIENT 1 (Address, Tel No. , and Fax No.):
[5] PROJECT PHASE/SITE/TASK:	[6] CTO OR DO NUMBER:	[9] LAB PO NUMBER:	[12] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 2 (Name and Company)	[15] RECIPIENT 2 (Address, Tel No. , and Fax No.):
[4] PROJECT CONTACT:	[7] PROJECT TEL NO AND FAX NO:	[10] LAB TEL NO AND FAX NO:	[13] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 3 (Name and Company)	[16] RECIPIENT 3 (Address, Tel No. , and Fax No.):

[25] ANALYSES REQUIRED (Include Method Numbers)

[17] ITEM	[18] SAMPLE IDENTIFIER	[19] SAMPLE DESCRIPTION/LOCATION	[20] MATRIX (see codes on SOP)	[21] DATE COLLECTED	[22] TIME COLLECTED	[23] DATA PKG LEVEL (see codes on SOP)	[24] TAT (calendar days)													[26] SAMPLE TYPE (see codes on SOP)	[27] COMMENTS/ SCREENING READINGS	[28] LAB ID (for lab's use)
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

[29] SAMPLER(S) AND COMPANY: (please print)	[30] COURIER AND SHIPPING NUMBER:	[31] SAMPLES TEMPERATURE AND CONDITION UPON RECEIPT (for lab's use):

[32] RELINQUISHED BY	DATE	TIME	[33] RECEIVED BY	DATE	TIME
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		

Distribution: [ ] Original - Laboratory (To be returned with Analytical Report); [ ] Copy 1 - Project File; [ ] Copy 2 - PMO

Appendix K: Example of Groundwater Sample Collection Form

hjgjhgjhWell Number ______________________ Project Name:
Sample No. ____________________ Project Number:
Date ______________ Collectors:

Well Information

Monument Condition ☐Good ☐Needs Repair______________________________
Well Cap Condition ☐Good ☐Locked ☐Replaced ☐Needs Replacement
Elevation Mark ☐ Yes ☐ Added ☐other
Well Diameter ☐ 2-inch ☐4-inch ☐6-inch ☐Other
☐Odor Comments ____

Purge Data

Total Well Depth ________ ft ☐ Clean Bottom ☐Muddy Bottom ☐Not Measured
Depth to Water ________ ft
Casing Volume ________ ft (H20) X ________ gpf = ______ X 3 = __________ gallons
3/4 " = 0.02 gpf 1"= 0.04 2" = 0.16 gpf 4"=0.65 gpf 6"=1.47 gpf

Purge Method

Pump Type: Tubing: Total volume purged _________
Sample Intake Depth _____________ Purge Rate ________
Purge Start Time ________ Purge Stop Time ________ Sample Rate ________

Field Parameters

Time	Gallons	pH	Turbidity (NTU)	Temperature (C)	Conductivity (mS/cm)	D.O. (mg/L)	Comments

Sampling Device

Filter Type: Size:

Sample Containers Collection Time__________

Tag No.	Type		Preservative	Analytical Method	QA Remarks
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			

Appendix L: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Standard Operating Procedures

Technical Procedure: FSOP-800
Revision: 02

STANDARD OPERATING PROCEDURE FOR SOIL SAMPLING IN THE FIELD

<u>KEMRON Environmental Services, Inc.</u>
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Leland J Meadows

Leland Meadows, Corporate QA/QC Manager	08/14/19 Date
John Dwyer, President	08/14/19 Date

VERSION CONTROL

Version	Changes	Affects Section	Effective Date
00	N/A	Entire Document	08 November 2004
01	Review for content, technology and methods, and quality control.	Entire Document	23 October 2014
02	Review for content, technology and methods, and quality control.	Entire Document	19 August 2019

TABLE OF CONTENTS

LIST OF APPENDICES

1 POLICY

KEMRON employees will take the necessary precautions to ensure that safety and health are maintained and that compliance with applicable regulations is upheld when soil sampling.

2 PRECAUTIONS

Soil sampling may involve chemical hazards associated with the materials being sampled. Adequate health and safety measures must be taken to protect project sampling personnel from potential chemical exposures or other hazards. Furthermore, risks and hazards associated with working in conjunction with excavators and drill rigs will be present at the site. These measures must be addressed in the project Health and Safety Plan (HASP). This plan must be approved by the project health and safety officer before work commences, must be distributed to the personnel performing sampling, and must be adhered to as field activities are performed.

The following precautions should be considered by field personnel when collecting soil samples:

- Special care must be taken to store samples in a safe and secure location to ensure the samples are not in contact with any material that could contaminate the samples. Ensure the custody seal is in place during long-term storage or shipment.
- Ensure samples are in the custody of the field sampler until the samples are relinquished to another party.
- The chain-of-custody must be filled out and remain with the samples until custody is relinquished.
- Shipping documents, such as air bills, bills of lading, etc., will be retained by the project leader in the project files.

3 PURPOSE

The objectives of soil sampling are to ensure that valid and representative samples are collected that meet the requirements of the project, and to prevent deterioration and contamination of the samples before laboratory analysis. By complying with procedures specified in this Standard Operating Procedure (SOP), KEMRON will ensure that the following are successfully completed:

- Proper soil sampling procedures using various methods of soil recovery.
- Soil collection procedures specific to analysis of volatile organic compounds (VOCs)
- Prevention of contamination or cross-contamination of soil samples during collection, containerization, transit and storage.
- Obtain and record accurate and complete sampling data.
- Preparation of complete and correct sample labels.
- Preparation and maintenance of sample chain-of-custody.

4 SCOPE

This procedure provides technical guidance on the collection and handling of soil samples including decontamination procedures, types, and uses of sampling equipment. This SOP applies to KEMRON personnel and subcontractors collecting soil samples for KEMRON projects. Client, federal, or state requirements, or project-specific requirements may dictate specific types of equipment or procedures to be used when applying this SOP to a particular project. Deviations from this SOP to accommodate site-specific requirements shall be documented in project planning documents and Appendix A and approved by the KEMRON Quality Assurance / Quality Control (QA/QC) Manager or client representative where applicable, prior to the performance of work.

5 RESPONSIBILITY

Project Manager Responsibilities
The KEMRON Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOP and the project-specific work plan. The KEMRON Project Manager ensures the field staff have reviewed and signed off on this SOP prior to beginning field work. A sign-off sheet covering the SOPs related to the project will be prepared and filed with project documents, when necessary.

Field Staff Responsibilities
The KEMRON field staff prepares, organizes, and inspects the equipment required for the sampling event prior to the initiation of sampling activities. The field sampler and shipper are responsible for initiating, maintaining, and transferring chain-of-custody. Upon completion of the sampling event, the field staff returns the equipment to the designated storage area, ensuring that the equipment is decontaminated and in a condition ready for reuse. KEMRON field staff is required to follow procedures specified in this SOP, or approved project-specific SOP, prior to initiating the sampling event. Field staff is required to sign off that they have read and understand this SOP prior to beginning field work.

Subcontractors
Subcontractors are secured under contract and required to meet local, state, and federal requirements (i.e., 29 CFR 1910.333(c)(3); 29 CFR 1926.550(a)(15)(i), (ii), (iii)).

6 DEFINITIONS

- **BGS**: Below Ground Surface

- **Dressing Soil Surfaces**: Dressing soil surfaces includes removing the exposed soil surface prior to sampling using a stainless steel shovel, spatula, knife, or spoon. The depth of soil removed depends on the technique used to expose the soil (excavation with a backhoe requires more removal than excavation with a shovel). Dressing soil is necessary to minimize the effects of contaminant migration interferences due to smearing of soil.

- **Discrete Soil Sample**: A discrete sample is a sample collected from one specific horizontal location and vertical interval.

- **Homogenization**: The process of mixing samples in order to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample. To homogenize a sample, place each grab or core material into a single mixing bowl (made of suitable material i.e. stainless steel), remove any large objects such as sticks, leaves or stones, etc. and stir thoroughly with a spoon to homogenize. Scrape the soil from the sides, corners, and bottom of the pan; roll to the middle of the pan; and complete a final mixing in the center of the pan. Flatten the sample, if needed, quarter the sample, and move to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled back to the center of the container and the entire sample mixed again. Aliquot as appropriate. If round bowls are used for sample mixing, adequate sampling is achieved by stirring the material in a circular fashion, reversing direction, and occasionally turning the material over. Samples for VOC analysis should not be homogenized.

- **Incremental Sampling**: A structured composite sampling and processing process that provides data sets with reduced data variability and an unbiased estimate of mean concentration of a given contaminant within a specific volume of soil targeted for sampling. Each site defines specific soil volumes as decision units (DUs) by collecting numerous increments (aliquots) of soil (typically 30–100) that are combined, processed, and subsampled.

- **Quality Control:** Quality control samples should be collected in accordance with the site-specific Work Plan, SAP and/or Quality Assurance Project Plan (QAPP). Examples of quality control samples include blind duplicates, equipment blanks, field blanks, Matrix Spike and Matrix Spike duplicates.

- **Records:** Field notes must be recorded during soil sampling activities. Field notes should be recorded in a bound field logbook, as described in KEMRON's SOP for Field Documentation (FSOP-200).

- **Sample Compositing**: Discrete samples are taken and then proportionally combined into one sample container. Composite samples are generally used to estimate the average concentration of the individual samples that make up the composite.

7 PLANNING

Planning will address all steps outlined in this procedure.

7.1 Site-Specific Written Instructions for Hand Tools

The site specific health and safety plan will reference this SOP. The SHSO will outline how and where tools will be stored when not in use. The SHSO will plan for identification of damaged tools and removal from service.

7.2 Written Instructions for Deviations

Any deviations from this SOP will be prepared and justified by the Project Manager and approved by the QA/QC Manager.

8 SPECIAL CONSIDERATIONS

8.1 Considerations for Trace Contaminant Sampling

- A new set of clean, disposable gloves should be donned immediately prior to each sample collection.
- Samples collected in areas that are suspected to contain high contaminant concentration should be store separately from other samples, including background samples.
- Samples should be collected from least contaminated to areas most suspected of contamination.
- In ideal situations, one field staff should be dedicated to filling out the field notes, sample labels, chain of custodies and taking photographs.

- Samples must be collected in containers provided by the laboratory, unless otherwise specified in the Work Plan or Sampling and Analysis Plan.

8.2 Sample Homogenization

Discrete and composite samples for laboratory testing must be adequately homogenized to ensure the sample is representative of the sampled interval.

- Samples for VOC analysis are not homogenized.
- If sub-sampling of the primary sample is to be performed in the laboratory (Multi-Incremental Sampling), transfer the entire primary sample directly into an appropriate, labeled sample container(s).
- Place the sample into a glass or stainless steel bowl and mix thoroughly. If the soil has a high clay content, a spoon may be used to break up large pieces of soil.
- With the exception of soil sampling for VOC analysis, all soil samples must be thoroughly mixed to ensure that the sample is representative of the sample media. The most common method of mixing is referred to as quartering.
- The steps for quartering is as follows
  - The material in the sample pan is divided into quarters and mixed individually.
  - Two quarters are then mixed to form halves.
  - The two halves are mixed to form a homogenous matrix

  This procedure should be repeated several times until the sample is adequately mixed. When round bowls are used for sample mixing, mixing is performed by stirring the material in a circular fashion, reversing direction, and turning the material over.

  Place the sample into an appropriate, labeled container(s) provided by the lab and secure the cap(s) tightly. When filling the sample containers, place a spoonful of soil in each container in sequence and repeat until the containers are full or the entire homogenized sample is placed into the container(s). Threads on the container and lid should be cleaned to ensure a tight seal when closed.

8.3 Considerations for VOC Analysis

Procedures for collecting soil samples for VOC analysis follow the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, and Method 5035. If samples are to be analyzed for VOCs, they should be collected in a manner that minimizes disturbance and potential volitization. For example, when sampling from an excavator bucket, the sample should be collected directly from the bucket or from minimally disturbed material immediately after the soil is dumped from the bucket.

Various tools can be used to collect soil samples for VOC analysis, including En Core® Sampler, syringes, stainless steel spatula, standard 2-oz soil VOC jars, or pre-filled (preserved) 40 mL vials. The sample is collected by filling an En Core® Sampler or other Method 5035 compatible container, such as a Terracore sampler or preserved vials.

When implementing Method 5035 sampling and analysis, an Encore™® or Terracore™® (or equivalent and EPA-approved) sampling device is required. The samplers are attached to a T-handle that serves to assist in pushing the sampler into the soil. Three (3) samplers are usually required to be used to complete a single sample; this provides the laboratory one sample for high contaminant analysis and two samples for low level analysis. The samples are either preserved by freezing upon receipt at the laboratory, or preserved within 48 hours with the appropriate preservative (methanol or sodium bisulfate). Please note that some regulatory programs do not accept freezing of samples as an adequate means of preservation. If freezing is not allowed, sample preparation in the laboratory must be performed within 48 hours of sample collection; therefore, advance coordination with the analytical laboratory regarding sample collection, delivery and preparation is critical to a successful sampling and analysis program.

Additionally, hard clays and gravels may not be able to be sampled with Encore™® or Terracore™® samplers; the Project Manager should assess the site geology to determine feasibility of sampling protocol. The Project Manager also should be aware that EnCore samplers typically have a higher associated cost than Terracores.

8.3.1 Use of Terracore Samplers with Pre-prepared Vials

An undisturbed soil sample is obtained by pushing the barrel of the coring tool into a freshly exposed surface and removing the corer once filled. An approximate five (5) gram weight sample is obtained for each Terracore™®, with sample weights determined in the field using a portable electronic scale. The sample is extruded into laboratory prepared, pre-tared and labeled 40 mL vials with a stir bar. The laboratory adds the necessary preservative upon log-in. A separate sample must be collected for soil moisture content measurement, using a wide-mouth glass jar; size of the sample is not critical.

8.3.2 Use of EnCore™® Samplers

The EnCore™® sampler serves as the sample shipping container. An undisturbed sample is obtained by pushing the barrel of the coring tool into the freshly exposed surface and removing the corer once filled. The exterior of the barrel is quickly wiped with a clean disposable towel to ensure a tight seal. An airtight cap is then attached to create a complete sample package. The sample is labeled and inserted into a sealable (e.g., zip lock) pouch, immediately cooled to 4 ± 2°C, and prepared for shipment to the analytical laboratory.

The sampler must review the manufacturer's instructions that accompany the sampling device prior to use, and must be trained by KEMRON personnel experienced in use of the sampling device prior to conduct of sampling.

Coordination between field and laboratory personnel is needed due to the large number of sampling options. The type of sampling containers and sampling tools needed during soil sampling will depend upon the detection levels, anticipated level of VOCs, and intended data use. For many long-term projects, such as Federal project, this information is typically detailed in the site specific SAP, QAPP and/or Work Plan.

9 Soil Sampling Method, Equipment and Procedures

Soil samples may be collected as discrete (grab) soil samples, composites, or incremental samples (IS). Discrete and composite sampling can be performed using a variety of techniques and are discussed within this SOP. IS of soil is typically applied during investigation or confirmation following remediation. IS will be performed in general accordance with Interstate Technology & Regulatory Council (ITRC) Guidance (February 2012). Details regarding decision units, number of aliquots and sampling procedures will be specified in the site-specific SAP, QAPP and /or Work Plan.

Soil sampling equipment and supplies can include the following:

- Maps/plot plan
- Safety equipment, as specified in the site-specific HASP (PPE, etc.)
- Survey equipment or global positioning system (GPS) to locate sampling points
- Tape measure
- Survey stakes or flags
- Camera

- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan - tools plated with chrome or other materials should not be used
- Sample containers
- Ziploc plastic bags
- Logbook
- Labels
- Chain-of-Custody records and custody seals
- Field data sheets and sample labels
- Cooler(s) with thermometer for checking temperature
- Ice
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel(s)
- Continuous flight (screw) auger
- Bucket auger
- Post hole auger
- Extension rods
- T-handle
- Portable electronic scale
- Sampling trier
- Thin wall tube sampler
- Split spoons
- Tubes
- Points
- Drive head
- Drop hammer
- Puller jack and grip
- Backhoe

The methods used to collect soil samples for laboratory analysis are provided on the tables below. Each table provides a description of equipment and sampling procedures for method used to collect soil samples and ranges from collection of surface soil using a spoon to collection of deep soils using a drill rig or excavator. The project work plan will specify the methods to be used at each site and any site-specific requirements. Once the soil is retrieved from the target location(s), the soil will be sampled in the following sequence or as stated in the project-specific planning documents: Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs), Pesticides, Herbicides, Polychlorinated Biphenyls (PCBs), Metals and Radiological Contaminants.

10 FIELD RECORDS

10.1 Field Log Book

See the Field Documentation FSOP-200, for generic documentation items. Examples of specific soil sampling documentation include the following:

1. Site Name;
2. Date and time of arrival;
3. Weather conditions, including ambient air temperature and/or miscellaneous observations;
4. Location/GPS coordinates;
5. Date and time sampling;
6. Sample location and boring ID;
7. Sample depth;
8. Sample sequence number;
9. Sample Equipment ID;
10. Method of sampling;
11. Field parameters (pH, conductivity, and temperature);
12. Fractions sampled and preservation method(s);
13. Signature of Sampler and Date;
14. Physical characteristics, to include the general soil type (sand, silt, clay, and organic/other matter such as wood chips, as determined using the Unified Soil Classification System (USCS)), approximate grain size (fine, medium, coarse), presence of observable biota, odor, color, layers, depth of layer changes;
15. Pertinent field observations and comments;
16. Site drawing showing sample locations, dimensions, and prominent features.

10.2 Chain-of-Custody

Completed chain-of-custody (COC) forms must be maintained for all samples. Sample labels should be checked against the completed COC for accuracy. An example COC form is included as Attachment G. The original form will be sent to the laboratory with the samples and signed by the lab upon receipt. Original completed COC forms will be returned to KEMRON with the analytical report. A copy of the COC will be retained by the field crew (sampler) and kept with field records.

11 DECONTAMINATION

Reusable equipment taken to the field should be clean prior to arrival on-site. The following procedures, or that specified in the site-specific documents, are completed between sampling locations for equipment associated with sampling, including drilling and excavation equipment. Also, the equipment will be decontaminated at the conclusion of equipment use at the site, as well as if visual evidence indicates a need at the onset of equipment use. Decontamination procedures must be performed in accordance with KEMRONs FSOP-100. In general, the following procedures apply:

1. Hand wash, or flush/pump through automatic samplers/equipment, with a non-phosphate laboratory detergent dissolved in tap water;
2. Rinse with tap water;
3. Rinse thoroughly with deionized water;
4. Allow to air dry;
5. Wrap in aluminum foil and a plastic bag, if needed, and store in a clean, dry area (no included for drilling or excavator, unless specified in the site-specific work plan).

Decontamination solvent such as isopropanol, acetone or hexane may be used for equipment exposed to high levels of organics (e.g., NAPL). Use of specific decontamination solvents should be addressed in project-specific planning documents and the waste solvents managed and disposed in accordance with applicable regulations.

12 SAMPLE SHIPMENT

Equipment decontamination chemicals may need to be shipped to the site and samples may need to be shipped to the laboratory. Shipping is completed in accordance with the current federal and international regulations (DOT, EPA, and IATA). Shipping stipulations are to be included in the project documents, but should you have any questions regarding shipping of any materials to and from the site, contact the authorized shipping representative in your home office.

13 REFERENCES

USEPA, Region 4, Groundwater Sampling Operating Procedure (SESDPROC-301-R3), August 2014.

ITRC Incremental Sampling Methodology, February 2012.

Appendix A: Request for Deviations

Deviation to FSOP-800: STANDARD OPERATING PROCEDURE FOR SOIL SAMPLING IN THE FIELD

Description of Deviation
1.
2.
Need for Deviation
1.
2.
Corrective Action Taken
1.
2.

Approved by:

Name: Signature:
KEMRON Project Manager Date

Name: Signature:
KEMRON QA/QC Manager Effective Date

- OR -

Name: Signature:
Client Representative Effective Date

Appendix B: Soil Sampling with Spoons, Shovels, Post-Hole Diggers, Bowls

Surface Soils, typically in range of 0 to 12" BGS

Equipment
Shovel, post-hole digger, stainless steel spoon, stainless steel bowl

Soil Collection Procedure
Use the spoon, shovel or post-hole digger as intended.

Soil Sampling Procedure
Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment, calibrate if necessary.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Put ice in coolers.
5. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
6. Perform a general site survey prior to site entry in accordance with the site specific HASP.
7. Use stakes, flagging, or cones to identify and mark the sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. Underground utility clearance should be performed in accordance with KEMRON's utility clearance FSOP 001, and utility clearance should always be confirmed before beginning work.

Sampling

1. Put on clean gloves.
2. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.
3. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.
4. Remove old gloves and don new set of gloves. If VOC analysis is to be performed via Method 5035 (Encore or equivalent) sampling, the sample is to be collected directly from the soil. Otherwise, transfer the sample directly into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. If soil is cohesive, the En Core® sampler can be used by pushing the sampler into the soil on the spoon. If the soil crumbles upon sampling, then collect the sample by pushing the sampler directly into the ground. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.
5. Field screen soil with properly calibrated equipment (i.e. PID, FID, etc.) (if required).
6. Place samples in cooler and cool to 4º Celsius (C) with wet ice.
7. Record sample observations in field log book.

Post-Sampling Activities
Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:

- Ensuring that the field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.

- Processing sample paperwork, including copies provided to laboratory.
- Compiling the field data for site records.
- Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure the appropriate sample analyses has been returned to sampler.
- Manage IDW in accordance with procedures defined in site Work Plan, SAP and/or QAPP.

Appendix C: Soil Sampling with Spoons, Shovels, Post-Hole Diggers, Bowls

- Surface Soils
- Shallow Subsurface Soils

Soil Depth:
- Based on project specific requirements, typically in range of 0 to 12" BGS
- 12 inches BGS to the depth that manual methods become impractical

Equipment
Stainless steel hand auger, stainless steel spoon, stainless steel bowl

Soil Collection Procedure
Typically, four (4)-inch auger buckets with cutting heads are pushed and twisted into the ground and removed as the auger bucket is filled. The auger holes are advanced one bucket at a time. When the depth of a sampling interval has been reached, one auger bucket is used to advance the auger hole to the first desired sampling depth.

Soil Sampling Procedure
Preparation
1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment, calibrate equipment, if necessary.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific HASP.
6. Use stakes, flagging, or cones to identify and mark the sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. Underground utility clearance should be performed in accordance with KEMRON's utility clearance FSOP-001, and utility clearance should always be confirmed before beginning work.
7. Place ice in cooler in preparation for sampling.

Sampling:
This system consists of an auger, or a thin-wall tube sampler, a series of extensions, and a "T" handle. The auger is used to bore a hole to a desired sampling depth and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin wall tube sampler. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected from the thin wall tube sampler. Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are better for direct sample recovery because they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and cannot be used below a depth of approximately three feet. The following procedure is used for collecting soil samples with the auger:
1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.
2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the drilling location.
3. Put on clean gloves and begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down

the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from the hole. When sampling directly from the auger, put on new gloves and collect the sample after the auger is removed from the hole and proceed to Step 10.
5. Remove auger tip from the extension rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.
6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the soil. Do not scrape the borehole sides. Avoid hammering the rods as the vibrations may cause the boring walls to collapse.
7. Remove the tube sampler, and unscrew the drill rods.
8. Remove the cutting tip, and the core from the device.
9. Discard the top of the core (approximately 1 inch), as this possibly represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required. Field screen soil and record in log book.
10. If VOCs analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. If Method 5035 (Encore or equivalent) sampling is required, the sample is to be collected directly from the core. Otherwise, place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.
11. Field screen soil with properly calibrated equipment (i.e. PID, FID, etc.) (if required).
12. Place samples in cooler and cool to 4º Celsius (C) with wet ice.
13. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.
14. Abandon the hole according to applicable state regulations. Generally, shallow holes can simply be backfilled with the removed soil material.
15. Record sample observations in field log book.

Post-Sampling Activities:

Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:

- Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing the sample paperwork, including copies provided to laboratory.
- Compiling the field data for site records.
- Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure the appropriate sample analyses has been returned to sampler.
- Manage IDW in accordance with the procedures outlined in the site Work Plan, SAP and/or QAPP.

Appendix D: Shelby or "Push Tube"

Soil Level Identification
- Surface Soils
- Shallow Subsurface Soils

Soil Depth
- Based on project specific requirements, typically in range of 0 to 12" BGS
- 12 inches BGS to depth that manual methods become impractical

Soil Collection Procedure
Drive the tube into the soil with a drill rig, if necessary.

Soil Sampling Procedure
Preparation
1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment, calibrate if necessary.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific HASP.
6. Use stakes, flagging, or cones to identify and mark the sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. Underground utility clearance should be performed in accordance with KEMRON's utility clearance FSOP-001, and utility clearance should always be confirmed before beginning work.
7. Place ice in cooler.

Sampling
1. Put on clean gloves and drill to first sampling depth, as described in the project planning documents. (Note: The goal is to get an undisturbed sample. If the sampling area has been disturbed with a split-spoon or other sampling device, the hole should be drilled to the next undisturbed location before driving the Shelby tube.)
2. Place decontaminated Shelby tube sampler on center rods.
3. Drive Shelby tube sampler with the push head of the drill rig, as described in ASTM Method D1587. Retrieve the sampling tube and remove the disturbed material from the top of the tube. In addition, remove 1 inch of soil from the base of the tube. Place an impervious disk at both ends of the tube seal with a wax plug prior to shipment to the laboratory.
4. If Shelby tubes are to be extruded in the field for composite sampling, the driller will use a hydraulic extruder to obtain the sample. Samples will then be composited, as necessary, for analysis.
5. Field screen soil with properly calibrated equipment (i.e. PID, FID, etc.) (if required).
6. Label and manage sample containers in accordance with the site-specific SAP/QAPP section for shipping and handling of samples. Mark Shelby Tube with an up arrow. The sample tube should be packed in Styrofoam™ plugs or other cushioning material to prevent disturbance of the sample while en route to the geotechnical laboratory for analyses. (Mark the shipping container with "fragile" and "this side up" designations to insure minimal disturbance during shipping.)
7. Record sample observations in field log book.
8. Manage IDW in accordance with the procedures outlined in the site Work Plan, SAP and/or QAPP.

Post-Sampling Activities
Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:

- Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing the sample paperwork, including copies provided to laboratory.
- Compiling the field data for site records.
- Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure the appropriate sample analyses has been returned to sampler.

Appendix E: Excavation Soil Sampling

Soil Level Identification
- Surface Soils
- Shallow Subsurface Soils

Soil Depth
- Based on project specific requirements, typically in range of 0 to 19 feet BGS
- 19 feet BGS –depth methods become impractical or the depth that the excavator arm can reach

Soil Collection Procedure
Heavy equipment operator is instructed the horizontal and vertical limits of the excavation or test pit.

Preparation
1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific HASP.
6. Use stakes, flagging, or cones to identify and mark the sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. Underground utility clearance should be performed in accordance with KEMRON's utility clearance FSOP-001, and utility clearance should always be confirmed before beginning work.

Sampling
Sampling of soil from an open excavation (test pit, trench or large excavation) may be necessary to collect surface and shallow soil samples. Trenches in the ground made by the excavator can allow for the collection of soil samples from specific intervals and to characterize the subsurface conditions. Soil samples should be collected without personnel entry into the trench. Soil samples can be collected from the bucket of the excavator or from a shovel. Remove any smeared soil and collect the sample using a clean scoop or shovel. The procedures for collecting soil samples from an open excavation is described below:

1. Prior to initiating any excavation activities, ensure that the area is clear of overhead and buried utilities.
2. Review the site specific HASP and for safety precautions and ensure appropriate monitoring equipment are calibrated and operating as required.
3. Using the appropriate equipment, such as a backhoe, the operator will excavate a trench approximately three feet wide and approximately one foot deep below the cleared sampling location. Excavated soils will be placed on plastic sheets using the bucket of the excavator. Trenches greater than four feet deep must be sloped or protected by a shoring system, as required by OSHA regulations.
4. A shovel is used to remove a one to two inch layer of soil from the vertical face of the pit where sampling is to be done.
5. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket. Field screen soil with PID, or other necessary equipment. KEMRON employees are not to enter trenches for the purposes of sample collection unless done so under specific health & safety requirements, work plans or procedures.

6. If VOC analyses are required, the Encore or equivalent sampling device is to be used to collect the sample. Otherwise, transfer the sample into an appropriate, labeled sample container with a stainless steel spoon or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.
7. Field screen soil with properly calibrated equipment (i.e. PID, FID, etc.) (if required).
8. Place samples in cooler and cool to 4^{o} Celsius (C) with wet ice.
9. Abandon the pit or excavation according to applicable state regulations. Generally, shallow excavations can simply be backfilled with the removed soil material.
10. Record sample observations in field log book.

Post-Sampling Activities

Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:

- Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing the sample paperwork, including copies provided to laboratory.
- Compiling the field data for site records.
- Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure the appropriate sample analyses has been returned to sampler.

Appendix F: Drill Rigs with Split Spoon (Barrel) Sampler

Soil Level Identification:
Deep Subsurface Soils

Soil Depth:
Shallow to > 20 feet

Soil Collection Procedure
Split-Spoon – Hammer driven:

- Drive the split-spoon sampler either inside a hollow-stem auger or inside an open borehole after rotary drilling equipment has been temporarily removed.
- Record the number of blows required to drive the spoon for each six-inch interval.
- Remove the spoon.

Continuous split-spoon
While drilling, advance the hollow-stem auger containing the split-spoon.
Soil Sampling Procedure:

Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment, calibrate as necessary.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific HASP.
6. Use stakes, flagging, or cones to identify and mark the sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. Underground utility clearance should be performed in accordance with KEMRON's utility clearance FSOP-001, and utility clearance should always be confirmed before beginning work.

Sampling
Split spoon sampling is generally used to collect undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augered hole and the core extracted.

When split spoon sampling is performed to gain geologic information, the work should be performed in accordance with ASTM D1586-98, "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils".

The following procedures are used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.
2. Place the sampler in a perpendicular position on the sample material.
3. Using a well ring, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.
4. Record in the site log book or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.
5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log along with field screening results. If a

split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in 2 and 3 ½ inch diameters. A larger barrel may be necessary to obtain the required sample volume.

6. Without disturbing the core, use the Encore or equivalent to collect the soil sample for VOC analysis. Otherwise, transfer portion for VOC analyses to appropriate labeled sample container(s) and seal tightly.
7. Place the remaining soil into a stainless steel bowl, homogenize, and transfer portions for remaining analyses to appropriate sample container(s) and seal tightly.
8. Field screen soil with properly calibrated equipment (i.e. PID, FID, etc.) (if required).
9. Place in cooler and cool to 4º Celsius (C) with wet ice.
10. If another sample is to be collected in the same hole, but at a greater depth, reattach a (decontaminated / clean) split spoon sampler to the drill rod, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.
11. Abandon the hole according to applicable state regulations or install monitoring well if applicable in accordance with the site work plan and KEMRON FSOP-500.

Post-Sampling Activities

Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:

- Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing the sample paperwork, including copies provided to laboratory.
- Compiling the field data for site records.
- Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure the appropriate sample analyses has been returned to sampler.
- Manage IDW in accordance with procedures outlined in the site Work Plan, SAP and/or QAPP.

Appendix G: Example of Chain of Custody Form

Kemron

CHAIN-OF-CUSTODY RECORD

[1] COC NUMBER:

[2] PROJECT NAME:	[5] PROJECT NUMBER:	[8] LAB NAME AND CONTACT:	[11] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 1 (Name and Company)	[14] RECIPIENT 1 (Address, Tel No. , and Fax No.):
[3] PROJECT PHASE/SITE/TASK:	[6] CTO OR DO NUMBER:	[9] LAB PO NUMBER:	[12] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 2 (Name and Company)	[15] RECIPIENT 2 (Address, Tel No. , and Fax No.):
[4] PROJECT CONTACT:	[7] PROJECT TEL NO AND FAX NO:	[10] LAB TEL NO AND FAX NO:	[13] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 3 (Name and Company)	[16] RECIPIENT 3 (Address, Tel No. , and Fax No.):

[17] ITEM	[18] SAMPLE IDENTIFIER	[19] SAMPLE DESCRIPTION/LOCATION	[20] MATRIX (see codes on SOP)	[21] DATE COLLECTED	[22] TIME COLLECTED	[23] DATA PKG LEVEL (see codes on SOP)	[24] TAT (calendar days)	[25] ANALYSES REQUIRED (Include Method Numbers)	[26] SAMPLE TYPE (see codes on SOP)	[27] COMMENTS/ SCREENING READINGS	[28] LAB ID (for lab's use)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

[29] SAMPLER(S) AND COMPANY: (please print)	[30] COURIER AND SHIPPING NUMBER:	[31] SAMPLES TEMPERATURE AND CONDITION UPON RECEIPT (for lab's use):

[32] RELINQUISHED BY	DATE	TIME	[33] RECEIVED BY	DATE	TIME
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		

Distribution: [ ] Original - Laboratory (To be returned with Analytical Report); [ ] Copy 1 - Project File; [ ] Copy 2 - PMO

Appendix H: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Technical Procedure: FSOP-1000

STANDARD OPERATING PROCEDURE FOR PERIMETER AIR MONITORING

Original Issue Date: November 8, 2004

Last Review/Implementation Date: October 2014 (Revision 03)

KEMRON Environmental Services, Inc.
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Marilyn K. Zumbro, Corporate Health and Safety Manager	10/23/14 Date
Lou Ehrhard, Corporate Quality Assurance Manager	10/23/14 Date
John Dwyer, Executive Vice President	10/23/14 Date

TABLE OF CONTENTS

LIST OF APPENDICES

1 POLICY

KEMRON personnel will follow this procedure in conjunction with both project specific guidance and field procedures to determine which quality control samples are necessary and technical collection procedures.

2 PURPOSE

The objective of perimeter air sampling is to measure airborne contaminant concentrations to assess impacts to off-site receptors due migration of contaminants from a site via the air migration pathway. Perimeter air monitoring can be performed as part of an investigation, and the data used in a risk assessment, and as an element of remedial action, where the data is used to assess compliance with established air action levels. The objective of this standard operating procedure (SOP) is to provide basic guidelines to ensure that valid and representative air samples are collected and analyzed to ensure the data can be used for its intended purpose. Screening level data can be collected with real-time direct-reading instruments to provide qualitative or semi-quantitive data for decision making purposes. Quantitive data can be collected for use in risk assessments or for comparison against established risk-based standards or action levels.

The procedures provided herein are meant to provide the minimum acceptable requirements for perimeter air monitoring at hazardous waste site. Project-specific requirements and data quality objectives (DQOs) should be evaluated to determine if modification to these SOPs are required for project-specific use. Core components of a perimeter air sampling program include identifying target parameters and action levels, monitoring instrumentation, data/telemetry, archiving and quality control. Project-specific perimeter air sampling plans should be prepared to set forth the action levels and contingencies needed to provide for protection of receptor populations.

By complying with procedures specified in this SOP, KEMRON will ensure that the following are successfully completed:

- Evaluate the need and effectiveness of vapor and/or dust controls
- Document air quality to establish background levels and record those generated during site activities
- Develop site-specific action levels that protect public health and supplement worker health and safety
- Monitor and document air quality during site activities near sensitive receptors
- Ensure data collection quality and defensibility
- Provide risk management information and address public confidence
- Reduce potential owner liabilities due to site activities
- Measure airborne radioactive material concentrations at the work site boundaries.
- Warn of significantly elevated levels of airborne radioactive materials.
- Evaluate the effectiveness of the design features and engineering controls.
- Determine compliance with offsite general public exposure limits.
- Confirm results of other air monitoring

3 SCOPE

This procedure provides technical guidance on perimeter air sampling including decontamination procedures, types of, and uses of sampling equipment. The air sampling station configuration and procedures, the number of samples to be collected, sample location, and the duration of the sampling event, are dependent upon the project objectives. Therefore, prior to field sampling activities, a detailed project specific perimeter air sampling plan will be prepared. The project perimeter air sampling work plan will incorporate the procedures specified in this SOP. This SOP is to be used along with the instrument and equipment manufacturer's operating manuals.

Client, federal, or state requirements, or project-specific requirements may dictate specific types of equipment or procedures to be used when applying this SOP to a particular project. Deviations from this SOP to accommodate site-specific requirements shall be documented in project planning documents and Appendix A and approved by the KEMRON Quality Assurance / Quality Control (QA/QC) Manager or client representative where applicable, prior to the performance of work

4 RESPONSIBILITY

Project Manager Responsibilities
The KEMRON Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the procedures in this SOP and the project-specific perimeter air sampling work plan.

Field Staff Responsibilities
The KEMRON field staff prepares, organizes, and inspects the equipment required for the sampling event prior to the initiation of sampling activities. Upon completion of the sampling event, the field staff returns the equipment to the designated storage area ensuring that the equipment is decontaminated and in a condition ready for reuse. KEMRON field staff are required to follow procedures specified in this SOP unless written site-specific protocol is provided by the Project Manager prior to initiating the sampling event.

Sampling Technician
It is the responsibility of the sampling technician to be familiar with the sampling procedures outlined within this SOP and with specific sampling, quality assurance, and health and safety requirements outlined within project-specific work plans (Field Sampling Plan (FSP), Health and Safety Plan (HASP), Quality Assurance Project Plan (QAPP)). The sampling technician is responsible for collection of air samples and for proper documentation of sampling activities as samples are being collected.

5 DEFINITIONS

- **Flow Controller:** Millaflow Controller, or equivalent, a mechanical flow controller made of stainless steel, having a flow range of 5 - 500 ml/min.

- **High Volume Air Sampler:** Air sampler capable of collecting greater than 3 cubic feet per minute (cfm), or 85 liters/min. liters/min) but less than 3 cfm (85 liters/min).

- **Low Volume Air Sampler:** Air sampler capable of collecting greater than 0.35 cfm (10 liters/min) but less than 3 cfm (85 liters/min).

- **Mass Flowmeter** -An Electronic Mass Flowmeter is used to calibrate the flow controller. The mass flowmeter measures flow rates between 0 -500 ml/min, within $\pm$1.5% full scale.

- **Particulate Matter Filter:** -2 micrometer stainless steel in-line filter (Nupro Co., Model SS4F-2, or equivalent) is attached to sample inlet line.

- **Polyurethane Foam (PUF):** Absorbent cartridge or tube for air sample collection and laboratory analysis.

- **Sample Pump:** Programmable SIS stainless steel/viton diaphragm vacuum pump/compressor, with a current draw at max load of 1.1 amps, used to draw air through filters, cartridges, or other air sample collection media.

- **Vacuum Pressure Gauge**: A separate vacuum gauge is connected to check vacuum pressure readings before and after sampling event.

6 PLANNING

Handle samples with care to prevent cross-contamination. Always wear gloves and use tweezers while handling the air sample filters to prevent sample contamination from contact with fingers and to prevent possible skin contamination.

Do not allow an air sampler to pick up debris from the floor, ground, or other surface.

The Project Manager provides written instructions of any project-specific information for the sampling crew. The written instructions can be as simple as a sampling requirements report or as detailed as a Sampling and Analysis Plan (SAP). Items in written sampling instructions may include the following:

- Sampling locations
- Method of sampling
- Action Levels
- Data Quality Objectives
- Analytical parameters
- Quality Assurance (QA)/Quality Control (QC) Procedures

Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific QAPP. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements typically suggest the collection of a sufficient quantity of QC samples such as field duplicate, equipment and/or field blanks and matrix spike/matrix spike duplicate (MS/MSD) samples. These requirements should be outlined in the QAPP.

Information regarding the number of air sample containers and sampling methods will be described in the project specific SAP/QAPP.

Adequate health and safety measures must be taken to protect project sampling personnel from potential chemical exposures or other hazards. These measures must be addressed in the project HASP. This plan must be approved by the project health and safety officer before work commences, must be distributed to the personnel performing sampling, and must be adhered to as field activities are performed.

7 SAMPLE COLLECTION EQUIPMENT

The tables in this section provide a description of equipment and sampling procedures for different perimeter air sampling methods. The project work plan will specify the method and any site-specific requirements. See Appendix B, Figures for diagrams of the sampling systems.

- SUMMA® Canister Sample Equipment:
  - Sample Canister
  - Vacuum Pressure Gauge
  - Sampling Inlet Line
  - Particulate Matter Filter (2 micrometer stainless steel in-line filter)

- Chromatographic-grade Stainless Steel Tubing and Fittings
- Canister Shipping Containers.
- Flow Controller
- Mass Flowmeter
- Sample Pump
- Particulate/Aerosol Monitor (DataRam or equivalent)

- Glass Fiber or cellulose filters
- Weather-tight enclosures
- Wind Speed Sensor
- Wind Direction Sensor
- Ambient dry bulb temperature sensor
- Barometric pressure sensor
- Data acquisition/Recording System
- Maps/Plot Plan
- Logbook
- Field data sheets and sample labels
- Survey equipment or global positioning system (GPS) to locate sampling points
- Tri-pod with grounding equipment
- Batteries
- Electrical Power source (115 VAC)
- Sampler Carrying Case

This equipment list was developed to aid in field organization and should be used in preparation for each sampling event. Depending on the site-specific sampling plan, additional material and equipment may be necessary and should be determined before the scheduled sampling event. Similarly, not all of the items shown in this list may be necessary for any one sampling event.

8 SAMPLE EQUIPMENT SITING CRITERIA AND PROCEDURES

Prevailing wind direction, based on historical meteorological data collected by the National Weather Service, along with the location of site activities and local conditions, should be used to select the conceptual sampling locations. KEMRON recognizes that the actual sampling locations may deviate from the “ideal” in that it may not be possible (or practical) to meet all of the desired sampling siting criteria. Equipment siting criteria include:

- Locate the monitors downwind of the site or site activities along the “fenceline” of the site or upgradient of potential receptor populations
- The monitor inlet should be placed at least two meters above the ground surface
- The monitor inlet should be placed at least 20 meters away from the nearest streets or trees
- The monitor should be well removed from obstacles (about two or more times the height of the obstruction)
- The immediate surroundings should have ground cover to prevent surface dust from affecting the measurements
- The monitor should receive unrestricted air flow from at least three cardinal wind directions (270◦), including the predominant wind direction
- There should be no incinerator or furnace flues nearby
- The location station must have suitable accessibility
- The monitor must be placed on a flat surface
- Security, electrical power, and (if remotely operated or reporting) communication lines must be considered and provided
- If a roof-top location is considered, the monitor must be at least 2 meters from walls, parapets, penthouses, etc.

It is possible that meeting all the above criteria may not be possible at any locations. Site-specific locations will be determined at the site by considering the above criteria.

See Appendices for sampling procedures.

9 FIELD RECORDS

9.1 Field Log Book

See the Field Documentation SOP for generic documentation items. Examples of specific surface water sampling documentation include the following:

- Site name
- Date and Time of Arrival
- Weather conditions, including ambient air temperature and/or miscellaneous observations
- Date and time sampling
- Equipment ID
- Flow rate recorded (if applicable)
- Sample sequence number
- Method of sampling
- Signature of sampler(s) and date, etc.

9.2 Chain-of-Custody

Completed chain-of-custody forms are maintained for all samples. A sample chain-of-custody form is included as Appendix C. The original form is sent to the laboratory with the samples and signed by the lab upon receipt. Original completed chain-of-custody forms are returned to KEMRON with the analytical report.

10 SHIPPING

Equipment decontamination chemicals may need to be shipped to the site and samples may need to be shipped to the laboratory. Shipping is completed in accordance with the current federal and international regulations (DOT, EPA, IATA). Shipping stipulations are to be included in the project documents, but should you have any questions regarding shipping of any materials to and from the site, contact the authorized shipping representative in your home office.

11 REFERENCES

- USEPA New England Regional Laboratory; Office of Environmental Measurements 2001
- Standard operating Procedure Sampling Volatile Organic Compounds Using Summa® Polished Stainless Steel Canisters, Revision 2, March 2001

Appendix A: Request for Deviations

Deviation to FSOP-1000: STANDARD OPERATING PROCEDURE FOR PERIMETER AIR MONITORING

Description of Deviation
1.
2.
Need for Deviation
1.
2.
Corrective Action Taken
1.
2.

Approved by:

Name: Signature:
KEMRON Project Manager Date

Name: Signature:
KEMRON QA/QC Manager Effective Date

- OR -

Name: Signature:
Client Representative Effective Date

Appendix B: Sampling Equipment

Figure 1. Sampler Configuration

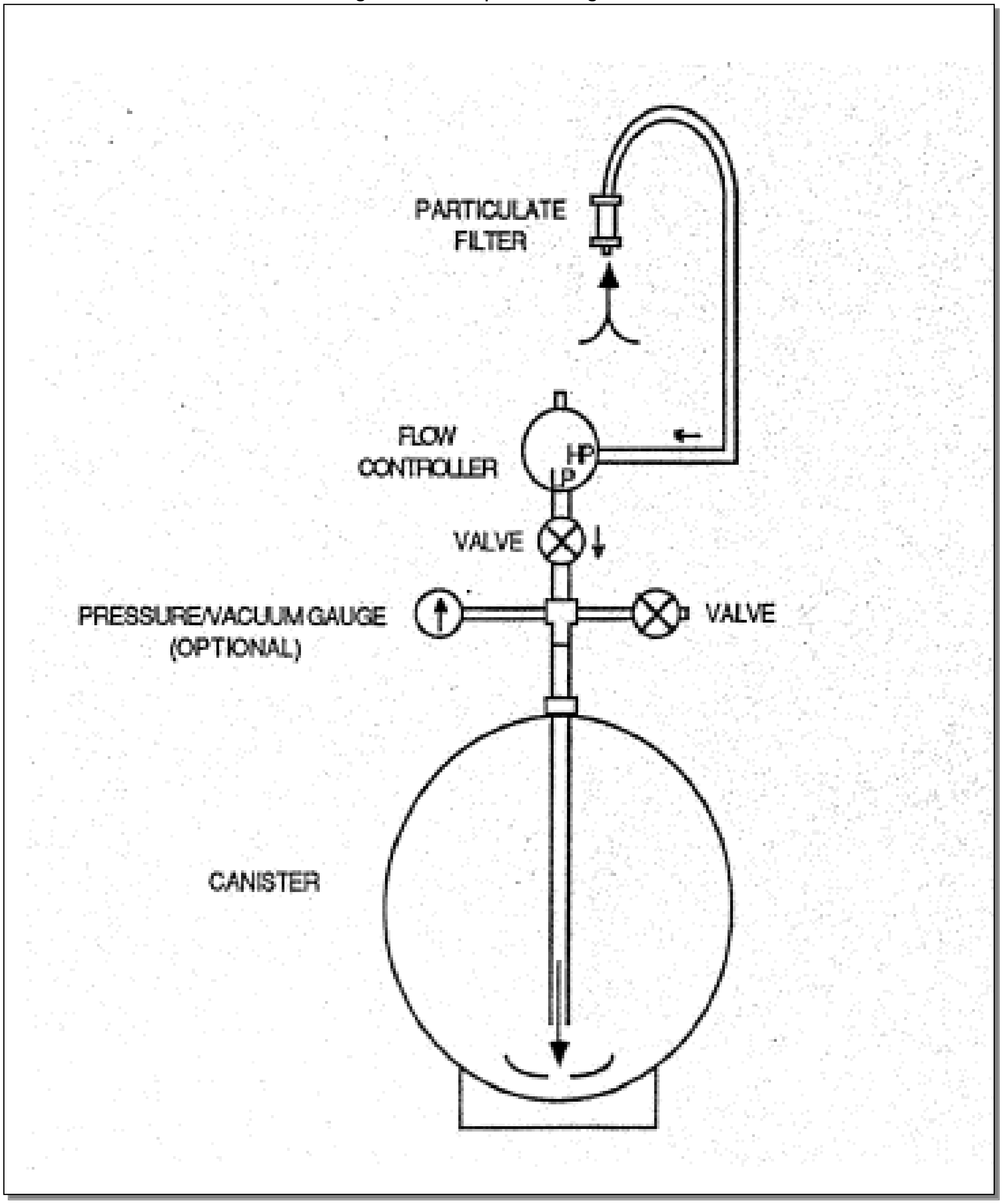


Figure 2. Pressurized Time-Integrated Air Sampler Configuration

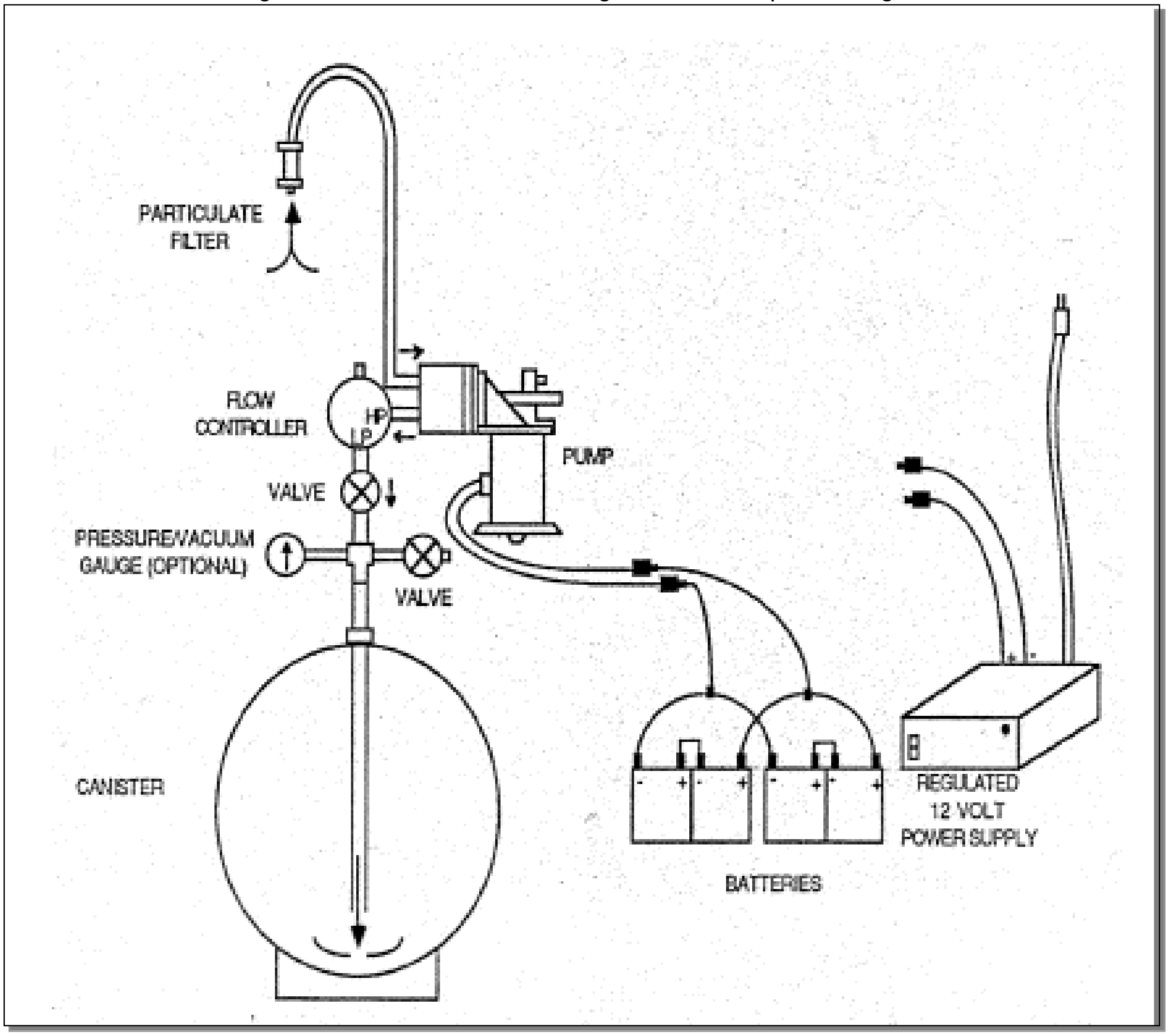


Figure 3. Example Air Monitor Thermo Electron Model pDR-1000AM

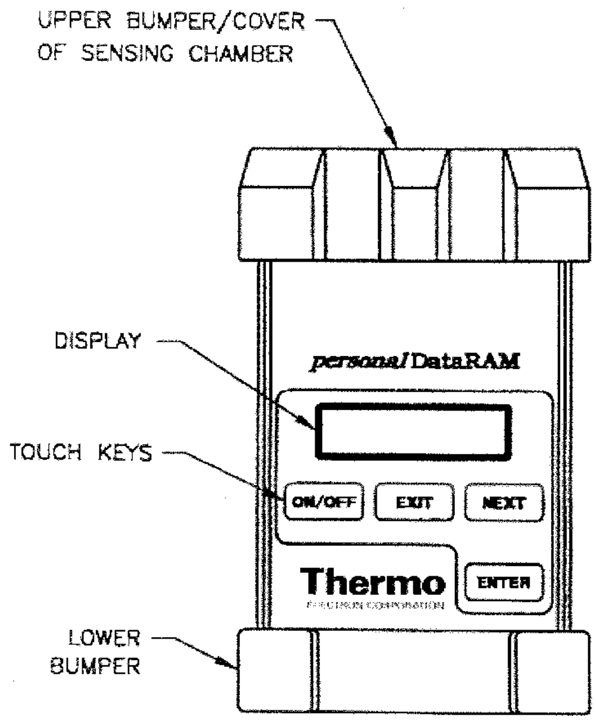
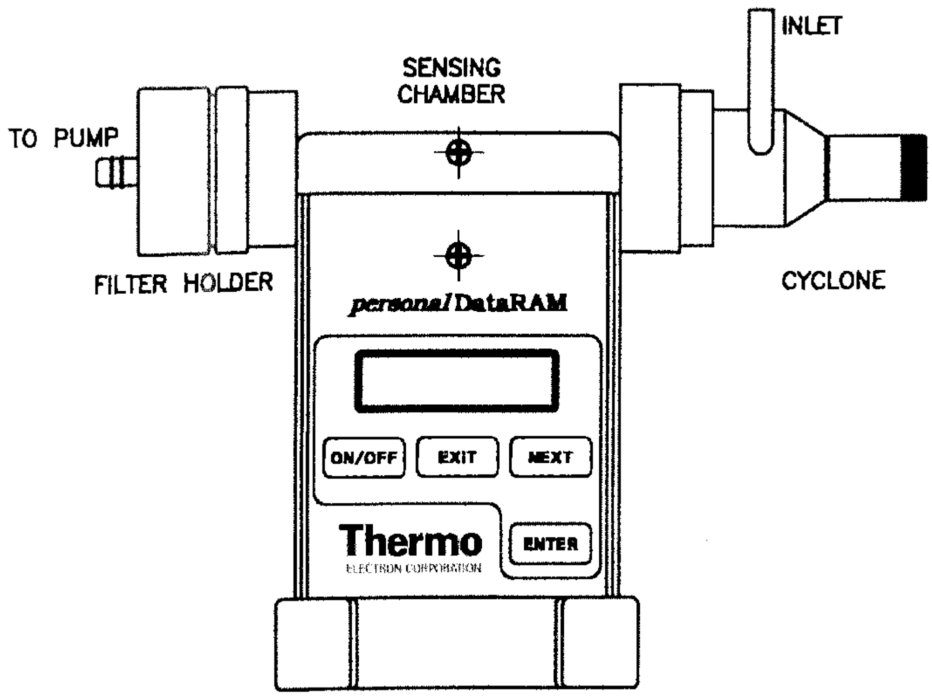


Figure 4. Example Aerosol Monitor Setup Thermo Electron Model pDR-1000AM



Appendix C: Meteorological Station Measurements

Equipment
Instruments for recording wind speed/direction, ambient temperature/relative humidity, and barometric pressure or use of local meteorological station data

Locating the Meteorological Station:
Locate a permanent meteorological monitoring station at an upwind location of the site.

Meteorological Station Sampling Procedure:
Preparation:
1. Obtain necessary sampling and monitoring equipment.
2. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
3. Perform a general site survey prior to site entry in accordance with the site specific HASP.
4. Perform equipment calibration checks in accordance with equipment specification manuals.
5. Assemble and erect meteorological station support tripod.
6. Locate 115 VAC electrical power source, if necessary, and connect to station;
7. Install each meteorological sensor (wind speed, wind direction, ambient dry bulb temperature, etc.) on the support tripod and connect it to the respective indicator according to manufacturer's instruction manual.

Sampling:
1. Verify wind speed, wind direction, ambient temperature, and barometric pressure sensors conforming to field experience and/or supplier's instructions.
2. Connect the indicators to the data recording device, if necessary, and compare the sensors with the output of the recorder.
3. Continuously record wind speed, wind direction, barometric pressure, and ambient temperature for each sampling period.

Post-Sampling Activities:
1. Tabulate meteorological data collected for each sampling period.
2. Analyze meteorological data collected to determine and confirm the locations of upwind and downwind air sample collection locations.

Appendix D: SUMMA® Canister Sampling

Air Monitoring Compound Identification
Volatile Organic Compounds (VOCs), certain Semi-Volatile Organic Compounds (SVOCs)

Equipment
SUMMA® Canister Assembly

Sampling Procedure
Preparation:
1. Obtain necessary sampling and monitoring equipment.
2. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
3. Perform a general site survey prior to site entry in accordance with the site specific HASP.
4. Configure the sampler as shown in Figure 1 in Appendix A
5. If the canister does not have a vacuum pressure gauge attached. Connect a gauge to the canister inlet, open the valve. Read the gauge. Close the valve, and remove the gauge.
6. If a vacuum pressure gauge is attached. Open valve, read the gauge, and then close the valve.
7. Connect the two (2) micrometer particulate matter filter and sampling line to the canister inlet as shown in Appendix A, Figure 1.

Sampling: (Refer to Appendix A for detailed procedures)
1. Open the canister valve slightly, just enough co slowly allow a sample to be drawn into the canister, The canister pressure differential causes the sample to flow into the canister. It will take approximately 30 seconds for the canister pressure to go from 30 psig vacuum to atmospheric pressure or 0 gauge.
2. In a field log book, record the project name, sampling event date, sampling location, canister number, initial canister pressure gauge reading, anti the sampling start time.
3. Allow the canister to collect air over the course of the pre-determined sampling period (i.e. 8 hours, 24 hours, etc.).
4. During the course of the sampling event, periodically check each sampling location to see if the sampler had been tampered with. In addition, if the canister has a vacuum pressure gauge attached, observe and record the gauge reading to determine if the canister is being filled at a constant rate. If no vacuum/pressure gauge is being used, connect an electronic mass flowmeter and check the flow rate, adjust if necessary.
5. At the conclusion of the predetermined sampling period, return to each sampling location and close the canister valve. **DO NOT OVER-TIGHTEN THE VALVE.**
6. Disconnect the sample inlet line with particulate matter filter from the flow controller and the flow controller from the canister.
7. If the canister does not have a vacuum/pressure gauge attached, connect a gauge to the canister inlet, open the valve, read the gauge, close the valve, and then disconnect the gauge from the canister.
8. If a vacuum/pressure gauge is attached, open valve, read the gauge, and then close the valve.
9. In a field log book record the final canister pressure gauge reading and the meteorological conditions during the sampling event.
10. Place canister into shipping container.
11. Complete chain-of-custody record form.

Post-Sampling Activities:
Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:

- Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.

- Processing sample paperwork, including copies provided to laboratory.
- Compiling field data for site records.
- Verifying analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure appropriate sample analyses has been returned to sampler.

Appendix E: Aerosol/Particulate Sampling

Air Monitoring Compound Identification:
Aerosol/Particulate Matter: PM_{10}, Total Dust, or Metals

Equipment:
Real time direct reading aerosol monitor and particulate matter filters (Refer to Appendix B for an example aerosol monitor and set up)

Sampling Procedure:
Preparation:
1. Obtain necessary sampling and monitoring equipment.
2. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
3. Perform a general site survey prior to site entry in accordance with the site specific HASP.
4. Calibrate instrument in accordance with manufacturer's instructions.
5. Program monitor to record PM_{10} or total dust as required.
6. Perform a daily particulate free calibration check at the measurement location. A zero (or particulate-free) test sample, using the appropriate particulate filter supplied by the manufacturer for this purpose, will be placed over the sample inlet. The data output for the monitor will be observed and the response recorded in the field data sheet.
7. Check/calibrate flow rate and adjust accordingly.

Sampling:
1. If measuring PM_{10} and/or total metals, Install the particle size-selective inlet cyclone and external sampling pump to ensure that PM_{10} is measured with the photometer and subsequently deposited on a 37 millimeter (mm) diameter Teflon filter at a constant flow rate.
2. In a field log book, record the project name, sampling event date, sampling location, filter number, and the sampling start time.
3. The pDR-1200 will sample at a flow rate of 1 liter per minute (L/min) to measure average PM_{10} or total dust at 15-minute intervals and collect a filter sample over a duration of 8 hours.
4. Record PM10 or total dust readings off monitor by datalogging or manually recording measurements at pre-determined intervals.
5. Allow the filter to collect air over the course of the pre-determined sampling period (i.e. 8 hours, etc.).
6. During the course of the sampling event, periodically check each sampling location to see if the sampler had been tampered with.
7. Disconnect the sample inlet line with particulate matter filter from the sampling pump.
8. In a field log book record the final sample time reading and the meteorological conditions during the sampling event.
9. Place particulate matter filter into shipping container and send to the laboratory.
10. Complete chain-of-custody record form. See Section 8.2.

Post-Sampling Activities:
Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:
- Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing sample paperwork, including copies provided to laboratory.
- Compiling field data for site records.
- Verifying analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure appropriate sample analyses has been returned to sampler.

Appendix F: Asbestos Air Sampling

Air Monitoring Compound Identification:
Asbestos

Equipment:
Gillian GilAir 5 sampling pump or equivalent and 25 mm diameter mixed cellulose ester (MCE) fiber filter

Sampling Procedure:
Preparation:
1. Obtain necessary sampling and monitoring equipment.
2. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
3. Perform a general site survey prior to site entry in accordance with the site specific HASP.
4. Calibrate sampling pump in accordance with manufacturer's instructions.
5. Program sampling pump to operate at 2 L/min or other preset flow rate.
6. Check/calibrate flow rate and adjust accordingly.

Sampling:
1. Install the 25 mm diameter mixed cellulose ester (MCE) fiber filter on the sample inlet line on the external sampling pump set to draw air at a flow rate of 2 L/min or other preset flow rate.
2. In a field log book, record the project name, sampling event date, sampling location, filter number, and the sampling start time.
3. The sample pump will sample at a flow rate of 2 L/min to collect a filter sample over duration of 8 hours.
4. Allow the filter to collect air over the course of the pre-determined sampling period (i.e. 8 hours, etc.).
5. During the course of the sampling event, periodically check each sampling location to see if the sampler had been tampered with.
6. Disconnect the sample inlet line with filter from the sampling pump.
7. In a field log book record the final sample time reading and the meteorological conditions during the sampling event.
8. Place MCE filter into shipping container and send to the laboratory.
9. Complete chain-of-custody record form.
10. Calibrate the sampling pump in accordance with manufacturer's instructions.

Post-Sampling Activities:
Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:
1. Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
2. Processing sample paperwork, including copies provided to laboratory.
3. Compiling field data for site records.
4. Verifying analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure appropriate sample analyses has been returned to sampler.

Appendix G: Real Time VOC Monitoring

Air Monitoring Compound Identification:
VOCs

Equipment:
Real time direct reading VOC monitor: Organic Vapor Analyzer (OVA) (such as Photo-ionization detector (PID), Flame-ionization detector (FID), or Multi-gas Detector with PID built in)

Sampling Procedure:
Preparation:
1. Obtain necessary sampling and monitoring equipment.
2. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
3. Perform a general site survey prior to site entry in accordance with the site specific HASP.
4. Calibrate instrument in accordance with manufacturer's instructions.
5. Program datalog measurements as required per HASP or other sampling plan.
6. Perform a daily zero calibration check at the measurement location. A zero (or VOC free) test sample location should be selected. The data output for the monitor will be observed and the response recorded in the field data sheet.

Sampling:
1. In a field log book, record the project name, sampling event date, sampling location, and the sampling start time.
2. The OVA will provide non-selective VOC readings continuously.
3. Record VOC measurements off the monitor by data logging or manually recording measurements at pre-determined intervals.
4. During the course of the sampling event, periodically check each sampling location to see if the sampler had been tampered with.
5. In a field log book, record the final sample time reading and the meteorological conditions during the sampling event.

Post-Sampling Activities:
Several activities need to be completed and documented once air sampling has been completed. These activities include, but are not limited to:
- Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Compiling field data for site records.

Appendix H: Polycyclic Aromatic Hydrocarbon (PAH), Organochlorine Pesticides, and Polychlorinated Biphenyls (PCBs) Sampling

Air Monitoring Compound Identification:
PAHs, PCBs, polychlorinated dibenzo-p-dioxins (PCDDs) or Organochlorine Pesticides

Equipment:
Gillian AirCon 2 sampling pump or equivalent and 4-inch diameter acid-washed quartz fiber filter and 2-inch diameter by 3-inch long absorbent cartridge (polyurethane foam or PUF)

Sampling Procedure:
Preparation:
1. Obtain necessary sampling and monitoring equipment.
2. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
3. Perform a general site survey prior to site entry in accordance with the site specific HASP.
4. Calibrate sampling pump in accordance with manufacturer's instructions.
5. Program sampling pump to operate at 20 L/min or other preset flow rate.
6. Check/calibrate flow rate and adjust accordingly.

Sampling:
1. Install the quartz fiber filter and PUF absorbent cartridge on the sample inlet line on the external sampling pump set to draw air at a flow rate of 20 L/min or other preset flow rate.
2. In a field log book, record the project name, sampling event date, sampling location, filter number, and the sampling start time.
3. The sample pump will sample at a flow rate of 20 L/min to collect a filter sample over a pre-set duration.
4. Allow the filter to collect air over the course of the pre-determined sampling period (i.e. 8 hours, 24 hours etc.).
5. During the course of the sampling event, periodically check each sampling location to see if the sampler had been tampered with.
6. Disconnect the sample inlet line with filter from the sampling pump.
7. In a field log book record the final sample time reading and the meteorological conditions during the sampling event.
8. Place filter and absorbent cartridge into shipping container and send to the laboratory for analysis by TO13A for PAHs, TO4A for PCBs or pesticides, or TO9A for PCDDs.
9. Complete chain-of-custody record form.
10. Calibrate the sampling pump in accordance with manufacturer's instructions.

Post-Sampling Activities:
Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:
- Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing sample paperwork, including copies provided to laboratory.
- Compiling field data for site records.
- Verifying analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure appropriate sample analyses has been returned to sampler.

Appendix I: Example Chain-of-Custody

Kemron

CHAIN-OF-CUSTODY RECORD

				[1] COC NUMBER:
[2] PROJECT NAME:	[5] PROJECT NUMBER:	[8] LAB NAME AND CONTACT:	[11] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 1 (Name and Company)	[14] RECIPIENT 1 (Address, Tel No., and Fax No.):
[3] PROJECT PHASE/SITE/TASK:	[6] CTO OR DO NUMBER:	[9] LAB PO NUMBER:	[12] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 2 (Name and Company)	[15] RECIPIENT 2 (Address, Tel No., and Fax No.):
[4] PROJECT CONTACT:	[7] PROJECT TEL NO AND FAX NO:	[10] LAB TEL NO AND FAX NO:	[13] FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 3 (Name and Company)	[16] RECIPIENT 3 (Address, Tel No., and Fax No.):

[17] ITEM	[18] SAMPLE IDENTIFIER	[19] SAMPLE DESCRIPTION/LOCATION	[20] MATRIX (see codes on SOP)	[21] DATE COLLECTED	[22] TIME COLLECTED	[23] DATA PKG LEVEL (see codes on SOP)	[24] TAT (calendar days)	[25] ANALYSES REQUIRED (Include Method Numbers)												[26] SAMPLE TYPE (see codes on SOP)	[27] COMMENTS/ SCREENING READINGS	[28] LAB ID (for lab's use)
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

[29] SAMPLER(S) AND COMPANY: (please print)	[30] COURIER AND SHIPPING NUMBER:	[31] SAMPLES TEMPERATURE AND CONDITION UPON RECEIPT (for lab's use):

[32] RELINQUISHED BY	DATE	TIME	[33] RECEIVED BY	DATE	TIME
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		

Distribution: [ ] Original - Laboratory (To be returned with Analytical Report); [ ] Copy 1 - Project File; [ ] Copy 2 - PMO

Appendix J: SUMMA® Canister Sampling

Scope
This canister sampling SOP describes procedures for sampling with canisters at final pressures above atmospheric pressure (referred to as pressurized sampling), below atmospheric pressure (referred to as subatmospheric sampling), and at atmospheric pressure (referred to as grab sampling). This method is applicable to specific VOCs that have been tested and determined to be stable when stored in pressurized and subatmospheric pressure canisters. These compounds have been measured at the parts per billion by volume (ppbv) level.

EPA Method TO15 Target Compound List
A wide range of compounds may be analyzed by EPA TO-15 including alkanes, alkenes, aromatics, halogenated VOCs, ketones, esters and some alcohols. Some aldehydes and sulfides may also be evaluated using this method.
EPA TO-15 does not specify a target compound list in the method. As a result, there is some variation among commercial environmental laboratories in the compound lists that are available for VOCs. Target compound lists may include anywhere from 40 to 60 compounds or more, and may provide results in µg/m3, ppbV, or both. Compound lists can usually be tailored to meet project-specific objectives. An example TO15 list is as follows:

- Dichlorodifluoromethane
- 1,2-Dichloropropane
- Chlorodifluoromethane
- Dibromomethane
- Freon 114
- Bromodichloromethane
- Chloromethane
- cis-1,3-Dichloropropene
- Vinyl Chloride
- 4-Methyl-2-Pentanone
- 1,3-Butadiene
- Toluene
- Bromomethane
- Octane
- Chloroethane
- trans-1,3-Dichloropropene
- Dichlorofluoromethane
- 1,1,2-Trichloroethane
- Trichlorofluoromethane
- Tetrachloroethene
- Pentane
- 2-Hexanone
- 1,1-Dichloroethene
- Dibromochloromethane
- Freon 113
- 1,2-Dibromoethane
- Acetone
- Chlorobenzene
- Carbon Disulfide
- 1,1,1,2-Tetrachloroethane
- 3-Chloropropene
- Ethylbenzene
- Methylene Chloride
- m/p-Xylene
- trans-1,2-Dichloroethene
- o-Xylene
- Methyl t-Butyl Ether
- Styrene
- Hexane
- Bromoform
- 1,1-Dichloroethane
- Cumene
- cis-1,2-Dichloroethene
- 1,1,2,2-Tetrachloroethane
- 2-Butanone
- 1,2,3-Trichloropropane
- Chloroform
- Bromobenzene
- 1,1,1-Trichloroethane
- 4-Ethyltoluene
- Carbon Tetrachloride
- 1,3,5-Trimethylbenzene
- 1,2-Dichloroethane
- 1,2,4-Trimethylbenzene
- Benzene
- 1,3-Dichlorobenzene
- Isooctane
- 1,4-Dichlorobenzene
- Heptane
- 1,2-Dichlorobenzene
- Trichloroethene
- Hexachloroethane

Canister Subatmospheric Time-Integrated Sampling Procedures:

1. In the Laboratory, prior to the sampling event, calibrate the flow controller using the procedure outlined in Section 8. **Note: For this procedure use an evacuated dummy canister.**
2. In the field, before placing the sampler at the desired sampling location, check the calibration of the ROM controller. **Note: For this procedure use an evacuated dummy canister.**
3. Select the canister and Row controller to be used for the sampling event and bring it to the desired sampling location. If the canister does not have a vacuum" pressure gauge attached, connect a gauge to the canister inlet, open the valve, read the gauge, close the valve, and then disconnect the gauge from the canister. If the canister to be used for the sampling event does have a vacuum pressure gauge attached, read the gauge and record value and canister number in field log book.
4. Connect the sample inlet line with particulate matter filter to the flow controller's high pressure inlet port (I-IP) and the low pressure outlet port (LP) to the canister inlet port using the components described in Section 8.
5. In a field log book record the project name, sampling event date, sampling location, canister number, flow controller number, and the initial canister pressure gauge reading.
6. After the samplers have been set-up at their desired sampling locations, go back to each location and open the canister valve to allow a sample to be drawn through the flow meter and into the canister. The canister pressure differential causes the sample to flow into the canister. In the field log book record the sampling event start time for each sampling location.
7. During the course of the sampling event, periodically check each sampling location to see if the sampler had been tampered with. In addition, if the canister has a vacuum pressure gauge attached, observe and record the gauge reading to determine if the canister is being filled at a constant rate, If the vacuum/pressure gauge is not being used, connect the Aalborg Electronic Mass Flowmeter and check the flow rate, adjust if necessary.
8. 45 to 30 minutes before the end of the sampling period, visit each sampling location and obtain a flow rate reading using the procedure outlined in Section 8.
9. At the conclusion of the predetermined sampling period, return to each sampling location and close the canister valve. **DO NOT OVER-TIGHTEN THE VALVE.** Disconnect the sample inlet line with particulate matter filter from the flow controller and the flow controller from the canister. If the canister does not have a vacuum pressure gauge attached, connect a gauge to the canister inlet, open the valve and read the gauge, close the valve, and then disconnect the gauge from the canister. If the canister does have a vacuum/pressure gauge attached, read the gauge, and record the value in the field log book. **Note: The gauge reading obtained in this step and in step 3 should agree with the predetermined final canister pressure used in the calculations described in Section 8. This step will help determine if the sample had been collected at a constant rate over the sampling period.**
10. Place canister into shipping container.
11. In a field log book record for each sampling location, the sampling event end time, final canister pressure, and meteorological conditions during the sampling event.
12. Complete chain-of-custody record form. See Section 9.2.

Canister Subatmospheric Time-Integrated Sampling Procedures:

1. In the laboratory, prior to the sampling event, calibrate the flow controller using the procedure outlined in Section 4.1.4. **Note: For this procedure use an evacuated dummy canister.**
2. In the field, before placing the sampler at the desired sampling location, check the calibration of the flow controller. **Note: For this procedure use an evacuated dummy canister.**
3. Select the canister and sampler to be used for the sampling event and bring it to the desired sampling location. If the canister does not have a vacuum pressure gauge attached, connect a gauge to the canister inlet, open the valve, read the gauge, close the valve, and then disconnect the gauge from the canister. If the canister to be used for the sampling event does have a vacuum pressure gauge attached, read the gauge and record the value and canister number in a field log book.

4. Connect the sample inlet line with particulate matter filter to the inlet vacuum side of the pump. Connect the outlet pressure side of the pump to the high pressure inlet port (HP) of the flow controller. Connect the low pressure outlet port (LP) side of the flow controller to the canister inlet port.
5. In a field log book record the project name, sampling event date, sampling location, canister number, sampler number, and the initial canister pressure gauge reading.
6. After the samplers have been set-up at their desired sampling locations, go back to each location and first turn on the sampling pump then open the canister valve. In the field log book record the sampling event start time for each sampling location.
7. During the course of the sampling event, periodically cheek each sampling Location to see if the sampler had been tampered with or that the pump *is* running, In addition, if the canister has a vacuum pressure gauge attached, observe and record the gauge reading to determine if the canister is being filled at a constant rate, If the no vacuum pressure gauge is being used, connect the Aalborg Electronic Mass Flowmeter and cheek the flow rate, adjust if necessary.
8. 45 to 30 minutes before the end of the sampling period, visit each sampling location and obtain a flow rate reading using the procedure outlined in Section 8.
9. At the conclusion of the predetermined sampling period, return to each sampling location and first close the canister valve then turn off the sampling pump. **DO NOT OVER-TIGHTEN THE. VALVE**. Disconnect the sampler from the canister. If the canister does not have a vacuum pressure gauge attached, connect a gauge to the canister inlet, open the valve, read the gauge, close the valve, then disconnect the gauge from the canister. If the canister does have a vacuum pressure gauge attached, read the gauge and record the value and in the field log book. **Note: The gauge reading obtained in this step and in step 3 should agree with the predetermined final canister pressure used in the calculations described in Section 8. This step will help determine if the sample had been collected at a constant rate over the sampling period.**
10. Place canister into shipping container.
11. In a field log book record for each sampling location, the sampling event end time, final canister pressure, and meteorological conditions during the sampling event.
12. Complete chain-of-custody record form. See Section 9.2.

QA/QC Procedures and Performance Criteria

Flow Controller Calibration
The canister sampling system uses a Millaflow flow controller, or equivalent to regulate the flow of sample entering the canister over the desired sample period. The flow controller is calibrated using an Aalborg Electronic Mass Flowmeter (Model GFM-1700) capable of measuring flow rates between 0-500 ml/min. within $\pm$1.5% of full scale.

Flow Rate Determination
Flow rates are determined based on the duration of the sampling event and whether sub-atmospheric or pressurized samples will be collected. Flow rates can be calculated using the following formula:

$$F = \frac{P \times V}{T \times 60}$$

Where:
F = flow rate (ml/min)

$$P = \text{final canister pressure, atmospheres absolute} = \frac{\text{gauge pressure (psig)} + 14.7\text{ psi}}{14.7\text{ psi}}$$

V = volume of canister (ml)
T = sampling period (hours)

For example, if a 15 liter canister is to be pressurized to 26 psig in 8 hours, the flow rate should be calculated as follows:

$$\text{Flow rate (ml/min)} = \frac{\dfrac{(26 \text{ psig} + 14.7 \text{ psi})}{14.7 \text{ psi}} \times 15{,}000 \text{ ml}}{8 \text{ hours} \times 60 \text{ min}}$$

$$= \frac{2.8 \text{ atmospheres absolute} \times 15{,}000 \text{ ml}}{480 \text{ min}}$$

$$= 88 \text{ ml/min}$$

If a subatmoshperic sample is to be collected in a 15 liter canister over an 8 hour period the flow rate should be calculated as follows to achieve a final canister gauge pressure reading of 8 in. Hg vacuum:

$$\text{Flow rate (ml/min)} = \frac{\dfrac{(-8 \text{ in. Hg} + 29.92 \text{ in. Hg})}{29.92 \text{ in Hg}} \times 15{,}000 \text{ ml}}{8 \text{ hours} \times 60 \text{ min}}$$

$$= \frac{0.73 \text{ atmospheres absolute} \times 15{,}000 \text{ ml}}{480 \text{ min}}$$

$$= 23 \text{ ml/min}$$

Subatmospheric Canister Laboratory and Field Flow Controller Calibration Procedures

1. On the inlet side of the Aalborg Electronic Mass Flowmeter (Model GFM-17001 connect the 7 micrometer stainless steel Nupro *Co.* particulate filter supplied with the flowmeter.
2. Power up the Aalborg Electronic Mass Flowmeter (Model GFM-1700) by connecting it to the power supply. **Note: The meter must be warmed up for a minimum= of 15 minutes prior to taking readings.**
3. Using an insulated screwdriver through the ZERO (lower) access window adjust the trim potentiometer until the display reads zero.
4. Configure the sampler as shown in Figure 1 Connect the sample inlet line with particulate matter filter to the flow controller’s high pressure inlet port (IHP) and the low pressure outlet port (LP) to an evacuated canister. **Note: This canister will serve as a dummy canister for calibrating all** the **flow controllers to be used during the sampling event.**
5. Connect the flowmeter to the sample inlet making sure the **FLOW ARROW** marked on the flowmeter is pointing in the right direction.
6. In a field log book record the project name, calibration date, and flow controller number.
7. Open the canister valve to allow a sample of room air or clean/background ambient air to be drawn through the flowmeter and into the canister. The canister pressure differential causes the sample to flow into the canister.
8. Observe the mass flowmeter reading and adjust the micro-metering valve on the flow controller until the predetermined flow rate registers on the meter. In the field log book record the flow rate reading. Refer to Section 4.1.1for the procedure to calculate flow rates. Note: With the mechanical flow controller, the difference between the inlet and outlet pressure must be 10 psi to maintain a constant flow rate. As the internal canister pressure approaches atmospheric pressure, there will be a decrease in the flow rate. Therefore, a 6 liter canister will only be able to collect a 2 -3 liter sample.
9. Close the canister valve. **DO NOT OVER-TIGHTEN THE VALVE**.
10. Turn off (unless it will be used for further calibrations] and disconnect the Aalborg Electronic Mass Flowmeter from the sample inlet.
11. Disconnect the sample inlet line with particulate matter filter from the flow controller and the flow controller from the canister.
12. Place flow controller in appropriate carrying case.

Subatmospheric Canister Field Flow Controller Post and During Sampling Flow Check Procedures:

1. On the inlet side of the Aalborg Electronic Mass Flowmeter (Mode3 GFM-1700) connect the *7* micrometer stainless steel Nupro *Go.* particulate filter supplied with the flowmeter.
2. Power up the Aaiborg Electronic 14ass Flowmeter by connecting it to the power supply, Note: The meter **must** be warned up for a minimum of ***25*** minutes prior to taking readings.
3. Using an insulated screwdriver through the ZERO (lower) access window adjust the trim potentiometer until the display reads zero.
4. Connect the flowmeter to the sample inlet making sure the **FLOW ARROW** marked on the flowmeter is pointing in the right direction.
5. Observe the mass flowmeter reading. In a field log book record the date, sampling location, flow controller number, and flow rate reading.
6. Turn off (unless it will be used at another sampling location) and disconnect the Aalborg Electronic Mass Flowmeter from the sample inlet.
7. Place flow controller in appropriate carrying case.

Pressurized Canister Laboratory and Field Flow Controller Calibration Procedures

1. On the inlet side of the Aalborg Electronic Mass Flowmeter (Model GFM-1700) connect the 7 micrometer stainless steel Nupro Co. particulate filter supplied with the flowmeter.
2. Power up the Aalborg Electronic Mass Flowmeter (Model GFM-1700j by connecting it to the power supply. Note: The meter must be warmed up for a minimum of 15 minutes prior to taking readings.
3. Using an insulated screwdriver through the ZERO (lower) access window adjust the trim potentiometer until the display reads zero.
4. Configure the sampler as shown in Figure 3 using the components described in Section 3.1. Connect the sample inlet line with particulate matter filter to the inlet/vacuum side of the pump. Connect the outlet/ pressure side of the pump to the high pressure inlet port (KP) of the flowcontroller. Connect the low pressure outlet port (LP) side of the flowcontroller to the canister inlet port, Note: This canister will serve as a d canister for calibrating a31 the flow controllers to be used during the sampling event.
5. Connect the Aalborg Electronic Mass Flowmeter (Model GYM-17001 to the sampler inlet making sure the ""FLOW ARROW" marked on the flowmeter is pointing in the right direction.
6. Power up the pump, open the canister valve to allow a sample of room air or clean/background ambient air to be drawn into the canister.
7. Observe the mass flowmeter reading and adjust the micrometering valve on the flow controller until the predetermined flow rate registers on the meter. In the field log book record the date, pump number, sampler number, and flow rate reading.
8. Close the canister valve. DO NOT OVER-TIGHTEN THE VALVE.
9. Turn off the pump and flowmeter (unless it will be used for further calibrations).
10. Disconnect the Aalborg Electronic Mass Flowmeter from the sample inlet.
11. Disconnect the sampler from the canister
12. Place flow controller and sampler in their appropriate carrying case.

Pressurized Canister Field Flow Controller Post and During Sampling Flow Check Procedures

1. On the inlet side of the Aalborg Electronic Mass Flowmeter (Model GFM-1700) connect the 7 micrometer stainless steel Nupro Co. particulate filter supplied with the flowmeter.
2. Power up the Aalborg Electronic Mass Flowmeter (Model GFM-1700) by connecting it to the power supply. **Note: The meter must be warned up for a minimum of 15 minutes prior to taking readings.**
3. Using an insulated screwdriver through the ZERO lower access window adjust the trim potentiometer until the display reads zero.
4. Connect the Aalborg Electronic Mass Flowmeter (Model GFM-1700) to the sampler inlet making sure the "**FLOW ARROW**" marked on the flowmeter is pointing in the right direction.
5. Observe the mass flowmeter reading. In a field log book record the date, sampling location, sampler number (includes flow controller and pump number), and flow rate reading.

6. Turn off (unless it will be used at another sampling location) and disconnect the Aalborg Electronic Mass Flowmeter from the sample inlet.
7. Place flow controller in appropriate carrying case.

Field Trip Blank

There will be no canister field/trip blanks brought back to the laboratory for analyses. The canisters and samplers designated for a specific project are certified clean and leak free by the laboratory prior to sample collection. This process eliminates the need to have field/trip blanks analyzed with canister samples.

Canister Storage

Canisters that have been certified clean and leak free by the ESD Laboratory are stored in a locked cabinet under pressure. Several days prior to the sampling event canisters are evacuated to their final canister pressure TGRR). After the sampling event and after being logged into the laboratory, the canister samples are stored in a locked cabinet. Two engineers from the Ambient Air and Emissions Monitoring Section responsible for collecting canister samples and a chemist from the Chemistry Section performing canister analyses have keys to the cabinet.

Canister Transport

Canisters are transported to the field and back to the laboratory in a SIS metal carrying case designed to carry two 15 liter canisters. The carrying case helps eliminate valves on the canisters from being inadvertently opened and/or damaged.

Appendix K: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Technical Procedure: FSOP-1001
Revision: 02

STANDARD OPERATING PROCEDURE FOR AIR SAMPLING

<u>KEMRON Environmental Services, Inc.</u>
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Leland Meadows, Technical Advisor — 08/19/19 Date

John Dwyer, President — 08/19/19 Date

VERSION CONTROL

Version	Changes	Affects Section	Effective Date
00	N/A	Entire Document	08 November 2004
01	Review for content, technology and methods, and quality control.	Entire Document	23 October 2014
02	Review for content, technology and methods, and quality control.	Entire Document	19 August 2019

TABLE OF CONTENTS

LIST OF APPENDICES

1 Policy

KEMRON personnel shall follow procedures outlined herein as well as project-specific guidance to include field procedures and technical collection procedures to determine which quality control samples are required.

2 Purpose

The purpose of this standard operating procedure (SOP) is to provide basic guidance for collecting and analyzing valid and representative air samples. Air samples measure airborne contaminant concentrations to assess impacts at off-site receptors due to contaminant migration via the air migration pathway. Air sampling may be required as part of, risk assessment, or as an element of remedial action where sampling data is used to assess compliance with established air action levels. Screening level data, collected in real-time with direct-reading instruments, measures quantitative data for decision-making purposes. Procedures provided herein provide the minimum acceptable requirements for air sampling at hazardous waste sites. Project-specific requirements and data quality objectives (DQOs) shall determine if project-specific modification is required.

3 Scope

Core components of KEMRON's air sampling program include identifying target parameters and action levels, instrumentation requirements, data collection and telemetry requirements, data archiving, and quality control. Project-specific air sampling plans shall be prepared to set action levels and address contingencies for the protection of site-specific receptor populations. Project-specific air sampling plans shall address the air sampling station configuration, air sampling procedures, data sample requirements, sampling location and duration. Client, federal, state, and project-specific requirements may prescribe specific types of equipment or procedures and may deviate from procedures prescribed herein. Site Managers shall document deviations from this SOP and request approval from the KEMRON Quality Assurance / Quality Control (QA/QC) Manager or client representative.

4 Responsibility

KEMRON Project Manager Responsibilities

Project Managers are responsible for communicating project-specific requirements are to the project team and for providing the materials, resources, and guidance necessary to perform air sampling in accordance with this SOP and project-specific work plans. The KEMRON Project Manager shall prepare and file an official record indicating field staff have review SOPs prior to beginning field work. Project Managers shall file compliance records with project documentation.

KEMRON Field Staff Responsibilities

KEMRON field staff shall prepare, organize, and inspect air sampling equipment prior to the initiation of sampling activities. The field sampler and shipper are responsible for initiating and maintaining chain-of-custody. Upon completion of a sampling event, the field staff shall return equipment to the designated storage area ensuring equipment is decontaminated and ready for reuse. KEMRON field staff shall follow procedures contained herein and approved project-specific SOPs. Prior to initiating air sampling, field staff shall sign an official record indicating they have read and understand this SOP.

KEMRON Sampling Technician

Sampling technicians are responsible for collecting air samples and properly documenting sampling data. It is the responsibility of the sampling technician to familiarize themselves with sampling procedures outlined in this SOP and with project-specific sampling plans, quality assurance plans, and health and safety plans such as Field Sampling Plans, Health and Safety Plans (HASP), and Quality Assurance Project Plan (QAPP).

Definitions

- **Flow Controller:** Millaflow Controller, or equivalent, a mechanical flow controller made of stainless steel, having a flow range of 5 - 500 ml/min.
- **High Volume Air Sampler:** Air sampler capable of collecting greater than 3 cubic feet per minute (cfm), or 85 liters/min. liters/min) but less than 3 cfm (85 liters/min).
- **Low Volume Air Sampler:** Air sampler capable of collecting greater than 0.35 cfm (10 liters/min) but less than 3 cfm (85 liters/min).
- **Mass Flowmeter**: An Electronic Mass Flowmeter is used to calibrate the flow controller. The mass flowmeter measures flow rates between 0 -500 ml/min, within $\pm$1.5% full scale.
- **Particulate Matter Filter:** 2 micrometer stainless steel in-line filter (Nupro Co., Model SS4F-2, or equivalent) is attached to sample inlet line.
- **Polyurethane Foam (PUF):** Absorbent cartridge or tube for air sample collection and laboratory analysis.
- **Sample Pump:** Programmable SIS stainless steel/viton diaphragm vacuum pump/compressor, with a current draw at max load of 1.1 amps, used to draw air through filters, cartridges, or other air sample collection media.
- **Vacuum Pressure Gauge**: A separate vacuum gauge is connected to check vacuum pressure readings before and after sampling event.

5 AIR SAMPLE COLLECTION PLANNING

Handle samples with care to prevent cross-contamination. Always wear gloves and use tweezers while handling the air sample filters to prevent sample contamination from contact with fingers and to prevent possible skin contamination.

Do not allow an air sampler to pick up debris from the floor, ground, or other surface.

The Project Manager provides written instructions of any project-specific information for the sampling crew. The written instructions can be as simple as a sampling requirements report or as detailed as a Sampling and Analysis Plan (SAP). Items in written sampling instructions may include the following:

- Sampling Locations
- Method of Sampling
- Action Levels
- Data Quality Objectives

- Analytical Parameters
- QA/QC Procedures

Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific QAPP. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements typically suggest the collection of a sufficient quantity of QC samples such as field duplicate, equipment and/or field blanks and matrix spike/matrix spike duplicate (MS/MSD) samples. These requirements should be outlined in the QAPP.

Information regarding the number of air sample containers and sampling methods will be described in the project specific SAP/QAPP.

Adequate health and safety measures must be taken to protect project sampling personnel from potential chemical exposures or other hazards. These measures must be addressed in the project HASP. This plan must be approved by the project health and safety officer before work commences, must be distributed to the personnel performing sampling, and must be adhered to as field activities are performed.

6 SAMPLE COLLECTION EQUIPMENT

The tables in this section provide a description of equipment and sampling procedures for different air sampling methods. The project work plan will specify the method and any site-specific requirements. See Appendix B, Figures for diagrams of the sampling systems.

- SUMMA® Canister Sample Equipment:
  - Sample Canister
  - Vacuum Pressure Gauge
  - Sampling Inlet Line
  - Particulate Matter Filter (2 micrometer stainless steel in-line filter)
  - Chromatographic-grade Stainless Steel Tubing and Fittings
  - Canister Shipping Containers
  - Flow Controller
  - Mass Flowmeter
  - Sample Pump
  - Particulate/Aerosol Monitor (DataRam or equivalent)
- Glass Fiber or Cellulose Filters
- Weather-tight Enclosures
- Wind Speed Sensor
- Wind Direction Sensor
- Ambient Dry Bulb Temperature Sensor
- Barometric Pressure Sensor
- Data Acquisition/Recording System
- Maps/Plot Plan
- Logbook
- Field Data Sheets and Sample Labels
- Survey Equipment or Global Positioning System (GPS) to Locate Sampling Points
- Tri-pod with Grounding Equipment
- Batteries
- Electrical Power Source (115 VAC)
- Sampler Carrying Case

This equipment list was developed to aid in field organization and should be used in preparation for each sampling event. Depending on the site-specific sampling plan, additional material and equipment may be necessary and should be determined before the scheduled sampling event. Similarly, not all of the items shown in this list may be necessary for any one sampling event.

7 SAMPLE EQUIPMENT SITING CRITERIA AND PROCEDURES

Prevailing wind direction, based on historical meteorological data collected by the National Weather Service, along with the location of site activities and local conditions, should be used to select the conceptual sampling locations. KEMRON recognizes that the actual sampling locations may deviate from the "ideal" in that it may not be possible (or practical) to meet all of the desired sampling siting criteria. Equipment siting criteria include:

- Locate the monitors downwind of the site or site activities along the "fenceline" of the site or upgradient of potential receptor populations
- The monitor inlet should be placed at least two meters above the ground surface
- The monitor inlet should be placed at least 20 meters away from the nearest streets or trees
- The monitor should be well removed from obstacles (about two or more times the height of the obstruction)
- The immediate surroundings should have ground cover to prevent surface dust from affecting the measurements
- The monitor should receive unrestricted air flow from at least three cardinal wind directions (270◦), including the predominant wind direction
- There should be no incinerator or furnace flues nearby
- The location station must have suitable accessibility
- The monitor must be placed on a flat surface
- Security, electrical power, and (if remotely operated or reporting) communication lines must be considered and provided
- If a roof-top location is considered, the monitor must be at least 2 meters from walls, parapets, penthouses, etc.

It is possible that meeting all the above criteria may not be possible at some locations. Site-specific locations will be determined at the site by considering the above criteria.

See Appendices for sampling procedures.

8 FIELD RECORDS

8.1 Field Log Book

See the Field Documentation SOP for generic documentation items. Examples of specific surface water sampling documentation include the following:

- Site name
- Date and time of arrival
- Weather conditions, including ambient air temperature and/or miscellaneous observations
- Date and time sampling
- Equipment ID
- Flow rate recorded (if applicable)
- Sample sequence number
- Method of sampling
- Signature of sampler(s) and date, etc.

8.2 Chain-of-Custody

Completed chain-of-custody forms are maintained for the samples. A sample chain-of-custody form is included as Appendix C. The original form is sent to the laboratory with the samples and signed by the lab upon receipt. Original completed chain-of-custody forms are returned to KEMRON with the analytical report.

9 SHIPPING

Equipment decontamination chemicals may need to be shipped to the site and samples may need to be shipped to the laboratory. Shipping is completed in accordance with the current federal and international regulations (DOT, EPA, IATA). Shipping stipulations are to be included in the project documents, but should you have any questions regarding shipping of any materials to and from the site, contact the authorized shipping representative in your home office.

10 REFERENCES

- Standard operating Procedure Sampling Volatile Organic Compounds Using Summa® Polished Stainless Steel Canisters, Revision 2, March 2001

Appendix A: Request for Deviations

Deviation to FSOP-1001: STANDARD OPERATING PROCEDURE FOR AIR SAMPLING

Description of Deviation
1.
2.
Need for Deviation
1.
2.
Corrective Action Taken
1.
2.

Approved by:

Name: Signature:
KEMRON Project Manager Date

Name: Signature:
KEMRON QA/QC Manager Effective Date

- OR -

Name: Signature:
Client Representative Effective Date

Appendix B: Sampling Equipment

Figure 1. Sampler Configuration

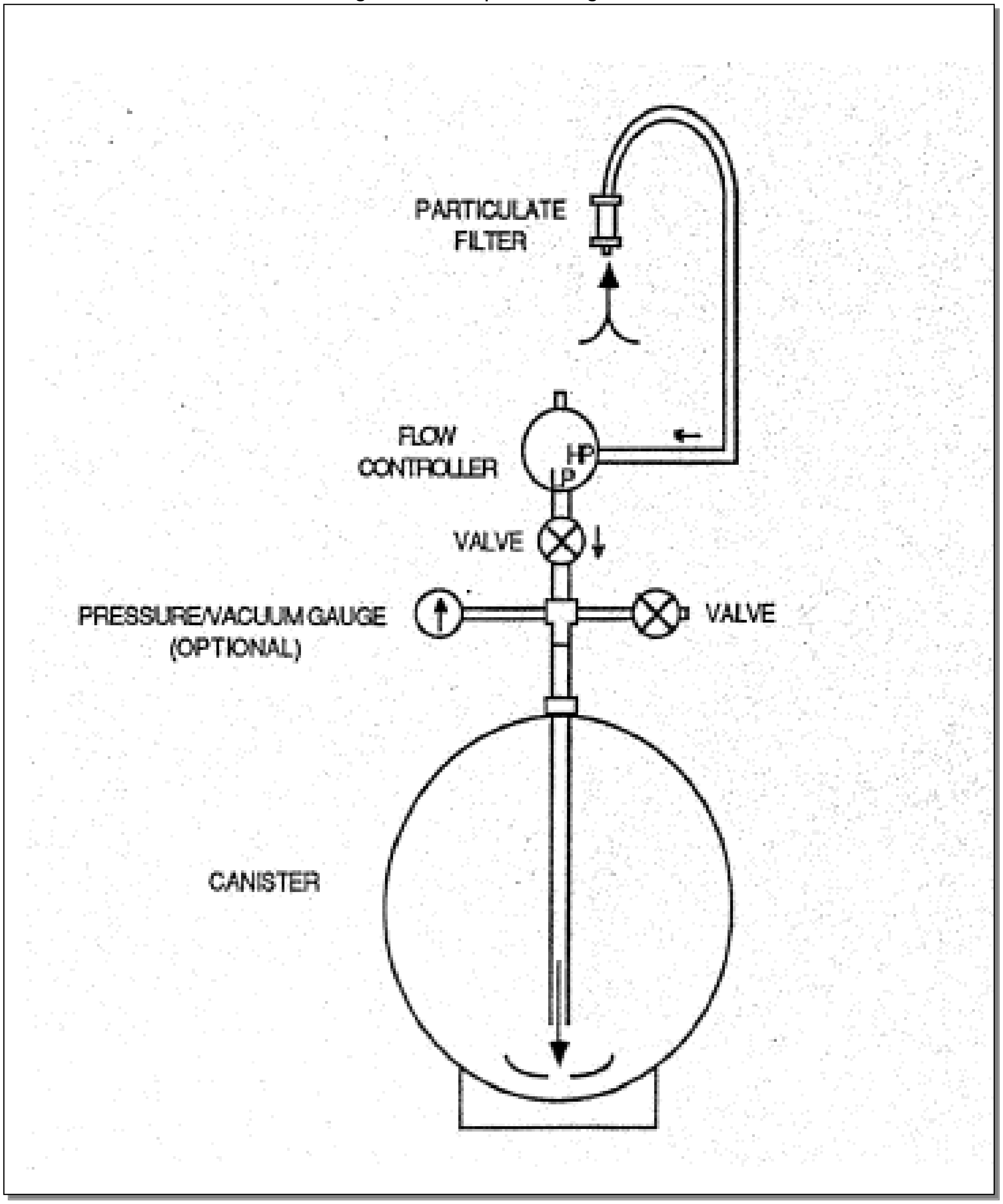
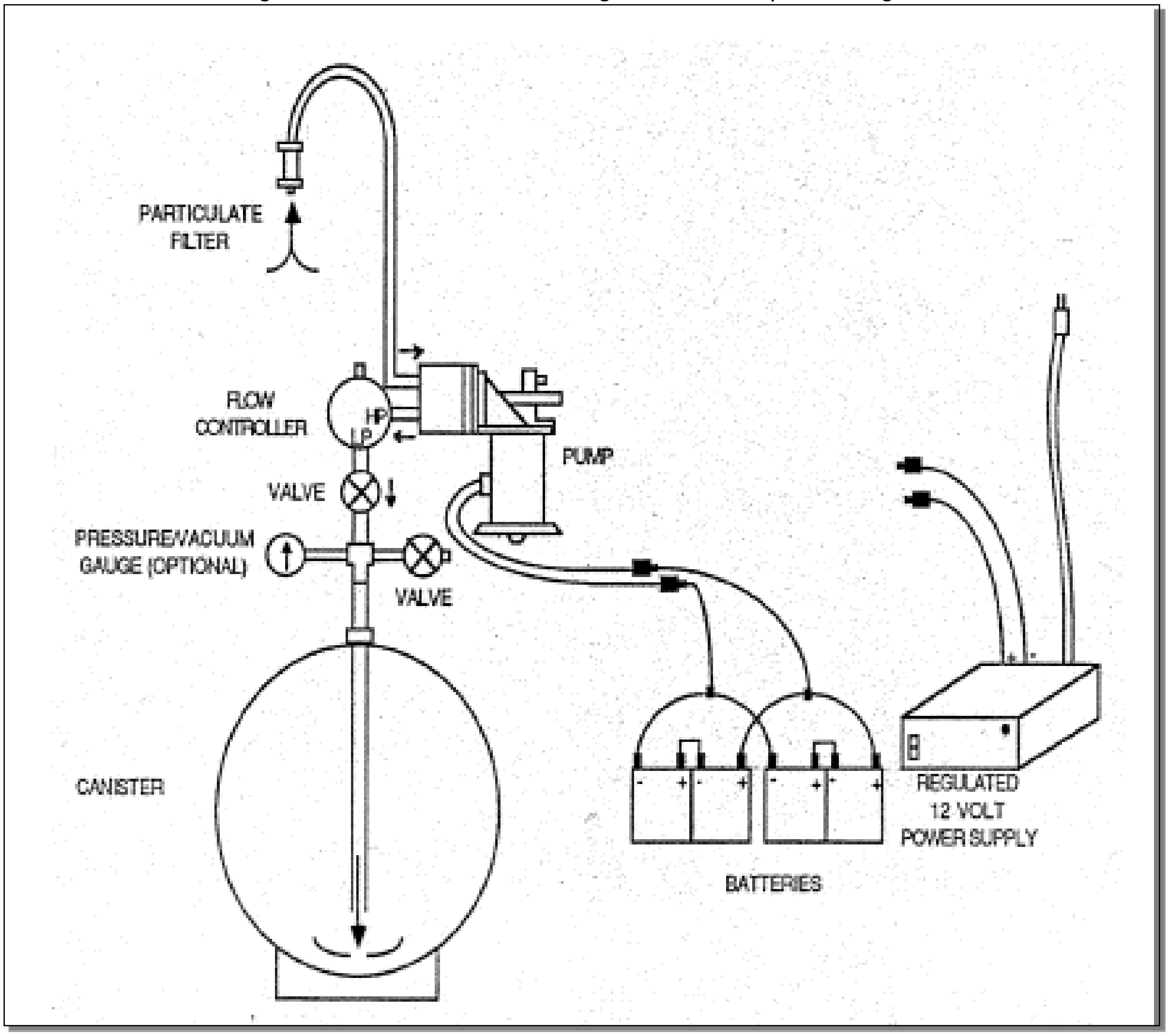


Figure 2. Pressurized Time-Integrated Air Sampler Configuration



Appendix C: Particulate Air Sampling

Equipment:
Gillian GilAir 5 sampling pump or equivalent and appropriate filter media

Sampling Procedure:
Preparation:
1. Obtain necessary sampling and monitoring equipment.
2. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
3. Perform a general site survey prior to site entry in accordance with the site specific HASP.
4. Calibrate sampling pump in accordance with manufacturer's instructions.
5. Program sampling pump to operate at 2 to 4 L/min or other preset flow rate.
6. Check/calibrate flow rate and adjust accordingly.

Sampling:
1. Install the filter on the sample inlet line on the external sampling pump set to draw air at a flow rate of 2 to 4 L/min or other preset flow rate.
2. In a field log book, record the project name, sampling event date, sampling location, filter number, and the sampling start time.
3. The sample pump will sample at a flow rate of 2 to 4 L/min to collect a filter sample over duration of 8 hours.
4. Allow the filter to collect air over the course of the pre-determined sampling period (i.e. 8 hours, etc.).
5. During the course of the sampling event, periodically check each sampling location to see if the sampler had been tampered with.
6. Disconnect the sample inlet line with filter from the sampling pump.
7. In a field log book record the final sample time reading and the meteorological conditions during the sampling event.
8. Place filter into shipping container and send to the laboratory.
9. Complete chain-of-custody record form.
10. Calibrate the sampling pump in accordance with manufacturer's instructions.

Post-Sampling Activities:
Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:
1. Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
2. Processing the sample paperwork, including copies provided to laboratory.
3. Compiling the field data for site records.
4. Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure appropriate sample analyses has been returned to sampler.

Appendix D: High Volume Sampling

Equipment:
Gillian AirCon 2 sampling pump or equivalent and 4-inch diameter acid-washed quartz fiber filter and 2-inch diameter by 3-inch long absorbent cartridge (polyurethane foam or PUF)

Sampling Procedure:
Preparation:
1. Obtain necessary sampling and monitoring equipment.
2. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
3. Perform a general site survey prior to site entry in accordance with the site specific HASP.
4. Calibrate sampling pump in accordance with manufacturer's instructions.
5. Program sampling pump to operate at 20 L/min or other preset flow rate.
6. Check/calibrate flow rate and adjust accordingly.

Sampling:
1. Install the quartz fiber filter and PUF absorbent cartridge on the sample inlet line on the external sampling pump set to draw air at a flow rate of 20 L/min or other preset flow rate.
2. In a field log book, record the project name, sampling event date, sampling location, filter number, and the sampling start time.
3. The sample pump will sample at a flow rate of 20 L/min to collect a filter sample over a pre-set duration.
4. Allow the filter to collect air over the course of the pre-determined sampling period (i.e. 8 hours, 24 hours etc.).
5. During the course of the sampling event, periodically check each sampling location to see if the sampler had been tampered with.
6. Disconnect the sample inlet line with filter from the sampling pump.
7. In a field log book record the final sample time reading and the meteorological conditions during the sampling event.
8. Place filter and absorbent cartridge into shipping container and send to the laboratory for analysis by TO13A for PAHs, TO4A for PCBs or pesticides, or TO9A for PCDDs.
9. Complete chain-of-custody record form.
10. Calibrate the sampling pump in accordance with manufacturer's instructions.

Post-Sampling Activities:
Several activities need to be completed and documented once soil sampling has been completed. These activities include, but are not limited to:
- Ensuring that field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing the sample paperwork, including copies provided to laboratory.
- Compiling the field data for site records.
- Verifying the analytical data processed by the analytical laboratory against field sheets and chain-of-custody to ensure appropriate sample analyses has been returned to sampler.

Appendix E: SUMMA® Canister Sampling

Scope
This canister sampling SOP describes procedures for sampling with canisters at final pressures above atmospheric pressure (referred to as pressurized sampling), below atmospheric pressure (referred to as subatmospheric sampling), and at atmospheric pressure (referred to as grab sampling). This method is applicable to specific VOCs that have been tested and determined to be stable when stored in pressurized and subatmospheric pressure canisters. These compounds have been measured at the parts per billion by volume (ppbv) level.

EPA Method TO15 Target Compound List
A wide range of compounds may be analyzed by EPA TO-15 including alkanes, alkenes, aromatics, halogenated VOCs, ketones, esters and some alcohols. Some aldehydes and sulfides may also be evaluated using this method.
EPA TO-15 does not specify a target compound list in the method. As a result, there is some variation among commercial environmental laboratories in the compound lists that are available for VOCs. Target compound lists may include anywhere from 40 to 60 compounds or more, and may provide results in µg/m3, ppbV, or both. Compound lists can usually be tailored to meet project-specific objectives. An example TO15 list is as follows:

- Dichlorodifluoromethane
- 1,2-Dichloropropane
- Chlorodifluoromethane
- Dibromomethane
- Freon 114
- Bromodichloromethane
- Chloromethane
- cis-1,3-Dichloropropene
- Vinyl Chloride
- 4-Methyl-2-Pentanone
- 1,3-Butadiene
- Toluene
- Bromomethane
- Octane
- Chloroethane
- trans-1,3-Dichloropropene
- Dichlorofluoromethane
- 1,1,2-Trichloroethane
- Trichlorofluoromethane
- Tetrachloroethene
- Pentane
- 2-Hexanone
- 1,1-Dichloroethene
- Dibromochloromethane
- Freon 113
- 1,2-Dibromoethane
- Acetone
- Chlorobenzene
- Carbon Disulfide
- 1,1,1,2-Tetrachloroethane
- 3-Chloropropene
- Ethylbenzene
- Methylene Chloride
- m/p-Xylene
- trans-1,2-Dichloroethene
- o-Xylene
- Methyl t-Butyl Ether
- Styrene
- Hexane
- Bromoform
- 1,1-Dichloroethane
- Cumene
- cis-1,2-Dichloroethene
- 1,1,2,2-Tetrachloroethane
- 2-Butanone
- 1,2,3-Trichloropropane
- Chloroform
- Bromobenzene
- 1,1,1-Trichloroethane
- 4-Ethyltoluene
- Carbon Tetrachloride
- 1,3,5-Trimethylbenzene
- 1,2-Dichloroethane
- 1,2,4-Trimethylbenzene
- Benzene
- 1,3-Dichlorobenzene
- Isooctane
- 1,4-Dichlorobenzene
- Heptane
- 1,2-Dichlorobenzene
- Trichloroethene
- Hexachloroethane

Canister Subatmospheric Time-Integrated Sampling Procedures:

1. In the laboratory, prior to the sampling event, calibrate the flow controller using the procedure outlined in Section 4.1.4. **Note: For this procedure use an evacuated dummy canister.**
2. In the field, before placing the sampler at the desired sampling location, check the calibration of the flow controller. **Note: For this procedure use an evacuated dummy canister.**
3. Select the canister and sampler to be used for the sampling event and bring it to the desired sampling location. If the canister does not have a vacuum pressure gauge attached, connect a gauge to the canister inlet, open the valve, read the gauge, close the valve, and then disconnect the gauge from the canister. If the canister to be used for the sampling event does have a vacuum pressure gauge attached, read the gauge and record the value and canister number in a field log book.
4. Connect the sample inlet line with particulate matter filter to the inlet vacuum side of the pump. Connect the outlet pressure side of the pump to the high pressure inlet port (HP) of the flow controller. Connect the low pressure outlet port (LP) side of the flow controller to the canister inlet port.
5. In a field log book record the project name, sampling event date, sampling location, canister number, sampler number, and the initial canister pressure gauge reading.
6. After the samplers have been set-up at their desired sampling locations, go back to each location and first turn on the sampling pump then open the canister valve. In the field log book record the sampling event start time for each sampling location.
7. During the course of the sampling event, periodically cheek each sampling Location to see if the sampler had been tampered with or that the pump *is* running, In addition, if the canister has a vacuum pressure gauge attached, observe and record the gauge reading to determine if the canister is being filled at a constant rate, If the no vacuum pressure gauge is being used, connect the Aalborg Electronic Mass Flowmeter and cheek the flow rate, adjust if necessary.
8. 45 to 30 minutes before the end of the sampling period, visit each sampling location and obtain a flow rate reading using the procedure outlined in Section 8.
9. At the conclusion of the predetermined sampling period, return to each sampling location and first close the canister valve then turn off the sampling pump. **DO NOT OVER-TIGHTEN THE. VALVE**. Disconnect the sampler from the canister. If the canister does not have a vacuum pressure gauge attached, connect a gauge to the canister inlet, open the valve, read the gauge, close the valve, then disconnect the gauge from the canister. If the canister does have a vacuum pressure gauge attached, read the gauge and record the value and in the field log book. **Note: The gauge reading obtained in this step and in step 3 should agree with the predetermined final canister pressure used in the calculations described in Section 8. This step will help determine if the sample had been collected at a constant rate over the sampling period.**
10. Place canister into shipping container.
11. In a field log book record for each sampling location, the sampling event end time, final canister pressure, and meteorological conditions during the sampling event.
12. Complete chain-of-custody record form. See Section 9.2.

QA/QC Procedures and Performance Criteria

Flow Controller Calibration
The canister sampling system uses a Millaflow flow controller, or equivalent to regulate the flow of sample entering the canister over the desired sample period. The flow controller is calibrated using an Aalborg Electronic Mass Flowmeter (Model GFM-1700) capable of measuring flow rates between 0-500 ml/min. within $\underline{+}1.5\%$ of full scale.

Flow Rate Determination
Flow rates are determined based on the duration of the sampling event and whether sub-atmospheric or pressurized samples will be collected. Flow rates can be calculated using the following formula:

F= $\underline{\quad P \times V}$

T x 60

Where:
F = flow rate (ml/min)
P = final canister pressure, atmospheres absolute = $\frac{\text{gauge pressure (psiq)} + 14.7\text{ psi}}{14.7\text{ psi}}$
V = volume of canister (ml)
T = sampling period (hours)

For example, if a 15 liter canister is to be pressurized to 26 psig in 8 hours, the flow rate should be calculated as follows:

$$\text{Flow rate (ml/min)} = \frac{\frac{(26\text{ psig} + 14.7\text{ psi})}{14.7\text{ psi}} \times 15{,}000\text{ ml}}{8\text{ hours} \times 60\text{ min}}$$

$$= \frac{2.8\text{ atmospheres absolute} \times 15{,}000\text{ ml}}{480\text{ min}}$$

$$= 88\text{ ml/min}$$

If a subatmoshperic sample is to be collected in a 15 liter canister over an 8 hour period the flow rate should be calculated as follows to achieve a final canister gauge pressure reading of 8 in. Hg vacuum:

$$\text{Flow rate (ml/min)} = \frac{\frac{(-8\text{ in. Hg} + 29.92\text{ in. Hg})}{29.92\text{ in Hg}} \times 15{,}000\text{ ml}}{8\text{ hours} \times 60\text{ min}}$$

$$= \frac{0.73\text{ atmospheres absolute} \times 15{,}000\text{ ml}}{480\text{ min}}$$

$$= 23\text{ ml/min}$$

Subatmospheric Canister Laboratory and Field Flow Controller Calibration Procedures

1. On the inlet side of the Aalborg Electronic Mass Flowmeter (Model GFM-17001 connect the 7 micrometer stainless steel Nupro *Co.* particulate filter supplied with the flowmeter.
2. Power up the Aalborg Electronic Mass Flowmeter (Model GFM-1700) by connecting it to the power supply. **Note: The meter must be warmed up for a minimum= of 15 minutes prior to taking readings.**
3. Using an insulated screwdriver through the ZERO (lower) access window adjust the trim potentiometer until the display reads zero.
4. Configure the sampler as shown in Figure 1 Connect the sample inlet line with particulate matter filter to the flow controller's high pressure inlet port (IHP) and the low pressure outlet port (LP) to an evacuated canister. **Note: This canister will serve as a dummy canister for calibrating all** the **flow controllers to be used during the sampling event.**
5. Connect the flowmeter to the sample inlet making sure the **FLOW ARROW** marked on the flowmeter is pointing in the right direction.
6. In a field log book record the project name, calibration date, and flow controller number.
7. Open the canister valve to allow a sample of room air or clean/background ambient air to be drawn through the flowmeter and into the canister. The canister pressure differential causes the sample to flow into the canister.
8. Observe the mass flowmeter reading and adjust the micro-metering valve on the flow controller until the predetermined flow rate registers on the meter. In the field log book record the flow rate reading. Refer to Section 4.1.1for the procedure to calculate flow rates. Note: With the mechanical flow

controller, the difference between the inlet and outlet pressure must be 10 psi to maintain a constant flow rate. As the internal canister pressure approaches atmospheric pressure, there will be a decrease in the flow rate. Therefore, a 6 liter canister will only be able to collect a 2 -3 liter sample.
9. Close the canister valve. **DO NOT OVER-TIGHTEN THE VALVE**.
10. Turn off (unless it will be used for further calibrations] and disconnect the Aalborg Electronic Mass Flowmeter from the sample inlet.
11. Disconnect the sample inlet line with particulate matter filter from the flow controller and the flow controller from the canister.
12. Place flow controller in appropriate carrying case.

Subatmospheric Canister Field Flow Controller Post and During Sampling Flow Check Procedures:
1. On the inlet side of the Aalborg Electronic Mass Flowmeter (Mode3 GFM-1700) connect the *7* micrometer stainless steel Nupro *Go.* particulate filter supplied with the flowmeter.
2. Power up the Aaiborg Electronic 14ass Flowmeter by connecting it to the power supply, Note: The meter **must** be warned up for a minimum of ***25*** minutes prior to taking readings.
3. Using an insulated screwdriver through the ZERO (lower) access window adjust the trim potentiometer until the display reads zero.
4. Connect the flowmeter to the sample inlet making sure the **FLOW ARROW** marked on the flowmeter is pointing in the right direction.
5. Observe the mass flowmeter reading. In a field log book record the date, sampling location, flow controller number, and flow rate reading.
6. Turn off (unless it will be used at another sampling location) and disconnect the Aalborg Electronic Mass Flowmeter from the sample inlet.
7. Place flow controller in appropriate carrying case.

Pressurized Canister Laboratory and Field Flow Controller Calibration Procedures
1. On the inlet side of the Aalborg Electronic Mass Flowmeter (Model GFM-1700) connect the 7 micrometer stainless steel Nupro Co. particulate filter supplied with the flowmeter.
2. Power up the Aalborg Electronic Mass Flowmeter (Model GFM-1700j by connecting it to the power supply. Note: The meter must be warmed up for a minimum of 15 minutes prior to taking readings.
3. Using an insulated screwdriver through the ZERO (lower) access window adjust the trim potentiometer until the display reads zero.
4. Configure the sampler as shown in Figure 3 using the components described in Section 3.1. Connect the sample inlet line with particulate matter filter to the inlet/vacuum side of the pump. Connect the outlet/ pressure side of the pump to the high pressure inlet port (KP) of the flowcontroller. Connect the low pressure outlet port (LP) side of the flowcontroller to the canister inlet port, Note: This canister will serve as a d canister for calibrating a31 the flow controllers to be used during the sampling event.
5. Connect the Aalborg Electronic Mass Flowmeter (Model GYM-17001 to the sampler inlet making sure the ""FLOW ARROW" marked on the flowmeter is pointing in the right direction.
6. Power up the pump, open the canister valve to allow a sample of room air or clean/background ambient air to be drawn into the canister.
7. Observe the mass flowmeter reading and adjust the micrometering valve on the flow controller until the predetermined flow rate registers on the meter. In the field log book record the date, pump number, sampler number, and flow rate reading.
8. Close the canister valve. DO NOT OVER-TIGHTEN THE VALVE.
9. Turn off the pump and flowmeter (unless it will be used for further calibrations).
10. Disconnect the Aalborg Electronic Mass Flowmeter from the sample inlet.
11. Disconnect the sampler from the canister
12. Place flow controller and sampler in their appropriate carrying case.

Pressurized Canister Field Flow Controller Post and During Sampling Flow Check Procedures
1. On the inlet side of the Aalborg Electronic Mass Flowmeter (Model GFM-1700) connect the 7 micrometer stainless steel Nupro Co. particulate filter supplied with the flowmeter.

2. Power up the Aalborg Electronic Mass Flowmeter (Model GFM-1700) by connecting it to the power supply. **Note: The meter must be warned up for a minimum of 15 minutes prior to taking readings.**
3. Using an insulated screwdriver through the ZERO lower access window adjust the trim potentiometer until the display reads zero.
4. Connect the Aalborg Electronic Mass Flowmeter (Model GFM-1700) to the sampler inlet making sure the "**FLOW ARROW**" marked on the flowmeter is pointing in the right direction.
5. Observe the mass flowmeter reading. In a field log book record the date, sampling location, sampler number (includes flow controller and pump number), and flow rate reading.
6. Turn off (unless it will be used at another sampling location) and disconnect the Aalborg Electronic Mass Flowmeter from the sample inlet.
7. Place flow controller in appropriate carrying case.

Field Trip Blank
There will be no canister field/trip blanks brought back to the laboratory for analyses. The canisters and samplers designated for a specific project are certified clean and leak free by the laboratory prior to sample collection. This process eliminates the need to have field/trip blanks analyzed with canister samples.

Canister Storage
Canisters that have been certified clean and leak free by the ESD Laboratory are stored in a locked cabinet under pressure. Several days prior to the sampling event canisters are evacuated to their final canister pressure TGRR). After the sampling event and after being logged into the laboratory, the canister samples are stored in a locked cabinet. Two engineers from the Ambient Air and Emissions Monitoring Section responsible for collecting canister samples and a chemist from the Chemistry Section performing canister analyses have keys to the cabinet.

Canister Transport
Canisters are transported to the field and back to the laboratory in a SIS metal carrying case designed to carry two 15 liter canisters. The carrying case helps eliminate valves on the canisters from being inadvertently opened and/or damaged.

Appendix F: Example Chain-of-Custody

CHAIN-OF-CUSTODY RECORD

KEMRON	1 COC NUMBER:

2 PROJECT NAME:	5 PROJECT NUMBER:	8 LAB NAME AND CONTACT:	11 FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 1 (Name and Company)	14 RECIPIENT 1 (Address, Tel No., and Fax No.):
3 PROJECT PHASE/SITE/TASK:	6 CTO OR DO NUMBER:	9 LAB PO NUMBER:	12 FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 2 (Name and Company)	15 RECIPIENT 2 (Address, Tel No., and Fax No.):
4 PROJECT CONTACT:	7 PROJECT TEL NO AND FAX NO:	10 LAB TEL NO AND FAX NO:	13 FAX AND MAIL REPORTS/EDD TO:: RECIPIENT 3 (Name and Company)	16 RECIPIENT 3 (Address, Tel No., and Fax No.):

17 ITEM	18 SAMPLE IDENTIFIER	19 SAMPLE DESCRIPTION/LOCATION	20 MATRIX (see codes on SOP)	21 DATE COLLECTED	22 TIME COLLECTED	23 DATA PKG LEVEL (see codes on SOP)	24 TAT (calendar days)	25 ANALYSES REQUIRED (Include Method Numbers)												26 SAMPLE TYPE (see codes on SOP)	27 COMMENTS/ SCREENING READINGS	28 LAB ID (for lab's use)
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

29 SAMPLER(S) AND COMPANY: (please print)	30 COURIER AND SHIPPING NUMBER:	31 SAMPLES TEMPERATURE AND CONDITION UPON RECEIPT (for lab's use):

32 RELINQUISHED BY	DATE	TIME	33 RECEIVED BY	DATE	TIME
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		
Printed Name and Signature:			Printed Name and Signature:		

Distribution: [ ] **Original** - Laboratory (To be returned with Analytical Report); [ ] Copy 1 - Project File; [ ] Copy 2 - PMO

Appendix G: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Technical Procedure: FSOP-1100
Revision: 02

STANDARD OPERATING PROCEDURE FOR WASTE IDENTIFICATION AND DISPOSAL

KEMRON Environmental Services, Inc.
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Leland Meadows
Leland Meadows, QA/QC Manager — 08/27/2019 Date

John Dwyer, President — 08/27/2019 Date

VERSION CONTROL

Version	Changes	Affects Section	Effective Date
00	N/A	Entire Document	24 January 2003
01	Review for content, technology and methods, and quality control.	Entire Document	November 2014
02	Review for content, technology and methods, and quality control.	Entire Document	27 August 2019

TABLE OF CONTENTS

LIST OF APPENDICES

1 POLICY

To follow procedures as stated regarding waste identification, profiling and disposal of various hazardous and non-hazardous wastes.

2 PURPOSE

To standardize a KEMRON procedure for identifying, profiling and disposing of various hazardous and non-hazardous wastes.

2.1 Precautions

Proper safety precautions must be observed when collect samples and managing waste. Refer to the site-specific Health and Safety Plans (HASPs) or Accident Prevention Plans (APPs) for guidelines on safety precautions, including personnel decontamination. As required in these plans, ensure the following:

- Sampling of waste in drums should be assessed for potential hazards by both the project leader and the Site Health and Safety Officer (SHSO).
- When collecting samples use safety glasses with splash shields or goggles and latex or nitrile gloves.
- When conducting decontamination using laboratory detergent, safety glasses with splash shields or goggles, and latex or nitrile gloves will be worn.
- No eating, smoking, drinking, chewing, or any hand to mouth contact should be permitted during decontamination operations.

3 SCOPE

This procedure applies to waste generated at any KEMRON site. This SOP applies to KEMRON personnel and subcontractors using hand tools for KEMRON projects. Client, federal, or state requirements, or project-specific requirements may dictate specific types of equipment or procedures to be used when applying this SOP to a particular project. Deviations from this SOP to accommodate site-specific requirements shall be documented in project planning documents and Appendix A and approved by the KEMRON Quality Assurance / Quality Control (QA/QC) Manager or client representative where applicable, prior to the performance of work.

4 RESPONSIBILITY

Transportation and Disposal (T&D) Coordinator Responsibilities
A T&D Specialist must have EPA Hazardous Waste Training (annually) and DOT Hazardous Materials Training (every 3 years).

Subcontractors
Subcontractors are secured under contract and required to meet local, state, and federal requirements (i.e., 29 CFR 1910.333(c)(3); 29 CFR 1926.550(a)(15)(i), (ii), (iii)).

5 DEFINITIONS

- **Brokers**: A broker may be secured to coordinate between KEMRON and multiple disposal facilities to ensure that the site waste streams are transported, stored and disposed of in a compliant manner. A three-bid analysis of qualified brokers should be conducted and is required for EPA ERRS projects.

- **CERCLA Offsite: Disposal Acceptability**: Waste generated at federal sites, to be disposed of off-site, must be disposed of at a facility deemed compliant and acceptable to receive the waste regulated by the CERCLA Off-Site Rule. Included are cleanups at Federal facilities under section 120 of CERCLA, and cleanups under section 311 of the Clean Water Act (CWA), except for cleanup of certain petroleum materials that are exempt under CERCLA. Prior to transport to the disposal facility, a request must be sent to the regional EPA CERCLA Off-Site contact to determine if the selected facility is in good standing. The compliance check provided by EPA is effective for 60 days. If waste will be disposed of over a period greater than 60 days, the facility compliance must be checked again prior to the lapse of the CERCLA acceptability notice issued by EPA. This process is usually done by email. Regional office contacts can be found at the following link: http://www.epa.gov/osw/hazard/wastetypes/wasteid/offsite/index.htm#listnames

- **Land Disposal Restrictions**: EPA's Land Disposal Restriction (LDR) program ensures that toxic constituents present in hazardous waste are properly treated before hazardous waste is land disposed. EPA has developed mandatory technology-based treatment standards that must be met before hazardous waste is placed in a landfill. These standards help minimize short and long-term threats to human health and the environment, which directly benefits local communities where hazardous waste landfills are located. LDR forms/notices must accompany hazardous waste transported for disposal and identify applicable restrictions and treatment technologies.

- **Municipal Solid Waste Landfills / Subtitle D Landfills**: Municipal Solid Waste Landfill (MSWLFs), often referred to as Subtitle D landfills can receive household waste as well as nonhazardous sludge, industrial solid waste, and construction and demolition debris. MSWLFs must comply with the federal regulations in 40 CFR Part 258 (Subtitle D of RCRA), or equivalent state regulations. Non-hazardous solid waste generated during site work may be disposed of in a Subtitle D landfill. Generally, the specific facility should be secured following (at least) a three-bid analysis and compliance evaluation. EPA ERRS projects are required to conduct a three-bid analysis on solicited transportation and disposal pricing.

- **OSC**: On-Scene Coordinator. An OSC is an EPA representative.

- **Publicly Owned Treatment Works**: Publicly owned treatment works (POTW), as defined by Section 212 of the CWA, is a water treatment facility owned by the state or municipality. This definition includes any devices and systems used in the storage, treatment, recycling, and reclamation of municipal sewage or industrial wastes of a liquid nature. It also includes sewers, pipes, and other conveyances only if they convey wastewater to a POTW treatment plant [40 CFR 403.3]. Privately-owned treatment works, Federally-owned treatment works, and other treatment plants not owned by municipalities are not considered POTWs. Occasionally, projects generate wastewater that may be acceptable, as shown through sample data to be compliant with local regulations, for discharge to the local POTW. While permitting for discharge to the POTW is not required for federal projects under CERCLA, KEMRON must show that the substantive requirements of a local permit are being met. Private projects must obtain necessary permits for wastewater discharge to the POTW.

- **Treatment, Storage and Disposal Facilities**: A TSDF (Treatment, Storage, and Disposal Facility) is a facility that is permitted to treat, store, and/or dispose of hazardous waste in special units. These units are commonly called hazardous waste management units. A facility may be permitted to accept hazardous wastes for treatment, storage, and/or disposal from outside generators (a commercial TSDF) or be permitted to treat, store, or dispose of its own hazardous waste (a private TSDF):

- Treatment - Treatment units use various processes (such as incineration or oxidation) to alter the character or composition of hazardous wastes. Some treatment processes enable waste to be recovered and reused, while other processes destroy or reduce the amount of hazardous waste.
- Storage - Storage units temporarily hold hazardous wastes until they are treated or disposed.
- Disposal - Disposal units permanently enclose hazardous wastes. Common types of disposal units include hazardous waste landfills and underground injection wells. Disposal units are designed to protect air, groundwater, and surface water resources.

Generally, the project TSDF should be secured following (at least) a three-bid analysis to evaluate pricing, proposed treatment technologies (if required), and facility compliance. It is noted that KEMRON often works in parts of the country in which there may be limited TSDF options due to reasonable proximity to the site or limitations in treatment technology and/or TSDF permitting limitations, which vary from facility to facility. EPA ERRS projects are required to conduct a three-bid analysis on solicited transportation and disposal pricing. To the extent practical, cost analysis should be conducted on TSDFs offering the same treatment technology. However, this may not always be feasible depending upon site location.

- **Toxicity Characteristics Leaching Procedure (TCLP)**: Toxicity characteristic leaching procedure (TCLP) is a sample extraction method for chemical analysis employed to simulate leaching through a landfill. The testing methodology is used to determine if a waste is characteristically hazardous (D-List). The extract is analyzed for substances appropriate to the protocol.

- **Underlying Hazardous Constituents**: Underlying hazardous constituent means any constituent listed in 40 CFR 268.48, Table UTS - Universal Treatment Standards, except fluoride, selenium, sulfides, vanadium, and zinc, which can reasonably be expected to be present at the point of generation of the hazardous waste at a concentration above the constituent-specific UTS treatment standards. If a hazardous waste is expected to contain any amount of a constituent in 40 CFR 268.48, the generator must identify on an LDR form to the TSDF what UHCs constituents must be treated for, if that particular waste requires treatment for UHCs.

  Only the waste codes in the Treatment Standard Table at 40 CFR 268.40 that have the following statement in their treatment standard: "...and meet 268.48 standards" require evaluation and treatment for UHCs. Only some of the characteristic waste codes reference this statement. None of the listed waste codes require treatment for UHC.

6 PROCEDURES

6.1 Waste Determination

1. The goal of waste determination is to determine if the waste is RCRA hazardous as well as determining proper disposal options. Determine if the waste is a Solid Waste - See 40 CFR part 260, Appendix 1.
2. If it is a solid waste, determine if it is a potential hazardous waste – See 40 CFR part 260 subparts C and D and look at site history.
3. If the waste source and identification is unknown, field testing to determine waste characteristics can aid in hazard determination and narrowing the number of analytical tests required to determine proper waste disposal options. See KEMRON Hazscan SOP (FSOP-1300). Hazscan allows for determining

the basic chemical characteristics of the waste and for compatibility for composite sampling for laboratory analysis.

4. Off-site laboratory analysis:
   Hazscan results, historical site documents, generator knowledge or TSDF/Subtitle D facility requirements will determine the analytical testing needed – consult a KEMRON T&D specialist or a KEMRON T&D subcontractor to determine applicable contaminants of concern and analytical methods.

   - Example: flammable samples will require Heat of Combustion and Percent Ash testing.
   - Example: corrosive samples – test for chlorines, fluorine, sulfates, nitrates, phosphates, etc.
   - Example: Toxicity Characteristic Leaching Procedure analyses for 40 CFR 261.24 analytes for soils and solids suspected of being non-hazardous and which have not been known to be contaminated with an F, K, P, or U-listed waste and show no hazardous characteristics during Hazscan testing.
   - Example: Soils, solids, sludges, or wastewaters anticipated to be hazardous (D-listed wastes) by toxicity characteristic (40 CFR 261.24) should have data collected to properly identify any Underlying Hazardous Constituents (UHCs) that may not meet the Universal Treatment Standards (UTS), as applicable. See 40 CFR 268.40 and 268.48 and the definition of UHC above.
   - Example: Non-hazardous wastewater that has been treated with a carbon filter may be eligible for discharge to the municipal sewer system, if available. Coordinate with the local municipality to ensure permit requirements can be met including analytical requirements.
   - Example: F and K-listed wastes should be sampled for the analytes listed under the appropriate waste code in 40 CFR 268.40.

   Composite samples (see 6.1.4 above) will be tested by the off-site laboratory for disposal analyses as recommended by the T&D Specialist.
5. Upon receipt of analytical results determine the waste codes of the material using the following methods:
   Determine if the waste is a RCRA hazardous waste - See 40 CFR part 260 Subpart C for toxicity characteristic wastes as determined by TCLP extractions and subsequent analysis and Subpart D for listed hazardous wastes as determined by historical facility operations, manufacturer labeling affixed to un-opened chemical reagents and drums, and/or analytical data.

If waste is non-hazardous, it is a non-regulated material and will not carry waste codes.

- Toxicity Characteristic Waste (D-listed wastes) – screen waste TCLP results against the criteria listed in Table 1 of 40 CFR 261.24. If the waste is hazardous by the toxicity characteristic, screen the sample TCLP and total analyte concentrations data for contaminants of concern against the Treatment Standards for Hazardous Wastes found in 40 CFR 268.40 and the UTS of 40 CFR 268.48, as applicable to identify any Land Disposal Restrictions.
- Listed F and K wastes – screen the analytical data against the treatment standards for the waste code.
- Document physical characteristics of the waste. Solid wastes that are > 50 % soil and wastes that are classified as debris have alternative LDR standards. This information will allow the T&D specialist to properly profile the waste.

6.2 Waste Disposal Options

1. Consult a KEMRON T&D specialist or a KEMRON T&D subcontractor to determine appropriate waste codes and UHCs, if applicable, as well identify the appropriate LDRs. State specific codes should also be evaluated.
2. Solicit bids (at least three bids) for T&D services. The KEMRON procurement procedures incorporate special Terms and Conditions for T&D services.

3. For EPA Work: Following receipt of proposals, the OSC reviews the bid package for pricing, time constraints, and treatment and/or disposal methods for bidding greater than $2,500.00.
4. For disposal events, check listed facilities and landfills for EPA compliance. See Section 4.2 CERCLA Off-Site Disposal Acceptability.

6.3 Waste Profiling

1. The goal is to record the description and characteristics of the waste for disposal purposes.
2. Obtain facility specific Waste Profile Form.
3. Complete as instructed on the form or forward to the T&D Specialist for completion. NEVER sign a waste profile for the generator unless the generator has issued a formal letter designating KEMRON personnel to sign in their place. Submit the completed profile to the client for review and signature. Submit the signed profile to the disposal facility for approval. Note that approval may take up to a week or more. Approval times are facility and/or agency specific. Sometimes a quick turn approval may be secured from the privately owned facility for additional fees. Sites in areas requiring State or Municipal waste approval in addition to facility approval are common. Plan in advance as approvals in these situations may not be speedy.
4. Following approval, transportation can be scheduled. If an approval letter is provided by the facility or government agency, it should be saved in the project files. Transportation should be provided by a vendor licensed and insured as appropriate for the waste being transported.
5. Ensure that the waste materials are packaged according to 49 CFR subpart B.

6.4 Manifesting – 40 CFR 262

1. For hazardous wastes, the Federal Form 8700-22 (see Attachment A) which is referred to as the Uniform Hazardous Waste Manifest (UHWM) must accompany waste loads. Non-hazardous wastes should be tracked by manifest or bill of lading.
2. See Uniform Hazardous Waste Manifest and Instructions - 40 CFR 262 Appendix
   Completely fill out the required information for sections 1 through 10 and sections A – H on the UHWM that correspond to generator, site and facility information. In box 1, use unique, sequential numbers per physical location.

   Determine if there is a reportable quantity (RQ) for a specific constituent in the waste – see Table 1 to Appendix, A 49 CFR 172.101. – convert to English system measurements (lbs).

   Section 11: If so, RQ is written first in the line items on the UHWM.

   Section 11: Determine the proper shipping name from DOT HAZMAT Table – 49 CFR 172.101, column 2, and record following the RQ, if it is required.

   Section 11: After the proper shipping name record the 2 major constituents of the waste in parenthesis, if n.o.s. was used in the proper shipping name. (n.o.s. – not otherwise specified).

   Section 11: Record the hazard class in number only – see 49 CFR 172.101, column 3.

   Section 11: Record the identification number (UN or NA) - see 49 CFR 172.101, column 4.

   Section 11: Determine the packing group of the hazard class listed – refer to 49 CFR part 173 sections 116 – 141. (packing group can be used to determine any special packing provisions for that listed waste – see 49 CFR Sections 172.102, 172.203 (m) (1-3), 172.505).

   Section 12: Input the number and type of containers in the respective sections. Two letter abbreviations for types of containers are listed in 40 CFR 262 Appendix.

Sections 13 & 14: Input the total quantity of waste and unit of waste. Single letter abbreviations for waste units are available in 40 CFR 262 Appendix.
Section I: Input the major waste codes for the waste of each line item - see 40 CFR Subpart C (261.20 – 261.33).

Section J: Input any additional descriptions for materials for line items listed in section 11 (this will include additional waste codes not listed in section I and profile approval numbers from the disposal facility).

Section K: input the ERG (Emergency Response Guidebook) codes for each line item listed in section 11.

Section 15: Make sure that emergency phone numbers are recorded. Our clients may request that a specific name and number be placed as the emergency contact for the shipment. In the case that a number is not provided by our client, record CHEMTREC @ (800) 424-9300 in Section 15 along with a KEMRON contract number. Other special handling information is also included in this section.

Section 16: After reading the generator certification, have the waste generator print, sign and date this section on the date that transportation occurs.

On the date of transportation make sure that the transporter fills out the relevant information that pertains to the transportation company's information (see sections 6-8 and C-F of the UHWM) and have the transporter representative print, sign and date either section 17 or 18, as applicable.

Review manifest to ensure proper compliance. Keep the bottom copy of the manifest and file with project.

6.5 Land Disposal Restrictions (LDRs) – Form Completion

1. Obtain an LDR form. Some disposal facilities may require the use of their own form.
2. See step 6.1 for information that must be included on the LDR form.
3. Follow facility specific instructions for LDR form completion.
4. See the KEMRON T&D Specialist for completion, if necessary.
5. The LDR form must accompany at least the first load of the waste stream to the landfill and is often stapled or clipped to the back of the manifest.

6.6 Generator Follow-up

1. After 30 days verify that the waste generator has received a signed waste manifest. Alternatively, KEMRON may receive the final generator manifest copies and will forward them to the generator during waste reporting.
2. If the manifests are not received within 30 days, KEMRON will contact the disposal facility to determine the status of waste. CODs should also be received during this timeframe. However, some facility permits do allow up to a year for waste to be treated and disposed after receipt. Requirements are facility specific.
3. After 45 days, if the signed manifest has not been received by the generator (the KEMRON client) from the disposal facility, the generator must submit an Exception Report to the EPA Regional Administrator of the region that the generator is located.

6.7 CERCLA Off-Site Reports (for EPA sites only)

- Upon receipt of the certificates of disposal (or destruction) (CODs), CERCLA Off-Site reports will be required to be submitted to the EPA.
- Notify and/or consult with the KEMRON T&D Specialist, if necessary.

6.8 Other State Off-Site Reports

- Check with State regulatory agent for any reporting requirements.
- Notify and/or consult with the KEMRON T&D Specialist, if necessary.

7 REFERENCES

KEMRON FSOP 1300: Hazscan Testing
Link to Code of Federal Regulation: (http://www.access.gpo.gov/nara/cfr/)

Appendix A: Request for Deviations

Deviation to FSOP-1100: WASTE IDENTIFICATION AND DISPOSAL

Description of Deviation
1.
2.
Need for Deviation
1.
2.
Corrective Action Taken
1.
2.

Approved by:

Name: Signature:
KEMRON Project Manager Date

Name: Signature:
KEMRON QA/QC Manager Effective Date

- OR -

Name: Signature:
Client Representative Effective Date

Appendix B: Example Uniform Hazardous Waste Manifest

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2050-0039

GENERATOR

UNIFORM HAZARDOUS WASTE MANIFEST | 1. Generator ID Number | 2. Page 1 of | 3. Emergency Response Phone | **4. Manifest Tracking Number**

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 No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	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

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Appendix C: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Technical Procedure: SOP-011
Revision: 01

STANDARD OPERATING PROCEDURE FOR OPERATIONS SECURITY (OPSEC) PLANS

KEMRON Environmental Services, Inc.
8521 Leesburg Pike, Suite 175, Vienna, VA 22182 (Vienna)
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318 (Atlanta)
2343-A State Route 821, Marietta, OH 45750 (Marietta)
108 Craddock Way, Suite 5, Poca, WV 25159 (Charleston)
3155 Black Hawk Drive, Building 379, Fort Sheridan, IL 60037 (Chicago)

Approved by:

Leland Meadows

Leland Meadows, Corporate QA/QC Manager — 08/30/2019 Date

John Dwyer, President — 08/30/2019 Date

VERSION CONTROL

Version	Changes	Affects Section	Effective Date
00	N/A		25 April 2014
01	Review for content, technology and methods, and quality control.	Entire Document	30 August 2019

Table of Contents

List of Appendices

1.0 PURPOSE

OPSEC is a systematic and proved process by which KEMRON Environmental Services, Inc. (KEMRON) and its supporting contractors can deny to potential adversaries information about capabilities and intentions by identifying, controlling, and protecting generally unclassified evidence of the planning and execution of sensitive KEMRON activities. The OPSEC process is most effective when fully integrated into planning and operational processes. The OPSEC process involves five steps: identification of critical information, analysis of threats, analysis of vulnerabilities, assessment of risk, and application of appropriate countermeasures.

2.0 SCOPE

This plan will provide information designed to show KEMRON project participants what information needs to be protected, what the threat is, what the potential vulnerabilities are, what to do with the risk, and what countermeasures can be applied to prevent information loss.

3.0 RESPONSIBILITIES

OPSEC Level II Coordinator Responsibilities

The KEMRON OPSEC Level II Coordinator will review and implement OPSEC requirements, draft site-specific OPSEC SOPs, coordinate the federal and local representatives, and provide awareness training and documentation of KEMRON Operational Security activities.

Project Manager Responsibilities

The KEMRON Project Manager ensures that any project specific deviations from this procedure will be provided to the staff.

Staff Responsibilities

The KEMRON staff follows procedures specified in this SOP unless written site-specific protocol is provided by the Project Manager and OPSEC Level II Coordinator.

4.0 DEFINITIONS

4.1 Critical Program Information

Critical program information (CPI) is information about intentions, capabilities, or activities that must be protected from loss to keep an adversary from gaining a significant military, economic, political, or technological advantage.

The process to identify critical information begins with an examination of the totality of the project to determine what exploitable but unclassified evidence of classified or sensitive activity is vulnerable to adversary acquisition in light of the known capabilities of potential adversaries. Such evidence is usually derived from openly available data. Certain “indicators” may be pieced together or interpreted to discern critical information. Indicators commonly stem from the routine administrative, physical, or technical actions taken to prepare for or execute the project.

4.2 Indicators

Detectable actions that can be heard, observed, or imaged. Obtained by an adversary, they could result in adversary knowledge or actions harmful to friendly intentions. They include such things as: personnel or material actions and movements that can be observed; public release conversations or documents; and habitual procedures when conducting a given type of operation or test. Detectable indicators that convey or infer critical information must be identified and protected if determined vulnerable.

4.3 Threat Analysis

Threat analysis is an examination of an adversary's technical and operational capabilities, motivation, and intentions to detect and exploit security vulnerabilities.

When considering threat, one must look at the CPI and the project in general and look at that information as an adversary would. A determination will need to be made as to who would want this technology, who would want to discredit this project, who would like to cause harm to the project participants, or who would like to do other nefarious activities directed at the project. Once the adversary(ies) is established, an analysis also needs to be done on capabilities, access, determination, etc.

4.4 Analysis of Vulnerabilities

Determining vulnerabilities involves a systematic analysis of how a project is actually conducted by the primary and supporting project team members. The project must be viewed as an adversary might view it. Actions and things that can be observed, or other data that can be interpreted or pieced together to derive critical information, must be identified. These potential vulnerabilities must be matched with specific threats.

Once it is determined what an adversary needs to know and where that information is available, it is necessary to determine if it is possible for the adversary to acquire and exploit the information in time to capitalize on it. If so, vulnerability exists.

4.5 Risk Assessment

Risk assessment is essentially the process of balancing vulnerability against the threat, then deciding if the resultant risk warrants applications of countermeasures. The determination of risk is a demanding step in the OPSEC Process. It requires a degree of subjective decision making based on the best estimate of an adversary's intentions and capabilities.

Included in the assessment of an adversary's capability is not only his ability to collect the information but also his capability to process and exploit (evaluate, analyze, interpret) in time to make use of the information. In order to complete the risk assessment, it is necessary to combine this information (i.e., the possibility of the adversary exploiting the information, with the resultant impact on the project). This process should result in a list of recommendations along with an estimate of the reduced impact upon the operation as achieved through their application. The decision maker can then weigh the cost of recommended OPSEC countermeasures in terms of resources and operational effectiveness against the impact of the loss of critical program information.

4.6 Application of Appropriate Countermeasures

A countermeasure is anything that effectively negates an adversary's ability to exploit vulnerabilities. The most effective countermeasures are simple, straightforward, procedural adjustments that effectively eliminate or minimize the generation of indicators. Following a cost-benefit analysis, countermeasures are implemented in priority order to protect vulnerabilities having the most impact on the project, as determined by the appropriate decision maker.

5.0 OPSEC PROCESS

The OPSEC Process addresses identification of critical information, recognition of indicators, determination of potential threats and vulnerabilities, and the risk and impact analysis of the adversary

5.1 Critical Information

Identify what information is critical to your task or operation that must be protected.

- Operational information – Dates, times, locations of operations
- Personnel – Strengthens, weaknesses, specialty skills
- Current intelligence assessments
- Technology – Information, equipment
- U.S. Critical infrastructure

5.2 Indicators

Recognize direct and indirect actions that expose your critical information.

- Increase (or decrease) in activity
- Sudden changes in procedures
- Staging of cargo or vehicles
- Presence of specialized equipment
- Increased security measures

5.3 Threat and Vulnerabilities

Determine potential threats and vulnerabilities within your operation.

- Threat Perception/ Awareness
- Policy Enforcement
- Training/Awareness
- Communications
- Recycling/Trash/Mail
- Internet/Email
- Stereotyped Operations
- Discussion in unsecured areas

- Technology
- Data Aggregation

5.4 Risk and Impact

Analyze the probability that your critical information will be obtained and potential outcome of the release of this information.

- Lives
- Time
- Efficiency
- Effectiveness
- $$$$

6.0 GENERAL OPSEC PROCEDURES

KEMRON employees will implement the following minimum OPSEC procedures prior to obtaining a comprehensive listing of critical information, threat analysis and countermeasures from the corresponding government security officer.

- Introduction of personnel electronic devices into government spaces, laptops, tablet PCs, cellular phones, cameras, recording devices, and data recording/storage devices is STRICTLY controlled and forbidden in most cases. KEMRON issued equipment required for the performance of work must be approved by the government Security Officer. Photography and recording is not allowed except for official use and by permit only. (Unless otherwise stipulated in the contract, contact the Installation Security Officer for approval.) Photographs will be reviewed by Security to ensure sensitive and/or classified information is not revealed.
- KEMRON personnel shall not discuss government operations in public or over unprotected or unencrypted communications. Official Business, controlled unclassified information may only be transmitted as directed in the SOW/PWS.
- KEMRON personnel shall not post to company websites, publications, newsletters or other media any images, data or information that reveal sensitive government operations, personnel, equipment, and/or classified or controlled unclassified information. When in doubt, KEMRON press releases should be coordinated through the Contracting Officer Representative (COR) or Technical Point of Contact, as applicable.
- Because observation of events, operations, physical changes, etc. may reveal National Security information, specific restrictions are needed to preclude unintentional release of this information to unauthorized parties. Therefore, KEMRON personnel shall not disclose to unauthorized third parties, post to unofficial sites (including Social Networking sites) any images, data or information, or observed events that reveal sensitive government operations, personnel, equipment, including, but not limited to:
    - o Tactics, techniques and procedures, production or work schedules, any visible or concealed modifications, upgrades, additions to vessels, aircraft, or weapons or equipment; increases, change, or decreases in work/deployment frequency or

government personnel, vehicle, vessel or aircraft movements; specialized equipment orders, deliveries, shipments, etc., Unauthorized disclosures and attempts to solicit this type of information by unauthorized third parties or others not affiliated with this contract shall be reported to the installation Security Office, contract point of contact, and/or the Defense Security Service. Non-Disclosure requirements remain in effect during the duration of this contract and indefinitely thereafter.

- Government issued badges, identification shall be removed and/or concealed from plain sight when off station and shall not be left in vehicles or unprotected. Badges and passes may not be duplicated or copied or loaned to others. Lost or stolen identification badges, vehicle passes etc. will be immediately reported to the installation Security Office.

- Practice OPSEC and implement countermeasures to protect CI and other sensitive unclassified information and execution of military operations performed or supported by the contractor in support of the mission. Protection of CI will include the adherence to and execution of countermeasures.

7.0 TRAINING

- KEMRON employees are required to complete AT Level I awareness training within 60 days of assignment.
- KEMRON employees are required to complete OPSEC Level I awareness training within 30 days of assignment and annually thereafter.
- KEMRON employees are required to participate in facility iWATCH programs and receive site-specific awareness training.

Appendix 1: SOP Signature Page

The following persons have read and understand this SOP:

Signature:	Date:

Signature:	Date:

Signature:	Date: