Main Installation Vapor Intrusion Soil Gas Sampling QAPP, Revision 1

Environmental Restoration Support at Former Defense Depot Memphis, Tennessee

Contract W91278-16-D-0061, Task Order 0002

September 2018

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Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
BEC	BRAC Environmental Coordinator
BFB	4-bromofluorobenzene
bgs	below ground surface
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
CA	corrective action
CCV	continuing calibration verification
cDCE	cis-1,2-dichloroethene
CF	chloroform
CFR	Code of Federal Regulations
Chemtech	Chemtech Consulting Group
CoC	chain-of-custody
COR	Contracting Officer's Representative
COPC	constituents of potential concern
CT	carbon tetrachloride
CVOC	chlorinated volatile organic compound
DDMT	Defense Depot Memphis, Tennessee
DoD	Department of Defense
DQCR	daily quality control report
DQO	data quality objective
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
ft	feet/foot
ft^2	square feet
FTL	Field Team Leader
GC/MS	gas chromatography/mass spectrometry
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDR	HDR Environmental, Operations and Construction, Inc.
He	Helium
HHRA	human health risk assessment
IAQ	Intermediate Aquifer
ICAL	initial calibration
ICV	initial calibration verification
IS	internal standard
J&E	Johnson and Ettinger
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LIMS	Laboratory Information Management System
MAQ	Memphis Aquifer
MDL	method detection limit
MI	Main Installation
MIP	membrane interface probe
MLGW	Memphis Light Gas & Water

MS	matrix spike
MSD	matrix spike duplicate
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCP	pentachlorophenol
PM	Project Manager
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RG	remediation goal
RI	Remedial Investigation
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RRT	relative retention time
RT	retention time
SOP	Standard Operating Procedure
SOW	Statement of Work
SVOC	semi-volatile organic compound
TCE	trichloroethene
TDEC	Tennessee Department of Environment & Conservation
TIC	tentatively identified compound
TM	Technical Manager
UFP-QAPP	Uniform Federal Policy – Quality Assurance Project Plan
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VI	vapor intrusion
VISL	Vapor Intrusion Screening Level Calculator
VOC	volatile organic compound
$\mu g/m^3$	micrograms per cubic meter

QAPP Worksheet #1 & 2: Title and Approval Page

Project Name	Environmental Restoration Support, Former Defense Depot Memphis, Tennessee (DDMT)
Site Location	Memphis, Shelby County, Tennessee
Contract Number	W91278-16-D-0061
Task Order	0002

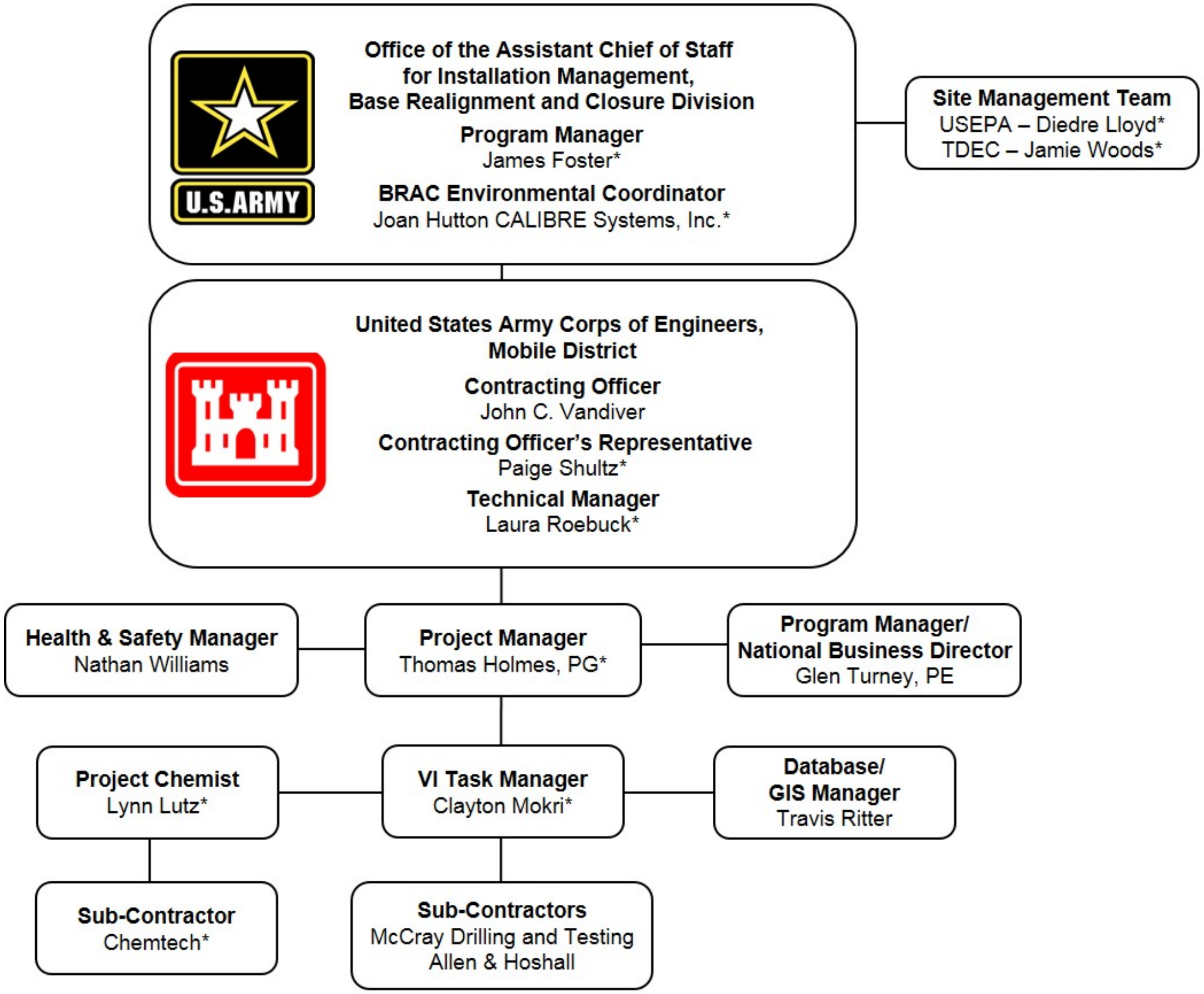
Approvals:

Role	Title	Organization	Name	Signature	Date
Lead Organization	Program Manager	United States Army, Assistant Chief of Staff for Installation Management, Base Realignment and Closure (BRAC) Division	James Foster		
Lead Organization	BRAC Environmental Coordinator (BEC)	CALIBRE Systems, Inc.	Joan Hutton		
Stakeholder Agency	Contracting Officer's Representative (COR)	United States Army Corps of Engineers (USACE), Mobile District	Paige Shultz		
Stakeholder Agency	Technical Manager (TM)	USACE - Mobile	Laura Roebuck		
Federal Regulatory Agency	Remedial Project Manager (RPM)	United States Environmental Protection Agency (USEPA), Region 4	Diedre Lloyd		
State Regulatory Agency	RPM	Tennessee Department of Environment & Conservation (TDEC)	Jamie Woods		
Plan Preparation and Implementation	Project Manager (PM)	HDR Environmental, Operations and Construction, Inc. (HDR)	Tom Holmes		
Plan Preparation and Implementation	Project Chemist	HDR	Lynn Lutz		
Plan Preparation and Implementation	Vapor Intrusion Task Manager	HDR	Clayton Mokri		

Previous Plans and Reports Relevant to Project:

Title	Date	Author
Memphis Depot Main Installation Record of Decision Memphis Depot Caretaker, Revision 2.	February 2001	CH2M HILL
Third Five-Year Review, Defense Depot Memphis, Tennessee, TN42100220570, Department of the Army, Revision 1.	November 2012	HDR
Main Installation Source Areas Investigation, Defense Depot Memphis, Tennessee, Revision 0.	February 2009	e²M
Annual Long-Term Monitoring Report-2016, Defense Depot Memphis, Tennessee, TN42100220570, Revision 0.	April 2017	HDR
Vapor Intrusion Screening Level Assessment Memorandum, Main Installation, Defense Depot Memphis, Tennessee.	August 2017	HDR

QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution



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QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet

ORGANIZATION: HDR

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Tom Holmes	PM	MS Geophysics 40 years	Registered Professional Geologist, Georgia, United States	
Lynn Lutz	Project Chemist	BA Chemistry 31 years	Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER), 40-hour; First Aid/CPR certification	
Clayton Mokri	Field Team Leader/ Vapor Intrusion Task Manager	BS Environmental Science 15 years	OSHA HAZWOPER, 40-hour	
Travis Ritter	Project DB/ GIS Manager	MS Environmental Science 15 years	OSHA HAZWOPER, 40-hour; OSHA 510 Construction Industry Health and Safety	

ORGANIZATION: Chemtech

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Loreana Davi	Laboratory PM	BA International Business and Management, one year experience	None	

**Signatures indicate personnel have read and agree to implement this Quality Assurance Project Plan (QAPP) as written.*

QAPP Worksheet #6: Communication Pathways

Communication Driver	Responsible Entity	Name	Contact Information	Procedure (timing, pathway, etc.)
Contract Execution/ Document Review	USACE TM	Laura Roebuck	251-690-3480	Email/verbal communication with HDR PM. Quality assurance (QA) supervision for contract activities
Regulatory Interface	BEC	Joan Hutton	770-317-4323	Communicate with USEPA/TDEC as needed and submit project documents for regulatory review.
Technical Direction	BEC	Joan Hutton	770-317-4323	Review project documents and represent the BRAC PM.
Manage Task Order activities	HDR PM	Tom Holmes	404-295-3279	Submit task order deliverables; notify USACE TM and BEC of field-related problems by phone or email by close of business the day of the event if possible and no later than noon Central Time the following day.
Manage VI Assessment	VI Task Manager	Clayton Mokri	916-817-4762	Supervise VI related activities. Communicate with HDR PM and Project Chemist.
Field Team Leader (FTL)	HDR Environmental Scientist	Clayton Mokri	916-817-4762	Supervise HDR field activities. Communicate with HDR PM and Project Chemist. Provide daily quality control reports (DQCRs) and notification of any work problems.
WP changes in the field	HDR Project Chemist	Lynn Lutz	303-754-4266	Manage and implement in-field QAPP changes. Notify VI Task Manager and PM of QAPP changes.
Reporting Lab Data Quality Issues	Laboratory PM	Chemtech	740-373-4071 805-526-7161 *2089	Notify the HDR Project Chemist regarding laboratory data quality issues including corrective actions (CAs) and data usability.
Field CAs	HDR FTL	Clayton Mokri	916-817-4762	Issue CAs in writing to the HDR PM for review and submittal to USACE TM and BEC.
Analytical CAs	HDR Project Chemist	Lynn Lutz	303-754-4266	Coordinate laboratory analyses, review deliverables, determine the need for CA on analytical issues and notify the HDR PM. Provide the data validation report and release data to the HDR PM.
Stop Work Authority	All Site Workers	-	-	All site workers can issue a stop work order for issues that present immediate and imminent danger. The HDR PM and Health and Safety Officer will be consulted verbally after the Stop Work and then with a follow-up report per the Site Safety and Health Plan.
Work Plan Changes	HDR Project Chemist / HDR PM	Lynn Lutz/ Tom Holmes	303-754-4266 404-395-3279	Manage and implement QAPP changes. Provide revisions to all QAPP recipients via email and hard copy, as applicable.

QAPP Worksheet #9: Project Planning Session Summary

No planning sessions were held, based on the status of environmental restoration at DDMT. The implemented remedies have either met cleanup standards or are making progress toward the standards, except for groundwater contamination on the Main Installation (MI). Enhanced bioremediation was implemented on the MI in 2006 to 2009 and 2012 to 2014. While concentrations of groundwater contaminants were reduced, the reductions were not sufficient to meet the cleanup standards. The presence of volatile organic compounds (VOCs) in soil and groundwater at the MI presents a potential VI risk to indoor air.

The requirements of the MI VI Study were established in the Statement of Work (SOW) for Contract No. W91278-16-D-0061 Task Order Number 0002 (USACE Mobile, 2016). The SOW requires the VI study be prepared in accordance with the DoD Vapor Intrusion Handbook (Tri-Services Workgroup, 2009). Other guidance documents to be considered are:

- EPA 9200.2-154, OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (USEPA, 2015)
- Vapor Intrusion Screening Level Calculator (USEPA, 2016a; online version: https://epa-visl.ornl.gov/cgi-bin/visl_search)
- TDEC Vapor Intrusion Process and Flowchart (DRAFT FINAL) – 08/25/14

This QAPP describes methods and procedures to evaluate and characterize the VI risk at the MI based on collection and analysis of soil gas samples and other site-specific data.

QAPP Worksheet #10: Conceptual Site Model

This conceptual site model presents a site history, documents lithology and hydrogeology at the DDMT, contaminant migration pathways, and potential VI risks that site contaminants may present to human health.

Background Information

DDMT is located in southeastern Memphis, Tennessee and consists of approximately 632 acres at the MI and Dunn Field. The MI contains approximately 567 acres with open storage areas, warehouses, former military family housing, and outdoor recreational areas. Dunn Field, which is located across Dunn Avenue from the northwest section of the MI, contains approximately 65 acres with former mineral storage and waste disposal areas.

From 1942 until closure in 1997, DDMT received, warehoused, and distributed supplies to U.S. military services and civilian agencies. The supplies included hazardous substances; textile products; food products; electronic equipment; construction materials; and industrial, medical, and general supplies.

Topography

DDMT is located in the Gulf Coastal Plain approximately three miles east of the bluffs at the edge of the Mississippi Alluvial Plain. Ground surface at the MI is nearly level with elevations generally from 290 to 305 feet (ft); the highest point is at 312 ft along Dunn Avenue near the northwest MI and the lowest point is at 267 ft below the earthen dam for Lake Danielson on the golf course in the southeast MI.

There are no naturally flowing streams or creeks on DDMT. Drainage occurs by overland flow via swales, ditches, concrete-lined channels, and a storm drainage system, which directs storm water into a series of storm drains for transport to discharge points around the perimeter. DDMT is generally level with or above surrounding terrain, so it receives little runoff from adjacent areas.

Geology and Hydrogeology

The geologic units of interest at DDMT are (from youngest to oldest): loess, including surface soil; fluvial deposits; Jackson Formation/Upper Claiborne Group (Jackson/Upper Claiborne); and Memphis Sand.

The loess consists of wind-blown and deposited brown to reddish-brown, low-plasticity clayey silt to silty clay. The loess deposits are about 20 to 30 ft thick and are continuous throughout the DDMT.

The fluvial (terrace) deposits at DDMT consist of two general layers. The upper layer is silty, sandy clay to clayey sand and ranges from about 0 to 30 ft thick. The lower layer is composed of interlayered sand, sandy gravel, and gravelly sand, and ranges from 30 to 100 ft thick. The uppermost aquifer is the unconfined Fluvial Aquifer, consisting of saturated sands and gravelly sands in the lower portion of the deposits. The saturated thickness ranges from 0 ft (dry) to approximately 70 ft, and is controlled by the uppermost clay configuration in the Upper Claiborne.

The groundwater in the Fluvial Aquifer is not a drinking water source for area residents; however, the current Tennessee groundwater classification at DDMT is General Use (TDEC Chapter 1200-04-03).

The Jackson/Upper Claiborne forms the upper confining unit for the Memphis Aquifer (MAQ) on a regional basis and separates the Fluvial Aquifer from the MAQ at DDMT. The Upper Claiborne Group includes the Cockfield and Cook Formations, and the individual formations of the Jackson/Upper Claiborne consist of clays, silts, and sands deposited in lenses or individual beds that are not areally extensive. The Jackson Formation is reported to be absent in the area of DDMT. The Cockfield Formation consists of inter-fingering fine sand, silt, clay, and local lenses of lignite. The Cook Mountain Formation consists primarily of clay with varying amounts of fine sand and is reported to be the most persistent clay layer in the Jackson/Upper Claiborne confining unit. The Intermediate Aquifer (IAQ) is locally developed in the Upper Claiborne sands.

The Memphis Sand primarily consists of thick bedded, white to brown or gray, very fine grained to gravelly, partly argillaceous and micaceous sand. The Memphis Sand ranges from 500 to 890 ft in thickness, and begins at a depth below ground surface (bgs) of approximately 120 to 300 ft. The MAQ is a regional deep, confined aquifer and is the primary source of water for the City of Memphis. Memphis Light Gas & Water (MLGW) extracts groundwater from several well fields in the Memphis area, which has created a regional cone of depression in the potentiometric surface, with steeper local cones of depression at each well field. The Allen Well Field is the closest well field and is located approximately 1 mile west of DDMT.

Land Use Considerations

All 567 acres on the MI have been transferred through public benefit and economic development conveyances. Land use controls implemented for the MI prevent residential use, drilling of groundwater wells and production or consumptive use of groundwater except in Functional Unit 6 (Administrative and Residential Areas) which is available for unrestricted use (CH2M Hill, 2004). The MI is primarily used for warehousing in the Memphis Depot Industrial Park and for operations at Barnhart Crane and Rigging.

Site Contaminants

Types of past activities that could result in the presence of hazardous materials in environmental media at the MI include repackaging hazardous substances for storage or shipment, pesticide application, painting and sandblasting, vehicle maintenance, and hazardous material handling/storage. Other historical activities in open and enclosed storage areas included storing transformers with polychlorinated biphenyls (PCBs), storing and using pesticides/herbicides, and treating wood products with pentachlorophenol (PCP). These industrial activities resulted in the presence of metals, pesticides, and other less frequently detected chemicals in surface soil, surface water, and sediment, and chlorinated volatile organic compounds (CVOCs) in groundwater at the MI.

Known or suspected contaminants or classes of contaminants

The MI Remedial Investigation (RI) (CH2MHILL, 2000) only found soil contamination in near-surface soils; contaminants consisted primarily of metals, PCBs, semi-volatile organic compounds (SVOCs), and a pesticide, dieldrin. Groundwater contaminants were limited to CVOCs primarily tetrachloroethene (PCE) and trichloroethene (TCE); carbon tetrachloride (CT) and chloroform (CF) were detected in the southeast MI, in addition to PCE and TCE. CVOCs were not detected at high concentrations in soil samples on the MI.

Two additional CVOCs (cis-1,2-dichloroethene and vinyl chloride) were identified as groundwater contaminants following field tests of enhanced bioremediation and its implementation as the selected remedy in 2006. These CVOCs result from reductive dechlorination of PCE and TCE in biodegradation.

Additional investigation was performed in 2008 to identify potential source areas for the observed groundwater plumes on the MI (e2M, 2009). The field investigation was conducted with sample grids overlaying the upgradient areas of the plumes. The magnitude and extent of CVOCs in soil were characterized by a membrane interface probe (MIP) survey and confirmation soil samples. The investigation included 334 MIP locations and 70 soil samples analyzed for VOCs. The soil samples were collected at locations with the full range of MIP readings but were biased to collect more samples at locations with high MIP readings. The MIP survey and soil sample locations are shown on Figure 1.

The soil sample results were compared to the soil remediation goals (RGs) established for Dunn Field, which has similar proposed land use and potential for impacts to groundwater. Only 5 of the 70 soil samples had CVOC concentrations above an RG, and 3 of those samples only slightly exceeded an RG for a single CVOC. One of the two remaining samples (TTA2-W-B2-SB-17) contained methylene chloride at 17 times the RG, but methylene chloride is not a common groundwater contaminant at the MI. The other sample (TTA2-W-B1-SB-27) exceeded the RG for carbon tetrachloride by a factor of 100, but the sample collected 2 feet deeper in the same boring (TTA2-WB1-SB-29) did not exceed the RG for any CVOC. The samples and the CVOCs at concentrations above an RG are shown on Table 1. The limited extent of soil with CVOC concentrations above the RGs was not considered to warrant remedial action of soil.

Table 1. Soil Samples Exceeding Remediation Goals

Sample	CVOC	RG (mg/kg)	Concentration (mg/kg)
TTA2-W-B1-SB-27	carbon tetrachloride	0.2150	**22.9**
	chloroform	0.9170	**1.07**
TTA2-W-B2-SB-17	methylene chloride	0.0305	**0.508**
TTA2-W-A2 26-27	methylene chloride	0.0305	**0.0389**
WCP-B3-SB-8	tetrachloroethene	0.1806	**0.199**
WCP-A4-7.5-9.5	tetrachloroethene	0.1806	**0.181**

Primary release mechanism

Release of contaminants to soil on the MI was associated with site operations and maintenance, and the release of CVOCs to groundwater is believed to be due to multiple, small spills and leaks.

Secondary contaminant migration

Secondary contaminant migration was limited to CVOCs on the MI. Following release through spills or waste disposal, contaminants were held in the loess because of limited permeability and adsorption to clay and organic matter in the fine-grained soils. CVOCs migrated into the fluvial soils beneath the loess with infiltration of rainwater and then to groundwater.

Potential Receptors and Exposure Pathways

A Baseline Risk Assessment (BRA) conducted during the MI RI (CH2MHILL, 2000) included a human health risk assessment (HHRA) and a screening level ecological risk assessment at the MI. Health risks to industrial workers were within acceptable levels for future industrial use of the property, except for lead in a limited surface soil area. However, it was concluded that soil contaminants of concern were present at levels that do not allow for unrestricted use and unlimited exposure.

The BRA concluded that contaminated groundwater in the Fluvial Aquifer poses an unacceptable risk through the ingestion pathway; however, land use controls prevent drilling of groundwater wells and production or consumptive use of groundwater on the MI, except in Functional Unit 6 as noted previously.

In July 2017, HDR used the October 2016 groundwater analytical results and the EPA Vapor Intrusion Screening Level Calculator (VISL) to evaluate whether VOCs are present in groundwater at the MI that may pose an unacceptable human health risk under commercial exposure scenarios. The VISL model calculated a cancer risk greater than $1x10^{-6}$ and non-cancer risk greater than 1.0. To further evaluate the VI risk, the October 2016 groundwater analytical results, depth to groundwater, and lithological data was input into the EPA's Johnson and Ettinger (J&E) VI model. Although the estimated risk from the J&E modeling was an order of magnitude less that from VISL, cancer risk greater than $1x10^{-6}$ and non-cancer risk greater than 1.0 was identified. Therefore, VOC concentrations in groundwater at the MI may present a human health risk via VI (HDR, 2017b).

QAPP Worksheet #11: Project Data Quality Objectives

Data Quality Objectives (DQOs) for this soil gas sampling effort were established using the seven step process developed by the EPA in the *Guidance on Systematic Planning Using the Data Quality Objective Process* (USEPA, 2006). The purpose of these DQOs are to identify the project objective and establish performance and acceptance criteria, which serves as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of the study (USEPA, 2006).

Step 1: State the Problem

As noted in Worksheet #9, the MI VI Study is being performed in accordance with the DoD VI guidance, which provides a 5-step approach for VI investigations.

DoD Step 1 requires the potential for VI to be evaluated in order to determine if a potential human exposure pathway exists at the site. The contaminants in groundwater at the MI are specific CVOCs, which consist of PCE, TCE, cis-1,2-dichloroethene (cDCE), vinyl chloride (VC), CT, and CF. The six CVOCs are listed as being sufficiently volatile and toxic to be considered for potential VI risk in Appendix A of the DoD VI guidance, which is taken from USEPA guidance (USEPA530-D-02-004). The CVOCs are present in groundwater at concentrations up to 300 micrograms per liter, and have been detected at low levels in shallow soils. The groundwater plumes, and potentially soil contamination, are present beneath commercial/industrial buildings at the MI resulting in a potential VI risk to current and future building occupants.

DoD Step 2 requires an evaluation to determine whether exposure to the vapors poses an immediate risk to building inhabitants – i.e., acute health risks or risk of explosion. Past investigations have demonstrated CVOC concentrations in groundwater and soil at the MI are relatively low and do not indicate potential for ‘free product’ in soil or groundwater. A previous VI study in the Off Depot area at DDMT, where CVOC concentrations in groundwater were an order of magnitude higher than on the MI, found that CVOC concentrations in shallow soil gas were below applicable residential screening levels. There have been no reports of suspected vapor intrusion from the businesses operating at the Memphis Depot Industrial Park. Based on the available information, no immediate risk to building occupants from VI is suspected but further investigation is planned as described in this QAPP.

In order to address a comment from USEPA, property owners on the Main Installation were sent an email on 14 August 2018 with an attached VI fact sheet and asked if employees or tenants at DDMT had reported concerns about VI. Three of the four owners have replied and each stated that no reports of VI have been received. Additional information on contacts with the owners will be provided in the soil gas sampling report.

DoD Step 3 requires a screening level VI human health assessment of volatile site contaminants based on comparison of soil-gas or groundwater data to conservative risk-based screening values. The assessment is described in the *Vapor Intrusion Screening Level Assessment Memorandum* (HDR, 2017b). As an initial step, HDR prepared a comprehensive VI map for the MI (Figure 2) to show the locations of the CVOC plumes, CVOC concentrations at individual wells, groundwater elevation contours, and the locations of existing buildings. The groundwater elevations and analytical results are from the October 2016 LTM event (HDR, 2017a).

The primary CVOCs detected on the MI were evaluated to develop the list of constituents of potential concern (COPCs), and the VISL calculator was used to determine the conservative risk-based screening levels shown in Table 2. One of the primary CVOCs for the MI, cDCE, was not included as a COPC because the toxicity data used to calculate VI screening levels are not established (USEPA, 2017b). cDCE will be included as an analyte in soil gas sample analyses; the screening value of 120,000 µg/m^3 calculated by USEPA Region 4 risk assessors will be used for comparison.

Table 2. Groundwater COPCs and Screening Levels

COPC	Screening Level (µg/L)
Carbon Tetrachloride (CT)	1.8
Chloroform (CF)	3.6
Tetrachloroethene (PCE)	65
Trichloroethene (TCE)	7.4
Vinyl Chloride (VC)	2.5

As illustrated on Figure 2, COPC concentrations in groundwater exceed the screening levels and are present beneath occupied commercial buildings in several areas.

In addition to using the VISL calculator to determine the screening levels, CVOC concentrations at three wells (DR2-1, MW-100B and PMW21-04) were used to estimate the cancer and non-cancer risk from VI of COPCs with both the VISL calculator and the J&E model. The VISL calculator incorporated commercial exposure assumptions and default risk factors, while the J&E model incorporated more site-specific data. The selected wells had the highest concentrations for PCE, TCE and VC reported in the October 2016 LTM event. The estimated total VI risk combined for the five COPCs at each well is shown on Table 3.

Table 3. VI Risk Results

Well	Cancer Risk		Non-Cancer Risk	
	VISL	*J&E*	*VISL*	*J&E*
DR2-1	**2.4×10^{-5}**	**3.5×10^{-6}**	**1.2163**	0.162
MW-100B	**4.2×10^{-5}**	**8.1×10^{-6}**	0.2812	0.0531
PMW21-04	**2.2×10^{-5}**	**2.6×10^{-6}**	**6.8053**	0.971

The VISL calculator identified a combined, cumulative cancer risk greater than 1×10^{-6} at all three wells, and a non-cancer risk greater than 1.0 at two wells. The J&E model identified a combined, cumulative cancer risk greater than 1×10^{-6} at all three wells, but did not identify a non-cancer risk greater than 1.0 at any of these wells. The cancer and non-cancer risks calculated by VISL are five to ten times greater than the risks calculated with the J&E model. However, both methods identified risks greater than the target risk of 1×10^{-6} for cancer (USEPA, 2015); therefore, COPCs in groundwater on the MI may present an unacceptable human health risk from VI and warrant further investigation.

DoD Step 4 requires a site-specific VI pathway evaluation including collection of near-slab soil gas, sub-slab soil gas and/or indoor air samples. The analytical results are incorporated in a HHRA to determine whether no further action is necessary or mitigation/remediation is warranted. Step 4 is being conducted in two sub-steps. Step 4A consists of a soil gas sampling and evaluation through a VI HHRA. Based on the results of the evaluation, indoor air samples will be collected and incorporated in the VI HHRA in Step 4B. This QAPP describes the site-specific approach for conducting Step 4A at the MI.

DoD Step 5 requires evaluation of mitigation/remediation options. It is not included in this work plan, but will be performed upon completion of sampling activities for the site-specific VI pathway evaluation.

Step 2: Identify the Goal of the Study

The goal of this investigation is to collect representative soil gas samples for laboratory analysis, soil samples for geotechnical testing, and input the collected data into the VISL and J&E models to calculate the estimated human health risk from VI on the MI.

Step 3: Identify Information Inputs

Soil gas samples will be collected from temporary soil borings and sub-slab sample ports and analyzed at a United States Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) laboratory for VOCs by Method TO-15. Thickness of the concrete slab will be measured at each sub-slab sample location. The soil gas samples will be collected at locations considered most likely to contain VOCs in soil and/or groundwater at concentrations that may present a VI human health risk (see Worksheet #17). Sample locations will also be adjacent to occupied buildings to evaluate potential impacts to site workers or adjacent to the MI perimeter to evaluate potential impacts to off-site residents.

Soil samples will be collected from three shallow soil borings adjacent to soil gas samples and analyzed to determine geotechnical soil parameters including grain size, permeability, dry bulk density, porosity and water-filled porosity. Additional site-specific information for adjacent structures will include enclosed floor space thickness, length, and width; enclosed height; and indoor air exchange rate.

Step 4: Define the Boundaries of the Study

The following boundaries are presented to identify the target population and constrain the extent of this soil gas investigation.

- Only one soil gas sampling event will be performed; and
- Soil gas samples will be collected on the MI adjacent or beneath buildings and from areas most likely to present a VI risk.

Step 5: Develop the Analytic Approach

The following analytical data will be obtained:

- Sub-slab and soil gas samples will be analyzed for VOCs, including PCE, TCE, CT, CF, and VC, by EPA Method TO-15; and

- Soil samples will be analyzed for grain size, permeability, dry bulk density, porosity and water-filled porosity and the soil lithology will be logged in accordance with the Unified Soil Classification System (USCS).

TO-15 laboratory analytical results, and commercial exposure assumptions, will be input into VISL to determine whether VOCs are present in shallow soil gas greater than $1\text{x}10^{-6}$ cancer risk or 1.0 non-cancer risk. If VISL identifies an unacceptable risk (greater than $1\text{x}10^{-6}$ or 1.0), the health risk will be further evaluated with the J&E model incorporating site-specific parameters. The potential for VI risk will be evaluated based on current and reasonably expected future conditions including use of residential-use based screening criteria.

Step 6: Specify Performance or Acceptance Criteria

Soil gas samples outside buildings will be collected at a depth of 5 ft bgs to obtain VOC concentrations nearest the building foundation while reducing the potential for short circuiting of ambient air into the soil gas sample. A shut-in test and helium (He) leak test will be performed at each soil gas sample location to identify leaks and reduce the potential for ambient air dilution in the samples.

A Tennessee-registered land surveyor will establish horizontal and vertical control for all sample locations. Vertical control will be established to 0.01 ft and will be based on the North American Vertical Datum of 1988. Horizontal control will be established to 0.1 ft and will be based on the Tennessee State Plane Coordinate System.

Sample borings will be sealed with neat cement grout or other methods in accordance with state and federal regulations.

The soil gas samples will be shipped under chain of custody control to an analytical laboratory which holds current DoD ELAP certification. The soil gas sampling, laboratory analysis, and data validation will be conducted in accordance with this work plan and the 2017 UFP-QAPP (HDR, 2017c).

Step 7: Develop the Plan for Obtaining Data

The specific tasks to be performed under this project QAPP are soil gas sampling for laboratory analysis of VOCs and soil sampling for determination of geotechnical parameters that influence vapor intrusion.

The project tasks and schedule are listed on Worksheet #14/16, and sampling design and rationale are described further on Worksheet #17.

QAPP Worksheet #12: Measurement Performance Criteria

Matrix: Air (soil gas)
Analytical Group or Method: VOCs
Concentration Level: Low

Data Quality Indicators	QC Sample and / or Activity Used to Assess Measurement Performance	Measurement Performance Criteria
Precision-overall	Field duplicate relative percent differences (RPDs)	<25% RPD
Precision-lab	Laboratory control sample (LCS)/ laboratory controls sample duplicate (LCSD) RPDs	<25% RPD
Accuracy/bias	Surrogate spike recoveries	70-130% recovery
Accuracy/bias	LCS/LCSD recoveries	Quality Systems Manual v.5 App. C Table 43 control limits
Accuracy/bias-contamination	Method blanks	No analyte detected at ≥1/2 reporting limit (RL) or > 10% sample concentration or regulatory limit

QAPP Worksheet #13: Secondary Data Uses and Limitations

Source	Data Type	Data Uses for Current Project
National Weather Service http://w2.weather.gov/climate/index.php?wfo=meg	Meteorological - Historical monthly rainfall, barometric pressure, and long-term averages	Document rainfall and barometric pressure during active soil gas investigation
CH2M Hill. *Memphis Depot Main Installation Land Use Control Implementation Plan, Revision 1*. February 2004.	Documentation of land use controls	Identification of land use controls.
HDR. *Third Five Year Review, Defense Depot Memphis Tennessee, Revision 1*. November 2012.	Latest approved Five-Year Review	Background information
e²M, *Main Installation Source Area Investigation, Revision 0*. February, 2009.	Site assessment and soil sample results.	Background information and selection of sample locations.
HDR, *Annual Long-Term Monitoring Report-2016, Defense Depot Memphis Tennessee, Revision 0*. April 2017.	Recent groundwater elevation and analytical data.	Background information and selection of sample locations.
HDR. *Vapor Intrusion Screening Level Assessment Technical Memorandum.* August *2017.*	Documentation of potential VI risk from VOCs in groundwater	Background information and selection of sample locations.

QAPP Worksheet #14/16: Project Tasks & Schedule

The tasks and schedule for the soil gas investigation and submittal of deliverables for regulatory agency review are shown below.

Activity	Responsible party	Planned start date	Planned completion date	Deliverable(s)	Deliverable due date
Draft Work Plan	HDR	1 August	20 October	Soil Gas Sampling QAPP, Rev. 0	20 October 2017
Regulatory Review	USEPA & TDEC	23 October	22 December	Comments or Approval Letter	22 December 2017
Final Work Plan	HDR	22 December	21 January	Soil Gas Sampling QAPP, Rev. 1	21 January 2018
Field Activities	HDR	12 February	16 February	Samples to laboratory, field reports to file	16 February 2018
Vapor Sample Analyses	Chemtech	19 February	13 March	Level 4 report and Electronic Data Deliverable (EDD)	13 March 2018
Geotechnical Sample Analyses	McCray	19 February	6 March	Data report	6 March 2018
Analytical Data Validation	HDR	14 March	23 March	Data validation narrative report	23 March 2018
Report	HDR	19 February	12 April	Soil Gas Investigation Technical Memorandum	12 April 2018

QAPP Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Air (soil gas)
Analytical Method: VOCs
Concentration level: Low/Medium

Analyte	Project Action Limit	Project Quantitation Limit Goal	Achievable Laboratory Limits[2]	
			MDLs	RLs
	(µg/M³)	(µg/M³)	(µg/M³)	(µg/M³)
cis 1,2-Dichloroethene	120,000 [3]	1.98	0.07	1.98
Carbon Tetrachloride	68	0.19	0.10	0.19
Chloroform	18	2.43	0.08	2.43
Tetrachloroethene	1,600	0.20	0.12	0.20
Trichloroethene	100	0.16	0.09	0.16
Vinyl Chloride	93	0.08	0.04	0.08

[1] Analytical method detection limits (MDLs) and RLs are those documented in validated methods.

[2] Achievable MDLs and RLs are limits that an individual laboratory can achieve when performing a specific analytical method.

[3] Screening value calculated for cis 1,2-dichloroethene by USEPA Region 4 will be used for comparison.

Project Action Limits are commercial Target Sub-Slab and Exterior Soil Gas Concentrations generated by the EPA's VISL Calculator version 3.5.1 using May 2016 RSLs

µg/M³ – micrograms per cubic meter

QAPP Worksheet #17: Sampling Design and Rationale

The sampling activities will be conducted in accordance with the *DOD Vapor Intrusion Guidance* (Tri-Services Workgroup, 2009) and *Vapor Intrusion Technical Guidance (*NJDEP, 2016). The number of samples and the analytical parameters are summarized in Worksheet #18. Planned samples consist of soil gas and soil.

Physical Boundaries for the Area

Soil gas samples are planned to be collected within the DDMT MI property boundary from areas with recent CVOC concentrations in groundwater that could pose an unacceptable risk to human health via vapor intrusion (Figure 2). CVOC concentrations in soil from the 2009 investigation were also considered. Soil gas vapor samples will be collected from 5 ft bgs, and sub-slab soil gas samples will be collected from beneath the concrete floor of Building 260/261. Soil samples for geotechnical analysis will be collected from three borings (Figure 2).

Basis for the Placement and Number of Sample Locations

Sample locations presented on Figure 2 were selected to further evaluate potential human health impacts from VI of VOCs to indoor air. The sections below document the rationale for the planned VI sampling.

Sub-Slab Samples

Three sub-slab soil gas samples (SS01-SS03) are planned to be collected from beneath the Building 260/261 concrete floor in accordance with *Vapor Intrusion Technical Guidance (*NJDEP, 2016). Building 260/261 was selected for sub-slab soil gas sampling as this building is located directly over or adjacent to groundwater impacted with elevated concentrations of CT, PCE, TCE, CF, and VC. This area generally contains greatest concentrations of VOCs in groundwater and includes a slab on grade concrete foundation. Based on the October 2016 groundwater analytical results and VISL modeling, Building 260/261 appears to have a greater potential for VI health risk relative to other buildings on the MI. Thickness of the concrete slab will be measured at each sub-slab sample location.

Building 260/261 has an enclosed area of approximately 7,000 square feet (ft^2). The NJDEP guidance recommends that four sub-slab soil gas samples should be collected from buildings with a square footage of between 5,001 ft^2 and 10,000 ft^2. However, HDR is planning on collecting only three sub-slab soil gas samples from beneath Building 260/261 for the following reasons:

- SG04 will be collected approximately 250 ft northwest of Building 260/261, in an area identified during the MIP investigation as containing high VOC concentrations in soil (Figure 1). A soil gas sample collected from boring SG04 will be used in addition to the sub-slab samples to characterize VI impacts to Building 260/261;
- The SOW limits the number of soil gas samples to 10. It is the opinion of HDR that Building 260/261 will be adequately characterized with the three sub-slab samples and SG04. Relocating one of the other soil gas samples (SG05 through SG10) to Building 260/261 would result in a data gap in that area; and
- This MI VI assessment is not intended to fully characterize VI impacts at the MI, but to use a biased sampling approach to characterize VI impacts in areas suspected to present the

greatest human health risk. Should VI impacts be identified, additional assessment or mitigation should be performed to further evaluate or eliminate the health risk.

Soil Gas Samples

Seven soil gas samples (SG04-SG10) are planned to be collected from soil borings located across the MI in areas with high concentrations of COPCs in soil and/or groundwater.

SG04: Located in an area approximately 250 ft northwest of Building 260/261 where MIP (Figure 1) and VISL VI calculation (Figure 2) identified elevated VOC concentrations in soil and a potentially unacceptable human health risk, respectively. The soil gas sample collected from SG04 is intended to evaluate potential risk to onsite commercial receptors. One soil gas sample collected from 5 ft bgs is planned to be collected from this location.

SG05: Located on the southern perimeter of the MI in an area with recently identified groundwater contamination. The soil gas sample collected from SG05 is intended to evaluate potential risk to onsite commercial and offsite residential receptors. One soil gas sample collected from 5 ft bgs is planned to be collected from this location.

SG06: Located adjacent to an occupied commercial building and an area where October 2016 groundwater analytical results yielded PCE, TCE, CF and CT greater than the VI screening level (HDR, 2017b). One soil gas sample collected from 5 ft bgs is planned to be collected from this location.

SG07: Located adjacent to the western perimeter of the MI and in an area where PCE may present a risk to onsite commercial receptors (HDR, 2017b). The SG07 sample location is also intended to evaluate potential VI risks to offsite receptors. One soil gas sample collected from 5 ft bgs is planned to be collected from this location.

SG08: Located adjacent to an occupied commercial building and PMW21-04 where concentrations of PCE and TCE were reported greater than the screening level (HDR, 2017b). One soil gas sample collected from 5 ft bgs is planned to be collected from this location.

SG09: Located in the vicinity of occupied commercial buildings and near MW-100B where VC was detected in groundwater two orders of magnitude greater than the screening level (HDR, 2017b). One soil gas sample collected from 5 ft bgs is planned to be collected from this location.

SG10: Located adjacent to a vacant building, but hydraulically downgradient from VOC plumes in the vicinity of Building 260/261 and upgradient from an occupied building. It is in an area where PCE, TCE, CT, and CF were detected in samples greater than screening levels (HDR, 2017b). One soil gas sample collected from 5 ft bgs is planned to be collected from this location.

Soil Samples

Soil samples are planned to be collected from three locations, adjacent to soil gas sample locations, and submitted for measurement of geotechnical soil parameters (Figure 2). Geotechnical testing of soil samples will determine grain size, permeability, dry bulk density, porosity and water-filled porosity for use in the J&E model. The soil samples and adjacent soil gas samples are SB01-SG06, SB02-SG04, and SB03-SG07.

QAPP Worksheet #18: Sampling Locations and Methods/SOP Requirements

Sampling Location	Number of Locations	Matrix	Depth (feet)	Analytical Group	Concentration Level	Number of Samples (identify field duplicates)	Sampling SOP Reference[1]	Rationale for Sampling Location
SS01-SS03	3	V	1	VOCs	Low	3 field	SOP 5	Evaluate VOCs in shallow soil gas
SG04-SG10	7	V	5	VOCs	Low	7 field, 1 duplicate	SOP 5	Evaluate VOCs in shallow soil gas
SB01-SB03	3	SO	5	ASTM Geotechnical	NA	3 field	SOP 2	Measure soil parameters for use in VI modeling

[1] Specify the appropriate letter or number from the Project Sampling SOP References (Worksheet #21).

SO: Soil

V: Air (Soil gas)

QAPP Worksheet #19 & 30: Sample Containers, Preservation, and Hold Times

Analytical Laboratory (Name, sample receipt address, point of contact, e-mail, and phone numbers): Chemtech Consulting Group (Chemtech), 284 Sheffield Street, Mountainside, New Jersey 07092, Kurt Hummler, 908-789-8900, kurt@chemtech.net

Required accreditations/certifications: DoD ELAP

Back-up Laboratory: Microbac Laboratories, Inc., 158 Starlite Drive, Marietta, Ohio 45750, Michelle Taylor, 800-373-4071, michelle.taylor@microbac.com

Sample Delivery Method: FedEx next day air

Analyte Group	Matrix	Method/ SOP Reference	Accreditation Expiration Date	Containers (number, size & type per sample)	Preservation Requirements	Maximum Holding Time (preparation/ analysis)	Data Package Turnaround
VOCs	Air (Soil gas)	USEPA TO-15 (L-1)	10/20/2018	1-liter Summa^{TM} canister	None	30 days	3 weeks for Level 3; 4 weeks for Level 4

Analytical Laboratory (Name, sample receipt address, point of contact, e-mail, and phone numbers): McCray Drilling, LLC., 6756 Buckles Cove, Memphis, TN 38133. David McCray 901-385-1199, david@mccraydrilling.com

Required accreditations/certifications: None

Back-up Laboratory: None

Sample Delivery Method: Hand Delivery

Analyte Group	Matrix	Method/SOP Reference	Accreditation Expiration Date	Containers (number, size & type per sample)	Preservation Requirements	Maximum Holding Time (preparation/ analysis)	Data Package Turnaround
Grain Size	Soil	ASTM D-422	None	1 Shelby Tube or 1 quart zip top bag	None	None	3 weeks
Permeability	Soil	ASTM D-5084	None	1 Shelby Tube**	None	None	3 weeks
Dry Bulk Density, Porosity, and Water Filled Porosity	Soil	Method 9100*	None	1 Shelby Tube**	None	None	3 weeks

* = Method 9100 of Test Methods for Evaluating Solid Waste, Third Edition SW-846
** = Can be analyzed from Shelby Tube provided for grain size analysis.

QAPP Worksheet #20: Field QC Summary

Matrix	Analyte/ Analytical Group	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total # analyses
Soil gas	VOCs	10	1	0	0	0	0	0	0	11
Soil	Soil parameters[1]	3	0	0	0	0	0	0	0	3

Note:

[1] Soil parameters are grain size, permeability, dry bulk density, porosity and water-filled porosity

QAPP Worksheet #21: Field SOPs

Method/ SOP Reference	Title, Revision Number and Date	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)
SOP1	General Procedures for Field Personnel, Rev. 2, August 2017	HDR	Log books, first aid kit, personal protective equipment	Y
SOP2	Drilling and Soil Sampling, Rev. 3, August 2017	HDR	Drilling equipment, sample jars, disposable scoops	Y
SOP5	Vapor Sample Collection, Rev. 3, August 2017	HDR	Summa canisters, flow controllers, vacuum pump or syringe, helium,	Y
SOP7	Sample Control and Documentation, Rev. 3, August 2017	HDR	Sampling log book, DQCR forms, digital camera, chain-of-custody (CoC) forms	Y
SOP9	Sampling Equipment Decontamination, Rev. 2, August 2017	HDR	American Society for Testing and Materials (ASTM) Type II water (supplied by lab) or distilled water, pesticide-grade methanol, Alconox detergent, brushes	Y
SOP Vapor Pin	Installation and Extraction of the Vapor Pin, September 9, 2016	Cox-Colvin & Associates, Inc.	Vapor Pin, Hammer Drill, 5/8” diameter hammer bit, 1 ½ inch diameter hammer bit, wet/dry vacuum,	Y

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Activity	SOP Reference	Title or position of responsible person	Frequency	Acceptance Criteria	Corrective Action
GasCheck G2	Helium Detector	SOP 5	FTL	Per Manufacture Specifications	Meet manufacturer’s specifications	Ship to rental company for repair/replacement
Summa® canister	Initial field pressure (vacuum) check	SOP 5	FTL	Every canister	Initial field vacuum should be -25 to -30 inches Hg	Use a different canister; request more canisters from the lab if necessary

QAPP Worksheet #23: Analytical SOPs

SOP #	Title, Revision Number and Date	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project Work? (Y/N)
Lab-1 MTO15-Air VOC	Determination of Volatile Organic Compounds in Air by method TO-15 (MTO15-Air VOC) Rev. 12 - 05/05/2017	Definitive	VOCs in Air	-Entech 7500 Head Space autosampler with 3 channel temperature controller -Entech 7100A pre-concentrator -Entech 7016 CA auto sampler -Entech Model 4600A Dynamic Diluter -Hewlett Packard 5890 or 6890 GC -60m capillary column, 0.32mm ID, with a 1.0-micron film thickness, RTX-1 Cat # 10157 or equivalent GC column -Hewlett Packard 5971 and 5975 mass selective detectors are used for this method MS	N
Lab-2 P250-Log-in Procedure	Sample Receipt, Sample Acceptance Policy, Sample Login, Sample Identification, & Sample Storage (P250-Log-in Procedure) Rev. 21 – 07/27/2017	NA	NA	NA	N

QAPP Worksheet #24: Analytical Instrument Calibration

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[1]
GC/MS for VOCs in Air TO-15	Mass spectral ion intensities with 4-bromofluoro-benzene (BFB)	Every 24 hours prior to initial calibration (ICAL), initial calibration verification (ICV) or continuing calibration verification (CCV)	Mass – Ion Abundance Criteria 50 – 8-40% of mass 95 75 – 30-66% of mass 95 95 – base peak, 100% relative abundance 96 – 5-9% of mass 95 173 – <2% of mass 174 174 – 50-120% of mass 95 175 – 4-9% of mass 174 176 – 93-101% of mass 174 177 - 5-9% of mass 176 (Established criteria in Table 3 of TO-15)	Retune instrument and repeat BFB check. Flagging criteria are not appropriate.	Analyst	Lab-1 MTO15-Air VOC
	Initial multipoint calibration for all analytes (ICAL) (minimum five standards)	ICAL prior to sample analysis	%Relative Spike Difference for all analytes < 30% with at most 2 exceptions up to 40%. Relative retention time (RRT) for each target compound at each calibration level must be within 0.06RRT units of the mean RRT for the compound. Internal Standard (IS): the area response at each calibration level must be within 40% of the mean area response over the ICAL range. Retention time (RT) shift for each of the ISs at each calibration level must be within 20 seconds of the mean RT over the ICAL range for each IS.	Inspect the system for problems. It may be necessary to clean the ion source, change the column, or take other CAs to meet the ICAL technical acceptance criteria. Flagging criteria are not appropriate.	Analyst	Lab-1 MTO15-Air VOC

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[1]
GC/MS for VOCs in Air TO-15 (cont'd)	CCV	Daily, before sample analysis unless ICAL performed on same day and every 24 hours of analysis time	All analytes within ± 30% of expected value.	Inspect the system for problems. It may be necessary to clean the ion source, change the column, or take other CAs to meet the continuing calibration technical acceptance criteria. Apply Q-flag to all results for the specific analyte(s) in all samples since last acceptable CCV.	Analyst	Lab-1 MTO15-Air VOC

[1] *Specify the appropriate reference letter or number from the Analytical SOP References (Worksheet #23).*

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
GC/MS for VOCs in Air	Concentrating Trap	GC/MS	NA	Routine maintenance includes periodic solvent cleaning	Acceptable performance	Fix issues as necessary.	Analyst	Lab-1 MTO15-Air VOC
	Column Performance			Monitored by observing both peak shapes and column bleed.	Acceptable performance	Fix issues as necessary.	Analyst	
	Vacuum System			Every 6 months, including changing the pump oil and checking the molecular sieve in the back-streaming trap.	Acceptable performance	Fix issues as necessary.	Analyst	

[1] *Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).*

QAPP Worksheet #26 & 27: Sample Handling, Custody, and Disposal

Sampling Organization: HDR
Laboratory: Chemtech
Method of sample delivery (shipper/carrier): FedEx
Number of days from reporting until sample disposal: 60

Activity	Organization and title or position of person responsible for the activity	SOP Reference
SAMPLE COLLECTION, PACKAGING, AND SHIPMENT		
Sample Collection	HDR Field Team	HDR SOP 2, HDR SOP 5
Sample Packaging	HDR Field Team	HDR SOP 7
Coordination of Shipment	HDR Field Team and Project Chemist, Laboratory (Chemtech) PM	HDR SOP 7
Type of Shipment/Carrier: Cardboard carton (air sample in Summa^{TM} canister), shipped via FedEx Ground.	HDR Field Team	HDR SOP 7
Type of Shipment/Carrier: Cooler with ice (soil samples in Terracore kit of three 40-milliliter vials), shipped via FedEx next morning delivery.	HDR Field Team	HDR SOP 7
SAMPLE RECEIPT AND ANALYSIS		
Sample Receipt	Laboratory (Chemtech) sample custodian	Chemtech SOP P250-Log-in Procedure (Lab-2)
Sample Custody and Storage	Laboratory (Chemtech) sample custodian	Chemtech SOP P250-Log-in Procedure (Lab-2)
Sample Preparation	Laboratory (Chemtech) sample preparation chemist or analyst	Chemtech SOP MTO15-Air VOC (Lab-1)
Sample Determinative Analysis	Laboratory (Chemtech) sample analyst	Chemtech SOP MTO15-Air VOC (Lab-1)

Activity	Organization and title or position of person responsible for the activity	SOP Reference
SAMPLE ARCHIVING		
Field Sample Storage (No. of days from sample collection): 60 days from data package report	Laboratory (Chemtech) sample custodian.	Chemtech SOP P250-Log-in Procedure (Lab-2)
Sample Extract/ Digestate Storage (No. of days from extraction/digestion): 60 days from data package report	Laboratory (Chemtech) sample custodian	Chemtech SOP P250-Log-in Procedure (Lab-2)
SAMPLE DISPOSAL		
Number of Days from Analysis: 60 days from data package report	Laboratory (Chemtech) sample custodian	Chemtech SOP P250-Log-in Procedure (Lab-2)

QAPP Worksheet #28: Analytical Quality Control and Corrective Action

Matrix: Air (Soil Vapor)
Analytical Group: VOCs
Analytical Method/SOP: TO-15 / Lab-1

QC SAMPLE	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Second-source calibration verification	Once per ICAL	All analytes within ± 30% of expected value	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL. Problem must be corrected. Samples may not be analyzed until the calibration has been verified.	Analyst	Accuracy/ Bias	All analytes within ± 30% of expected value Flagging criteria are not appropriate.
Internal Standards (ISs)	Every field sample, standard, and quality control (QC) sample.	Area response within ± 40% of the area response for each IS in the most recent valid calibration (CCV or mid-point from the ICAL, whichever is most current). RT within ± 0.33 minutes of the RT for each IS in the most recent valid calibration (CCV or mid-point from the ICAL, whichever is most current).	1) Inspect MS and GC for malfunctions. 2) Take appropriate CAs. 3) Reanalyze samples analyzed while system was malfunctioning. 4) If sample exceeds criteria, reanalyze sample. If still out, report both analyses and document CA.	Analyst	Accuracy	Area response within ± 40% of the area response for each IS in the most recent valid calibration (CCV or mid-point from the ICAL, whichever is most current). RT within ± 0.33 minutes of the RT for each IS in the most recent valid calibration (CCV or mid-point from the ICAL, whichever is most current). Apply Q-flag to analytes associated with the non-compliant IS.

QC SAMPLE	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method blank (humid zero air)	Immediately after ICV or daily CCV, and whenever a high concentration sample is encountered and carryover is suspected	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	The source of the contamination must be investigated and appropriate corrective measures need to be taken and documented before further sample analysis proceeds. If an analyte in the blank is found to be out of control (i.e., contaminated) and the analyte is also found in associated samples, those sample results should be "flagged" by the lab as possibly contaminated.	Analyst	Accuracy/ bias-contamination	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.
LCS for all analytes	One LCS per analytical batch	All analytes within ± 30% of expected value	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL. Problem must be corrected. Samples may not be analyzed until the calibration has been verified.	Analyst	Precision-lab	All analytes within ± 30% of expected value Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.

QC SAMPLE	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Surrogate spike recoveries	Every sample, spike, standard, and reagent blank	70-130% recovery	1) Recalculate result, and reanalyze sample if still out. 2) Re-extract and reanalyze sample, if still out. 3) Report both analyses and document in report that steps 1 and 2 were performed. 4) Qualify the data.	Analyst	Accuracy/ bias	70-130% recovery Apply Q-flag to all associated analytes if acceptance criteria are not met.
Field duplicate	Sampling: 1 for every 10 field samples Lab: NA	RPD ≤ 25%	1) Review lab QC data to determine if they are in control. 2) Qualify data. Use data to evaluate whether proper collection procedures were followed. 3) Determine further CA.	Analyst	Precision-overall	RPD ≤ 25%
Laboratory duplicate	Daily	RPD ≤ 25%	1) Review lab QC data to determine if they are in control. 2) Qualify data. Use data to evaluate whether proper collection procedures were followed. 3) Determine further CA.	Analyst	Precision-laboratory	RPD ≤ 25%
MDL study	Once per year, upon any major system change, or quarterly MDL check.	MDLs established as described in 40 Code of Federal Regulations (CFR) Part 136, App. B shall not exceed one-half the RL	MDLs that exceed established criteria shall be submitted to the USACE for approval prior to the analysis of any project samples.	Analyst	Sensitivity	MDLs established as described in 40 CFR Part 136, App. B shall not exceed one-half the RL

QC SAMPLE	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Tentatively identified compound (TIC) search for 1,2,3-trichloropropane	Each sample	--	--	Analyst	--	Each sample will be TIC searched for the presence of 1,2,3-trichloropropane; if found*, this compound will be quantitated against the nearest internal standard using a relative response factor of 1.0 and reported as an estimated (J) value.
TIC search	Each sample	--	--	Analyst	--	Unidentified GC peaks in each sample will be TIC searched and identified and quantitated against the nearest internal standard using a relative response factor of 1.0 and reported as an estimated (J) value.

*The peak for a TIC should have an area or height > 10% of the area or height of the nearest internal standard.

QAPP Worksheet #29: Project Documents and Records

Sample Collection and Field Records			
Record	***Generation***	***Verification***	***Storage location/archival***
Field Notes, and Logbooks	HDR FTL	HDR PM, Chemist	HDR Network Drive Project Folder
GIS files	HDR FTL	HDR PM	HDR Network Drive Project Folder
CoC Forms	HDR FTL	HDR PM, Chemist	HDR Network Drive Project Folder
Airbills	HDR FTL	HDR PM, Chemist	HDR Network Drive Project Folder
DQCRs	HDR FTL	HDR PM	HDR Network Drive Project Folder
Equipment Calibration Forms	HDR FTL	HDR PM	HDR Network Drive Project Folder
Logbooks	HDR FTL	HDR PM	HDR Network Drive Project Folder
Instrument data files	HDR FTL	HDR PM	HDR Network Drive Project Folder
Photo-documentation	HDR FTL	HDR PM	HDR Network Drive Project Folder

Project Assessments			
Record	***Generation***	***Verification***	***Storage location/archival***
Analytical Data Packages	Lab	HDR Project Chemist	HDR Network Drive Project Folder
Validation Checklists	HDR Project Chemist	HDR Project Chemist/ HDR PM	HDR Network Drive Project Folder
Data Validation Reports	HDR Project Chemist	HDR Project Chemist/ HDR PM	HDR Network Drive Project Folder
CA Reports	HDR Project Chemist	HDR Project Chemist/ HDR PM	HDR Network Drive Project Folder

Laboratory Records			
Record	***Generation***	***Verification***	***Storage location/archival***
CoC Forms	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Equipment Logs	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Sample Prep Logs	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Analytical Run Logs	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
CA Forms	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Extraction Records	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Reported Sample Results	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Raw Data Printouts	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Laboratory Information Management System (LIMS) Reports	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Data Packages and Checklists	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
TIC searches for 1,2,3-trichloropropane and unidentified peaks	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)

Laboratory Data Deliverables		
Record	***VOCs (Air-Soil Vapor)***	***Geotechnical Parameters (Soil)***
CoC Forms	X	X
Equipment Logs	X	NA
Sample Prep Logs	X	NA
Analytical Run Logs	X	NA
CA Forms	X	NA
Extraction Records	X	NA
Reported Sample Results	X	X
Raw Data Printouts	X	NA
LIMS Reports	X	NA
Data Packages and Checklists	X	NA
TIC searches for 1,2,3-trichloropropane and unidentified peaks	X	NA

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable due date
Off-Site Laboratory TSA	DoD ELAP personnel or contractor	Annual	NA	ELAP annual certification audit report	NA
Laboratory Performance Audit	HDR Data reviewer/ validator, HDR Project Chemist	Ongoing with data package data validation	NA	Email from HDR Project Chemist to Laboratory PM	14 days after receipt of analytical data package

Assessment Response and Corrective Action:

Assessment Type	Responsibility for responding to assessment findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsible for monitoring Corrective Action implementation
Off-Site Laboratory TSA	Laboratory Representative	Per ELAP	Per ELAP	Laboratory PM, Analysts, Technicians	Laboratory PM and HDR Project Chemist
Laboratory Performance Audit	Laboratory PM, Analysts, Technicians	Documented in data package if edits to the data package required	Corrections are to be made before final data package is issued, and included in final data package	Laboratory PM, Analysts, Technicians	HDR Project Chemist

QAPP Worksheet #34: Data Verification and Validation Inputs

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP	X	X
2	Field SOPs	X	X
3	Laboratory SOPs	X	X
Field Records			
4	Field Logbooks	X	X
5	Equipment Calibration Records	X	X
6	CoC Forms	X	X
7	Sampling Forms	X	X
8	Drilling Logs	X	X
9	Relevant Correspondence	X	X
10	Field Audit Reports	X	X
11	Field CA Reports	X	X
Analytical Data Package			
12	Cover Sheet (laboratory identifying information)	X	X
13	Case Narrative	X	X
14	Internal Laboratory CoC	X	X
15	Sample Receipt Records	X	X
16	Sample Chronology (i.e. dates and times of receipt, preparation and analysis)	X	X
17	Communication Records	X	X
18	Standards Traceability	X	X
19	Instrument Calibration Records	X	X
20	Definition of Laboratory Qualifiers	X	X
21	Results of Reporting Forms	X	X
22	QC Sample Results	X	X
23	CA Reports	X	X
24	Raw Data	X	X
25	TIC searches for 1,2,3-trichloropropane and unidentified peaks	X	X
26	Electronic Data Deliverable	X	X

QAPP Worksheet #35: Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
CoC Forms, Shipping Airbills	CoC Forms, Shipping Airbills	CoC Forms and shipping documents will be reviewed and verified for completeness and accuracy against the actual contents of the coolers represented in the shipment. Three sheet carbon CoC forms will be used with the original and second copy sent with the samples, and the third copy kept by the sampling team.	HDR FTL, Laboratory Sample Custodian
Field Notes	Field Logbook, Forms and Drilling Logs	Field notes and forms will be reviewed for completeness and accuracy prior to being placed in the site file and scanned into electronic files.	HDR FTL
Laboratory Data	Laboratory Data	All data packages will be verified internally by laboratory personnel for technical accuracy and completeness prior to delivery to HDR. Upon receipt, the HDR Project Chemist will verify all data in accordance with standard data validation procedures.	Laboratory PM, HDR Project Chemist
SOPs	SOPs	Verify that all SOPs associated with field activities were met.	HDR PM, HDR FTL
Documentation of QC Sample Results	Documentation of QC Sample Results	Confirm that all method required QC samples were run and met required limits.	HDR Project Chemist
Off-site laboratory raw data	USEPA National Functional Guidelines for Organic and Inorganic Superfund Data Review (2017)	Compare and evaluate all sampling procedures, sampling plans, duplicate criteria, project quantitation limits, method performance criteria, and data qualifiers as specified in the UFP-QAPP.	HDR Project Chemist

QAPP Worksheet #36: Data Validation Procedures

Data Validator: Project Chemist, HDR

Analytical Group/Method	Organics (VOCs in Soil, VOCs in Air)
Data Deliverable Requirements:	Level 4 data package including all instrument raw data
Analytical Specifications:	Per method and this QAPP
Measurement of Performance Criteria:	DQOs in this QAPP
Percent of Data Packages to be Validated:	100%
Percent of Raw Data to be Reviewed:	10%
Percent of Results to be Recalculated:	One result per analytical method per matrix
Validation Procedure:	National Functional Guidelines for Superfund Organic Methods Data Review, OLEM 9355.0-136, EPA-540-R-2017-002, January 2017
Validation Code:	S2bVM (100%), S3VM (10%)
Electronic Validation Program/Version:	NA

Validation Code and Label Identifier Table:

Validation Code*	Validation Label	Description/Reference
S2bVM	Stage 2b Validation Manual	EPA 540-R-08-005
S3VM	Stage 3 Validation Manual	EPA 540-R-08-005

Qualifier	Explanation
The following data qualifiers will be applied during data validation. Potential impacts on project-specific DQOs will be discussed in the data validation report.	
U	Not detected above MDL
J	Detected, concentration is estimated (also used for quantitation of TICs)
J+	Detected, concentration is estimated, possibly biased high
J-	Detected, concentration is estimated, possibly biased low
UJ	Not detected, MDL is estimated
R	Rejected, data not usable

QAPP Worksheet #37: Data Usability Assessment

Project Manager: Tom Holmes
VI Task Manager/ Field Team Leader: Clayton Mokri
Project Chemist: Lynn Lutz

Step 1	**Review the project's objectives and sampling design** Review the key outputs defined during systematic planning (i.e., Project Quality Objectives or DQOs and Measurement Performance Criteria) to make sure they are still applicable. Review the sampling design for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps.
Step 2	**Review the data verification and data validation outputs** Review available QA reports, including the data verification and data validation reports. Perform basic calculations and summarize the data (using graphs, maps, tables, etc.). Look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant PT sample results, and SOP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.
Step 3	**Verify the assumptions of the selected statistical method** Verify whether underlying assumptions for selected statistical methods (if documented in the QAPP) are valid. Common assumptions include the distributional form of the data, independence of the data, dispersion characteristics, homogeneity, etc. Depending on the robustness of the statistical method, minor deviations from assumptions usually are not critical to statistical analysis and data interpretation. If serious deviations from assumptions are discovered, then another statistical method may need to be selected.
Step 4	**Implement the statistical method** Implement the specified statistical procedures for analyzing the data and review underlying assumptions. For decision projects that involve hypothesis testing (e.g., "concentrations of lead in groundwater are below the action level") consider the consequences for selecting the incorrect alternative; for estimation projects (e.g., establishing a boundary for surface soil contamination), consider the tolerance for uncertainty in measurements.
Step 5	**Document data usability and draw conclusions:** Determine if the data can be used as intended, considering implications of deviations and CAs. Discuss data quality indicators. Assess the performance of the sampling design and Identify limitations on data use. Update the conceptual site model and document conclusions. Prepare the data usability summary report which can be in the form of text and/or a table.

The following is a summary of the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:
For samples analyzed by off-site laboratories, results will be subjected to data review, verification and validation, in accordance with the USEPA's National Functional Guidelines for Organic Data Review (USEPA, 2017a).

Equations used to assess acceptance criteria include:

For Accuracy:

Percent Recovery for Matrix Spike (MS)

$$\%R = \left(\frac{Spike\ conc. - Sample\ conc.}{Amount\ of\ spike\ added}\right) x\ 100$$

Percent Recovery for LCS

$$\%R = \left(\frac{Spike\ conc.}{Amount\ of\ spike\ added}\right) x\ 100$$

For Precision:

Relative Percent Different for Matrix Spike Duplicate (MSD), and field duplicates

$$\%\ RPD = \left[\frac{|Amount\ in\ sample\ 1 - Amount\ in\ Sample\ 2|}{\frac{Amount\ in\ Sample\ 1 + Amount\ in\ sample\ 2}{2}}\right] x\ 100$$

For Completeness:

$$\%Completeness = \left(\frac{Number\ of\ usable\ measurements}{Number\ of\ planned\ measurements}\right) x\ 100$$

All data collected from the SI field activities will be evaluated against the following data quality parameters:

Precision – Precision refers to the degree to which repeated measurements are similar to one another, when obtained under prescribed conditions. Laboratory precision will be assessed by evaluating results of field and laboratory duplicates to determine RPD, LCSs, and MS/MSDs. The requirements for RPD are shown in the Worksheets above.

Accuracy – Accuracy is defined as the measure of the closeness of an individual measurement or the average of a number of measurements to the actual or 'true' value. Laboratory accuracy will be assessed by evaluating LCSs and MSs and calculating the %R. The requirements for %R are shown in the Worksheets above.

Representativeness – Representativeness is defined as a measure of the degree to which data accurately and precisely represents the characteristics and conditions of the sample from where the measurement was taken. Laboratory representativeness is assessed by ensuring that all analytical methods and laboratory procedures were followed consistently. In addition, method and instrument blanks are evaluated against the sample data to determine if results could be due to an outside source, such as glassware cross-contamination or instrument carryover. Field representativeness is evaluated in the same manner, through equipment blanks and review of sampling/decontamination techniques. Target analytes should not be present in any blanks. Data may be qualified accordingly if any analytes are detected in blank samples.

Completeness – Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data that was expected or planned for. Qualified data will be considered unless it has been rejected (R), in which case it is unusable. The goal for completeness is 100%, however rejected (unusable) data will be evaluated to determine whether data gaps exist, or if the project objectives were met, without it.

Comparability – Comparability is a measure of the confidence with which data sets may be compared to each other. Comparability is evaluated by reviewing adherence to Work Plans, SOPs, method requirements, and consistency in task execution, both in the field, and at off-site laboratories.

Sensitivity – Sensitivity is the ability of the method or instrument to detect the target analytes at the level of interest. In order to meet the project-specific DQOs, definitive data will be compared to the project’s action limits or quantitation goals as listed in Worksheet #15.

Identify the personnel responsible for performing the usability assessment:
Lynn K. Lutz, Project Chemist, HDR

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:
A Data Validation Report will be included as an Appendix to the final report and will document the results of the data review, verification and validation. This report will describe the conclusions made during the data assessment regarding the data usability. Any limitations on the usability of the data will be explained, including the reasons for data qualifiers, the definitions of the qualifiers and a summary of the specific acceptance criteria that was assessed and found to be outside of control limits.

References

CH2M HILL, 2000. *Memphis Depot Main Installation Remedial Investigation Report*. Prepared for the U.S. Army Engineering and Support Center, Huntsville, Alabama. January 2000.

CH2M HILL, 2001. *Memphis Depot Main Installation Record of Decision Memphis Depot Caretaker, Revision 2*. Prepared for the U.S. Army Engineering and Support Center, Huntsville, Alabama. February 2001.

CH2M HILL, 2004. *Memphis Depot Main Installation Land Use Control Implementation Plan, Revision 1.* Prepared for the Defense Logistics Agency and the U.S. Army Engineering and Support Center, Huntsville, Alabama. February 2004.

Tri-Service Environmental Risk Assessment Workgroup, 2009*. DOD Vapor Intrusion Guidance.* Prepared for the Department of Defense. January 2009.

e²M, 2009. *Main Installation Source Areas Investigation, Defense Depot Memphis, Tennessee, Revision 0.* Prepared for the Defense Logistics Agency and the Air Force Center for Engineering and the Environment. February 2009.

HDR, 2012. *Third Five Year Review, Defense Depot Memphis Tennessee, Revision 1*. Prepared for the U.S. Army Corps of Engineers, Tulsa District. November 2012.

HDR, 2017a. *Annual Long-Term Monitoring Report-2016, Defense Depot Memphis Tennessee, Revision 0*. Prepared for the U.S. Army Corps of Engineers, Mobile District. April 2017.

HDR, 2017b. *Vapor Intrusion Screening Level Assessment Memorandum, Main Installation, Defense Depot Memphis, Tennessee.* Prepared for the U.S. Army Corps of Engineers, Mobile District. August 2017.

HDR, 2017c. *2017 Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 0.* Prepared for the U.S. Army Corps of Engineers, Mobile District. May 2017.

New Jersey Department of Environmental Protection (NJDEP), 2016. *Vapor Intrusion Technical Guidance,* August 2016.

USACE Mobile, 2016. *Appendix A, Statement of Work, Environmental Restoration Support 2017 – 2019, Defense Depot Memphis Tennessee (DDMT), Contract No. W91278-16-D-0061 Task Order Number 0002*. November 2016.

USEPA, 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*, *EPA QA/G-4*. EPA/240/B-06/001. February 2006.

USEPA, 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. OSWER Publication 9200.2-154. June 2015

USEPA, 2016a. *Vapor Intrusion Screening level (VISL) Calculator Users Guide*. Available online at: http://www.epa.gov/oswer/vaporintrusion/guidance.html

USEPA, 2017a. *National Functional Guidelines for Superfund Organic Methods Data Review. January 2017.*

USEPA, 2017b. *Regional Screening Levels*, https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017. June.

Figures

Note; MIP survey and sample locations from Main Installation Source Areas Investigation, Defense Depot Memphis, Tennessee, Revision 0 (e²M, 2009).

Legend

ECD Catagory

- 🟢 0 to 0.3 Volts
- 🟠 0.3 to 3 Volts
- 🔴 >3 Volts
- ✚ Confirmation Soil Sample Exceeding Remediation Goal

- ☐ SampleGrid
- — Property Boundary
- ▭ Buildings
- ▭ Roads
- ▨ Clay Elevation Exceeds Groundwater Elevation

Figure 1

MIP Survey and Soil Sample Locations

Main Installation VI Study

Defense Depot
Memphis, Tennessee

N W E S

0 250 500
Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet , NAVD88

Date: 9/18/2017
Edition: Rev 0

Path: W:\LTM\LS25\GIS\Figure MI MIP Sample Locations.mxd

Figure 2

Planned Sample Locations

Main Installation VI Study

Defense Depot
Memphis, Tennessee

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet , NAVD88

Date: 9/19/2017
Edition: Rev 0

HDR

Notes:
1. Groundwater contours from October 2016.
2. CVOC contours from October 2016.
3. Only Fluvial Aquifer results used for CVOC contours.

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Appendix A
Field Standard Operating Procedures

STANDARD OPERATING PROCEDURE 1 - GENERAL PROCEDURES FOR FIELD PERSONNEL

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose

This Standard Operating Procedure (SOP) provides guidance for the general field practices to be followed during field activities at Defense Depot Memphis, Tennessee (DDMT); review is mandatory prior to the start of each field event. This SOP provides general guidance; the project-specific work plan must be reviewed for specific project requirements.

2 Health and Safety

Each individual assigned to field work must participate in the HDR Medical Monitoring Program, must have taken the Occupational Safety and Health Administration (OSHA) 40-Hour course (updated with the 8-Hour OSHA Refresher, when necessary), and must be certified as able to wear respiratory protection.

Each individual is required to have read and understood the project Site Safety and Health Plan (SSHP) for the specific project activity. Upon arrival at the site, each person shall sign the acknowledgement sheet confirming their review of the SSHP. Personal protective equipment (PPE) and other provisions for site safety requirements are discussed in the project specific Health and Safety plan.

All equipment will only be used by properly trained personnel. Only personnel that have received forklift operator safety training are permitted to use the forklift. Proper tools will be made available to each employee as necessary. Any questions should be addressed to the Field Team Leader (FTL).

3 Personnel Qualifications and Responsibilities

Field activities will be directed by the FTL, an environmental professional (engineer, geologist or scientist) with experience in performing and directing the planned activities. Field staff will be junior to mid-level environmental professionals or environmental technicians. Field work will be conducted by persons with experience in performing the planned activities. At least one person on each team will have a current certification in first aid and CPR.

The FTL will provide direction to field staff to ensure work is performed in accordance with the project documents (Quality Assurance Project Plan [QAPP], project work plan and SOPs). The field staff will carefully review the project documents, conduct the work as planned, seek direction from the FTL when questions or problems arise, and carefully complete field documentation.

4 Equipment and Supplies

The required equipment and supplies will be identified in the SOPs for the specific field activities to be performed and in the project work plan. Field activities should not proceed until the proper tools and equipment are available and in good working order.

Each team will have use of a truck/van during field activities. An initial safety check should be performed at the start of each shift to confirm the vehicle is in good working condition. The vehicle should then be checked daily for damage or required maintenance. For each HDR owned vehicle, mileage will be recorded on the vehicle mileage log at the start and end of each field event.

5 Procedure

5.1 Start-Up Activities

5.1.1 Office

Prior to leaving the office for field work, personnel will perform the following actions:

1. The Project Manager (PM) will assign an FTL to direct field activities and coordinate with project personnel. Task specific responsibilities of the FTL will be addressed in the appropriate SOP; general responsibilities include:
    a. Review project work plan, SSHP, and QAPP.
    b. Work with PM to properly staff the field activity.
    c. Coordinate sampling activities with the project chemist and analytical laboratory.
    d. Confirm availability and condition of DDMT-owned equipment and order additional equipment/supplies for delivery prior to the start of each event.
    e. Prepare field forms and other documentation for the planned event.
    f. If work is to be subcontracted, review the subcontract agreement, work plan, and SSHP.
    g. Confirm that field staff have Driver's License (or other picture identification) and current OSHA Certification in their possession prior to leaving the office.

5.1.2 Field

After arrival on site, but prior to commencement of operations, the following activities will be performed:

- Complete equipment and supply checklists and verify that required documentation and equipment for field activities are on site.
- Review condition of DDMT-owned and rental equipment; inventory field supplies and laboratory-provided sampling supplies.

- Review locations for planned field activities for hazards, determine requirements for site preparation and clearance, and select location for the storage of purge and decontamination waters.
- Conduct team safety meetings as required by the SSHP.
- Conduct team review of the project documents including SOPs to be utilized.
- Complete the Field Event Startup Report and submit to PM (Attachment 1-1).

5.2 Field Operations

Field staff responsibilities are project-specific. At a minimum, field personnel will perform the following activities:

1. Document field activities in a log book for each team and/or field records as required by the work plan or SOPs.
2. Record the following additional information for field measurements:
   a. The identification number and calibration results for each field instrument
   b. The numerical value and units of each measurement
   c. A description of any unexpected delays or problems observed during purging or sampling activities
3. Complete required data collection/sample control forms (e.g., Chain-of-Custody, Field Sampling Report, etc.).
4. Communicate with the PM regarding site conditions and out of scope work to be performed.
5. Perform following activities daily before leaving the site:
   a. Decontaminate and check condition of field equipment.
   b. Provide log books and other field documentation to FTL for review and scanning.
   c. Properly dispose of trash, debris and used PPE.
   d. Safely store purge and decontamination water, or transfer to large storage tank at Dunn Field.
   e. Make arrangements for shipment of samples (if applicable) and follow-up with the analytical laboratory to confirm samples arrived in good condition.
   f. Complete activity-specific field reports as required by applicable SOPs.
   g. Complete the Daily Field Report and submit to PM (Attachment 1-2).

5.3 Field Log Books and Documentation

Dedicated log books will be used by each field team in addition to documentation required by activity-specific SOPs.

- The first page of each log book will list the following information:
  - Site Name: Former Defense Depot Memphis Tennessee

  - EPA ID (TN4210020570)
  - Project Location: 2241 Truitt Street, Memphis, TN 38114
- The first entry for each field event will list the following information: log books:
  - Project Name and Number
  - FTL (full name) and initials
  - Sample team leader and members (full names) and initials
- At minimum, the log book will describe general activities performed, date and time, personnel and weather conditions. All field equipment calibration and maintenance records will be documented in the logbook. Communications with the FTL, PM or project chemist regarding field activities will be documented. Additional field data will be recorded in the log book if other field records are not used.
- Any deviations from the QAPP or work plan will be noted in the log books.
- Errors will be crossed out with a single line, the correction added and the entry initialed.
- Each page will be numbered and dated. A diagonal line will be drawn through any unused portion of a page containing an entry. To indicate the end of an entry, personnel are required to initial and date the page at the conclusion of each day.

5.4 Closeout

Upon the completion of field activities, the FTL will view each site to verify the area has been cleared and restored as closely as possible to its prior condition. Trash will be removed from the site, and surface damage, including ruts caused by vehicles, will be repaired.

Confirm all equipment is accounted for and properly decontaminated and in good working condition. Notify PM if repairs are needed. Properly package and ship all rental equipment to the vendor. When shipping equipment, use the proper HDR FedEx number and insure the package for the cost of the equipment. Follow manufacturer’s instructions on long and short term storage when storing government and/or HDR equipment.

Rental trucks should be fueled and returned to the rental company as soon as possible. HDR leased trucks should also be fueled and cleaned prior to storing at the shop.

Work areas should be cleaned with tools and equipment properly stored.

The FTL will make a final check of all logbooks and other field records to ensure there are no blanks or missing data and the entries are legible. FTL will organize scanned forms in proper order and transmit to PM.

The FTL will complete Field Event Closeout Report and submit to PM (Attachment 1-3).

6 Data and Records Management

All field forms and log book entries will be scanned and copied to the project folder on the HDR network file share drive within one week of the field event completion. All photographs taken during the field event will be uploaded along with a typed photograph log (date, project and subject) to the HDR network file share drive. The photographs will then be erased from the camera. All original forms will be stored on site in Memphis in the filing cabinet in the proper folder labeled for the project. The PM, project chemist and project administrator will be sent a link for the data.

7 Quality Control and Quality Assurance

All work will be performed in accordance with the QAPP, the specific work plan, and applicable SOPs. All field activities will be recorded in the log books in sufficient detail to reconstruct the events. No erasures or mark outs will be made on field forms or log books. A single line will be used to strike out errors and will be annotated with the initials and date of the editor.

8 References

HDR, 2017a. *2017 Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 0*. Prepared for the U.S. Army Corps of Engineers, Mobile District. May 2017.

USEPA Region 4 SESD Guidance, *Soil Sampling* (SESDPROC-010-4). October, 2010.

Field Event Startup Report

Prepared by: Date:

Event Name:

Project-Activity Number:

Summary of Planned Event:

Planned Performance Period: _______to__________

Project Documents - Title, Date

Work Plan:

Health and Safety Plan:

Other SOPs – List number/revision and title:

Field Event Staffing

Position	Name	OSHA Cert. (Y/N)	First Aid/ CPR (Y/N)	Driver's License (Y/N)	Proj. Plans reviewed (Y/N)	Experience (Hi-Med-Low-None)
Field Team Leader						

DDMT Field Equipment

Name/Use	Mfr./Model No.	Condition	Calibration Req'd.(Y/N)	Calibration supplies	Other supplies (batteries, etc.)

Rental Equipment

Name/Use	Mfr./Model No.	Condition	Calibration Req'd.(Y/N)	Calibration supplies	Other supplies (batteries, etc.)

Lab-provided Sampling Supplies

Sample Type	Number	Supplies

Additional Tools/Supplies

Camera
Field forms (list):
Sample supplies (list):
Water/Ice cooler
Sample cooler

Final Check

1. All required equipment/tools received and condition checked

Yes ___ No ___ Comment:

2. Initial equipment calibration completed

Yes ___ No ___ Comment:

3. Vehicles inspected

Yes ___ No ___ Comment:

4. Field locations reviewed

Yes ___ No ___ Comment:

5. Weather forecast checked

Yes ___ No ___ Comment:

6. Staff documents (OSHA, DL) checked

Yes ___ No ___ Comment:

7. Review of project plans confirmed and activities discussed

Yes ___ No ___ Comment:

8. Initial Safety Meeting held and SSHP signed

Yes ___ No ___ Comment:

Daily Field Report

Project Number/Activity:	**Date:**
Project Name:	**Field Team Leader:**
Brief Work Description:	

Weather:	**Temp:**

Previous Day's Samples received at laboratory – Y / N Comment:

Time	Description

Name/Organization of Field Staff, Subcontractors and Site Visitors	

Samples Collected

Problems or Deviations from Work Plan

Tasks to be completed next workday

Name

Signature

Date

Field Event Close-Out Report

Prepared by: Date:

Event Name:

Project-Activity Number:

Performance Period: ________to__________

Field Team Leader:

Field Staff:

Summary of Completed Event:

Field problems and/or changes from planned activities:

Change in number/type of samples collected:

Health and Safety problems/Injuries:

Close-out Checklist

1. Log book and field forms scanned and originals placed in project file

Yes ___ No ___ Comment:

2. Equipment/tools decontaminated

Yes ___ No ___ Comment:

3. Rental equipment shipped to supplier

Yes ___ No ___ Comment:

4. Rental vehicles returned

Yes ___ No ___ Comment:

5. DDMT equipment and tools properly stored

Yes ___ No ___ Comment:

6. List damaged equipment

Yes ___ No ___ Comment:

7. Replacement supplies ordered

Yes ___ No ___ Comment:

8. Field locations inspected and trash/debris removed

Yes ___ No ___ Comment:

9. Field shop/office cleaned

Yes ___ No ___ Comment:

STANDARD OPERATING PROCEDURE 2 – DRILLING AND SOIL SAMPLING

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operating Procedure (SOP) provides guidance for drilling and soil sampling operations in support of investigative activities at Defense Depot Memphis, Tennessee (DDMT). Drilling activities will enable collection of subsurface soil samples and allow the installation of monitoring wells. This SOP provides general guidance; the project-specific work plan must be reviewed for specific project requirements.

2 Overview

There are several methods by which drilling operations may be conducted including, manual (hand) augering, power augering with hollow-stem augers, sonic drilling, and cable tool or mud rotary drilling with installation of surface casing. Generally, hand augering is useful only for surficial soil sampling while the other methods are used for deeper, subsurface investigations, sampling and installation of monitoring wells. Sonic drilling is the recommended drilling method for well installation at DDMT; it has proven to be the most effective method for boring advancement and well installation based on the depth to water (i.e. 75-105 feet below ground surface [ft bgs]) and geologic characteristics of the fluvial aquifer (i.e. tight sands mixed with gravel up to cobble size).

Drilling activities that require the use of a truck-mounted drill rig will be conducted by a Tennessee-licensed subcontractor with experience on similar projects. The drilling subcontractor will advance boring to the target depth using the selected drilling technology and provide equipment sufficient to carry out the work as specified. Drilling and soil sampling will be overseen by the field team leader (FTL), an environmental professional (engineer, geologist or scientist), with support staff if required. HDR personnel will prepare soil boring logs with lithologic descriptions and observations relevant to investigative activities, collect soil samples for field or laboratory analysis and monitor compliance with the project Site Safety and Health Plan (SSHP).

3 Health and Safety

Proper safety precautions must be observed during drilling activities and when collecting soil samples in accordance with the SSHP. Each individual assigned to field work must: (1) participate in the HDR Medical Monitoring Program, or subcontractor medical surveillance program, as applicable, (2) must have taken the Occupational Safety and Health Administration (OSHA) 40-Hour course (updated with the 8-Hour OSHA Refresher, when necessary), and (3) must be certified as able to wear respiratory protection.

Each individual is required to have read and understood the SSHP for the specific project activity. Upon arrival at the site, each person shall sign the acknowledgement sheet confirming their review of the SSHP. Personal protective equipment (PPE) and other provisions for site safety requirements are discussed in the SSHP. At a minimum for drilling all personnel will wear a hard hat, steel toe shoes, safety glasses, hearing protection, and a high visibility outer garment.

All equipment will only be used by properly trained personnel. In particular, the use of a photoionization detector (PID) will only be performed by personnel familiar with the equipment. Proper tools will be made available to each employee as necessary. Any questions should be addressed to the FTL.

All drilling locations will be cleared for underground and above ground utilities prior to beginning drilling activities. Prior to setting up on the drilling location, the FTL will confirm the location has been cleared with the appropriate utility companies and the property owner/tenant. Drilling will only proceed where no aboveground or subsurface obstructions exist. Locations will be offset if these obstructions are identified prior to drilling, or encountered after drilling has begun. The new locations will be as close as possible to the originally proposed locations; utility clearance will be performed again as necessary.

If drilling is to occur in the vicinity of overhead utilities, HDR personnel will measure utility line height from the ground surface using a clinometer (or similar device) to ensure a minimum safe clearance distance is maintained between on-site equipment and overhead utility lines. As needed, the appropriate utility company will be contacted in order to determine a recommended safe clearance distance from all aboveground or underground on-site utilities.

Prior to the start of drilling activities, the drilling subcontractor will hand auger at each drilling location to a depth of 4 ft bgs, in order to verify that no underground utilities or objects are present.

4 Personnel Qualifications and Responsibilities

Field activities will be directed by the FTL, an engineer/geologist with experience in the planned drilling activities; junior to mid-level geologists will assist, if necessary. Field activities will be overseen by a Tennessee-licensed geologist or engineer. Drilling will be conducted by a licensed driller and crew familiar with planned activities, the project-specific work plan and SSHP. At least one person on each team will have a current certification in first aid and CPR. Operation of fork lifts on site will be limited to personnel that have documentation for forklift operator safety training.

The FTL will provide direction to field staff to ensure work is performed in accordance with the project documents (Quality Assurance Project Plan [QAPP], project-specific work plan, SSHP, and SOPs). The field staff will carefully review the project documents, conduct the work as planned, seek direction from the FTL when questions or problems arise, and carefully complete field documentation.

5 Equipment and Supplies

The required equipment and supplies will be identified in the project-specific work plan. Field activities should not proceed until the proper tools and equipment are available and in good working order. Usual equipment/supplies for a drilling project will include: a PID, tape measure, Munsell color chart, knife, nitrile gloves, field drill log forms, camera, and work table.

Each team will have use of a truck/van during field activities. An initial safety check should be performed at the start of each shift to confirm the vehicle is in good working condition. The vehicle should then be checked daily for damage or required maintenance.

6 Procedures

6.1 Start-Up Activities

6.1.1 Office

Prior to leaving the office for field work, personnel will perform the following actions:

1. The Project Manager (PM) will assign a FTL to direct field activities and coordinate with project personnel. Task specific responsibilities of the FTL will be addressed in the appropriate SOP; general responsibilities include:
    a. Review project-specific work plan, SSHP, QAPP, and for subcontracted work, review of the subcontract agreement.
    b. Work with PM to properly staff the field activity.
    c. Arrange site access with the property manager (Colliers International-Memphis Depot Industrial Park), tenants and/or property owners.
    d. Have a surveyor locate the proposed drilling locations, and mark each location with a wooden stake and white flagging or white paint.
    e. Notify the Tennessee One Call underground utility location and, if necessary, a private utility location service.
    f. Provide drilling subcontractor with proposed boring location and depth for well permits from Shelby County Health Department (SCHD); confirm receipt of permits.
    g. Coordinate sampling activities and supplies with the project chemist and analytical laboratory.
    h. Confirm availability and condition of DDMT-owned equipment and order additional equipment/supplies for delivery prior to the start of each event.
    i. Prepare field forms and other documentation for the planned event.
    j. Provide all HDR and subcontracted field personnel with time and location for personnel to meet prior to beginning field activities.
    k. Confirm that field staff have a valid Driver's License (or other picture identification) and current OSHA Certification in their possession prior to leaving the office.

6.1.2 Field

After arrival on site, but prior to commencement of operations, the following activities will be performed:

- Complete equipment and supply checklists and verify that required documentation and equipment for drilling and soil sampling activities are on site.
- Notify SCHD prior to start of drilling activities in accordance with permit requirements.
- Review condition of DDMT-owned and rental equipment; inventory field supplies and laboratory-provided sampling supplies.
- Confirm drilling and soil sampling locations are clearly marked and review locations for hazards; determine if the utility locators have adequately marked utilities on the site. Check for overhead dangers such as power lines, and make necessary height measurements to ensure safe clearance distances are maintained.
- Determine requirements for site preparation and clearance, and select location for the placement of the decontamination area, storage of decontamination waters, and soil cuttings.
- Confirm locations and requirements for each sample to be collected.
- Conduct site set up activities to include posting of signage (if applicable) and delineation of work zones as required in the SSHP.
- Calibrate field equipment.
- Conduct team safety meetings as required by the SSHP.
- Conduct team review of the project documents including SOPs to be utilized.
- Complete the Field Event Startup Report and submit to PM.

6.2 Field Operations

Field staff responsibilities are project-specific. At a minimum, field personnel are required to ensure the following items are completed as part of field operations during drilling and soil sampling activities.

6.2.1 Field Documentation

Field activities will be documented in a bound logbook for each team and in field records as required by the project-specific work plan or SOPs. At minimum, the logbook will describe general activities performed, date and time, personnel performing the activity, and weather conditions.

For field measurements, the following additional information will be required:

- The numerical value and units of each measurement
- The identity of and calibration results for each field instrument

For sampling activities, the following additional information will be required:

- Sampling type and method

- The identity of each sample and the depth(s) from which it was obtained
- The amount of each sample
- Sample description (e.g., color, odor, clarity)
- Identification of sampling devices
- Identification of conditions that might reflect representativeness of a sample (e.g., refueling operations, damaged well casings)

Field personnel will complete required data collection/sample control forms (e.g., Chain-of-Custody [COC], Drill logs, Field Sampling Report, etc.).

6.2.2 Drilling Logs

The geologist/engineer will log the subsurface conditions encountered in the boring, and record the information on the drilling log and the logbook. Additional pertinent information will be recorded on the drilling log, including, but not limited to, the following:

- Drilling date
- Drilling method
- Geologist name
- Location of boring/Boring identification
- Driller's name/Drilling subcontractor name/Type of drill rig
- Diameter of inner and outer sonic drill casings
- Diameter of surface casing, casing type and method of installation
- Types of drilling fluids and depths at which they were used
- Weather conditions
- Start and completion time for each boring
- Standard Penetration Test blow counts per six inch advance, if applicable
- Recovery length of each sample
- Visual description of soil using the Unified Soil Classification system (ASTM-D-2488-00)
- Depths at which each soil sample was collected for chemical or physical analysis
- Total number of samples taken
- Total depth of boring
- Boring refusal
- Water losses (if applicable)
- Water bearing strata (depth and thickness)
- Depth at which saturated conditions were first encountered

- Lithologic descriptions and depths of lithologic boundaries
- Zones of caving or heaving
- Depths at which drilling fluid was lost and amount lost
- Drilling rate
- Drill rig reactions such as chatter, rod drops, or bouncing
- Location of the boring relative to an easily identifiable landmark.

6.2.3 Drilling Procedures

Generally, drilling activities will be completed in accordance with the planned activities presented in project work plan. Additionally, the following requirements will apply to drilling activities at DDMT:

- Drilling will conform to Shelby County rules and regulations, and Rules of Tennessee Department of Environment and Conservation (TDEC), Division of Water Supply, Chapter 12-4-10.
- All necessary precautions will be taken to prevent leakage of hydraulic oil or other contaminants from the drilling rig into the borehole or onto equipment that is placed in the hole.
- The only acceptable drilling fluid to be used while advancing the borehole is water. However, water will be used only when necessary as approved by the FTL, and will be from an approved potable water source. If the onsite subcontractor and HDR personnel determine drilling fluid additives (e.g. sodium bentonite) are necessary for drilling operations, PM authorization must be obtained prior to their use.
- During drilling of boreholes with a sonic rig, soil will be collected continuously as 10-foot sections of soil core. These cores will be deposited from the drill casing into 10-foot polyethylene liners; the liners will be laid out for visual logging and sampling for headspace readings and laboratory analysis.
- The drilling subcontractor will place all soil cores on the ground near the drill rig in order for the HDR geologist/engineer to safely examine, log, and collect samples from the recovered soil core.
- The HDR geologist/engineer will maintain visual and verbal communication with the onsite subcontracted driller in order to maintain awareness of any changes in subsurface conditions, amount of water used (if any) during drilling, quantities of materials used during drilling and well installation, or any mechanical problems with the drill rig or support equipment.
- The HDR geologist/engineer will carefully and thoroughly complete all required field documentation in order to provide a complete record of drilling activities, including drill rig maintenance and repairs, subcontractor down time, subsurface conditions and geologic materials encountered.
- The HDR geologist/engineer will determine and record the depth to groundwater observed during drilling.

- When the HDR geologist/engineer is finished with visual logging and sampling of a given 10 foot section of soil core, the drilling subcontractor will place the core in an approved soil cutting disposal container.
- During drilling activities, the drilling subcontractor will notify the onsite HDR geologist/engineer of any significant changes in lithology encountered, significant changes in amount of water being used, and any mechanical problems with the drill rig.
- The HDR geologist/engineer will monitor the breathing zone for organic vapors in accordance with the procedures contained in the SSHP. The tops of the boreholes will be monitored for organic vapors using a PID.
- The HDR geologist/engineer collect soil samples at specified intervals in borings for soil classification and/or chemical analysis or field screening as specified in the project-specific work plan.
- All drilling equipment will be decontaminated prior to drilling activities in accordance with SOP 9 *Equipment Decontamination*.
- Any investigative-derived waste (i.e., drill cuttings, drilling fluid) that is contaminated will be disposed as specified in the project work plan.
- Soil cuttings will be examined for contamination. If contamination is suspected, they will be noted on the boring log form and the suspect soil cuttings will be segregated.
- The HDR geologist/engineer will communicate with the PM regarding site conditions and out of scope work to be performed.

6.2.4 Boring Diameter

The boring diameter is based on a minimum of 2 inches of annular space between the outside diameter of the well casing and the borehole wall. The majority of borings and wells at DDMT are completed in the fluvial aquifer, which is underlain by the uppermost clay of the Jackson Formation/Upper Claiborne Group. For these borings, a 6-inch diameter borehole is advanced 5-10 feet into the clay; after the depth to the clay is confirmed, the boring is back-filled to just below the top of clay or to the target well depth. A borehole diameter of 6 inches allows proper installation of a nominal 2-inch outside diameter well casing.

For wells to be installed in the deeper intermediate or Memphis aquifer, a surface casing is typically installed into the uppermost clay of the Jackson Formation/Upper Claiborne Group in order to prevent cross contamination between formations. For the deeper borings, a 12-inch borehole will be advanced 10 feet into the uppermost clay and an 8-inch diameter surface casing will be installed, either welded sections of carbon steel or threaded Schedule 80 polyvinyl chloride (PVC). After placing the surface casing, the driller will lower a galvanized or PVC tremie pipe connected to a grout pumping unit through the inner annulus of the casing. The driller will pump grout through the injection pipe until the grout returns to the ground surface. The grout will cure for 24 hours before continuing to advance the borehole. Water present in the inner annulus of the casing will be pumped to a holding tank before the borehole is advanced to the target depth. A 6-inch diameter borehole will then be advanced to the target depth for installation of a 2-inch diameter well.

6.2.5 Soil Sampling Procedures

During drilling of boreholes with a sonic rig, soil samples will be collected continuously as 10-foot sections of soil cores. These cores are deposited from the drill casing into 10-foot polyethylene liners, and the liners laid out for visual logging, and to obtain samples for headspace readings and laboratory analysis, if required by the project work plan.

During advancement of the soil borings, the following sampling devices may also be used:

- Chemical Sample Collection: 2 or 3-inch diameter carbon steel split-barrel sampler lined with California brass rings (CBRs)
- Geotechnical Sample (disturbed) Collection: 2-inch diameter carbon steel split-barrel sampler
- Geotechnical Sample (undisturbed) Collection: 3-inch diameter “Shelby Tube” or thin-walled tube sampler

6.2.5.1 Soil Description

Soils will generally be described in accordance with the 1990 ASTM D-2488-90, *Standard Practice for Description and Identification of Soils* (Visual-Manual Procedure). Descriptive information to be recorded in the field will include:

- Identification of the predominant particle size and range of particle sizes
- Percent of gravel, sand, fines, or all three
- Description of grading and sorting of coarse particles
- Particle angularity and shape
- Maximum particle size or dimension

The plasticity of fines description will include:

- Color using Munsell Color System
- Moisture (dry, wet, or moist)
- Consistency of fine grained soils
- Structure of consolidated materials
- Cementation (weak, moderate, or strong)

The Unified Soil Classification System (USCS) group symbols will be used for identification. Additional information to be recorded includes: depth to the water table, caving or sloughing of the borehole, changes in drilling rate, depths of laboratory sample collection, presence of organic materials, presence of fractures or voids in consolidated materials, and other noteworthy observations or conditions, such as the locations of geologic boundaries.

6.2.5.2 Headspace Sampling

At five-foot intervals within the soil cores, the headspace will be screened with a PID. The headspace samples will be collected and analyzed using the following procedure:

- From the sampling location within the soil core, remove the top 1 to 2 inches of soil using a decontaminated stainless steel spoon.

- Partially fill two decontaminated 16-ounce containers with soil using the stainless steel spoon.

- Cover the jars immediately with aluminum foil and fasten the jar lids.

- Allow the sample vapors to equilibrate in the jars (approximately 5 minutes). If necessary, the headspace samples will be brought to a temperature of 20 degrees Celsius (°C) (68 degrees Fahrenheit [°F]) to 32°C (90°F)

- Collect a reading from the first sample jar by puncturing the aluminum foil with the tip of a calibrated PID and recording the highest reading.

- If the reading is > 10 parts per million, collect a reading with the activated charcoal filter on the calibrated FID for the second jar. Determine corrected hydrocarbon measurement of the sample by subtracting the filtered reading from the unfiltered reading.

6.2.5.3 Soil Sample Collection for Laboratory Analysis

Selected soil samples may be collected for laboratory analysis based upon the results of the headspace screening. At these selected locations, samples for volatile organic compound (VOC) analysis will be collected using an Encore or Terracore sampler, or acceptable equivalent. (Note: There is no difference in field criteria for the two samplers. Different laboratories supply different devices and there is a difference in cost.) Samples collected for VOC analysis should be collected from the soil cores in a manner that minimizes disturbance of the sample.

The following items should be considered when collecting soil samples:

- A clean pair of new, non-powdered, disposable gloves will be worn each time a sample is collected.
- Samplers must use new, verified/certified-clean disposable or non-disposable equipment cleaned in accordance with SOP 9 *Equipment Decontamination*.
- Document field sampling, including field conditions, any problems encountered during sampling and sample appearance, in the field logbook. Samples collected will also be noted on the drilling log sheet at the corresponding depth.
- Place any unused sample material into the approved transport/disposal containers along with other drill cuttings generated during sonic drilling activities.
- When soil sampling is completed or when time permits, transfer samples to site office for final packaging. Complete COC documentation and shipping procedures in accordance with relevant SOPs. The completed COC will remain with the samples until custody is relinquished.
- Note any problems encountered during sampling in the Field Sampling Report Form and Daily Quality Control Report Form.

- For borings where a monitoring well will be installed, a sample for total organic carbon (TOC) analysis may be collected from the interval to be screened. The TOC samples will be collected from the soil core using a pre-cleaned stainless steel spoon and placed in the appropriate laboratory supplied container.

6.2.5.3.1 Encore ™ Sampler Procedure

The procedure for collection of VOC samples using an Encore ™ Sampler are as follows:

- Remove sampler and cap from package and attach T-handle to the 5-gram sampler body.
- Quickly push the sampler into a freshly exposed surface of soil until the sampler is full.
- Carefully wipe the exterior of the sampler head with a clean disposable paper towel so that the cap can be tightly attached.
- Push cap on with a twisting motion to attach and seal the sampler.
- Attach the label onto the sampler body, place the sampler into a plastic Ziploc™ bag and place into a cooler with ice.
- Repeat steps a) through e) for the remaining 5-gram and 25-gram sampler.
- Collect a bulk soil sample for screening and moisture determination in a 2 or 4-ounce wide mouth glass jar. Fill the jar completely allowing no headspace. Place the sample in a cooler containing ice.
- Thoroughly mix remaining soil and place into specified labeled containers for remaining parameters.
- Place sample bottles into Ziploc™ or bubble bag and in an iced cooler.
- Complete COC documentation and shipping procedures in accordance with relevant SOPs.

6.2.5.3.2 Terracore Sampler Procedures

The procedure for collection of VOC samples using a Terracore Sampler are as follows:

- Label appropriate laboratory containers
- Quickly push the sampler (Terracore or equivalent) into a freshly exposed surface of soil to collect 5 grams (+ 0.5g) of sample. Also collect a bulk aliquot container for moisture content analysis in the laboratory supplied 4 ounce container.
- Carefully wipe the exterior of the sampler head with a clean disposable paper towel.
- Empty sampler into appropriate laboratory container. The cored samples must be extruded from the selected coring tool to a volatile organic analysis (VOA) vial in accordance with collection and preservation methods described in EPA method 5035A. The extruded core is transferred into a laboratory pre-weighed (tared) VOA vial with septum cap. Unpreserved VOA vials must be analyzed within 48 hours of collection, VOA vials preserved with sodium bisulfate or methanol must be analyzed within 14 days of collection.
- Place the sample into a plastic Ziploc™ bag and place into a cooler with ice.
- Complete COC documentation and shipping procedures in accordance with relevant SOPs.

6.2.6 Post Run Tubing Boring Construction

The post run tubing (PRT) drill rod will be advanced into the subsurface to 5.5 feet bgs by a direct-push drill rig. After reaching 5.5 feet bgs, the PRT rod will be retracted approximately 6 inches exposing the soil interval (5 feet bgs to 5.5 feet bgs) to be sampled. Teflon® tubing will be threaded into the PRT adaptor through the center of the PRT rod and capped to prevent soil gas venting. The annulus around the PRT rod where it penetrates ground surface will be packed with bentonite crumbles and hydrated. The boring will not be disturbed or sampled for a minimum of 2 hours to allow the bentonite crumbles to seal the annulus and allow soil gas to equilibrate. After the soil gas sample has been collected, the PRT drill rod and tubing will be removed from the boring and the boring will be filled to ground surface with neat cement.

6.3 Closeout

6.3.1 Daily Closeout

Perform following activities daily before leaving the site:

- Decontaminate and check condition of field equipment.
- Provide logbooks and other field documentation to FTL for review.
- Properly dispose of trash, debris and used PPE.
- Make arrangements for shipment of samples (if applicable) and follow-up with the analytical laboratory to confirm samples arrived in good condition.
- Secure the site for the night and/or weekend.
- Prepare the daily field report as required by the project-specific work plan or SOPs and submit report to the PM. Note any problems or deficiencies in field activities.

6.3.2 Field Event Closeout

Upon completion of field activities, the FTL will view each site to verify the area has been cleared and restored as closely as possible to its prior condition. The following activities will be performed prior to the completion of each field event:

- All trash will be removed from site and disposed of appropriately
- Any damage to the ground surface, including ruts, will be repaired
- All equipment is accounted for, properly decontaminated, and in good working condition. The FTL will be notified if repairs are needed
- Rental equipment has been properly cleaned, packaged, and shipped to the appropriate vendor
- Shipments are made using the correct HDR FedEx number and packages insured for the cost of the rental item
- Manufacturer’s instructions are followed regarding long and short term storage for all equipment

- Rental vehicles are refueled and returned to the rental company
- HDR leased vehicles are cleaned and refueled
- All work areas have been cleaned, and tools and equipment have been stored properly

The FTL will make a final check of all drilling logs, logbooks and other field records to ensure there are no blanks or missing data and the entries are legible. The FTL will complete Field Event Closeout Report and submit to PM.

7 Data and Records Management

All field forms and logbook entries will be scanned and copied to the project folder on the network file share drive within one week of the field event completion. All photographs taken during the field event will also be uploaded along with a typed photograph log (date, project and subject) to the network file share. All uploaded photographs will then be erased from the camera. All original forms will be stored on site at the field office in Memphis in the appropriate project-specific filing cabinet and task-specific labeled folder.

8 Quality Control and Quality Assurance

All work will be performed in accordance with the QAPP, the project-specific work plan, and applicable SOPs. All field activities will be recorded in the logbooks in sufficient detail to reconstruct the events. No erasures or mark outs will be made on field forms or logbooks. A single line will be used to strike out errors and will be annotated with the initials and date of the editor. Boring logs will be typed into a spreadsheet provided by the CAD operator for the inclusion into computerized drill logs.

9 References

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USEPA Region 4 SESD Guidance, *Design and Installation of Monitoring Wells* (SESDGUID-101-R1), January, 2013.

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STANDARD OPERATING PROCEDURE 5 – VAPOR SAMPLE COLLECTION

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operating Procedure (SOP) provides guidance for vapor sample collection at Defense Depot Memphis, Tennessee (DDMT). The project work plan must be reviewed for specific requirements.

2 Health and Safety

General Information on health and safety requirements are provided in SOP 1. Each individual is required to have read and understood the Site Safety and Health Plan for the specific project activity and signed the acknowledgement sheet confirming their review.

Health and safety concerns for vapor sampling include the use of lead-acid batteries, pressurized tubing, hot surfaces, and biological hazards. Batteries should be handled and transported properly to avoid acid spills. Some vapor samples locations are under positive pressure, and safety glasses should be worn at all times. Equipment in the machine rooms, including metal piping, can be very hot and care should be taken to not come in contact with the hot surfaces. Biological hazards include spiders, wasps, bees, and possibly snakes; care should be taken when reaching into areas that cannot be visually inspected.

3 Personnel Qualifications and Responsibilities

Vapor sampling will be directed by a Field Team Leader (FTL), an environmental professional (engineer, geologist or scientist) with appropriate experience. Field staff will be junior to mid-level environmental professionals or environmental technicians.

4 Equipment and Supplies

The required equipment and supplies will be identified in the project work plan for the specific field activities to be performed. Field activities should not proceed until the proper tools and equipment are available and in good working order. Usual equipment/supplies for a vapor sampling will include: a photoionization detector (PID), a vacuum pump, a set of tedlar bags, Summa canisters (1 liter or 6 liters) and Summa canisters wrenches.

Each sampler will have use of a truck/van during field activities. An initial safety check should be performed at the start of each shift to confirm the vehicle is in good working condition. The vehicle should then be checked daily for damage or required maintenance.

5 Procedure

5.1 Start-Up Activities

5.1.1 Office

The Project Manager (PM) will assign a FTL to direct field activities and coordinate with project personnel. General responsibilities are described in SOP 1. Task specific responsibilities include:

- Coordinate sampling activities with the project chemist (PC) and analytical laboratory; prepare a sampling plan detail listing the sample locations and schedule shipment of laboratory-supplied Summa canisters and equipment for arrival prior to the start of sampling.
- Confirm availability and condition of DDMT-owned equipment and order additional equipment/supplies (tubing and Tedlar bags) for delivery prior to the start of sampling event.
- Prepare field forms and other documentation for the planned event.

5.1.2 Field

After arrival on site, but prior to commencement of operations, the following activities will be performed:

- Complete equipment and supply checklists and verify that required documentation and equipment for field activities are on site.
- Review condition of DDMT-owned and rental equipment; inventory field supplies and laboratory-provided sampling supplies. Sample tubing and Tedlar bags should be replaced every three months.
- Confirm the exact locations of the samples to be collected.
- Check that monitoring equipment is functioning properly, and calibrated as needed.
- Due to the limited field activities for vapor sampling, completion of the Field Event Startup Report (SOP 1, Attachment 1-1) is not required.

5.2 Field Operations

Prior to sampling, a field station will be established. The station will contain equipment, supplies, safety gear, and instrumentation necessary for the collection of samples. Environmental conditions will also be noted. Each sampling site will be characterized by the following factors:

- Location of work
- Weather conditions including precipitation, temperature and wind direction
- Ongoing activities that may influence or disrupt sampling efforts

- Accessibility to the sampling locations

All laboratory sampling will be documented in the field logbook. The logbook will summarize sampling events include sampling locations and times, field conditions and other significant information.

5.2.1 Sample Locations

Field screening and laboratory vapor samples are collected from individual soil vapor extraction (SVE) wells, the SVE system effluent (vapor stream from all SVE wells), and vapor monitoring points (VMPs), sub-slab vapor ports, and soil borings. Samples for field measurements will be collected using an oil-less vacuum pump and captured in Tedlar bags for photoionization detector (PID) and/or helium detector readings. Laboratory vapor samples will be collected via Summa canisters.

5.2.2 Sample Containers

Laboratory samples will be collected by field personnel in accordance with the project work plan and at the direction of the PM. Sample collection will follow United States Environmental Protection Agency (USEPA) TO-15 volatile organic compounds (VOCs) procedures. Laboratory samples from the SVE system effluent will be collected in 6-liter Summa canisters; a 200 milliliter/minute (mL/min) regulator for laboratory analysis will be used when collecting samples from VMPs. Laboratory samples from sub-slab sample ports and soil borings will be collected in 1-liter Summa canisters restricted with a 200 mL/min regulator. Standard turnaround time (TAT) for laboratory results is 15 workdays.

Summa canisters will be delivered from the analytical laboratory; a pressure gauge and a flow regulator (if needed) for each canister should be included. Arrangement for delivery will be coordinated by the PC.

5.2.3 SVE Wells and System Effluent

Field measurements and samples for laboratory analysis will be collected to monitor system performance and VOC concentrations in emissions.

5.2.3.1 Field Measurements

Field measurements will be collected from individual SVE wells and the system effluent. While online, the SVE system is continuously pulling vapor from the subsurface; thus, no purging of wells or the system is required prior to field (PID) sample collection. Ensure all wells to be sampled are online for a minimum of two hours prior to sample collection. Field measurement procedures are as follows:

- Connect sampling pump inlet hose to SVE well sample port located on SVE manifold.
- Open appropriate well sample port ball valve.
- Turn on sampling pump and allow it to run for five seconds to purge the pump and tubing.
- Connect tedlar bag to discharge of sampling pump by inserting nipple of bag into pump discharge tube.

- Allow tedlar bag to fill (approximately 20 seconds).
- Once filled, disconnect tedlar bag from sampling pump.
- Close SVE well sample port ball valve.
- Connect calibrated PID Meter to tedlar bag.
- Allow PID Meter to measure VOC concentration. Ensure reading on PID meter stabilizes before recording VOC concentration. This usually takes 10 to 15 seconds.
- Record peak VOC concentration and time.

5.2.3.2 Laboratory Samples

Procedures for sample collection from the SVE wells and system effluent are as follows:

- Fill out Summa canister tag with sampling information using a pen with blue or black waterproof ink.
- Remove the Summa canister valve cap.
- Run dedicated tubing from SVE manifold to canister by connecting swagelock.
- Open appropriate SVE well/effluent sample port ball valve.
- Record starting Summa canister pressure on chain-of-custody (COC). The starting Summa canister pressure should be at least -25 inches of mercury (in. Hg) or greater. If not, the canister has leaked and should not be used for sampling. Additional canisters will be ordered from the laboratory if needed. The laboratory will be notified of canisters with insufficient starting vacuum levels to prevent charges for unusable canisters.
- Open Summa canister valve located at top of sampling canister.
- Record sampling start time on COC.
- Allow Summa canister to fill until pressure gauge reads -5 in. Hg. (approximately 2 minutes with a 6-liter canister).
- Close sampling port ball valve at SVE well.
- Disconnect Summa canister from regulator.
- Record time of sample collection, date, and Summa canister serial and regulator numbers on COC form.

5.2.4 Vapor Monitoring Points

Field measurements and samples for laboratory analysis will be collected from VMPs to evaluate system performance and determine SVE well vacuum influence. It is necessary to purge VMPs prior to sample collection. Procedure will be repeated for the ‘A’ and ‘B’ screens at each VMP.

Purging:

- Unlock VMP well casing (secured by padlock).
- Attach regulator to “quick connect” on well cap, run line to a “T” connection.

- Run one line out from the “T” to the pump.
- Attach second line to the Summa canister via swagelock.
- Turn on sampling pump and allow lines to purge for approximately five minutes. Purge time is based on tubing diameter and length and is intended to remove three tubing volumes.

<u>Field (PID) Measurements:</u>

- Attach tedlar bag to discharge of sampling pump by inserting nipple of bag into pump discharge tube.
- Allow tedlar bag to fill (approximately 20 seconds).
- Once filled, disconnect tedlar bag from sampling pump.
- Connect calibrated PID Meter to tedlar bag.
- Allow PID Meter to measure VOC concentration. Ensure reading on PID meter stabilizes before recording VOC concentration. This usually takes 10 to 15 seconds.
- Record peak VOC concentration and time.
- Open valve on tedlar bag to completely deflate bag.
- Collect additional PID readings following the previous steps until three consecutive readings are within 10% of each other.

5.2.4.1 Laboratory Samples

Procedures for sample collection from the Dunn Field VMPs are as follows:

- Attach the vacuum pump and its dedicated tubing to the VMP well quick connect fitting.
- Close the valve to the “T” fitting and open the valve to the pump and start the pump.
- Each VMP has a purge time determined and it is on the VMP sample collection sheet for each VMP; run the vacuum pump for the allotted time.
- Attach a tedlar bag to the output from the vacuum pump and allow it to fill.
- Read the tedlar bag with a PID and record the result; repeat this procedure until three readings are within 10%.
- Fill out the Summa canister tag with sampling information using a pen with blue or black waterproof ink.
- Remove the Summa canister valve cap.
- Attach regulator to 6-liter Summa canister. An individual regulator should be provided by the laboratory for each Summa canister to be used for VMPs.
- Connect the Summa canister to the “T” tubing that was used to purge the VMP tubing. The Summa canister is connected before the vacuum pump, because the Summa canister is under its own vacuum.
- Open appropriate VMP sample port ball valve.

- Record starting Summa canister pressure on COC. The starting Summa canister pressure should be at least -25 in. Hg or greater. If not, the canister has leaked and should not be used for sampling. Additional canisters will be ordered from the laboratory if needed. The laboratory will be notified of canisters with insufficient starting vacuum levels to prevent charges for unusable canisters.
- Open Summa canister valve located at top of sampling canister.
- Record sampling start time on COC.
- Allow Summa canister to fill until pressure gauge on regulator reads -5 in. Hg (approximately 30 minutes with a 6-liter canister and a 200 mL/min flow regulator).
- Close sampling port ball valve at VMP cap.
- Disconnect Summa canister from regulator.
- Record time of sample collection, date, and Summa canister serial and regulator numbers on COC form.

5.3 Sub-Slab and Soil Boring Vapor Sampling

Sub-slab sample ports and temporary soil borings will be installed to evaluate VOC concentrations beneath or adjacent to impervious surfaces. VaporPin, or equivalent device, will be constructed in accordance with manufacture specifications to allow for collection of sub-slab samples. Shallow soil gas samples will be collected from soil borings via the post run tubing (PRT) method. Procedures for these sampling methods are presented below.

<u>Leak Check</u>

Leak check should be performed prior to sample train purging and sampling to verify the integrity of the sub-slab sample port (Water Dam Procedures) and PRT annular seal (Tracer Test) and to identify the presence of leaks in the sample train (Shut-In Test).

5.3.1 Water Dam Procedure

Leak testing of the Vapor Pin annular seal will be performed with a water dam in accordance with the method prescribed in the Vapor Intrusion Technical Guidance (NJDEP, 2016). The water dam will be constructed from PVC and surround the sub-slab sample port. The water dam will be sealed to the concrete floor with modeling clay or other VOC free inert material. The water dam will be filled with distilled/deionized water so that it is covering the sub-slab sample port annular seal. The water level will be briefly observed to verify that the water level is not receding. If the water level remains stable the sample train will be purged and a sample will be collected while continuing to observe the water level. Should the water level decrease, the sampling will be stopped, a new sub-slab sample port will be installed and the process repeated.

5.3.2 Tracer Test

A tracer test is used to determine whether ambient air is introduced into the soil gas sample during the collection process. The tracer test and well purging will be performed simultaneously by the steps described below:

1. Connect aboveground sample train to PRT tubing and place a shroud over the drive rod and sample train;
2. Inject He gas under the shroud to achieve a target shroud concentration of two orders of magnitude greater than the He meter minimum detection limit;
3. Purge three casing volumes from the sample train with a syringe or pump, at a flow rate of 100 to 200 ml/min and contain the purged gas in a Tedlar bag;
4. Use the He detector to measure the He concentration in the Tedlar bag and beneath the shroud;
5. If the He concentration in the Tedlar bag is less than 5 percent (%) of the concentration beneath the shroud then a sample can be collected; and
6. If the He concentration in the Tedlar bag is greater than 5% of the concentration beneath the shroud than the annular seal may be compromised. A sample can still be collected, but the technician will note that the He test failed and the result will be flagged.

5.3.3 Shut-In Test

A shut-in test will be performed prior to purging and sampling soil gas and sub-slab aboveground sampling trains to locate leaks. This test is performed by assembling the sample train, as if a sample was being collected, and a vacuum of at least 100 inches of water (7.4 inches of mercury) is applied. At this point, the sample train should be isolated from the sub-slab sample port either by a valve or disconnected and plugged so that the vacuum can be applied without evacuating soil gas. After the vacuum is applied, the field technician will observe the vacuum gauge on the sample train for any change in vacuum. If the vacuum in the sample train dissipates then the leak will be located, corrected, and the test will be repeated until the sample train can hold a vacuum for at least thirty seconds.

Sampling

After the field technician has completed the shut-in test, tracer test, and purged three casing volumes, the soil gas sample will be collected. This will be performed by opening the valve on the top of the 1-liter Summa canister and allowing the canister vacuum to remove one liter of soil gas at a 200 ml/min flow rate. The Summa canister will be labeled with the sample identification, starting vacuum, ending vacuum, sampler's initials, sample date, and sample time.

Field records will be maintained that detail site activities and observations so that an accurate, factual account of field procedures may be reconstructed. At a minimum, the field records will contain sample identification, collection time, location description, methods used, daily weather conditions, field measurements, name of sampler(s), names of contractor/subcontractor personnel, and other site-specific observations including any deviations from the project work plan. HDR will periodically record the precipitation, temperature, and barometric pressure from a nearby weather station during and 72 hours prior to sample collection.

5.4 Closeout

5.4.1 Field

Following sample collection, the following procedures will be performed by on-site personnel:

- Decontaminate all field equipment.
- Ensure all field documentation is completely filled out. This includes the COC and Summa sampling tag. Unless revised by the project manager, standard turn-around time (15 days) will be used. Retain copy of COC for the project file.
- Package Summa canisters in sturdy cardboard boxes with packing material to prevent any potential puncture of the canister. In most cases, the boxes and packing material used by the laboratory to ship the Summa canisters to the site can be reused.
- Affix a custody seal across the top taped seam of the canister shipping carton and elsewhere as necessary to ensure security.
- Ship Summa canisters to laboratory for analysis. Ensure copy of COC is included in shipment.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Ensure that equipment and associated supplies have been shipped back to the office or supplier.
- Ensure that all IDW/trash has been disposed in accordance with the project work plan and QAPP.

5.4.2 Office

Upon return to the office, field personnel will perform the following:

- Submit logbook and any original forms to Project/Task Manager for review
- Completion of the Field Event Closeout Report (Attachment 1-3) is not required.

6 Data and Records Management

All field forms and log book entries will be scanned and copied to the project folder on the “Z” drive within one week of the field event completion. All photographs taken during the field event will be uploaded along with a typed photograph log (date, project and subject) to the “Z” drive. All original forms will be stored on site in Memphis in the filing cabinet in the proper folder labeled for the project. The PM and PC will be sent a link for the data.

7 Quality Control and Quality Assurance

All work will be performed in accordance with the Quality Assurance Project Plan (HDR, 2017a), the project work plan, and applicable SOPs. All field activities will be recorded in the log books in sufficient detail to reconstruct the events. No erasures or mark outs will be made on field forms or log books. A single line will be used to strike out errors and will be annotated with the initials and date of the editor.

8 References

HDR, 2017a. *2017 Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 0*. Prepared for the U.S. Army Corps of Engineers, Mobile District. May 2017.

New Jersey Department of Environmental Protection (NJDEP), 2016. *Vapor Intrusion Technical Guidance,* August 2016.

STANDARD OPERATING PROCEDURE 7 – SAMPLE CONTROL AND DOCUMENTATION

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operating Procedure (SOP) provides guidance for sample control and identification, data recording, and proper completion of Chain-of-Custody (COC) forms.

2 Health and Safety

General Information on health and safety requirements are provided in SOP 1. Each individual is required to have read and understood the Site Safety and Health Plan for the specific project activity and signed the acknowledgement sheet confirming their review.

Health and safety concerns for sample handling include potential for exposure to contaminants, sample container preservatives, and injury from breakage of sample containers. Contamination levels at Defense Depot Memphis, Tennessee (DDMT) are relatively low but care should be taken to avoid exposure. Sample containers should be handled carefully; nitrile gloves and safety glasses should be used.

3 Personnel Qualifications and Responsibilities

Sample control activities will be directed by the Field Team Leader (FTL), an environmental professional (engineer, geologist or scientist) with experience in sampling activities. The field staff, environmental professionals or technicians, are responsible for proper sample handling and documentation of the sample collection.

4 Equipment and Supplies

The field staff will use a pen with blue or black waterproof ink to record field activities and document sample handling in a field logbook and on field data sheets. A laptop computer with laboratory-provided software may also be used for sample documentation.

5 Procedure

Proper field sampling and documentation help ensure sample authenticity and data integrity. These procedures describe sample collection documentation and sample handling, tracking, and custody procedures to ensure that sample integrity and custody are maintained.

If the computer is being used to scan the samples as they are collected the data recorded by the computer should be checked for correctness. The date and time on the computer should be checked prior to scanning of any samples. The sample label should be completed when the sample is collected. If a hand written COC will be used, all information should be recorded in a log book as to the type of sample, date and time collected and number of sample containers. The COC can then be filled out back at the field office in a quiet environment with out disturbances to avoid errors.

Corrections to the COC, field logbook or field data forms will be made by a single line to strike out errors annotated with the initials and date of the editor; the correct information will be inserted as appropriate.

The number of sample containers on the COC should be physically checked against the number of containers collected. Once this is confirmed the sample crew can properly store the samples for shipment.

5.1 Start-Up Activities

5.1.1 Office

The FTL will work with the project chemist (PC) to:

- Prepare the sampling plan detail (Attachment 7-1).
- Coordinate with the analytical laboratory and ensure that sample forms including chain of custody forms and custody seals are shipped to the site.

5.1.2 Field

After arrival on site, but prior to commencement of operations, the FTL will confirm that required documentation and equipment for field activities are on site.

5.2 Field Operations

5.2.1 Sample Identification

Individual samples will be identified by a unique alphanumeric code (also referred to as a sample ID number or field number) which will be written on the sample label and recorded on the COC form. The sample ID will include the location and sampling event as described in Worksheet #17 of the Quality Assurance Project Plan (QAPP). Additional information to be written on the label includes sample ID, time and date of sample, sampler's initials, and the analytical methods to be performed, as described in Section 5.2.3 of this SOP.

Field Quality Control (QC) samples to be collected at DDMT include trip blanks, rinsate blanks, field (ambient) blanks, and field duplicates. The ID for trip blanks, rinsate blanks and field blanks will consist of the prefix TB, RB or FB, respectively, followed by a number, followed by the sampling event, as shown below:

TB-1-ODPM-9	first Trip Blank for event ODPM-9
TB-2-ODPM-9	second Trip Blank for event ODPM-9
RB-1-ODPM-9	Rinsate Blank for event ODPM-9
FB-1-ODPM-9	Field Blank for event ODPM-9

Matrix spike and matrix spike duplicate samples will also be collected. The ID for these samples will consist of the location ID, followed by the sampling event, followed by the suffix matrix spike (MS) or matrix spike duplicate (MSD), as shown below:

MW-164-ODPM-9-MS	Matrix Spike sample for well MW-164
MW-164-ODPM-9-MSD	Matrix Spike Duplicate sample for well MW-164

The identity of field duplicate samples will be concealed from the laboratory by using a consecutively numbered duplicate identifier, followed by the sampling event, as shown below:

DUP-1-ODPM-9	first field duplicate for event ODPM-9
DUP-2-ODPM-9	second field duplicate for event ODPM-9

The location of field duplicates will be recorded on the sampling plan detail (SPD) and field notebook. The final SPDs will be maintained in the project file and copies will be kept at the on-site field office. At the end of the sampling event, the FTL will send the PM and PC the final SPD with changes to field duplicate or MS/MSD sample IDs, additional blanks collected, and any other changes.

5.2.2 Field Documentation

5.2.2.1 Logbook

The logbook is a written record of sampling activities to be completed in the field during sampling. The purpose is to document field conditions or procedural exceptions that may aid in the analysis of data generated from sampling activities. The log book will have with sequentially numbered pages and information will be recorded in blue or black waterproof ink. The recorder will sign and date each entry.

Information pertaining to environmental conditions at the site during the field investigation will be noted in the field log book for each day. The following information will be recorded for each activity:

1. Activity
2. Location
3. Date and time
4. Weather conditions

For field sampling activities, the following information will be recorded, if a sampling form is not used:

1. Sample type and sampling method

2. The identity of each sample and the depth(s) from which it was collected
3. Sample description (e.g., color, odor, clarity)
4. Identification of sampling devices used
5. Identification of sampling conditions that might affect the representativeness of a sample (i.e., refueling operations, damaged casings)

5.2.2.2 Daily Field Reports

Each day the FTL will prepare a Daily Field Report (SOP 1, Attachment 1-2). The report will include daily weather, time and description of field activities, samples collected, and any problems or changes in scope that occurred that day. The report also lists field staff, subcontractors and site visitors.

5.2.2.3 Photographs

Photographs taken for the purpose of project documentation will be noted in the field logbook. The sequential number of the photograph, photographer, date, time, location, description, and orientation of the photograph will be recorded in the logbook as the photographs are taken. The photographs and documentation will be loaded on the HDR network project file.

5.2.3 Sample Labels/Tags

Sample labels will be filled out for each sample with an indelible pen. The label will be protected from water and solvents with clear label protection tape. Any change in the pre-prepared label information will be initialed by the sampler.

5.2.3.1 Labels for Groundwater Samples

Pre-printed labels from the laboratory for groundwater sampling events contain the following information:

- Sample ID
- Preservative
- Date the bottle was prepared
- Matrix
- Tests
- Laboratory name
- Bar code

The sample collector will write in the following information:

- Date of collection
- Time of collection
- Name or initials of collector

5.2.3.2 Sample Tags for Air Samples

Sample tags from the laboratory for air sampling events contain the following information:

- Laboratory name, address, phone number and fax number

The sample collector will write in the following information:

- Client name (HDR)
- Sample ID
- Analysis (TO-15)
- Date and time of sample collection
- Sampler's initials
- Comments

5.2.4 Sample Custody

Sample custody is a part of a quality field or laboratory operation. Custody of a sample is defined as:

1. Having physical possession
2. Being in view, after being in possession
3. Having possession, then being placed in a secure area
4. Being maintained in a secure area by the person who had possession last

These custody practices will be observed in the field. They will be performed according to the procedures described in the following subsections.

5.2.4.1 COC Records

A hand-written three-part COC will be fully completed, in triplicate. The first two pages will accompany the cooler to the laboratory, and the bottom copy will be retained in the files at the field office after it is scanned into the computer file.

A computer-generated COC will have one copy printed that will accompany the cooler to the laboratory. The data used to generate the COC will be transmitted via E-mail to the laboratory and a PDF copy of the COC will be saved on the computer in the sampling file.

The information specified on the COC record will contain the same level of detail found in the site log book, with the exception that on-site measurement data will not be recorded. The custody record will include at least the following information:

- Name of person collecting the samples
- Date samples were collected
- Type of sampling conducted (composite/grab)
- Location of sampling station (including the site location)
- Number and type of containers used

- Signature of the HDR person relinquishing samples to a non-HDR person (such as a FedEx agent), with the date and time of transfer noted, and the cooler designation
- Airbill Number

If samples will require rapid turnaround in the laboratory because of project time constraints or analytical concerns such as extraction time or sample retention period limitations, these constraints will be noted in the remarks section of the custody record. The FTL or designee will contact the laboratory to confirm the turnaround time can be achieved. The computer generated COC is for use with Microbac Laboratories only. Other laboratories will provide COCs for use.

It is not practicable to seal the sample coolers or cartons at a FedEx office; they will be sealed beforehand. The custody record will, therefore, have the signature of the relinquishing field technician with the date and time, but the “relinquished to” box will not be completed.

The duplicate custody record will then be placed in a plastic bag, taped to the underside of the cooler lid, and the cooler closed. COCs for air samples will be included in the carton. The container will be tightly bound with filament tape. Finally, custody seals will be signed by the individual relinquishing custody and affixed in such a way that the cooler or carton cannot be opened without breaking the seals.

The original and duplicate custody records and the airway bill or delivery note together constitute a complete record. The FTL will email a copy of the airbill and the COC to the PC, who will maintain the custody records as part of the analytical data file.

Custody Seals: Custody seals will be preprinted, adhesive-backed seals designed to break if disturbed. For groundwater samples, affix custody seals on the sample shipping containers (coolers) in as many places as necessary to ensure security. For vapor samples affix a custody seal across the top, taped seam of the canister shipping carton and additional locations as necessary. Seals will be signed and dated before application.

Laboratory custody procedures are described in the laboratory sample handling and storage SOPs L8 and L104, included in Appendix C of the QAPP.

5.3 Closeout

Before leaving the site daily, the following procedures will be performed by on-site personnel:

- Maintain custody of samples, maintaining them as specified for the analyses to be performed.
- Prepare samples for shipment to the laboratory.
- Complete the COC forms.
- Contact the laboratory to inform them that samples will be shipped and also remind them of any special requirements for the sample analyses.
- Verify completion of logbook, ensuring that required information has been recorded.

Upon the completion of sample collection and shipment, copies of the COCs will be scanned and sent to interested parties to include the PM and PC. The FedEx tracking numbers will be checked each day to confirm the samples were delivered and the laboratory will be contacted to check on problems with the samples or COCs.

6 Data and Records Management

All field forms, COCs, and log book entries will be scanned and copied project folder on the HDR network project file within one week of the field event completion. All original forms will be stored on site in Memphis in the filing cabinet in the proper folder labeled for the project. The PM and PC will be sent a link for the data.

7 Quality Control and Quality Assurance

Work will be performed in accordance with the QAPP, the specific work plan, and applicable SOPs. Field activities will be recorded in the log books in sufficient detail to reconstruct the events and forms provided with the SOP will be completed. No erasures or mark outs will be made on field forms or log books. A single line will be used to strike out errors and will be annotated with the initials and date of the editor; the correct information will be inserted as appropriate.

8 References

HDR, 2017a. *2017 Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 0*. Prepared for the U.S. Army Corps of Engineers, Mobile District. May 2017.

SESDPROC-209-R2, *Operating Procedure: Packing, Marking, Labeling and Shipping of Environmental and Waste Samples,* 2011.

Attachment 7-1

EXAMPLE: Sample Plan Detail

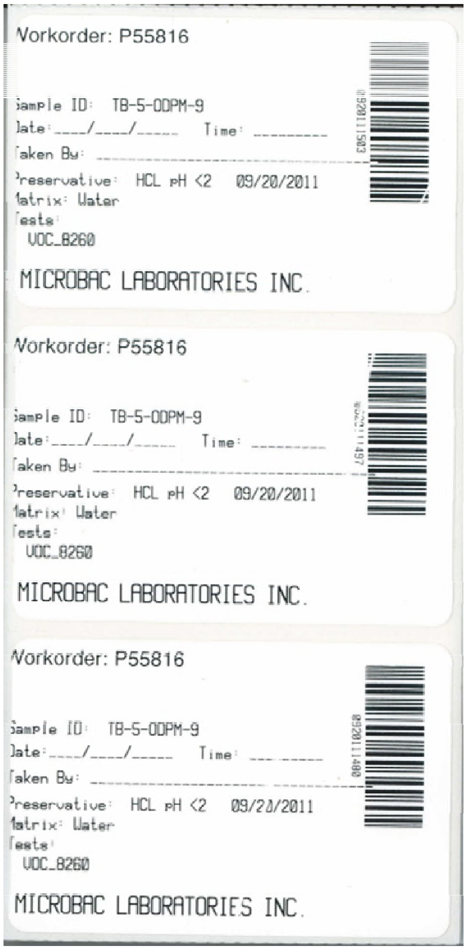
SAMPLING PLAN DETAIL (OFF DEPOT PM WELLS September 2011) - ODPM-9

Parameter	**VOCs**
Method	**8260B**
Container	**40 mL VOA**
Preservative	**HCl to pH<2** **Cool to 4°C**

#	Well ID	Sample ID	Additional	No. of Containers
1	MW-54	MW-54-ODPM-9		3
2	MW-70	MW-70-ODPM-9		3
3	MW-76	MW-76-ODPM-9		3
4	MW-77	MW-77-ODPM-9		3
5	MW-79	MW-79-ODPM-9	DUP-1	3
6	MW-148	MW-148-ODPM-9		3
7	MW-149	MW-149-ODPM-9		3
8	MW-150	MW-150-ODPM-9		3
9	MW-151	MW-151-ODPM-9		3
10	MW-152	MW-152-ODPM-9		3
11	MW-155	MW-155-ODPM-9		3
12	MW-157	MW-157-ODPM-9		3
13	MW-158	MW-158-ODPM-9		3
14	MW-158A	MW-158A-ODPM-9		3
15	MW-159	MW-159-ODPM-9	DUP-2	3
16	MW-160	MW-160-ODPM-9		3
17	MW-161	MW-161-ODPM-9		3
18	MW-162	MW-162-ODPM-9		3
19	MW-163	MW-163-ODPM-9		3
20	MW-164	MW-164-ODPM-9		3
20	MW-164	MW-164-ODPM-9-MS	MS	3
20	MW-164	MW-164-ODPM-9-MSD	MSD	3
21	MW-165	MW-165-ODPM-9		3
22	MW-165A	MW-165A-ODPM-9		3
23	MW-166	MW-166-ODPM-9		3
24	MW-166A	MW-166A-ODPM-9		3
25	MW-241	MW-241-ODPM-9		3
26	MW-242	MW-242-ODPM-9		3
27	MW-243	MW-243-ODPM-9		3
28	MW-244	MW-244-ODPM-9		3
29	MW-245	MW-245-ODPM-9		3
30	MW-246	MW-246-ODPM-9		3
31	RB	RB-ODPM-9		3
32	DUP-1	DUP-1-ODPM-9		3
33	DUP-2	DUP-2-ODPM-9		3
34	TB-1	TB-1-ODPM-9		3
35	TB-2	TB-2-ODPM-9		3

Attachment 7-2

<u>EXAMPLE:</u> Sample Labels for Groundwater Samples



Workorder: P55816

Sample ID: TB-5-ODPM-9
Date:____/____/_____ Time: _________
Taken By: __________________________________
Preservative: HCL pH <2 09/20/2011
Matrix: Water
Tests:
VOC_8260

MICROBAC LABORATORIES INC.

0920111503

Workorder: P55816

Sample ID: TB-5-ODPM-9
Date:____/____/_____ Time: _________
Taken By: __________________________________
Preservative: HCL pH <2 09/20/2011
Matrix: Water
Tests:
VOC_8260

MICROBAC LABORATORIES INC.

0920111497

Workorder: P55816

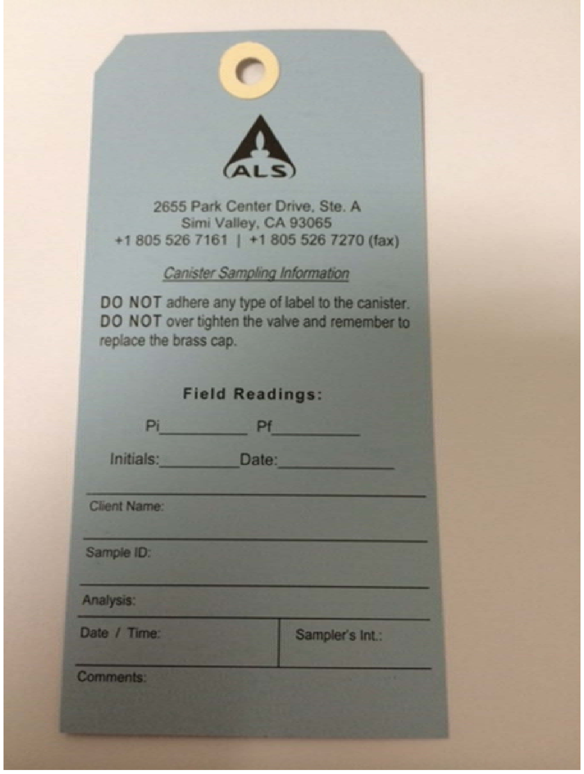
Sample ID: TB-5-ODPM-9
Date:____/____/_____ Time: _________
Taken By: __________________________________
Preservative: HCL pH <2 09/20/2011
Matrix: Water
Tests:
VOC_8260

MICROBAC LABORATORIES INC.

0920111480

Attachment 7-3

EXAMPLE: Sample Labels for Air Samples



ALS

2655 Park Center Drive, Ste. A
Simi Valley, CA 93065
+1 805 526 7161 | +1 805 526 7270 (fax)

Canister Sampling Information

DO NOT adhere any type of label to the canister. **DO NOT** over tighten the valve and remember to replace the brass cap.

Field Readings:

Pi________ Pf________

Initials:________Date:________

Client Name:

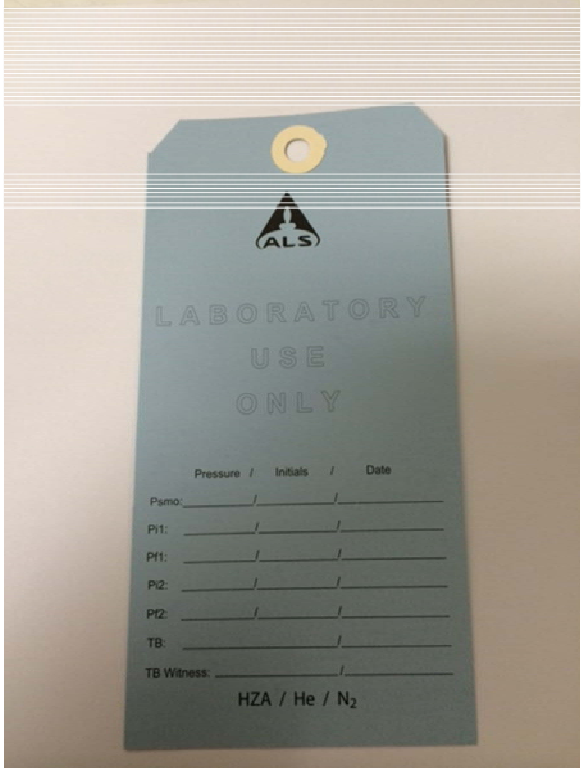
Sample ID:

Analysis:

Date / Time:

Sampler's Int.:

Comments:



ALS

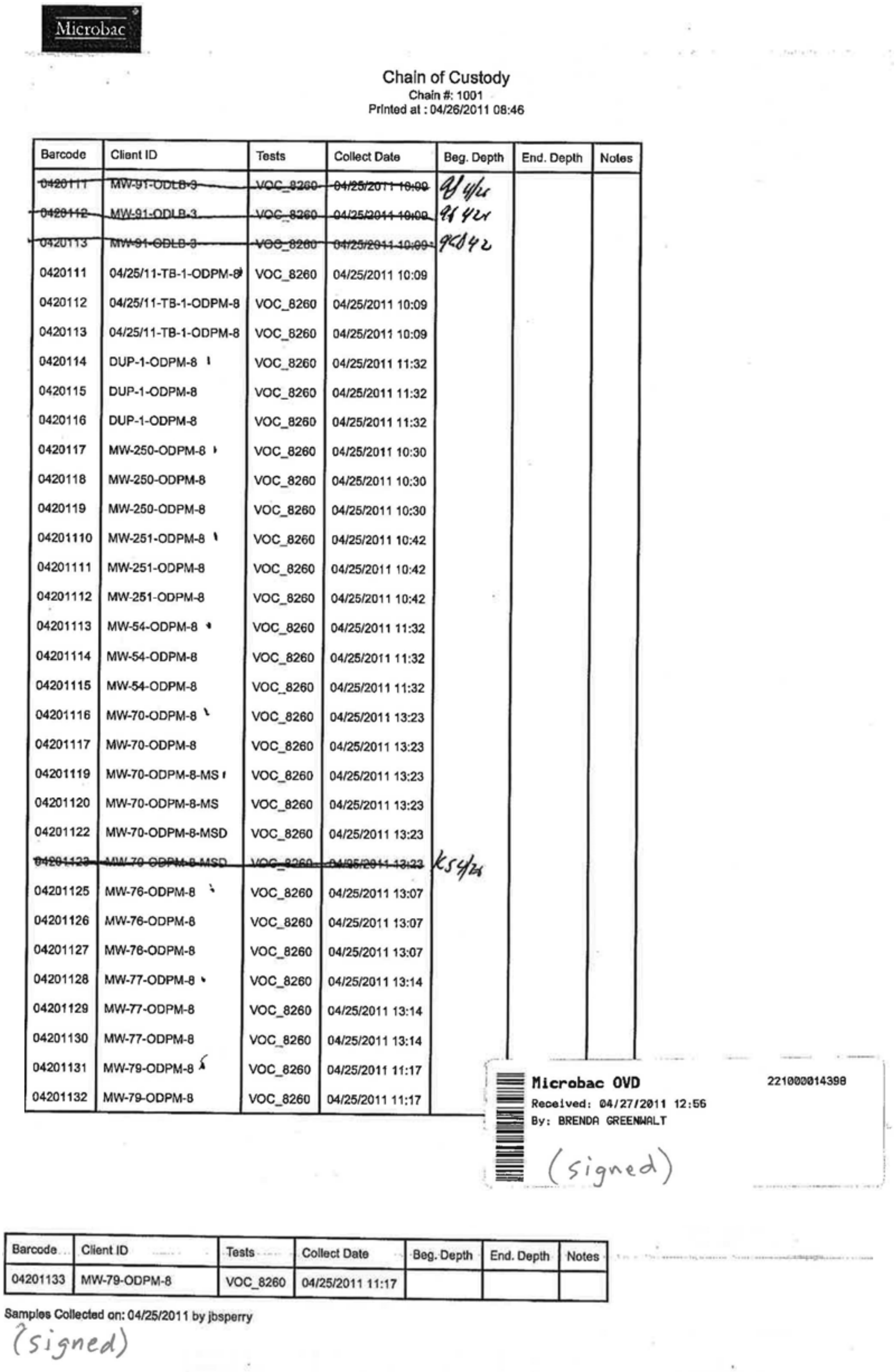
LABORATORY USE ONLY

	Pressure	Initials	Date
Psmo:			
Pi1:			
Pf1:			
Pi2:			
Pf2:			
TB:			
TB Witness:			

HZA / He / N_2

Attachment 7-4

EXAMPLE: Microbac Chain-of-Custody Form (Computer)



Microbac

Chain of Custody
Chain #: 1001
Printed at : 04/26/2011 08:46

Barcode	Client ID	Tests	Collect Date	Beg. Depth	End. Depth	Notes
~~0420111~~	~~MW-91-ODLB-3~~	~~VOC_8260~~	~~04/25/2011 10:09~~	[illegible] 4/26		
~~0420112~~	~~MW-91-ODLB-3~~	~~VOC_8260~~	~~04/25/2011 10:09~~	[illegible] 4/26		
~~0420113~~	~~MW-91-ODLB-3~~	~~VOC_8260~~	~~04/25/2011 10:09~~	[illegible]		
0420111	04/25/11-TB-1-ODPM-8	VOC_8260	04/25/2011 10:09			
0420112	04/25/11-TB-1-ODPM-8	VOC_8260	04/25/2011 10:09			
0420113	04/25/11-TB-1-ODPM-8	VOC_8260	04/25/2011 10:09			
0420114	DUP-1-ODPM-8	VOC_8260	04/25/2011 11:32			
0420115	DUP-1-ODPM-8	VOC_8260	04/25/2011 11:32			
0420116	DUP-1-ODPM-8	VOC_8260	04/25/2011 11:32			
0420117	MW-250-ODPM-8	VOC_8260	04/25/2011 10:30			
0420118	MW-250-ODPM-8	VOC_8260	04/25/2011 10:30			
0420119	MW-250-ODPM-8	VOC_8260	04/25/2011 10:30			
04201110	MW-251-ODPM-8	VOC_8260	04/25/2011 10:42			
04201111	MW-251-ODPM-8	VOC_8260	04/25/2011 10:42			
04201112	MW-251-ODPM-8	VOC_8260	04/25/2011 10:42			
04201113	MW-54-ODPM-8	VOC_8260	04/25/2011 11:32			
04201114	MW-54-ODPM-8	VOC_8260	04/25/2011 11:32			
04201115	MW-54-ODPM-8	VOC_8260	04/25/2011 11:32			
04201116	MW-70-ODPM-8	VOC_8260	04/25/2011 13:23			
04201117	MW-70-ODPM-8	VOC_8260	04/25/2011 13:23			
04201119	MW-70-ODPM-8-MS	VOC_8260	04/25/2011 13:23			
04201120	MW-70-ODPM-8-MS	VOC_8260	04/25/2011 13:23			
04201122	MW-70-ODPM-8-MSD	VOC_8260	04/25/2011 13:23			
~~04201123~~	~~MW-70-ODPM-8-MSD~~	~~VOC_8260~~	~~04/25/2011 13:23~~	KS 4/26		
04201125	MW-76-ODPM-8	VOC_8260	04/25/2011 13:07			
04201126	MW-76-ODPM-8	VOC_8260	04/25/2011 13:07			
04201127	MW-76-ODPM-8	VOC_8260	04/25/2011 13:07			
04201128	MW-77-ODPM-8	VOC_8260	04/25/2011 13:14			
04201129	MW-77-ODPM-8	VOC_8260	04/25/2011 13:14			
04201130	MW-77-ODPM-8	VOC_8260	04/25/2011 13:14			
04201131	MW-79-ODPM-8	VOC_8260	04/25/2011 11:17			
04201132	MW-79-ODPM-8	VOC_8260	04/25/2011 11:17			

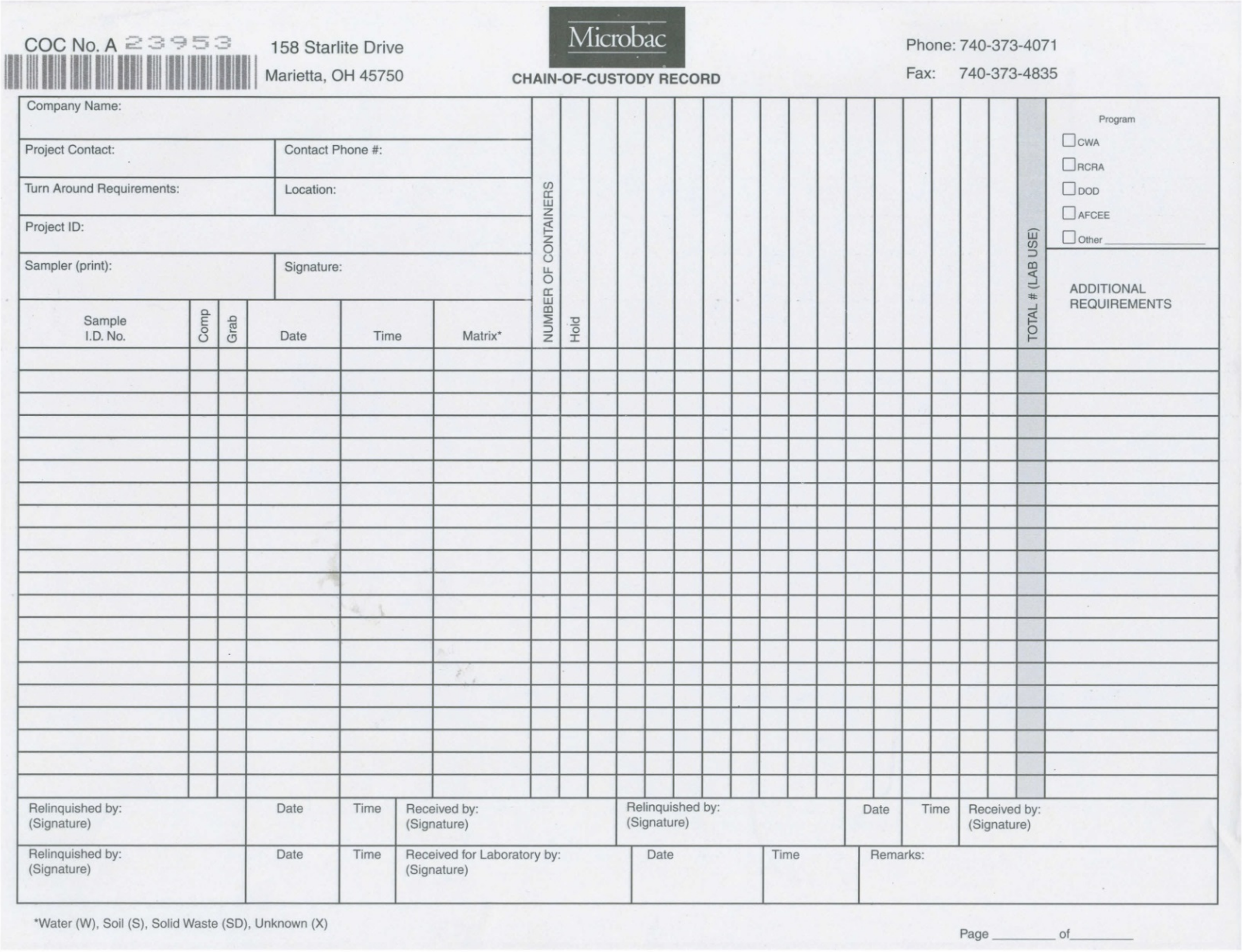
Microbac OVD 221000014398
Received: 04/27/2011 12:56
By: BRENDA GREENWALT
(signed)

Barcode	Client ID	Tests	Collect Date	Beg. Depth	End. Depth	Notes
04201133	MW-79-ODPM-8	VOC_8260	04/25/2011 11:17			

Samples Collected on: 04/25/2011 by jbsperry
(signed)

Attachment 7-4

EXAMPLE: Microbac Chain-of-Custody Form (Hand)



COC No. A 23953

158 Starlite Drive
Marietta, OH 45750

Microbac

CHAIN-OF-CUSTODY RECORD

Phone: 740-373-4071
Fax: 740-373-4835

Company Name:

Project Contact:

Contact Phone #:

Turn Around Requirements:

Location:

Project ID:

Sampler (print):

Signature:

Program
- ☐ CWA
- ☐ RCRA
- ☐ DOD
- ☐ AFCEE
- ☐ Other ________

Sample I.D. No.	Comp	Grab	Date	Time	Matrix*	NUMBER OF CONTAINERS	Hold																TOTAL # (LAB USE)	ADDITIONAL REQUIREMENTS

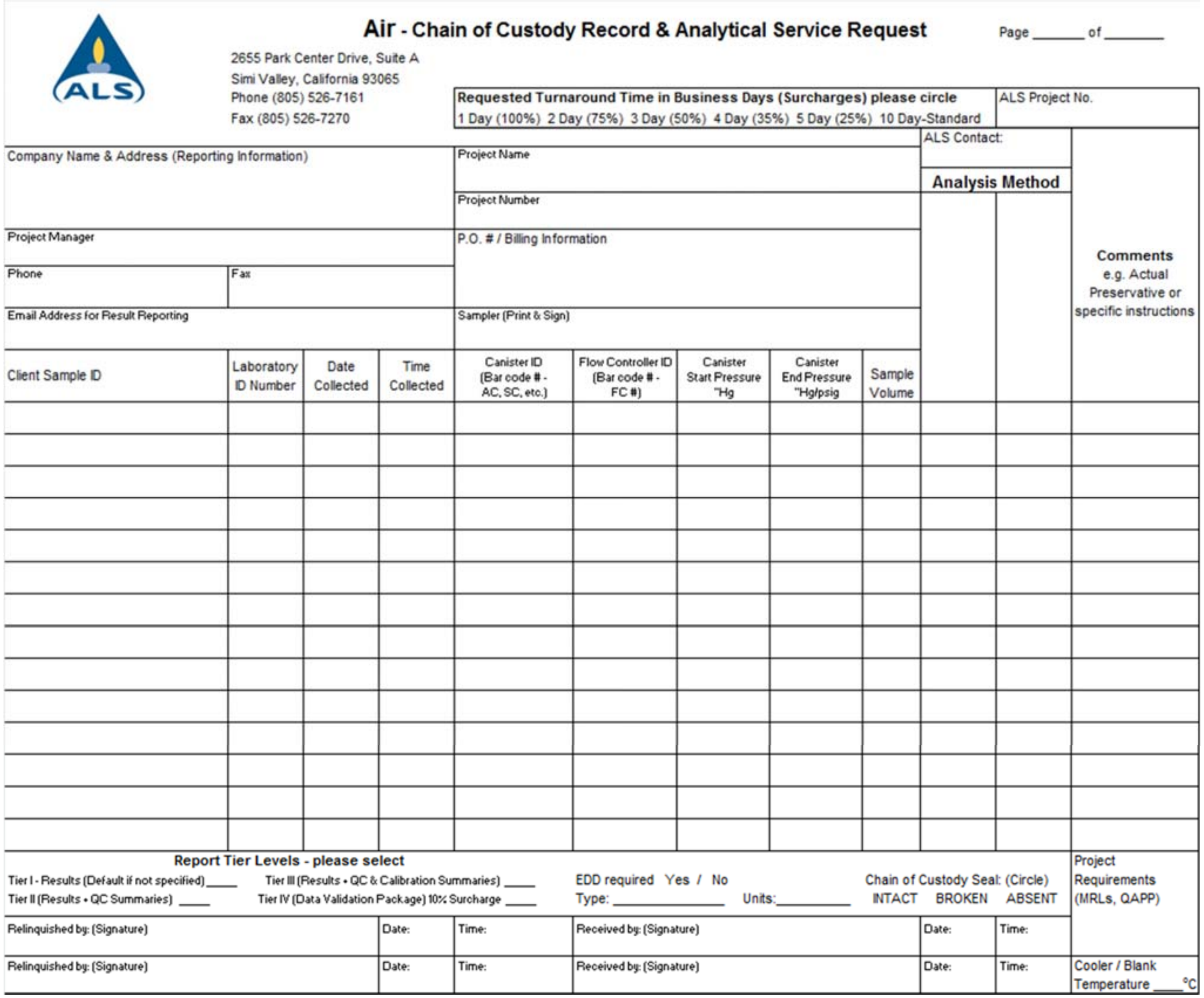
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:	

*Water (W), Soil (S), Solid Waste (SD), Unknown (X)

Page ________ of________

Attachment 7-5

EXAMPLE: ALS Chain-of-Custody Form



ALS

Air - Chain of Custody Record & Analytical Service Request

Page ______ of ______

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

ALS Project No.

ALS Contact:

Company Name & Address (Reporting Information)

Project Name

Project Number

Project Manager

P.O. # / Billing Information

Phone

Fax

Email Address for Result Reporting

Sampler (Print & Sign)

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code # - FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	**Analysis Method**		**Comments** e.g. Actual Preservative or specific instructions

Report Tier Levels - please select

Tier I - Results (Default if not specified) ____
Tier III (Results + QC & Calibration Summaries) ____
Tier II (Results + QC Summaries) ____
Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ______________ Units:__________

Chain of Custody Seal: (Circle)
INTACT BROKEN ABSENT

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:

Cooler / Blank Temperature ____°C

STANDARD OPERATING PROCEDURE 9 –EQUIPMENT DECONTAMINATION

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operation Procedure (SOP) provides guidance for proper decontamination of equipment used in sampling and collection of equipment rinsates to evaluate effectiveness of decontamination procedures.

2 Health and Safety

General Information on Health and Safety requirements is provided in SOP 1. Each individual is required to have read and understood the Site Safety and Health Plan for the project and signed the acknowledgement sheet confirming their review.

Health and safety concerns for equipment decontamination include exposure to contaminants from sampling equipment. Nitrile gloves and safety glasses should be used during decontamination.

3 Personnel Qualifications and Responsibilities

Sampling equipment decontamination and rinsate sample collection will be directed by the Field Team Leader (FTL), an environmental professional (engineer, geologist or scientist) with experience in equipment decontamination and sampling activities. The field staff, environmental professionals or technicians, are responsible for following these procedures and seeking direction from the FTL when questions or problems arise.

4 Equipment and Supplies

The required equipment and supplies will consist of Alconox soap, deionized water (DI), tap water, paper towels, foil, and sample containers.

5 Procedure

Proper equipment decontamination will prevent cross-contamination of samples due to residual contamination from previous sample locations and spread of contamination via sampling equipment. Proper decontamination also supports the legal defensibility of data generated during site activities.

Decontamination procedures will be evaluated by the collection of equipment rinsate samples. These samples consist of reagent water collected from final rinse of sampling equipment after the decontamination procedure has been performed. The samples are analyzed with the environmental sample to assess the adequacy of the decontamination performed.

5.1 Start-Up Activities

5.1.1 Office

The FTL will confirm that sufficient equipment and supplies are available at the site based on the number of samples and estimated field days.

5.1.2 Field

After arrival on site, but prior to commencement of operations, the FTL will confirm that decontamination supplies and equipment are available on site and review procedures with field staff.

5.2 Field Operations

5.2.1 Decontamination Area

The location of the decontamination area, used primarily for larger pieces of equipment, will be determined in consultation with subcontractor personnel. The decontamination pad will include a sump lined with 6-mil polyethylene sheeting to collect the decontamination water. The sump will be constructed by either excavating a small area to create a depression or by elevating the edges of the sheeting. Existing concrete pads with containment areas can be used for large equipment like drill rigs. Small handheld equipment will be decontaminated in 5-gallon buckets in order to contain the water.

5.2.2 Decontamination Water Source

Potable water from the municipal water system will be used as a rinse in the decontamination procedure. The FTL will be responsible for coordinating with the subcontractor personnel to secure an adequate supply of potable water for decontamination procedures. If large quantities of water are to be used, the subcontractor will rent a water meter from Memphis Light Gas and Water (MLGW). For smaller amounts, the field office water supply can be used.

5.2.3 Decontamination Procedures

The required decontamination procedure for large pieces of equipment such as drill rigs, auger flights, and drilling and well casing is:

1. Wash the external surface of equipment or materials with high pressure hot water and Alconox or equivalent, and scrub with brushes if necessary until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed from the equipment.
2. Air dry.
3. Decontamination waste water will be stored at the site and analyzed prior to disposal.

The required decontamination procedure for sampling equipment except the water level indicator probe is:

1. Wash and scrub with Alconox solution (or equivalent) and nylon brushes.
2. Double tap water rinse.
3. Rinse with American Society for Testing and Materials (ASTM) Type II Reagent - Grade Water
4. Wrap in oil free aluminum foil for transport.
5. Collect all decontamination rinse water in 5 gallon buckets. Rinse water will be combined with other wastewater generated during sampling activities and disposed of according to the work plan.

During water level sweeps and measurements in low-flow sampling, the water level tape and indicator in contact with groundwater will be decontaminated before initial use and before moving to a new location. The decontamination procedure for the water level indicator is:

1. Hand wash the calibrated tape and probe with Alconox solution (or equivalent).
2. Rinse with deionized (Reagent Grade II) water.

5.2.4 Equipment Rinsate Collection

When non-dedicated sampling equipment is used, the equipment will be decontaminated before initial use and after each sample is collected. An equipment rinsate sample will be collected for equipment type (bladder pump or bailer). At least one equipment rinsate will be collected for each sampling protocol (i.e. soil sampling, bladder pumps used for groundwater sampling) during each week of sampling. Equipment rinsate samples will be collected to be representative of field decontamination procedures.

<u>Sampling Equipment</u>: Equipment rinsate samples will be obtained from decontaminated bladder pumps, bailers, stainless steel split-spoons, hand augers, and stainless steel bowls with ASTM Type II water or better.

The equipment rinsate protocol will be as follows:

a. <u>Label Sample Container</u> - Label the sample container as outlined in SOP 7 – Sample Control and Documentation.

b. <u>Collect Sample</u> - After sample collection and equipment has been decontaminated as described above, an equipment rinsate will be collected. ASTM Type II water (or better) will be poured over and through the sampling equipment into a cleaned stainless steel bowl (preferably the equipment and bowl to be used on a specifically identifiable sample location). The collected water will be poured into the appropriate sample container. Repeat the process as necessary to fill each container to the required volume. Vials for volatile analysis and bottles for total organic carbon (TOC) analysis will be completely filled, leaving no air space above the liquid portion (to minimize volatilization). Check that the Teflon on the Teflon- lined silicone septum is toward the sample in the caps and secure the cap tightly. If semi-volatile compounds are to be sampled for, collect these samples next. Proceed to the collection of samples for the remaining analyses. Be careful of all pre-preserved bottles. If acids are present, open the bottle downwind and away from the body.

c. Custody, Handling and Shipping - Complete the procedures as outlined in SOP 7 – Sample Control and Documentation and SOP 8 - Sample Packing and Shipping.

5.3 Closeout

Before leaving the site daily, the following procedures will be performed by the FTL or designated field staff:

- Confirm all equipment is decontaminated and properly stored all equipment.
- Add decontamination rinse water to the wastewater storage tank
- Note equipment decontamination activities and rinsate sample collection on the Daily Field Report (SOP 1, Attachment 1-2).

6 Data and Records Management

All field forms and log book entries will be scanned and copied project folder on the “Z” drive within one week of the field event completion.

7 Quality Control and Quality Assurance

Work will be performed in accordance with the Quality Assurance Project Plan (QAPP), the specific work plan, and applicable SOPs.

8 References

HDR, 2017a. *2017 Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 0*. Prepared for the U.S. Army Corps of Engineers, Mobile District. May 2017.

SESDPROC-205-R2, *Operating Procedure Field Equipment Cleaning and Decontamination,* 2011.

Standard Operating Procedure
Installation and Extraction of the Vapor Pin®

Updated September 9, 2016

Scope:

This standard operating procedure describes the installation and extraction of the VAPOR PIN® for use in sub-slab soil-gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the VAPOR PIN® for the collection of sub-slab soil-gas samples or pressure readings.

Equipment Needed:

- Assembled VAPOR PIN® [VAPOR PIN® and silicone sleeve(Figure 1)]; Because of sharp edges, gloves are recommended for sleeve installation;
- Hammer drill;
- 5/8-inch (16mm) diameter hammer bit (hole **must** be 5/8-inch (16mm) diameter to ensure seal. It is recommended that you use the drill guide). (Hilti™ TE-YX 5/8" x 22" (400 mm) #00206514 or equivalent);
- 1½-inch (38mm) diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾-inch (19mm) diameter bottle brush;
- Wet/Dry vacuum with HEPA filter (optional);
- VAPOR PIN® installation/extraction tool;
- Dead blow hammer;
- VAPOR PIN® flush mount cover, if desired;
- VAPOR PIN® drilling guide, if desired;
- VAPOR PIN® protective cap; and
- VOC-free hole patching material (hydraulic cement) and putty knife or trowel for repairing the hole following the extraction of the VAPOR PIN®.

Figure 1. Assembled VAPOR PIN®

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½-inch (38mm) diameter hole at least 1¾-inches (45mm) into the slab. Use of a VAPOR PIN® drilling guide is recommended.

4) Drill a 5/8-inch (16mm) diameter hole through the slab and approximately 1-inch (25mm) into the underlying soil to form a void. Hole **must** be 5/8-inch (16mm) in diameter to ensure seal. It is recommended that you use the drill guide.

VAPOR PIN® protected under US Patent # 8,220,347 B2, US 9,291,531 B2 and other patents pending

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of VAPOR PIN® assembly into the drilled hole. Place the small hole located in the handle of the installation/extraction tool over the vapor pin to protect the barb fitting, and tap the vapor pin into place using a dead blow hammer (Figure 2). Make sure the installation/extraction tool is aligned parallel to the vapor pin to avoid damaging the barb fitting.

Figure 2. Installing the VAPOR PIN®

During installation, the silicone sleeve will form a slight bulge between the slab and the VAPOR PIN® shoulder. Place the protective cap on VAPOR PIN® to prevent vapor loss prior to sampling (Figure 3).

Figure 3. Installed VAPOR PIN®

7) For flush mount installations, cover the vapor pin with a flush mount cover, using either the plastic cover or the optional stainless-steel Secure Cover (Figure 4).

Figure 4. Secure Cover Installed

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to re-equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the VAPOR PIN®. This connection can be made using a short piece of Tygon™ tubing to join the VAPOR PIN® with the Nylaflow tubing (Figure 5). Put the

Nylaflow tubing as close to the VAPOR PIN® as possible to minimize contact between soil gas and Tygon™ tubing.

Figure 5. VAPOR PIN® sample connection

10) Conduct leak tests in accordance with applicable guidance. If the method of leak testing is not specified, an alternative can be the use of a water dam and vacuum pump, as described in SOP Leak Testing the VAPOR PIN® via Mechanical Means (Figure 6). For flush-mount installations, distilled water can be poured directly into the 1 1/2 inch (38mm) hole.

Figure 6. Water dam used for leak detection

11) Collect sub-slab soil gas sample or pressure reading. When finished, replace the protective cap and flush mount cover until the next event. If the sampling is complete, extract the VAPOR PIN®.

Extraction Procedure:

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the VAPOR PIN® (Figure 7). Turn the tool clockwise continuously, don't stop turning, the VAPOR PIN® will feed into the bottom of the installation/extraction tool and will extract from the hole like a wine cork, DO NOT PULL.

2) Fill the void with hydraulic cement and smooth with a trowel or putty knife.

Figure 7. Removing the VAPOR PIN®

- Prior to reuse, remove the silicone sleeve and protective cap and discard. Decontaminate the VAPOR PIN® in a hot water and Alconox® wash, then heat in an oven to a temperature of 265° F (130° C) for 15 to 30 minutes. For both steps, **STAINLESS – ½ hour, BRASS 8 minutes**

3) Replacement parts and supplies are available online.

Appendix B
Analytical Standard Operating Procedures

QA Control Code: A2070131

SOP Name:	Determination of Volatile Organic Compounds in Air by method TO-15
SOP ID:	MTO15-Air VOC
Revision #:	12
Date Created:	October 11, 2004
Effective Date:	May 5, 2017
Reason for Revision:	Annual review
SUPERCEDS:	MTO15-Air VOC-11

Approvals:

Analyst	Date
Supervisor	Date
QA/QC Director	Date
Technical Director	Date

“The technical information contained herein is to be considered confidential and proprietary and is not to be disclosed, copied, or otherwise made available to other parties without the express written consent of Chemtech.”

DETERMINATION OF VOLATILE ORGANIC COMPOUNDS IN AIR BY EPA METHOD TO-15

1. Test Method

1.1 Determination of Volatile Organic Compounds in Air by EPA method TO-15.

2. Applicable Matrices

2.1 Air

3. Detection Limit

3.1 0.03-0.1ppbv

4. Scope and Application

4.1 This method covers the procedure for the measurement Volatile Organic compounds.

4.2 This method applies to ambient concentrations of VOCs above 0.1ppbv and typically requires VOC enrichment by concentrating up to one liter of a sample volume.

4.3 The method applies under most conditions encountered in sampling of ambient air into canisters.

4.4 Tedlar bags also may be analyzed using this method

5. Summary

5.1 The Air sample is introduced into a specially prepared stainless steel canister.

5.2 After the sample is collected, the canister valve is closed and identification tag is attached to the canister. The canister is transported to the laboratory for analysis.

5.3 Once in the laboratory the canister data is recorded and the canister is stored until analysis.

5.4 The analysis consists of a known volume of sample directed from the canister through a solid multisorbent concentrator. To reduce the water content of the sample a dry purge with helium is applied to the concentrator.

5.6 The VOCs are thermally desorbed into a multi-sorbent trap and then thermally desorbed into the GC/MS for analysis.

6. Definitions

6.1 Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

6.2 Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

6.2.1 Analytical Batch: is composed of prepared environmental samples, which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

6.3 Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis the blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.

6.4 Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.5 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.6 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.7 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations tat impact the analytical results for sample analyses.

6.8 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.9 Pure Reagent Water: Water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method.

6.10 Standard Operating Procedures (SOPs): A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive task.

6.11 Test Method: An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP.

6.12 Volatile Organic Compound: Any compound containing carbon and hydrogen or containing carbon and hydrogen in combination with any other element which has a vapor pressure of 1.5psi absolute (-26.9”Hg) or greater under actual storage conditions.

6.13 Verification: confirmation by examination and provision of evidence that specified requirements have been met.

6.14 Absolute Canister Pressure: Gauge pressure in the canister (kPa, psi) and Pa = barometric pressure.

6.15 Absolute Pressure: Pressure measured with reference to absolute zero pressure (as opposed to atmospheric pressure), usually expressed as kPa, “Hg or psig.

6.16 Cryogen: A refrigerant used to obtain very low temperatures in the cryogenic trap of the analytical system. A typical cryogen is liquid nitrogen (bp. -195.8^{o}C) or liquid argon (bp. -185.7 ^{o}C).

6.17 Dynamic Calibration: Calibration of an analytical system using calibration gas standard concentrations in a form identical or very similar to the samples to be analyzed and by introducing such standards into the inlet of the sampling or analytical system in a manner very similar to the normal sampling or analytical process.

6.18 Gauge Pressure: Pressure measured above ambient atmospheric pressure (as opposed to absolute pressure). Zero gauge pressure is equal to ambient atmospheric (barometric) pressure.

6.19 GC/MS Scan: The GC is coupled to a MS programmed in the SCAN mode to scan all ions repeatedly during the GC run. As used in the current context, this procedure serves as a qualitative identification and characterization of the sample.

7. Interferences

7.1 Chloromethane and Vinyl Chloride can display peak broadening and co-elution with other species if the compounds are not delivered to the GC column in a small volume of carrier gas.

7.2 Interferences in canister samples may result from improper use or from contamination of the canisters, the canister cleaning apparatus and the sampling or analytical system.

8. Safety

8.1 Wear appropriate safety clothing and eye protection.
8.2 Use protective gloves when handling corrosive chemicals
8.3 Always use safety carts when transporting large bottles of chemicals.
8.4 Read material safety data sheet (MSDS) for the chemical used in the laboratory for the identity of the ingredients, the physical and chemicals characteristics of the substance, the physical hazards, and safe handling and safety precautions.

9. Equipment and Supplies

9.1 Sample containers
 9.1.1 6 Liter passivated (have an inert coating) Summa Canisters. Restek Catalog # 24157 or equivalent.
 9.1.2 1.4 Liter Summa Canisters
 9.1.3 3.0L Summa Canisters
 9.1.4 Tedlar bags
9.2 Syringes
 9.2.1 50mL glass gas-tight with shut-off valve – Restek Catalog #009670
 9.2.2 25 μL (RESTEK Corp Catalog #24722) and 100 μL (RESTEK Corp Catalog #81300) glass gas-tight microsyringes.
9.3 Glass Septum capped bulb 2.0
9.4 Air Instrument
 9.4.1 Entech 7500 Head Space autosampler with 3 channel temperature controller
 9.4.2 Entech 7100A pre-concentrator
 9.4.3 Entech 7016 CA auto sampler
 9.4.4 Entech Model 4600A Dynamic Diluter
9.5 Gas Chromatograph:
 9.5.1 GC used for analysis is a Hewlett Packard 5890 or 6890.
 9.5.2 GC column is a 60m capillary column, 0.32mm ID, with a 1.0-micron film thickness, RTX-1 Cat # 10157 or equivalent.
 9.5.3 The interface between the GC and MS systems is a direct one with a portion of the carrier flow being split off at the injection port.
9.6 Mass Spectrometer:
 9.6.1 Hewlett Packard 5971 and 5975 mass selective detectors are used for this method.
 9.6.2 The models scan from 35-300amu every 1-second or less, utilizing 70 volts (nominal) electron energy in the electron impact ionization mode.

9.6.3 The MS used is capable of producing a mass spectrum that meets all instrument performance criteria Table 1 when 50ng of p-Bromofluorobenzene (BFB) is introduced through the GC inlet.

9.7 Data Systems:

9.7.1 Hewlett Packard Enviroquant Software, Aug. 2003 Edition is used to view, evaluate, quantitate and print the data.

9.7.2 Mass spectral library, 2002, from HP Analytical NIST MS Spectral Database that contains 125,000 reference compounds that are used in tentative identification of unknown peaks.

9.7.3 Store all GC/MS data on backup server for five years, so that it may be retrieved as needed once the hard disk has been cleared.

9.8 Mass Flow Controller System: Tylan Mass Flow Controller Model FC-280s with a Dyna Mass Model KM-4 controller.

9.9 Absolute Pressure Gauge: WIKA Model NR 61C-1A-0030.

9.10 Canister Cleaning Assembly:

- Stainless steel, custom-made 8 canister 6L or 21 canister 1.4L plumbing unit.
- Edwards vacuum pump
- Precision Scientific Mechanical Convention Oven Model 645

9.11 Tenax Tube- 16mm Supelco or equivalent

9.12 Instrument Software: MSD Chemstation D.03.00.611

10. REAGENTS AND STANDARDS

10.1 Reagents:

10.1.1 Water - analyte free, generated by boiling deionized water and transferring the hot water to a clean glass jar for cooling before use.

10.1.2 Methanol - purge and trap grade, used in the preparation of stock standards - JT Baker Catalog #9077-02 or equivalent.

10.1.3 Compressed Air – O grade

10.2 Standards and Solutions:

10.2.1 Internal Standard/Surrogate Mix-Spectra Gases 1.0ppm consisting of Bromochloromethane, 1-Bromo-4-fluorobenzene, 1,4-Difluorobenzene and Chlorobenzene-d5.

10.2.1.1 Prepare 80ppbv in Air by taking 2.4PSIA to a 6Liter canister diluted with Air to 30PSIA.

10.2.2 Calibration Standard (Either standard can be alternatively used as required)

10.2.2.1 Calibration stock standard: Restek # 34435, 25 compounds at 100ppb each, Restek # 34421, 39 compounds at 100ppb each, Restek # 561585 (special order standard from Restek for four calibration compounds at 100ppb each – Ethanol, tert-butanol, methyl methacrylate, o-chlorotoluene).

10.2.2.2 Calibration stock standard: Custom gas solutions standard Part # COF-TO-15-79, 79 compounds + Nitrogen + 2-Methylnaphthalene at 500ppb each. Use a different lot # for second source ICV.

Note: Additional compounds standards may be purchased if necessary for any specific project.

10.2.3 Calibration mix
Prepare as follows:

Standard Concentration	Amount used from 500ppb stock	Final volume
15ppbv	45 sccm	1455 sccm humidified air in 6L, final 30psi
2ppbv	4psi from 15ppbv std.	26 psi humidified air in 6L, final 30psi
0.2ppbv	3psi from 2ppbv	27psi humidified air, final 30psi

From this standard, prepare a five level calibration curve using the following amount. (*Standard concentrations are subject to change)

*Standard concentration	Working standard	Concentration of Stock ppbv	Amount from 80ppbv internal/ surrogate standard
0.5ppbv	100mL	2ppbv	50mL
1.0ppbv	200mL	2ppbv	50mL
2.0ppbv	400mL	2ppbv	50mL
10.0ppbv	267mL	15ppbv	50mL
15.0ppbv	400mL	15ppbv	50mL
0.1ppbv	20mL	2ppbv	50mL
0.03ppbv (if required)	6mL	2ppbv	50mL

11. Sample Collection, Shipment, and Storage

11.1 Obtain a clean, evacuated and tagged 6L Summa Canister, 3L Summa Canister or a 1.4L canister from the laboratory.
11.2 Follow all external and internal chain of custody procedures during the transportation of the canister.
11.3 Once at the area where ambient air is to be tested, open the canister by turning the valve on top of the canister counter-clockwise.
11.4 The sampler should hear a hissing sound associated with the ambient air going into the canister.
11.5 Firmly close the canister by turning the valve clockwise.
11.6 Record all information about the location of the site on the chain of custody or other field notebook.
11.7 Immediately return the sample canister to the laboratory.
11.8 Store samples at ambient temperature.
11.9 Analyze all samples within 30 days of sampling date.
11.10 Analyze Tedlar bags within 48hours of sampling.

Note: Initiate one External Chain of Custody form per Sample Canister. Fill out the grey areas before shipping. Fill out remaining fields upon sample receipt. Initiate an Internal Chain of Custody Form upon sample receipt.

12. Quality Control

12.1 BFB-MS Tuning Check Compound

- 12.1.1 Analyze daily to verify instrument performance.
- 12.1.2 Spectrum produced must meet criteria outlined in Table 1.

12.2 Initial Calibration

- 12.2.1 Analyze a minimum of 5 concentration levels: 0.5 to 15ppbv for regular targeted compounds.
- 12.2.2 Lowest initial calibration concentration must be near MDL. The rest of the concentration levels must define the linear range of this method.
- 12.2.3 Assure that % Relative Standard Deviation (%RSD) criteria are met. The acceptance criterion is listed in Section 13 of this SOP.

12.3 Continuing Calibration

- 12.3.1 Analyze each day to verify initial calibration.
- 12.3.2 Recovery of each analyte must meet acceptance criteria in Section 13.3.3.

12.4 Method Blanks

- 12.4.1 Analyze immediately after the calibration standards each day.
- 12.4.2 Analyze a method blank after calibration standards to insure that the system is free from carry-over or any other interferences.
- 12.4.3 Make sure method blank meets criteria listed in Section 18.4.

12.5 Accuracy and Precision

- 12.5.1 Each analyst must perform an initial, one time demonstration of accuracy and precision. Documentation must be delivered to the QA officer for inclusion in personnel folder.
- 12.5.2 Prepare four aliquots of a 10ppbv QC check sample from a source other than that used for calibration.
- 12.5.3 Analyze these four aliquots under the same conditions used for sample analysis.
- 12.5.4 Calculate the average recovery (X) in μg/L and the standard deviation of the recovery (S) for each analyte.
- 12.5.5 X should be between 70 and 130 % and S should be less than 20%. If X and S meet criteria for all analytes, begin sample analysis.
- 12.5.6 If any individual X or S fails, repeat the entire procedure, or repeat it only for the analytes that failed.
- 12.5.7 Repeated failure for a particular analyte indicates a system or training problem that requires further attention.

12.6 Method Detection Limits

- 12.6.1 Determine MDL by analyzing seven replicate standards each containing analytes at a concentration of 0.2ppbv.
- 12.6.2 After analysis, down load the data to a personal computer where Excel and use standardized MDL templates to perform the statistical calculations.

12.6.3 Calculate the MDL by determining the standard deviation of the values and multiplying by the "t" value of 3.143.

12.6.4 The calculated MDL must be below the quantitation limits for the method. If they are not, the data is reviewed again for possible sources of error and the procedure will be repeated.

12.6.5 Perform an MDL study annually for all normally targeted compounds or when conditions change (different column installed).

12.6.6 Perform an MDL study for extra-targeted compounds as required.

12.6.7 Standard templates for MDL calculations are mandatory for use, and available from the QA officer.

12.7 Limit of Detection (LOD)

12.7.1 Establish LOD by spiking a quality system matrix at approximately 1-4X detection limit.

12.7.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.7.3 LOD must be verified quarterly.

12.7.4 LOD must be verified on each instrument used, and every time the method is modified.

12.8 Limit of Quantitation (LOQ)

12.8.1 LOQ must be greater than the LOD.

12.8.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.

12.8.3 LOQ must be performed if the method is modified.

12.9 Laboratory Control Sample (LCS)/LCS Replicate

12.9.1 At a minimum, one pair of LCS and LCS Replicate needs to be analyzed per analytical batch.

13. Calibration and Standardization

13.1 GC/MS Tuning and Performance Check

13.1.1 Prior to the analysis of calibration standards, tune the GC/MS system using 4-BFB.

13.1.2 Tune the mass axis and abundance scales such that the analysis of the instrument performance check solution (BFB) meets the criteria outlined in Table 1.

13.1.3 Retune the MS and reanalyze the BFB if the spectrum does not meet criteria.

13.1.4 Analyze the BFB solution daily to verify acceptable instrument performance.

13.1.5 Do not make any adjustment to the system once an acceptable BFB has been acquired, instrumental conditions must remain the same throughout the calibration and sample analyses.

13.2 Initial Calibration

13.2.1 After tuning criteria has been met, analyze an initial calibration consisting of 5 calibration standards at the following levels: 0.5, 5.0, 2.0, 10.0, 15.0ppbv.

13.2.2 Tabulate the area response of the characteristic ions against the concentration for each target analyte and each internal standard.

13.2.3 Calculate response factors (RF) for each target analyte relative to one of the internal standards.

13.2.4 The RF is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

Where:
A_s = Peak area of the analyte or surrogate
A_{is} = Peak area of the internal standard
C_s = Concentration of the analyte or surrogate
C_{is} = Concentration of the internal standard

13.2.5 Calculate the %RSD for all target analytes from the initial calibration.

$$\%RSD = \frac{\text{Standard Deviation}}{\text{Mean}} \quad X \quad 100$$

13.2.6 The %RSD should be less than 30% for each target analyte. For DOD, Each analyte must meet one of the three options, Option 1: RSD for each analyte $\leq$ 30%, Option 2: linear least squares regression for each analyte: r2 $\geq$ 0.99, Option 3: non-linear least squares regression (quadratic) for each analyte: r2 $\geq$ 0.99

13.2.7 If this criterion is not met, check instrument conditions and analyze a new initial calibration.

13.2.8 If the %RSD of any target analyte is less than 30% it is assumed to be constant over the calibration range, and the average response factor may be used for quantitation.

13.2.9 If the client requests extra target compounds the curve for these compounds will be deemed acceptable only when a 30% RSD is achieved over the 5 initial calibration responses factors.

13.3 Continuing Calibration

13.3.1 Analyze a BFB. Make sure it meets criteria listed in Table 1.

13.3.2 Analyze a midrange standard (10ppbv) every 24 hours.

13.3.3 The acceptance criteria for the %D for each compound is $\underline{+}$30%.

13.4 Initial Calibration Verification (ICV)

13.4.1 Analyze an initial calibration verification standard using second source standard at the midpoint of the initial calibration curve immediately following the initial calibration.

13.4.2 The acceptance criteria for the %D for each compound is $\underline{+}$30%.

14. Procedure

14.1 Obtain the current GC/MS VOA Laboratory Instrument Logbook for instrument MSVOAM, fill it out with all of the required information.

14.2 Allow all standards to warm to ambient temperature prior to use.

14.3 Rinse all syringes to be used with air prior to use.

14.4 BFB Tuning

14.4.1 Analyze the BFB standard by injecting 50mL of 80ppbv Internal/Surrogate solution from a 6L canister.

14.4.2 Analyze the BFB as follows:

- Click on the instrument icon.

- Edit sequence to run BFB
- Click on OK
- Click on run sequence
- Wait for instrument to complete the run

14.4.3 Use the HP ChemStation software to acquire the spectrum of BFB in the following manner:

- Integrate m/z 95 (the major ion of BFB) to find the max scan or apex of the peak.
- Average three scans; the max scan and the scans immediately before and after the max.

Note: Background subtract, must be a scan chosen before the elution of the BFB peak but no more than 20 scans from the beginning of the BFB peak.

14.4.4 Check the resulting spectrum; it must meet the ion abundance criteria outlined in Table 1.

14.5 Initial Calibration

14.5.1 After tuning criteria has been met, initially calibrate the GC/MS system at five levels (Section 13.2).

14.5.2 Analyze all standards, blanks, and samples using the following steps:

- Click on the instrument icon.
- Click on Edit sequence to run the curve
- Click on OK
- Click on run sequence
- Wait for instrument to complete the run

14.5.3 Use the following temperature program for the instrument

HP5975MS		**HP5971MS**	
Initial Temperature	40°C	Initial Temperature	40°C
Initial Hold	2 min	Initial Hold	2 min
Rate A	6°C/min	Rate A	6°C/min
Temperature A	150°C	Temperature A	150°C
Hold A	0	Hold A	0
Rate B	16°C/min	Rate B	16°C/min
Final Temp	220°C	Final Temp	220°C
Final Hold	2.29min	Final Hold	2.29 min
Injection Port	220°C	Injection Port	220°C
Detector B	180°C	Detector B	280°C
Total Run time	27 min	Total Run time	27 min

Note: The GC column separates the analytes that are then detected by the mass spectrometer.

14.5.4 Acquire data for each of the five calibration points.

14.5.4.1 Compare the data using a METHOD FILE set up for the target, internal standard, and surrogate compounds, containing expected retention times, and ion ratios for each analyte.

14.5.4.2 A quant ion and one or two secondary ions have been chosen (Table 2) for each analyte and make up a characteristic ratio used to identify each compound.

14.5.4.3 The quant ion for each compound is integrated and these areas are used to generate RFs.

14.5.5 Create a calibration file inside the METHOD from the data points run for the initial curve.

14.5.5.1 The METHOD shows a RF for each analyte at each concentration level.

14.5.5.2 The average RF, the relative retention time (each analyte's distance from the internal standard), and the Relative Standard Deviation (RSD) are calculated.

14.5.6 Monitor standard areas and retention times from initial calibration.

14.5.6.1 The extracted ion current profile (area of the quantitation ion) must not change by more than a factor of -40% to +80% from the midpoint of the initial calibration.

14.5.6.2 The retention time for any analyte must not change by more than 0.33 minutes.

14.5.6.3 Should either of these two items be out of limits, the GC/MS system must be inspected for potential problems and corrections made as needed.

14.5.7 Once a valid initial curve is run and evaluated, proceed with the analysis of blanks, spikes and samples.

14.5.7.1 Update the average response factors from the curve into the METHOD and they will be used for quantitation for all blanks and samples that follow.

14.5.7.2 If the BFB passes criteria, analyze the CCC.

14.6 Continuing Calibration

14.6.1 Analyze a BFB.

14.6.2 If the BFB passes criteria, analyze the CCC.

14.6.3 If the CCC meets the necessary criteria, proceed with the analysis of blanks and samples.

14.6.4 If CCC does not meet criteria, analyze another one, if the second one also fails, analysis must stop and a new BFB and initial calibration must be run.

14.6.5 A CCC must be performed daily.

14.7 Method Blank & LCS/LCS Replicate

14.7.1 Analyze a method blank immediately following either the initial calibration or CCC and prior to analyzing any samples.

14.7.2 Prepare the method blank by injecting a 400mL aliquot of zero grade humidified air from a clean SUMMA canister into the Entech 7100A.

14.7.3 Analyze the method blank after the calibration standards to ensure that the system is free from carryover or any other interferences that may be present.

14.7.4 The method blank must not have any analyte above the reporting limit.

14.7.5 At a minimum, analyze a pair of LCS/LCS replicate per analytical batch after the analysis of Method Blank. If the daily CCV is prepared in a canister, then the initial and closing CCVs can serve as the LCS and LCS Replicate as well. Both the CCV and LCS acceptance criteria would apply.

14.7.6 One canister standard is analyzed two times in the analytical run. A laboratory must use the QSM Appendix C Limits for batch control if project specific limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. RPD between the LCS and LCS Replicate for each target analyte must be < 30%.

14.7.7 If LCS/LCS Replicate fails meet criteria, Correct problem, and then reanalyze the LCS and all samples in the associated analytical batch for failed analytes if sufficient sample material is available.

14.7.8 If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated analytical batch.

14.7.9 LCS/LCS Replicate must contain all analytes to be reported. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

14.8 Sample Analysis

Note: Samples may only be analyzed once the tune, calibration, and blank have all met criteria.

- *Measure and record the pressure of each canister upon arrival.*
- *Notify client if pressure of the received canister is not between -0.6"Hg and -26"Hg, indicating too less or too much pressure in the canister.*

14.8.1 Inject the sample into the Entech 7100A noting the flow controller increase in reading while injecting.

14.8.2 Analyze appropriate sample volume.

14.8.3 Analyze the sample as follows:

- Click on the instrument icon
- Click on Edit sequence, add samples to sequence
- Click on OK
- Click on run sequence
- Wait for instrument to be ready

Note: The Entech 7100A unit goes through the same sequence for all samples, blanks, and standards.

- *Trap temperature of -150 °C during sample cryofocusing.*
- *The sample is desorbed for 10 minutes while rapidly heating the trap to 180°C and back flushed with helium.*
- *The trap is then baked for 15 minutes at 150 °C to remove any residue remaining on the trap.*

- *The trap is allowed to cool down to room temperature, and is then ready to accept the next sample.*

14.8.4 Use the temperature program in section 14.5.3.2 to chromatographically separate the volatiles transferred to the GC.

Note: Any analyte that exceeds the calibration range requires a dilution.

14.8.5 Sample Dilution

14.8.5.1 If any target compound exceeds the initial calibration range in a sample, the sample must be diluted.

14.8.5.2 The dilution factor should get the largest analyte peak in the upper half of the initial calibration range.

14.8.5.3 All dilutions must meet the same QC requirements as non-diluted samples.

Note: Do not dilute the sample for high concentrations of Tracer gases (Isopropyl alcohol and Ethanol).

14.9 Air Canister Cleaning

14.9.1 See SOP P241-Air Canister Cleanup for details and corrective actions.

14.10 Analytical Sequence:

Initial Analytical Run	Continuing Analytical Run
BFB	BFB
STD Level 1	Mid range standard (10ppbv)
STD Level 2	Blank
STD Level 3	Blank Spike
STD Level 4	Samples
STD Level 5	
ICV (Second Source)	
Blank	
Blank Spike	
0.1ppbv RPT Check	
0.03ppbv RPT Check Samples	

14.11 Manual Integration

14.11.1 Integrate the area of the quantitation ion of the compound of interest.

14.11.2 Do not include baseline background noise, and include only the area between where the beginning and end of the peak intersects with the baseline.

14.11.3 Integrate the compound in the sample any time it is integrated in the calibration standard.

14.11.4 Flag the compound with an “m” in the hardcopy (quantitation report) when a manual integration is performed.
14.11.5 Sign all compounds flagged with an “m” by initialing and dating them on the quantitation report.
14.11.6 Print out the EICP for all compounds that have been manually integrated.
14.11.7 If more than one compound is flagged, sign and date the compounds individually or bracket all compounds, sign and date once to indicate that all-manual integrations have been reviewed.
14.11.8 Document the reason for each manual integration on each quantitation report.
14.11.9 Report the before and after chromatograms of every manual integration.

14.12 Data Interpretation

- Maintain all GC and mass spectral data generated with each run of the instrument within a data file.
- Store data files on the computer hard drive, and archived on backup server for retrieval as needed once the hard drive has been cleared.
- For quantitation, send data files through **Enviroquant**, where the computer compares known information about target compounds to what is present in each data file.
- Information contained in the Method File used by the program **Enviroquant** includes:
- The relative retention time of each analyte
- The ion to be used for quantitation and one or two secondary ions, which are characteristic to each compound (Table 2).
- The response factor for each analyte to be used in determining the concentration.

14.12.1 Procedure Enviroquant

14.12.1.1 Highlight every run on a copy of the instrument logs that are applicable to the SDG you are processing.
14.12.1.2 Put the instrument logs in date order with the initial calibration analytical run instrument log first.
14.12.1.3 Go to the processing PC and click the **Enviroquant** icon.
14.12.1.4 Load the EPA T0-15 method by using the pull down menu top left choice and click on select method.
14.12.1.5 Load the first BFB Data File from the first instrument log using the pull down menu top left choice and click on select data file.
14.12.1.6 Find the BFB peak on the chromatogram and click on the max scan (max ion 95).

- Note the scan number.

14.12.1.7 Determine where the scan to the left and the scan to the right are located by clicking slightly to the right and left of the max scan noting the scan numbers.
14.12.1.8 Drag the cursor from the max scan –1 to the max scan +1.

- Click on a background scan directly to the left of the BFB peak and click on subtract in the pull down menu called Tuner.

14.12.1.9 Click on “evaluate BFB”.

14.12.1.10 Click on Save BFB to Forms File under the Tuner pull down menu.

14.12.1.11 Click on Print BFB under the Tuner menu.

- The criterion is listed in Table 1.

14.12.1.12 Load the low point file (0.1ppbv) from the initial calibration.

14.12.1.13 Click on quantitate to screen

14.12.1.14 Click on clear all calibration responses

14.12.1.15 Click on calibrate

- Add new level
- Enter standard level

14.12.1.16 Load the next initial calibration data file.

- Repeat steps 14.12.1.12 – 14.12.1.15
- Do this for calibration points.

14.12.1.17 Print out the initial calibration using the pull down menu, click on response factors to printer.

14.12.1.18 Carefully review all information on the printout.

- Look for isomeric pairs that separate chromatographically and have the same retention time and response factors (ethyl benzene and o & m/p-xylene).
- Go to step 14.12.1.19 to edit.
- Verify that all compounds are picked up. Check to see if the initial calibration meets criteria.

14.12.1.19 Qarea using the pull down menu, each point that needs editing and repeat step 14.12.1.15 choosing recalibrate. Refer to Section 14.11.

14.12.1.20 Load the second BFB.

14.12.1.21 Pass it by repeating steps 14.12.1.5 – 14.12.1.9.

14.12.1.22 Load the check standard data file.

- Send to quant using the pull down menu.
- Click on View Results on screen and verify that the program is picking up all of the compounds correctly. If not repeat step 14.12.1.19.

14.12.1.23 Click on calibrate, add new level, enter standard level CC (QC Check sample), enter 2.5 for internal standard concentration and standard level concentration.

14.12.1.24 Verify that Quantitate using Initial Calibration is clicked on.

14.12.1.25 Load next data file (blank), quantitate it and review in qarea, checking surrogate recoveries, and correct integration of peaks, internal standard area recoveries and any necessary dilutions of target compounds.

14.12.1.26 Repeat step 14.12.1.25 for each blank and sample that is associated with the SDG maintaining the order of steps 14.12.1.20 – 14.12.1.26 when you get to the next BFB. See Section 14.12.2 for Data Interpretation.

14.12.1.27 Send each blank and sample to the tentative identified program using the software pull down menus. Use information from the summary discussion to review the non-target data.

14.12.1.28 Print out each run, standards and spikes in medium format (quant report and chromatogram), blanks and samples in full format (quant report + Chromatogram + spectra).

14.12.1.29 Put the reports in data file order with the BFB report first. Put the instrument logs with each set of reports.

- Data is now ready for **Enviroforms.**

14.12.2 Data Interpretation for Enviroquant

14.12.2.1 Examine all spectra for all possible "hits" or matches made to target compounds from printed out file by an analyst trained in the interpretation of mass spectra by doing the following:

14.12.2.1.1 Generate a reference spectrum for each analyte by running known standards (QREF from pull down menu).

14.12.2.1.2 Compare this reference to the spectrum of the peak found in the sample.

14.12.2.1.3 Compare the criteria required for positive identification of an analyte as follows:

- The analyte in the sample must elute at the same relative retention time as in the daily calibration standard (±0.06 RRT units).
- All ions present in the reference spectrum >10% of the largest ion must be found in the sample spectrum.
- The ratio of the ions found in the sample must agree within ±20% of the ions found in the reference spectrum.
- Ions >10% in the sample spectrum but not found in the reference spectrum must be accounted for.
- Quantitative analysis is done once a target compound is identified by the internal standard method using the equations below. The relative response factor from the initial calibration standard is used to calculate the concentration of the sample.

14.12.2.1.4 Send all samples and blanks through a library search program in an effort to identify 15 non-target compounds or as requested.

14.12.2.1.5 Do <u>not</u> report the following compounds:

- Compounds less than 10% of the nearest internal standard area,
- Compounds which elute earlier than 30 seconds before the first target compound or three minutes after the last purgeable compound,
- Carbon dioxide, and
- Semivolatile target compounds.

14.12.2.1.6 The computer software provides a mass spectral library of 125,000 compounds for comparison to unknown compounds found in samples. Criteria for making tentative identifications are:

- Ions >10% of the largest ion in the reference spectrum must be present in the sample spectrum.
- The relative intensities of major ions should agree within ±20%.
- Molecular ions present in the reference spectrum must be present in the sample spectrum.
- Ions present in the sample spectrum, but not the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.
- Ions present in the reference but not the sample should be verified by performing manual background subtraction to remove interferences.
- If after review, the analyst is at a loss to identify the compound use the following method:
  - If the computers match probability is 85% or greater report that compound.
  - If the computer match probability is <85%, try to classify the compound and give it a name like “unknown chlorinated hydrocarbon” if it can be determined.

14.12.2.1.7 Do the quantitation of tentatively identified compounds based on comparison of the total ion area of an unknown peak to the total ion area of the nearest internal standard:

- Do not identify peaks that have an area <10% of the nearest internal standard.
- Since no calibrations are run for these unknown peaks, use response factor of 1 to calculate concentrations.

14.13 Documentation Requirements

14.13.1 Assure that GC Instrument log contains the following:

- CHEMTECH sample ID
- Client sample ID
- Tag number
- Dilution details
- All standards, samples, blanks, etc., run on the instrument in the order they were analyzed
- Date and time of injection of each sample and standard
- Computer data file number
- mL of sample analyzed
- Column ID and temperature program

- Analyst signature
- Supervisor signature

14.13.2 Label all chromatograms as follows:

- CHEMTECH and client sample number
- Volume injected
- Date and time of injection
- GC column ID
- GC Instrument ID
- Identified compound names

14.13.3 The following quant reports and chromatograms and data system printouts must be included in the data package:

- All standards and blanks from initial calibrations and QC Check sample
- All samples and blanks

Note: Do not report Tracer gases (Isopropyl alcohol and Ethanol) on the Report of Analysis Form. Document the concentration of these compounds in the case narrative/non-conformance sheet, if detected.

14.14 <u>Instrument Maintenance</u>

14.14.1 For routine maintenance, flush the autosampler inlet ports and bake out the traps daily using Entech sequence.

14.14.2 Replace traps if recoveries of the analytes are failing.

14.14.3 Clean the MSD source when the BFB no longer meets ion ratio criteria, or when the low level standard is not showing a response greater than 2.5 times the noise level of the instrument.

14.14.4 Replace column when peak tailing is observed.

14.14.5 Call 1-800-COMPCO6 with the details of the problem and schedule a service call.

14.14.6 Record all maintenance in the Maintenance Logbook adjacent to the Instrument Logbooks.

14.15 Record in the logbook if there are any instrument errors.

- Rerun the samples.

Note: Errors include

- *Leaked samples*
- *Electric shutdown*

15. CALCULATIONS

15.1 Calculation in ppbv

$$\text{Concentration ppbv} = \frac{Ax \times Cis \times DF}{Ais \times \overline{RRF}}$$

Ax = Area of the characteristic ion for the compound to be measured, counts.

Ais = Area of the characteristic ion for the specific internal standard, counts.
Cis = Concentration of the internal standard spiking mixture, ppbv
$\overline{\text{RRF}}$ = Mean relative response factor from the initial calibration.

15.2 Calculation in ug/m3

$$\text{Concentration in ug/m3} = \frac{\text{ppbv X molecular weight}}{24.45}$$

16. METHOD PERFORMANCE

16.1 Analysis is performed in accordance with the method. All quality control and quality assurance procedures are followed. Please refer to P203-MDL SOP for further information.

16.2 Each analyst will make a one-time demonstration of the ability to generate acceptable accuracy and precision with this method. Please refer to P&A SOP for further information.

17. POLLUTION PREVENTION

17.1 Use only the amounts of chemicals required. Do <u>not</u> make large quantities of solutions.

17.2 Use hood when working with solvents.

17.3 Keep the area clean and clutter free in the lab and around the instruments in order to avoid any mishaps.

17.4 Vent the exhaust from the canister cleaning assembly.

17.5 Trap septum vent and split vent on GC.

17.6 Keep chemicals away from drains.

17.7 Properly collect and dispose of waste according to Chemtech's Waste Disposal SOP.

17.8 Laboratory is properly equipped with spill cleanup equipment and laboratory personnel trained. Depending upon the size and type of spill, it may be handled by the individual or department creating the spill or by specially trained personnel.

17.9 Small spills may occur routinely and shall be handled by the individual person or department creating the spill. Spill kits are stored in a blue basket or blue cover bin located in each laboratory and chemical storage area. The spill kits can handle water based, solvent and mercury spills. Specially trained personnel handle larger spills, which may pose a threat to health or environment involves a large volume not easily contained.

17.10 A detailed description of the procedure for handling a spill or accident is covered in the CHEMTECH Emergency and Contingency Plan.

17.11 The Safety Coordinator is responsible for implementing the Chemical Hygiene and the CHEMTECH Emergency and Contingency Plans. It is the responsibility of various company personnel to assist in implementing the different aspects of the Plan. These include: Laboratory Coordinator, Technical Director, Operations Manager, Department Managers and Supervisors.

18. DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QC

18.1 <u>BFB</u>

18.1.1 Resulting spectrum must meet criteria in Table 1.

18.2 <u>Initial Calibration</u>

18.2.1 Analyze 5 points defining the calibration range.

18.3 %RSD criteria must be <30%. For DOD, Each analyte must meet one of the three options, Option 1: RSD for each analyte ≤ 30%, Option 2: linear least squares regression for each analyte: r2 ≥ 0.99, Option 3: non-linear least squares regression (quadratic) for each analyte: r2 ≥ 0.99.

18.3.1 Any extra compounds requested by the client must also meet the <30% RSD criteria.

18.3.2 MDL verification standard must meet ± 50%

18.3 Initial Calibration Verification

18.3.1 The acceptance criteria for the %D for each compound is ±30%.

18.4 Continuing Calibration

18.4.1 Recovery of each analyte must meet acceptance criteria ±30%.

18.5 Method Blank

18.5.1 The method blank must not contain any analyte above the quantitation level (3X MDL).

18.5.2 For DoD work, Method Blank should contain no analytes detected >1/2 LOQ (Reporting Limit) or <1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. If this requirement does not meet, rerun once.

18.6 Lab Control Sample(LCS)/LCS Replicate

18.6.1 Recovery of each analyte must meet acceptance criteria of ±30%.

18.6.2 For DOD, A laboratory must use the QSM Appendix C Limits for batch control if project specific limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. RPD between the LCS and LCS Replicate for each target analyte must be < 30%.

18.7 Internal Standard

18.7.1 The internal standard must not vary more than 40% on area response from the most recent valid CCC.

18.8 Retention time

18.8.1 Retention time for internal standards must meet ± 0.33min of the most recent CCC.

18.9 Limit of Detection

18.9.1 All analytes spiked should be positively identified.

18.10 Limit of Quantitation

18.10.1Analysis must meet the acceptance criteria for the laboratory control sample.

18.10 Initial Calibration Verification

18.10.1 Recovery of each analyte must meet the acceptance criteria ±30%D.

18.11 Surrogate

18.11.1 Recovery for the surrogates must be within ±30%

19. CORRECTIVE ACTION FOR OUT-OF-CONTROL DATA

19.1 BFB-MS Tuning Check Compounds

19.1.1 Rerun the BFB tune.

19.1.2 If it still fails, retune the instrument (PFTBA tuning).

19.1.3 If it still fails, then clean the source.

19.2 Initial Calibration

19.2.1 Up to 2 compounds can fail to meet the ±30% criteria, but the %RSD must be <40% for these compounds.

19.2.2 If the %RSD criteria are not met for more compounds or %RSD>40% for any compound, analyze a new initial calibration.

19.3 Continuing Calibration

19.3.1 All compounds must meet ±30%D criteria

19.3.2 If the CCC sample fails again, reanalyze the initial calibration curve.

19.4 Method Blank

19.4.1 Rerun the method blank if it fails the first time.

19.4.2 If it fails second time, evaluate the system and contact the department supervisor.

19.5 Lab Control Sample(LCS) / LCS Replicate

19.5.1 If LCS/LCS Replicate fails meet criteria, Correct problem, and then reanalyze the LCS.

19.5.2 If the second LCS fails criteria again reanalyze the entire batch if sufficient sample is available.

19.5.3 If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-Flag to specific analyte(s) in all samples in the associated analytical batch.

19.5.4 Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

19.6 Internal Standards

19.6.1 If the internal standard vary more than ±40%, then the instrument must be inspected for malfunction and reanalyze all samples that ran during the instrument malfunction.

19.6.2 Report the data from the analysis that meets the criteria.

19.7 Retention time

19.7.1 If the retention time falls outside the criteria, reanalyze the samples and report the data from the analysis that meets the criteria.

19.8 Limit of Detection

19.8.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.9 Limit of Quantitation

19.9.1 Reevaluate the LOD and the LOQ.

19.10 Initial Calibration Verification

19.10.1 If ICV fails to meet criteria, reanalyze the ICV.

19.10.2 If the ICV fails again, reanalyze the initial calibration curve.

19.11 Surrogate

19.11.1 If the surrogate recovery fails to meet criteria, reanalyze the sample.

19.11.2 Surrogate recovery must meet criteria for the Blank and LCS sample analysis before the sample analysis can continue.

19.12 General Contingencies

19.12.1 Verify that the mass spectrometer is operating under the proper vacuum. Attach a vacuum to the mass spectrometer. The vacuum should be in the 10-5 range. If it is not, call 1-800-COMPCO6 to arrange for a repair.

19.12.2 Verify that there isn't any other background mass spectrometer problem.

- Go into Mtune on the PC that is running the instrument.
- Open the Calibration valve, which will release PFTBA into the system.
- Load the tune file for the instrument you are using.
- Click on Profile Scan.
- The Profile Scan should have ion 69 as 100%, 131 at approximately 55% and ion 219 also at approximately 55%.
- Other ions will be present but they should be <10% of these.
- If they are not call 1-800-COMPCO6 to arrange for a repair.

19.12.3 Trap and/or Column replacement may be necessary if a particularly bad sample contaminated the system.

- Bake the system overnight.
- Test operation starting with BFB, Standard and Blank.
- If trap and/or column are suspected problems are suspected, replace with a new one, and condition overnight before use.

20. CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1 Issue a corrective action form any time there is a deviation from the SOP or the client requirements are not met.

20.2 If a sample is damaged, broken or volume is inadequate, contact the project manager and issue a corrective action.

21. WASTE MANAGEMENT

21.1 Keep samples for 28 days after analysis and set the canister aside for cleaning, evacuation and re-use according to the procedures explained in this SOP.

22. REFERENCES

22.1 Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) In Ambient Air Using Specially Prepared Canisters with Subsequent Analysis By Gas Chromatography. Center for Environmental Research Information, Office of Research and Development, US EPA January, 1999.

22.2 USEPA Method TO-15 for Ambient Air NJDEP Regulatory Reporting Format

22.3 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013 & Version 5.1, January 2017.

23. LIST OF TABLES/ATTACHMENTS

Table 1	BFB Tuning Criteria
Table 2	Characteristic Ions and Molecular weights for Volatile Target Compounds.
Attachment 1	Daily Analysis Run Log for GC/MS
Attachment 2	Chemtech External Chain Of Custody Form

TABLE 1
BFB TUNING CRITERIA

Mass	**Ion Abundance Criteria**[1]
50	8.0-40.0 percent of mass 95
75	30.0-66.0 percent of mass 95
95	Base peak, 100 percent relative abundance
96	5.0-9.0 percent of mass 95
173	Less than 2.0 percent of mass 174
174	50.0-120.0 percent of mass 95
175	4.0-9.0 percent of mass 174
176	93.0-101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

[1] All ion abundance must be normalized to mass 95, the nominal base peak even though the ion abundance of mass 174 may be up to 120% of mass 95.

TABLE 2
CHARACTERISTIC IONS FOR VOLATILE TARGET COMPOUNDS

Compound	CAS No.	Primary Ion	Secondary Ion
Methyl chloride (chloromethane); CH3Cl	74-87-3	50	52
Carbonyl sulfide; COS	463-S8-1	60	62
Vinyl chloride (chloroethene); C2H3Cl	7S-01-4	62	64
Diazomethane; CH2N2	334-88-3	42	41
Formaldehyde; CH2O	50-00-0	29	30
1,3-Butadiene; C4H6	106-99-0	39	54
Methyl bromide (bromomethane); CH3Br	74-83-9	94	96
Phosgene; CCl2O	75-44-5	63	65
Vinyl bromide (bromoethene); C2H3Br	593-60-2	106	108
Ethylene oxide; C2H4O	75-21-8	29	44
Ethyl chloride (chloroethane); C2H5Cl	75-00-3	64	66
Acetaldehyde (ethanal); C2H4O	75-07-0	44	29, 43
Vinylidene chloride (1,1-dichloroethylene); C2H2Cl2	75-35-4	61	96
Propylene oxide; C3H6O	75-56-9	58	57
Methyl iodide (iodomethane); CH3I	74-88-4	142	127
Methylene chloride; CH2Cl2	75-09-2	49	84, 86
Methyl isocyanate; C2H3NO	624-83-9	57	56
Allyl chloride (3-chloropropene); C3H5Cl	107-05-1	76	41, 78
Carbon disulfide; CS2	75-15-0	76	44, 78
Methyl tert-butyl ether; C5H12O	1634-04-4	73	41, 53
Propionaldehyde; C2H5CHO	123-38-6	58	29, 57
Ethylidene dichloride (1,1-dichloroethane); C2H4Cl2	75-34-3	63	65, 27
Chloroprene (2-chloro-1,3-butadiene); C4H5Cl	126-99-8	88	53, 90
Chloromethyl methyl ether; C2H5ClO	107-30-2	45	29, 49
Acrolein (2-propenal); C3H4O	107-02-8	56	55
1,2-Epoxybutane (1,2-butylene oxide); C4H8O	106-88-7	42	41, 72
Chloroform; CHCl3	67-66-3	83	85, 47
Ethyleneimine (aziridine); C2H5N	151-56-4	42	43
1,1-Dimethylhydrazine; C2H8N2	57-14-7	60	45, 59
Hexane; C6H14	110-54-3	57	41, 43
1,2-Propyleneimine (2-methylazindine); C3H7N	75-55-8	56	57, 42
Acrylonitrile (2-propenenitrile); C3H3N	107-13-1	53	52
Methyl chloroform (1,1,1 trichloroethane); C2H3Cl3	71-55-6	97	99, 61
Methanol; CH4O	67-56-1	31	29
Carbon tetrachloride; CCl4	56-23-5	117	119
Vinyl acetate; C4H6O2	108-05-4	43	86
Methyl ethyl ketone (2-butanone); C4H8O	78-93-3	43	72

TABLE 2

CHARACTERISTIC IONS FOR VOLATILE TARGET COMPOUNDS (continue)

Compound	CAS No.	Primary Ion	Secondary Ion
Benzene; C6H6	71-43-2	78	77,50
Acetonitrile (cyanomethane); C2H3N	75-05-8	41	40
Ethylene dichloride (1,2-dichloroethane); C2H4Cl2	107-06-2	62	64, 27
Triethylamine; C6H15N	121-44-8	86	58, 101
Methylhydrazine; CH6N2	60-34-4	46	31, 45
Propylene dichloride (1,2-dichloropropane); C3H6Cl2	78-87-5	63	41, 62
2,2,4-Trimethyl pentane; C8H18	540-84-1	57	41, 56
1,4-Dioxane (1,4 Diethylene oxide); C4H8O2	123-91-1	88	58
Bis(chloromethyl) ether; C2H4Cl2O	542-88-1	79	49, 81
Ethyl acrylate; C5H8O2	140-88-5	55	73
Methyl methacrylate; C5H8O2	80-62-6	41	69, 100
1,3-Dichloropropene; C3H4Cl2 (cis)	542-75-6	75	39, 77
Toluene; C7H8	108-88-3	91	92
Trichloethylene; C2HCl3	79-01-6	130	132, 95
1,1,2-Trichloroethane; C2H3Cl3	79-00-5	97	83, 61
Tetrachloroethylene; C2Cl4	127-18-4	166	164, 131
Epichlorohydrin (l-chloro-2,3-epoxy propane); C3H5ClO	106-89-8	57	49, 62
Ethylene dibromide (1,2-dibromoethane); C2H4Br2	106-93-4	107	109
N-Nitrso-N-methylurea; C2H5N3O2	684-93-5	60	44, 103
2-Nitropropane; C3H7NO2	79-46-9	43	41
Chlorobenzene; C6H5Cl	108-90-7	112	77, 114
Ethylbenzene; C8H10	100-41-4	91	106
Xylenes (isomer & mixtures); C8H10	1330-20-7	91	106
Styrene; C8H8	100-42-5	104	78, 103
p-Xylene; C8H10	106-42-3	91	106
m-Xylene; C8H10	108-38-3	91	106
Methyl isobutyl ketone (hexone); C6H12O	108-10-1	43	58, 100
Bromoform (tribromomethane); CHBr3	75-25-2	173	171, 175
1,1,2,2-Tetrachloroethane; C2H2Cl4	79-34-5	83	85
o-Xylene; C8H10	95-47-6	91	106
Dimethylcarbamyl chloride; C3H6ClNO	79-44-7	72	107
N-Nitrosodimethylamine; C2H6N2O	62-75-9	74	42
Beta-Propiolactone; C3H4O2	57-57-8	42	43
Cumene (isopropylbenzene); C9H12	98-82-8	105	120
Acrylic acid; C3H4O2	79-10-7	72	45, 55
N,N-Dimethylformamide; C3H7NO	68-12-2	73	42, 44
1,3-Propane sultone; C3H6O3S	1120-71-4	58	65, 122

TABLE 2

CHARACTERISTIC IONS FOR VOLATILE TARGET COMPOUNDS (continue)

Compound	CAS No.	Primary Ion	Secondary Ion
Acetophenone; C8H8O	98-86-2	105	77,120
Dimethyl sulfate; C2H6O4S	77-78-1	95	66,96
Benzyl chloride (a-chlorotoluene); C7H7Cl	100-44-7	91	126
1,2-Dibromo-3-chloropropane; C3H5Br2Cl	96-12-8	57	155, 157
Bis(2-Chloroethyl)ether; C4H8Cl2O	111-44-4	93	63, 95
Chloroacetic acid; C2H3ClO2	79-11-8	50	45, 60
Aniline (aminobenzene); C6H7N	62-53-3	93	66
1,4-Dichlorobenzene (p-); C6H4Cl2	106-46-7	146	148, 111
Ethyl carbamate (urethane); C3H7NO2	51-79-6	31	44, 62
Acrylamide; C3H5NO	79-06-1	44	55, 71
N,N-Dimethylaniline; C8H11N	121-69-7	120	77, 121
Hexachloroethane; C2Cl6	67-72-1	201	199, 203
Hexachlorobutadiene; C4Cl6	87-68-3	225	227, 223
Isophorone; C9H14O	78-59-1	82	138
N-Nitrosomorpholine; C4H8N2O2	59-89-2	56	86, 116
Styrene oxide; C8H8O	96-09-3	91	120
Diethyl sulfate; C4H10O4S	64-67-5	45	59, 139
o-Cresol; C7H8O	95-48-7	108	107
Catechol (o-hydroxyphenol); C6H6O2	120-80-9	110	64
Phenol; C6H6O	108-95-2	94	66
1,2,4-Trichlorobenzene; C6H3Cl3	120-82-1	180	182, 184
Nitrobenzene; C6H5NO2	98-95-3	77	51, 123

ATTACHMENT 1

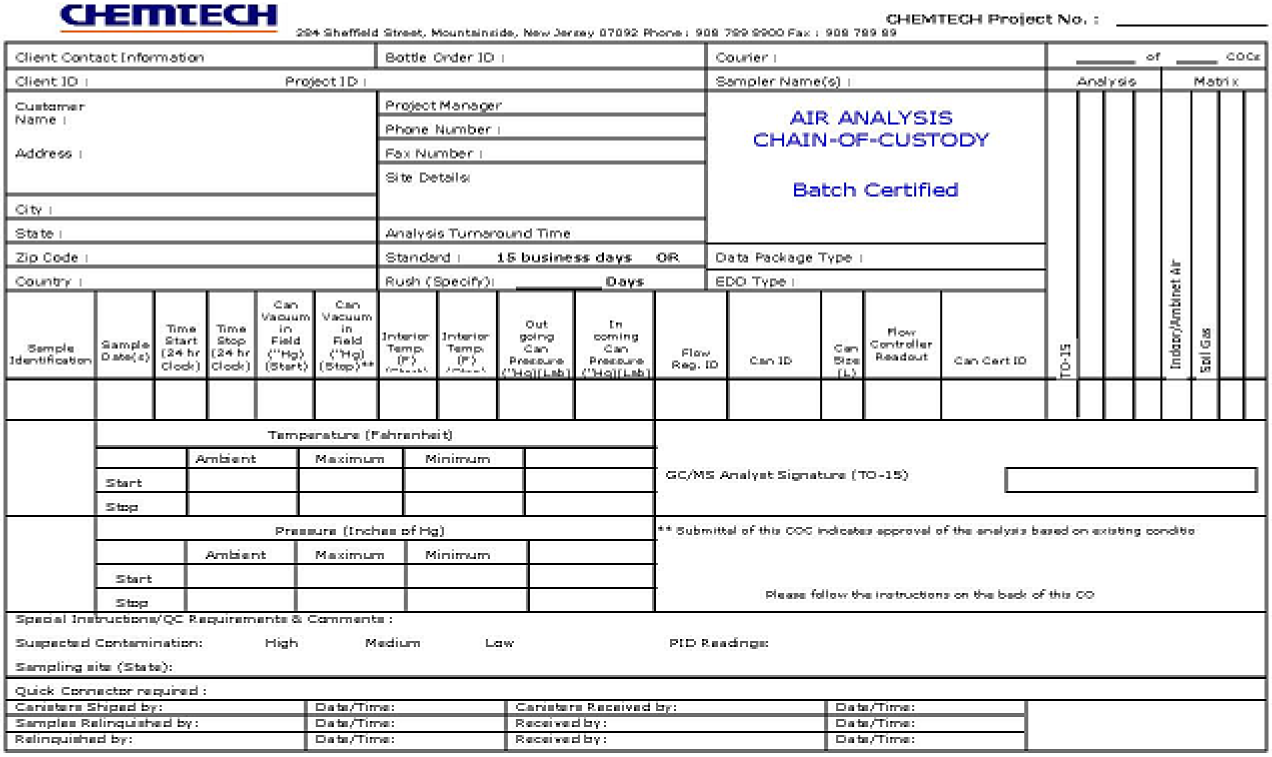
CHEMTECH 284 Sheffield Street, Mountainside NJ 07092 (908) 789-8900

Daily Analysis Runlog For Instrument ID

STD. NAME	**STD REF. #:**	**STD NAME**	**STD REF. #:**
Review By		Review On	
Tune/Reschk		Initial Calibration Stds	
CCC		SubDirectory	
Internal Standard/PEM		HP Acquire Method	
ICV/I.BLK		HP Processing Method	

SR #:	**Sample ID**	**Data File Name**	**Comment**	**Status**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				

Attachment 2: Chemtech External Chain of Custody Form



CHEMTECH
294 Sheffield Street, Mountainside, New Jersey 07092 Phone : 908 789 8900 Fax : 908 789 89

CHEMTECH Project No. : ______

AIR ANALYSIS
CHAIN-OF-CUSTODY

Batch Certified

Client Contact Information	Bottle Order ID :	Courier :	____ of ____ COCs
Client ID : Project ID :		Sampler Name(s) :	Analysis / Matrix
Customer Name :	Project Manager		
Address :	Phone Number :		
	Fax Number :		
	Site Details:		
City :			
State :	Analysis Turnaround Time		
Zip Code :	Standard : 15 business days OR	Data Package Type :	
Country :	Rush (Specify): ______ Days	EDD Type :	

Sample Identification	Sample Date(s)	Time Start (24 hr Clock)	Time Stop (24 hr Clock)	Can Vacuum in Field ("Hg) (Start)	Can Vacuum in Field ("Hg) (Stop)**	Interior Temp. (F)	Interior Temp. (F)	Out going Can Pressure ("Hg)(Lab)	In coming Can Pressure ("Hg)(Lab)	Flow Reg. ID	Can ID	Can Size (L)	Flow Controller Readout	Can Cert ID	TO-15				Indoor/Ambient Air	Soil Gas		

Temperature (Fahrenheit)

	Ambient	Maximum	Minimum	
Start				
Stop				

GC/MS Analyst Signature (TO-15)

Pressure (Inches of Hg)

	Ambient	Maximum	Minimum	
Start				
Stop				

** Submittal of this COC indicates approval of the analysis based on existing conditio

Please follow the instructions on the back of this CO

Special Instructions/QC Requirements & Comments :

Suspected Contamination: High Medium Low PID Readings:

Sampling site (State):

Quick Connector required :

Canisters Shiped by:	Date/Time:	Canisters Received by:	Date/Time:
Samples Relinquished by :	Date/Time:	Received by :	Date/Time:
Relinquished by:	Date/Time:	Received by :	Date/Time:

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: ______________________________

Department: ______________________________

______________________________ MTO15-Air VOC ______________________________
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above-mentioned method or document.

____________________________________ __________________
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

____________________________________ __________________
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

QA Control Code: A2040128

SOP Name:	SAMPLE RECEIPT, SAMPLE ACCEPTANCE POLICY, SAMPLE LOGIN, SAMPLE IDENTIFICATION, & SAMPLE STORAGE
SOP ID:	P250-Log-in Procedure
Revision #:	21
Date Created:	April 9, 2002
Effective Date:	July 27, 2017
Reason for Revision:	Annual Review
Supercedes:	P250-Log-in Procedure-20

Approvals:

Analyst	Date
Supervisor	Date
QA/QC Director	Date
Technical Director	Date

“The technical information contained herein is to be considered confidential and proprietary and is not to be disclosed, copied, or otherwise made available to other parties without the express written consent of Chemtech

SAMPLE MANAGEMENT

SAMPLE RECEIPT, SAMPLE ACCEPTANCE POLICY, SAMPLE LOG-IN, SAMPLE IDENTIFICATION, & SAMPLE STORAGE

1. Scope and Application

1.1 Procedures for sample handling, receipt, acceptance, login, and storage are defined in this SOP.

1.2 Defining sample acceptance and handling practices is critical to ensure the validity of the laboratory data.

2. Purpose and Responsibility

2.1 This SOP defines the procedures that Sample Management staff must utilize whenever receiving and logging in samples.

2.2 The SOP instructs the staff to use checklists to ensure sample integrity and provides the resources to electronically track samples through the laboratory.

3. Definitions

3.1 <u>Document Control Officer (DCO)</u>**:** The person who is to contact the people at the SMO or region when there are questions about the SDG.

3.2 <u>Sample Management Office (SMO)</u>**:** Federal contractor run department responsible for making sure that the contract laboratory receives the sample correctly. SMO also handles scheduling the work.

3.3 <u>Sample Delivery Group (SDG)</u>**:** A set of samples that can come in all at once or over a maximum of seven days for the same site.

- There are to be no more than twenty samples per SDG.
- If more than twenty samples come in for the same project, then the set is split up so that no more than twenty samples are grouped together.

3.4 <u>Sample Management Technician</u>**:** The individual responsible for correctly receiving and logging samples in for the laboratory.

3.5 <u>Chain of Custody (COC)</u>**:** An unbroken trail of accountability that ensures the physical security of samples & extracts, and includes the signatures of all who handle the samples.

3.6 <u>Laboratory Chronicle</u>**:** A form that must be completed with every set of samples that is received. This form documents the condition in which the samples were received.

3.7 <u>Preservation</u>**:** Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

3.8 <u>Pure Reagent Water</u>**:** Water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method.

3.9 <u>Record of Communication</u>**:** A form that documents the communication between the client and laboratory personnel.

3.10 <u>Standard Operating Procedures (SOPs)</u>**:** A written document which details the method of an operating, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive task.

3.11 Test Method**:** An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP.

3.12 Trip Blank**:** Organic-free reagent water that is place in a 40ml vial and carried through sampling and handling to serve as a check on the contamination of volatiles by diffusion.

3.13 Validation**:** The process of substantiating specified performance criteria.

4. Procedure

4.1 *Sample Acceptance Policy*

4.1.1 Sample storage locations are unique. Upon receipt of sample coolers at the laboratory, examine the coolers for damage or broken custody seals. Note the condition of the seals and cooler(s) on the Chain of Custody and follow Section 4.2.1. Send the COC to the Project Manager and obtain the Login Guidance (See Appendix K). Samples are logged into separate SDGs based on the analyses to be done.. If custody seals and coolers are intact, begin the sample acceptance procedure. If they are not intact, immediately notify the appropriate Laboratory Project Manager by email and request that they contact the client.

4.1.2 After the Test Detail, Lab Chronicle and labels are received, remove the samples from the shipping containers under the hood, and set them up on the bench according to the Field Chain of Custody (COC). See SOP P204-COC for information regarding field COCs'. See Appendix B for a copy of the Field COC. Make sure that all sample labels are legible, written in indelible ink, and water- resistant.

4.1.3 Check the COC/Test Detail and ensure that all sample containers listed on the COC are present. Any deviation from the number of sample containers, and/or sample damage or contamination must be listed on the Laboratory Chronicle. Inform the Laboratory Project Manager of the non-conformances by raising the ticket.

4.1.4 Examine the field (COC) for completeness and correctness. Use the Sample Acceptance Checklist, Appendix A, as a guideline whenever accepting samples. Check the following:

4.1.4.1 Check the client name and address, and make sure that it is legible.

4.1.4.2 Ensure that the client has clearly written the project sampling location and identification, and that the client has indicated the name of the firm that has collected the samples. Verify the sample collector's name. Check that the billing information is also completed. If any information is missing, request the information from the client, if the client is present. If not, make a note on the Laboratory Chronicle.

4.1.4.3 Now check the sample information. Check the individual sample identification, the sample location, date and time of sample collection, matrix, number of containers, analysis request, and indication that the proper preservatives were used. See Appendix C for a listing of the correct preservative for each test performed. Check for any special remarks concerning the samples. List any non-conformances on the Laboratory Chronicle.

4.1.4.4 Pay close attention to the sample holding time and sample volume requirements. See Appendix C for a list of test holding times and sample volumes. If any sample holding times are less than 3 days, notify the appropriate supervisor of the situation. If holding times have been exceeded or the client did not provide sufficient volume, immediately inform the appropriate Laboratory Project Manager by raising a ticket and list the non-conformant samples on the laboratory chronicle. The Laboratory Project Manager will contact the client and give instructions to proceed with the acceptance or the Project Manager will indicate whether you should ship the non-conformant samples back to the client.

4.2 *Sample Receipt*

4.2.1 Check the cooler for the presence of a temperature blank. If the cooler has a temperature blank, check the temperature and record. If a temperature blank is not provided, check the temperature of the samples utilizing the Wahl Infrared Thermometer-Model DHS 100X or equivalent. Aim the gun at the sample and press the measure temperature button. Record the cooler temperature on the COC and the laboratory chronicle. See Appendix C for proper sample preservation.

4.2.1.1 All samples that require thermal preservation shall be considered acceptable if the arrival temperature is 2-6°C of the required temperature.

Note: Refer to Appendix C for the required preservation.

4.2.1.2 Samples that are brought to the laboratory soon after collection may not meet this criterion. These samples are acceptable if there is evidence (the samples are packed in a cooler with ice) that the sample collection personnel have initiated the chilling process.

4.2.1.3 Copy of the COC sent to PM to make log-in guidance via e-mail.

4.2.1.4 The Laboratory Project Manager and the Client should resolve all discrepancies between the AR & TRP and the COC prior to sample login.

4.2.1.5 Make sure to keep the samples cool at 4°C.

4.2.1.6 Proceed to Sample Login if there are no discrepancies and/or sample non-conformances. Sign the COC and enter the date and time of receipt.

4.2.1.7 If there are discrepancies and/or non-conformances, proceed to Sample Login once the client has given us clarifications and/or instructions to proceed.

4.2.1.7.1 Once all discrepancies and/or non-conformances have been resolved, login the samples according to the Record of Communication given to you by the Laboratory Project Manager. See Appendix F for a copy of the Record of Communication.

4.2.1.7.2 If the client does not wish to proceed with the analysis of the non-conformant samples, place the appropriate samples in the disposal area or ship back to the client as per their instructions.

4.2.1.8 Sign the field COC and enter the date and time of receipt.

4.2.2 Take the pH of any samples requiring a preservative using the narrow range pH paper.

4.2.2.5 Collect a portion of the sample in a small plastic cup.

4.2.2.6 Dip the pH paper in the sample.

4.2.2.7 Record the pH of the sample by fraction on the Laboratory Chronicle.

4.2.2.8 Discard the sample use following the waste disposal guidelines in P205-Waste disposal SOP.

4.2.2.9 Notify the client of any pH discrepancy.

4.2.2.10 If the pH does not comply with the preservative requirement, adjust the pH of the sample to the proper pH and note the pH and the pH adjustment on the Laboratory Chronicle. Use Appendix C as a guide for the appropriate preservative to use.

Note: Aqueous samples for metals analysis may be collected and shipped without acid preservation. However, acid must be added at least 24 hrs. before analysis to dissolve any metals that adsorb to the container walls.

4.2.3 Check the residual chlorine for all samples that have preservation dependent upon residual chlorine levels, see Appendix C. Samples containing residual chlorine have a preservative added at the time of sampling.

- Determine if sample has residual chlorine using the HACH Test Kit.
- Add contents of one pillow to a portion of the sample.
- If the sample develops a pink/pinkish color, sample has residual chlorine. Follow direction in Appendix C.

Note: Ascorbic acid will be used for Cyanide preservation only if the sampling site is known to be positive for residual chlorine.

4.2.4 Verify that the date and time on the sample container matches the sample date and time on the COC/Test Detail.

4.2.5 Verify that the client sample identification listed on the label of the sample container matches the client sample identification on the COC exactly.

4.2.6 If the sample identifications or sample dates and times do not match, indicate this on the Laboratory Chronicle and notify the Laboratory Project Manager by raising a ticket.

4.2.7 SM/PM ticket is raised if there is any issue with the shipment or login guidance.

Note: <u>For North Carolina Work</u>*: When aqueous samples received from North Carolina for the Pesticide (By method 8081A/B or EPA 608) or PCB (EPA 608) analysis, Total Residual Chlorine needs to be logged in to find out the presence of Total Residual Chlorine before samples are given to extraction department.*

4.3 *<u>Sample Log- In Procedure</u>*

4.3.1 The Login Module contains mainly 3 sections:

4.3.1.1 <u>Project Management</u>: This section shows the number of orders created by project management department and provides the link for detailed view of the order and login report.

4.3.1.1.1 <u>New Order</u>

4.3.1.1.1.1 The Project Manager creates a new order.

4.3.1.1.1.2 Information for Priority, PO#, Customer ID, Customer Contacts, Billing Contacts, Project ID, EDD Type, Data Package Type and Special Comments are added. Appropriate protocol has been selected from options Regular, DoD, NJDKQP as per clients request.

4.3.1.1.1.3 The Project Manager selects Test Groups and Tests as per the Chain of Custody requirements or pre-defined Statement of Work.

4.3.1.1.1.4 Add the required method, associated bottle type and preservation as per the Chain of Custody.

4.3.1.1.2 <u>Edit Order</u>

4.3.1.1.2.1 Follow same steps as in Section 4.3.1.1.1, to check and edit login. This step allows Project Manager to change, modify or delete any inserted data.

4.3.1.1.3 <u>Copy Order</u>

4.3.1.1.3.1 Provide Order from which all details are copied to the new Order.

4.3.1.1.3.2 Change login as per new requirement if required.

4.3.1.2 Sample Management: After New Project is created by Project Management, Sample Management enters the remaining information for login. This section shows the number of orders created by sample management department and provides the link for detailed view of the order and login report.

4.3.1.2.1 Login

4.3.1.2.1.1 Enter sample information per Matrix for each sample – Lab Sample ID, Sequence, Customer Sample ID, Sample Date, Sample Time, Receive Date, Receive Time, No. of Container, Comment.

4.3.1.2.1.2 Select Test Group or Test for each sample. Compare log in test with Chain of Custody to make sure that all requested test has been logged.

4.3.1.2.1.3 Click on Submit button to approve selected data.

4.3.1.2.1.4 Click on Summary button to review login summary. View and edit data, if required.

4.3.1.2.1.5 Once all correct information is entered, click on Proceed for Signoff.

4.3.1.2.1.6 Status for this Order ID changes to Signoff Pending.

4.3.1.2.1.7 Click on sample number for updating sample priority, Test Group and Test.

4.3.1.2.2 Verification of Shipment

4.3.1.2.2.1 Enter storage location for each test, or all tests.

4.3.1.2.2.2 Enter information on Method of Shipping and Shipping charges.

4.3.1.2.2.3 Click on submit.

4.3.1.2.2.4 View and edit Bottle Type and Preservative for each test.

4.3.1.2.2.5 Click on Update.

4.3.1.2.2.6 Answer questions for Sample receipt.

4.3.1.2.2.7 Click on Update.

4.3.1.2.2.8 View and edit any login information entered.

4.3.1.2.2.9 Click on Update and Transfer data.

4.3.1.3 Other:

4.3.1.3.1 Invoice

4.3.1.3.1.1 Invoice is created by accounting personnel.

4.3.1.3.2 Labels

4.3.1.3.2.1 After data transfer, Enter Order ID to print labels for each sample bottle from Sample Master in Sample Management.

4.3.1.3.2.2 Print laboratory chronicle or Question report or Shipment Verification Detail form and Test Detail from intranet program to perform all sample checks (See Appendix L and M).

4.3.1.3.2.3 Project is signed off, reviewed, scanned and saved on the server by sample management.

4.3.1.3.2.4 If any problems are observed while labeling the samples, communicate to PM to follow up with the client by raising a ticket.

4.3.1.3.3 <u>Report</u>

4.3.1.3.3.1 Login Report: Enter Order ID and Click on View Report button.

4.3.1.3.3.2 Test Detail/Laboratory Chronicle: Enter Order ID and select Checkbox as per requirement (Sample Test Report or Question Report).

4.3.1.3.3.3 Click on View Report button.

4.3.1.3.4 <u>Login – Log Additional Samples</u>

4.3.1.3.4.1 Select Order ID.

4.3.1.3.4.2 Samples already logged will be displayed with the test details.

4.3.1.3.4.3 Enter additional samples and click on Submit button.

4.3.1.3.5 <u>Project Track</u>: This section shows the tickets which are under New Login status, Signoff Pending, and Signoff but not Supervised projects, and provides the link for detail data. This section redirects to Project Track Module to reply a ticket or Review and Supervised functionality.

4.3.2 Take folder and label the folder with the order number (with proper project code number), client name, and fax and hardcopy due dates.

4.3.3 Place a copy of the login report in the appropriately colored project folder. Make sure and add the original COC, Laboratory Chronicle and the Record of Communication (if one was necessary) to the folder.

4.3.4 Add third party carrier information (i.e. Federal Express or UPS receipts) to the project folder. Add the pickup and delivery tickets to the project folder if Chemtech was the sample carrier.

4.3.5 Give the completed project folder to the Laboratory Project Manager. (The Laboratory Project Manager must review each hard copy login summary against the COC for comparability and completeness. He/she must correct any errors, sign and date the login sheet).

4.4 <u>Sample Storage & Security</u>

4.4.1 Sample Custodian: See Appendix I for list of authorized sample custodians.

4.4.1.1 Store the samples in the assigned refrigerator and according to conditions specified in methods or preservative protocols until the samples are requested.

4.4.1.1.1 Check refrigerator temperature daily and record.

4.4.1.1.2 Thermal preservation must be kept ±2ºC of specified preservation temperature.

4.4.1.1.3 Samples that require a 4ºC thermal preservation have an acceptable preservation range of just above freezing for water to 6ºC.

4.4.1.1.4 Do not store volatile samples with any other samples. Place the volatile samples in the refrigerators designated for volatiles only.

4.4.1.1.5 Store any suspected highly contaminated volatile samples in the refrigerator designated for suspected highly contaminated volatile samples.

4.4.1.1.6 Make sure that all volatile refrigerators have storage blanks.

4.4.1.2 Keep the samples locked at all times and release the samples only when samples are requested via the Sample Request Form (work list) by the analyst. See Appendix G for a copy of the Sample Request Form.

4.4.1.3 Obtain the samples listed on the Sample Request Form and sign the appropriate sections of the Sample Retrieval & Return Logbook. See Appendix H for a copy of a logbook page.

4.4.1.4 Ask the analyst, extraction or digestion technician receiving the samples to sign the Sample Retrieval & Return Logbook to acknowledge they have received the samples.

4.4.1.5 The analyst will inform the Sample Custodian when the samples can be returned to storage. All samples must be returned to storage at the by the end of the day. Make sure that the analyst or extraction technician signs the appropriate sample return section of the Sample Retrieval & Return Logbook. See SOP P204-COC-01 for a detailed description of internal chain of custody procedures.

4.4.1.6 Tracking Extracts and Digestates:

4.4.1.6.1 When the extractions or digestions are complete, the extraction or digestion technician will have the appropriate analyst sign the extraction or digestion log that the extracts/digestates have been received.

4.4.1.6.2 When analysts have completed work with the extracts or digestates, sign the extract or digestate log book and place them in refrigerators designated for extracts or digestates.

4.4.1.7 Retain the samples for a one-month period after the report is submitted to the client. The sample custodian in consultation with Sample Management Supervisor decides the samples to be disposed after 30 days.

4.5 Sample Receiving (EPA PE CLP Samples)

4.5.1 Upon receipt of sample coolers at the laboratory, examine the coolers for damage or broken custody seal. Note the condition of the seal(s) and cooler(s) on the TR (Traffic Report)/COC (Chain of Custody) and follow Section 4.2.1. Note the temperature on the TR. Sign the field TR and enter the date and time of receipt. Send the TR to the project manager.

4.5.2 Follow log-in procedure as per Section 4.3.

4.5.3 Once the log-in procedure is complete, print the DC-1 Form and labels.

4.5.4 Record in the ‘Remarks’ column of the DC-1 form if samples were received on ice.

4.5.5 Take DC-1 form (Appendix J), TR and labels to the place where the samples are lined up. Check all items on the checklist and label all containers. Store them at the assigned location.

4.5.6 Notify SMO if there are any discrepancies between the TR and the samples received (circle on DC-1 Form with ‘*’). Contact SMO if any of the items are missing, e.g. temperature bottle, custody seal, sample tag, air bill, etc. or if there is any sample breakage or MS/MSD is not assigned, etc. Wait for the Record of Resolution and make changes to log-in if required and notify the laboratory. Record cooler temperature in Remark #9.

4.5.7 For aqueous Proficiency testing samples, log each bottle individually and assign separate lab ID #.

4.6 Procedure for relinquishing samples to client

4.6.1 Sample management supervisor or sample management personal will have to verify that “Relinquished by & Date” field is properly filled out before shipping samples back to client.

4.6.2 All signed documents needs to be scanned and saved on server.

4.6.3 Any sample which needs to be shipped with ice must be shipped between Monday to Thursday unless there is a specific instruction from project manager to ship it on Friday, Saturday or Sunday.

4.6.4 Sample cooler must have custody seal and cooler must have tape around it so cooler cannot be tampered.

5. Disposal of Samples

5.1 Samples are retained for 1 month after report submission to clients unless otherwise directed by client.

5.2 Dispose all non-CLP samples according to the Waste Disposal Plan (See Chemtech Chemical Waste Disposal Guidelines SOP P205-Chemical Waste Disposal-02.

5.3 Unused CLP sample volume and used sample containers are kept for 60 days after report submission. After 180 days, the samples are properly discarded utilizing the appropriate waste disposal procedure SOP P205-Chemical Waste Disposal-02.

6. Health and Safety

6.1 The toxicity and carcinogenity of each reagent used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure of these compounds should be minimized.
6.2 Always wear safety glasses for eye protection when working with these reagents.
6.3 Use protective gloves when handling the chemicals.

7. Corrective Action Procedure

7.1 A corrective action report is issued whenever there is damage to a sample (broken or lost) where data quality may be affected. This process is explained in detail in the Corrective Action Procedure SOP P202-CAR-02.
7.2 Issue a corrective action report whenever there is a deviation from the SOP.

8. Personnel Qualifications

8.1 All employees must undergo laboratory health and safety training and ethics training and must read the laboratory QA Manual and all SOPs related to their area of work.
8.2 A signed and dated statement from each technical employee that they have read, understood, and are using the latest version of the laboratory QA Manual and SOPs, and that they have read, acknowledged and understood their personal, ethical and legal responsibilities, is maintained in their training file.
8.3 The Technical Director certifies and documents that all technical employees have the appropriate education and/or technical background to perform the tasks for which the employee is responsible.

9. References

9.1 USEPA Contract Laboratory Program - National Functional Guidelines for Organic Data Review, Office of Emergency and Remedial Response. OSWER 9240.1-05A-P, PB99-963506, EPA540/R-99/008, October 1999.
9.2 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013 & Version 5.1 January 2017.

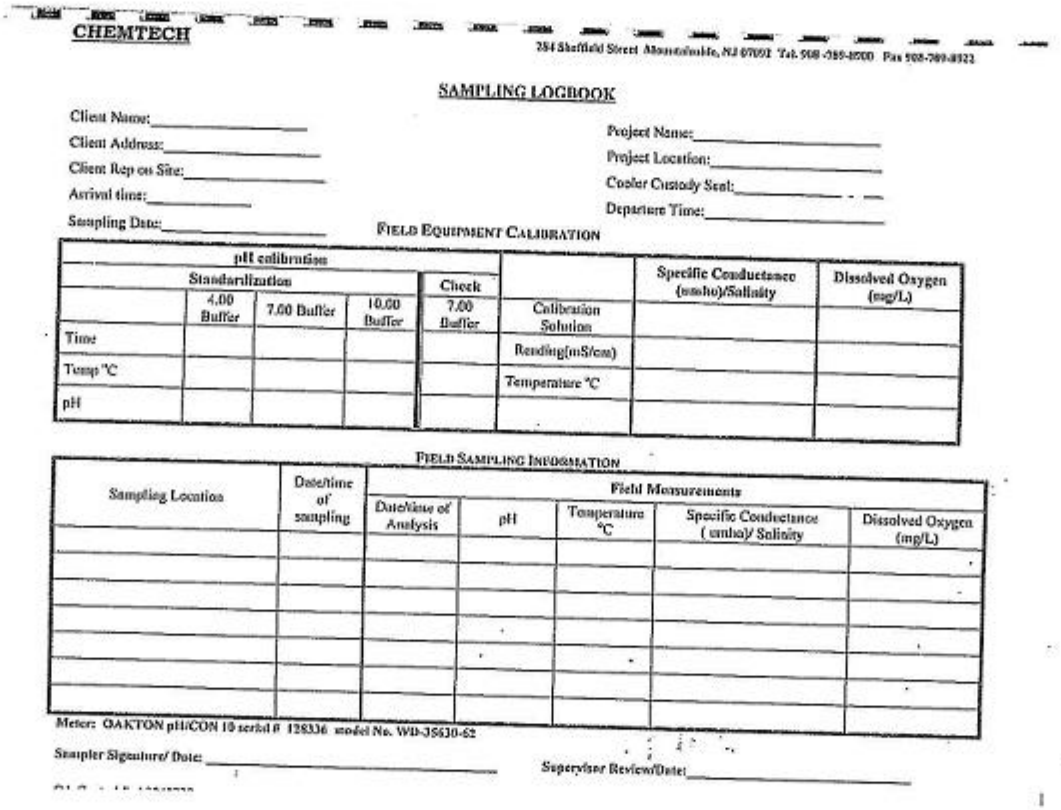
10. Appendices

10.1 Appendix B - Field Chain of Custody
10.2 Appendix C - Sample Holding Times, Preservatives, and Volume
10.3 Appendix D - Analytical Request and Test Review Forms
10.4 Appendix E - Rush Approval Form
10.5 Appendix F - Record of Communication
10.6 Appendix G - Sample Request Form
10.7 Appendix H - Sample Retrieval and Return Logbook Page

10.8 Appendix I - Authorized Sample Custodians
10.9 Appendix J – DC-1 form
10.10 Appendix K – Log-in guidance
10.11 Appendix L – SM Login Sample Test Detail
10.12 Appendix M – SM Login Question Report

APPENDIX B

Field Chain of Custody



CHEMTECH

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SAMPLING LOGBOOK

Client Name:________________
Client Address:________________
Client Rep on Site:________________
Arrival time:__________
Sampling Date:________________

Project Name:________________
Project Location:________________
Cooler Custody Seal:________________
Departure Time:________________

FIELD EQUIPMENT CALIBRATION

	pH calibration					Specific Conductance (mmho)/Salinity	Dissolved Oxygen (mg/L)
	Standardization			Check			
	4.00 Buffer	7.00 Buffer	10.00 Buffer	7.00 Buffer	Calibration Solution		
Time					Reading(mS/cm)		
Temp °C					Temperature °C		
pH							

FIELD SAMPLING INFORMATION

Sampling Location	Date/time of sampling	Field Measurements				
		Date/time of Analysis	pH	Temperature °C	Specific Conductance (umho)/ Salinity	Dissolved Oxygen (mg/L)

Meter: OAKTON pH/CON 10 serial # 128336 model No. WD-35630-62

Sampler Signature/ Date:____________________ Supervisor Review/Date:____________________

APPENDIX C

Water Sampling and Holding Time Information

Parameter	EPA Method	Standard Method and/or SW 846 Method	Preservation	Container	Holding Time	Minimum Volume
Turbidity	180.1	2130B	Cool, 4 deg C	P or G	48 Hrs	100 mL
Nitrate	300	-----	Cool, 4 deg C	P or G	48 Hrs	250 mL
Nitrate-Nitrite	300	-----	Cool to 4 deg C, Conc. H_2SO_4 to pH<2	P or G	28 Days	250 mL
Fluoride	300	4500 F-C	Cool, 4 deg C	P or G	28 Days	300 mL
Cyanide	-----	4500-CN C&E	Cool, 4 deg C 50%NaOH pH>12	P or G	14 Days	500 mL
Sulfate	300	4500-SO4 E	Cool, 4 deg C	P or G	28 Days	50 mL
Total Dissolved Solids	-----	2540C	Cool, 4 deg C	P or G	7 Days	100 mL
Calcium	200.7	-----	1:1 HNO_3 to pH<2	P or G	6 Months	100 mL
Calcium-Hardness	200.7	-----	1:1 HNO_3 to pH<2	P or G	6 Months	100 mL
Alkalinity	-----	2320B	Cool, 4 deg C	P or G	14 Days	100 mL
Bromide	300	-----	None	P or G	28 Days	250 mL
Chloride	300	4500-CL C	Cool, 4 deg C	P or G	28 Days	100 mL
Chlorite	300	-----	1mL EDA to 1L Cool, 4 deg C	P or G	14 Days 10 mins	250 mL
Color	-----	2120B	Cool, 4 deg C	P or G	24 Hrs	100 mL
Foaming Agents (MBAS)	-----	5540C	Cool, 4 deg C	P or G	48 Hrs	250 mL
Odor	-----	2150B	Cool, 4 deg C	G only	24 Hrs	200 mL
Conductivity	120.1	2510B, 9050A	Cool, 4 deg C	P or G	28 Days	100 mL
Silica	200.7	-----	Cool, 4 deg C	P only	7 Days	50 mL
Ortho Phosphate	300	4500 P-E	Cool, 4 deg C	P or G	48 Hrs	50 mL
Chlorine, Residual Disinfectant	-----	4500Cl-G	None	P or G	15 minutes	200 mL
pH, Hydrogen ion	-----	4500-H-B	None	P or G	15 minutes	25 mL
Temperature	-----	2550B	None	P or G	15 minutes	1000 mL
Volatiles (Regulated)	524.2	-----	Cool, 4 deg C 1:1 HCl to pH<2	G, screw cap Teflon faced silicone septum	14 Days	60-120 mL

Parameter	EPA Method	Standard Method and/or SW 846 Method	Preservation	Container	Holding Time	Minimum Volume
Acidity as $CaCO_3$	-----	ASTM D1067-92	Cool, 4 deg C	P or G	14 Days	100 mL
Alkalinity as $CaCO_3$	-----	2320B	Cool, 4 deg C	P or G	14 Days	100 mL
Ammonia	-----	4500-NH3 H	Cool, 4 deg C, Conc. H_2SO_4 to pH<2	P or G	28 Days	400 mL
Biochemical Oxygen Demand	-----	5210B	Cool, 4 deg C	P or G	24 Hrs.	1000 mL
Carbonaceous BOD	-----	5210B	Cool, 4 deg C	P or G	24 Hrs.	1000 mL
Cyanide	-----	9012A	Cool 4 deg C, 50% NaOH to pH>12 0.6 g ascorbic acid if residual chlorine present	P or G	Sulfide absent: 14 Days (Sulfide Present 24 Hrs.)	500 mL
Cyanide, Amenable	-----	4500-CN C,G	Cool 4 deg C, 50% NaOH to pH>12 0.6 g ascorbic acid if residual chlorine present	P or G	Sulfide absent: 14 Days (Sulfide Present 24 Hrs.)	500 mL
Acid Soluble & Insoluble Sulfide	-----	9030B	2N Zn Acetate, 6N NaOH to pH > 9, Cool, 4 deg C	P or G	7 Days	8 oz.
Total Hardness	200.7	-----	HNO_3 to pH<2	P or G	6 Months	100 mL
Total Kjeldahl Nitrogen	-----	4500-N OrgBorC	Cool, 4 deg C Conc. H_2SO_4 to pH<2	P or G	28 Days	500 mL
Oil & Grease	-----	1664A	Cool 4 deg C, 1:1 HCL or conc. H_2SO_4 to pH<2	G	28 Days	1000 mL
Orthophosphate	300	4500-P E	Filter immediately, Cool 4 deg C	P or G	48 Hrs.	50 mL
Phenols	420.1	9065	Cool 4 deg C, Conc. H_2SO_4 to pH<2	G	28 Days	500 mL
Total Phosphorus	365.3	-----	Cool 4 deg C, Conc. H_2SO_4 to pH<2	G	28 Days	50 mL
Total-Residue (TS)	-----	2540 B	Cool, 4 deg C	P or G	7 Days	100 mL
Residue-filtered (TDS)	-----	2540 C	Cool, 4 deg C	P or G	7 Days	100 mL
Residue-non-filtered (TSS)	-----	2540 D	Cool, 4 deg C	P or G	7 Days	100 mL

Parameter	EPA Method	Standard Method and/or SW 846 Method	Preservation	Container	Holding Time	Minimum Volume
Residue-Settleable (SS)	-----	2540 F	Cool, 4 deg C	P or G	48 Hrs.	1000 mL
Residue-Volatile	160.4	-----	Cool, 4 deg C	P or G	7 Days	100 mL
Salinity	-----	2520 C	Cool, 4 deg C	G	28 Days	100 mL
Specific Conductance	120.1	2510B, 9050A	Cool, 4 deg C	P or G	28 Days	100 mL
Sulfate	300	4500-SO4 E	Cool, 4 deg C	P or G	28 Days	50ml
Sulfide	-----	9034	Cool 4 deg C, add 2N Zinc Acetate + 6N NaOH to pH>9	P or G	7 Days	50 mL
Sulfite (SO3)	-----	4500-SO3 B	Fix cooled samples (<50°C) immediately by adding 1mL EDTA soln./100mL sample	G, Bottle and Top	15 minutes	50 mL
Temperature	-----	2550 B	None Required	G, Bottle and Top	15 minutes	1000 mL
Metals	200.7	-----	1:1 HNO_3 to pH<2	G	6 Months	100 mL
Mercury	-----	7470A	Cool, 4 deg C	P or G	28 Days	8 oz.
Organochlorine Pesticides/PCB	608	8081A/N,8082/ 8082A	Cool, 4 deg C 0.008% $Na_2S_2O_3$ if residual chlorine present , Adjust to pH 5-9 with 10N NaOH or 1:1 H2SO4	G, Amber Teflon-lined screw cap	7 days until extraction 40 days after extraction	1000 mL
Volatile Organics	624	8260B/C	Cool, 4 deg C 4 drops 10% $Na_2S_2O_3$ if residual chlorine present 1:1 HCl to pH <2	G, Vial screw cap with center hole Teflon-faced silicone septum	7 days without HCl 14 days with HCl	40 mL
Semi volatile Organics	625	8270C/D	Cool, 4 deg C 0.008% $Na_2S_2O_3$ if residual chlorine present	G, Amber Teflon-lined screw cap	7 days until extraction 40 days after extraction	1000 mL
DRO	-----	8015B	Cool, 4 deg C 0.008% $Na_2S_2O_3$ if residual chlorine present	G, Amber Teflon-lined screw cap	7 days until extraction 40 days after extraction	1000 mL
COD	-----	SM5220D	Cool, 4 deg C H2SO4 to pH<2	P	28 Days	1000 mL
TOC	-----	SW9060 Lloyd Kahn	Cool, 4 deg C HCl or H2SO4 to pH<2	P	28 days 14 days	1000 mL
Herbicide	-----	SW8151	Cool, 4 deg C	G, Amber	7 days until extraction 40 days after extraction	1 L

Parameter	EPA Method	Standard Method and/or SW 846 Method	Preservation	Container	Holding Time	Minimum Volume
GRO	-----	8015B	Cool, 4 deg C 0.008% $Na_2S_2O_3$ if residual chlorine present 1:1 HCl to pH <2	G, Vial screw cap with center hole Teflon-faced silicone septum	7 days without HCl 14 days with HCl	40 mL
Gases	-----	3810	Cool, 4 deg C 0.008% $Na_2S_2O_3$ if residual chlorine present 1:1 HCl to pH <2	G, Vial screw cap with center hole Teflon-faced silicone septum	7 days without HCl 14 days with HCl	40 mL
HPLC (Explosive)	-----	8330A/B	Cool, 4 deg C	G, Amber Teflon-lined screw cap	7 days until extraction 40 days after extraction	1000mL
Hexavalent Chromium	-----	3500 Cr D	Cool, 4 deg C	P	24 Hrs.	100mL
Ferrous Iron	-----	HACH 8146	Cool, 4 deg C	Amber G	24 Hrs.	250mL
RSK 175	-----	RSK 175	Cool, 4 deg C 1:1 H2SO4 or HCl to ph<2	G, Vial screw cap with center hole Teflon-faced silicone septum	14 days	40 mL
Formaldehyde	-----	HACH 8110	Cool, 4 deg C	P	Analyze Immediately within 48hrs	1000mL
Ferrous Iron	-----	HACH 8146 SM3500	Cool, 4 deg C	P	Analyze Immediately within 48hrs	1000mL
Chemical Warfare Agents	-----	8270-modified	Cool, 4 deg C	G, Amber Teflon-lined screw cap	7 days until extraction 40 days after extraction	1000mL
Glycols	-----	Chemtech SOP	Cool, 4 deg C	G	28 days	100mL
Perchlorate	314.0	-----	-----	P or G	28 days	500mL

Container Key:
P = Plastic
G =Glass
DW= Drinking Water

Soil/Hazardous Waste Sampling and Holding Time Information

Parameter	EPA Method	Standard Method and/or SW 846 Method	Preservation	Container	Holding Time	Minimum Volume
Ignitability	-----	1010	None	P or G	None	8 oz.
Ignitability of Solids	-----	1030	None	P or G	None	8 oz.
Corrosivity pH Waste>20% water	-----	9040B	Cool, 4 deg C	P	15 minutes	4 oz.
Corrosivity Toward Steel	-----	1110	Cool, 4 deg C	P	14 Days	4 oz.
Reactivity Cyanide	-----	SW-846 7.3.3.2	Cool, 4 deg C	P	14 Days	8 oz.
Reactivity Sulfide	-----	SW-846 7.3.4.2	Cool, 4 deg C	P	14 Days	8 oz.
TCLP Volatile Organics	-----	1311	Cool, 4 deg C	G	14 Days to TCLP extraction, 14 days to analysis	4 oz.
TCLP Metals	-----	1311	Cool, 4 deg C	G	180 Days to TCLP extraction, 180 days to analysis	16 oz
TCLP Mercury	-----	1311	Cool, 4 deg C	G	28 Days to TCLP extraction, 28 days to analysis	16 oz
TCLP Semi volatiles	-----	1311	Cool, 4 deg C	G	14 Days to TCLP extraction, 7 days to extraction, 40 days to analysis	16 oz
TCLP Pesticides and Herbicides	-----	1311	Cool, 4 deg C	G	14 Days to TCLP extraction, 7 days to extraction, 40 days to analysis	16 oz
PH	-----	9040B, 9041A, 9045C	Cool, 4 deg C	P	15 minutes	4 oz.

Parameter	EPA Method	Standard Method and/or SW 846 Method	Preservation	Container	Holding Time	Minimum Volume
Temperature	-----	2550 B	-----	P	15 minutes	4 oz.
Metals	-----	6010B/C	Cool, 4 deg C	P or G	6 Months	8 oz.
Mercury	-----	7471A	Cool, 4 deg C	P or G	28 Days	8 oz.
Organochlorine Pesticides	-----	8081A/B	Cool, 4 deg C	P or G	14 Days for extraction, 40 days to analysis	8 oz.
PCB's	-----	8082/8082A	Cool, 4 deg C	P or G	14 Days for extraction, 40 days to analysis	8 oz.
Chlorinated Herbicides	-----	8151A	Cool, 4 deg C	G, wide mouth, Teflon liner	14 Days	8 oz.
Volatile Organics	-----	8260B/C	Cool, 4 deg C	G, wide mouth, Teflon liner	14 Days	4 oz.
Semi volatile Organics	-----	8270C/D	Cool, 4 deg C	Amber Glass	14 Days to extraction, 40 days to analysis	8 oz.
Total Cyanide	-----	9012A	Cool, 4 deg C	P or G	14 Days	8 oz.
Amenable Cyanide	-----	9010B	Cool, 4 deg C	P or G	14 Days	8 oz.
Acid Soluble & Insoluble Sulfide	-----	9030B	Cool, 4 deg C No Headspace	P or G	7 Days	8 oz.
Extractable Sulfide	-----	9031	Cool, 4 deg C Fill solid surface with 2N Zinc Acetate until moistened, 4 drops 2N Zinc Acetate/100mL sample, 50%NaOH to pH>9	P or G	7 Days	8 oz.
Sulfate	-----	9038, 9056	Cool, 4 deg C	P or G	28 Days	8 oz.
pH, Soil and Waste	-----	9045C	Cool, 4 deg C	G	15 minutes	8 oz.

Parameter	EPA Method	Standard Method and/or SW 846 Method	Preservation	Container	Holding Time	Minimum Volume
Phenol	-----	9065	Cool 4 deg C	G	28 Days	8 oz.
Oil & Grease (Sludge, Sludge-Hem)	-----	9071B	Cool 4 deg C	G	28 Days	8 oz.
Paint Filter Liquids Test	-----	9095	Cool, 4 deg C	P or G	-----	8 oz.
Nitrate	-----	9056	Cool, 4 deg C	P or G	48 Hrs	8 oz.
Bromide	-----	9056	Cool, 4 deg C	P or G	28 Days	8 oz.
Chloride	-----	9056	None	P or G	28 Days	8 oz.
Fluoride	-----	9056, 9214	None	P	28 Days	8 oz.
Cation-Exchange Capacity	-----	9080, 9081	Cool, 4 deg C	P	-----	8 oz.
DRO	-----	8015B	Cool, 4 deg C	Amber Glass	14 Days to extraction, 40 days to analysis	8 oz.
GRO	-----	8015B	Cool, 4 deg C	G, wide mouth, Teflon liner	14 Days	4 oz.
Gases	-----	3810	Cool, 4 deg C	Amber Glass	14 Days	8 oz.
Hexavalent Chromium	------	3060, 7196A	Cool, 4 deg C	P	30 Days to extraction, 7 days to analysis	4 oz.
Explosives	------	8330A/B	Cool, 4 deg C	Amber Glass	14 Days to extraction, 40 days to analysis	16 oz.
TOC	-----	SW9060 Lloyd Kahn	Cool, 4 deg C	G	28 Days 14 Days	8 oz.
Herbicide	-----	SW8151	Cool, 4 deg C	G	14 Days to extraction, 40 days to analysis	4 oz.
Formaldehyde	-----	HACH 8110	Cool, 4 deg C	G	Analyze Immediately within 48hrs	4 oz.
Ferrous Iron	-----	HACH 8146 SM3500	Cool, 4 deg C	G	Analyze Immediately within 48hrs	4 oz.
Chemical Warfare Agents	-----	8270-modified	Cool, 4 deg C	G	14 days until extraction 40 days after extraction	8 oz.

Grain Size	-----	ASTM D422	-----	P or G	-----	4 oz.

CLP Sampling and Holding Time Information

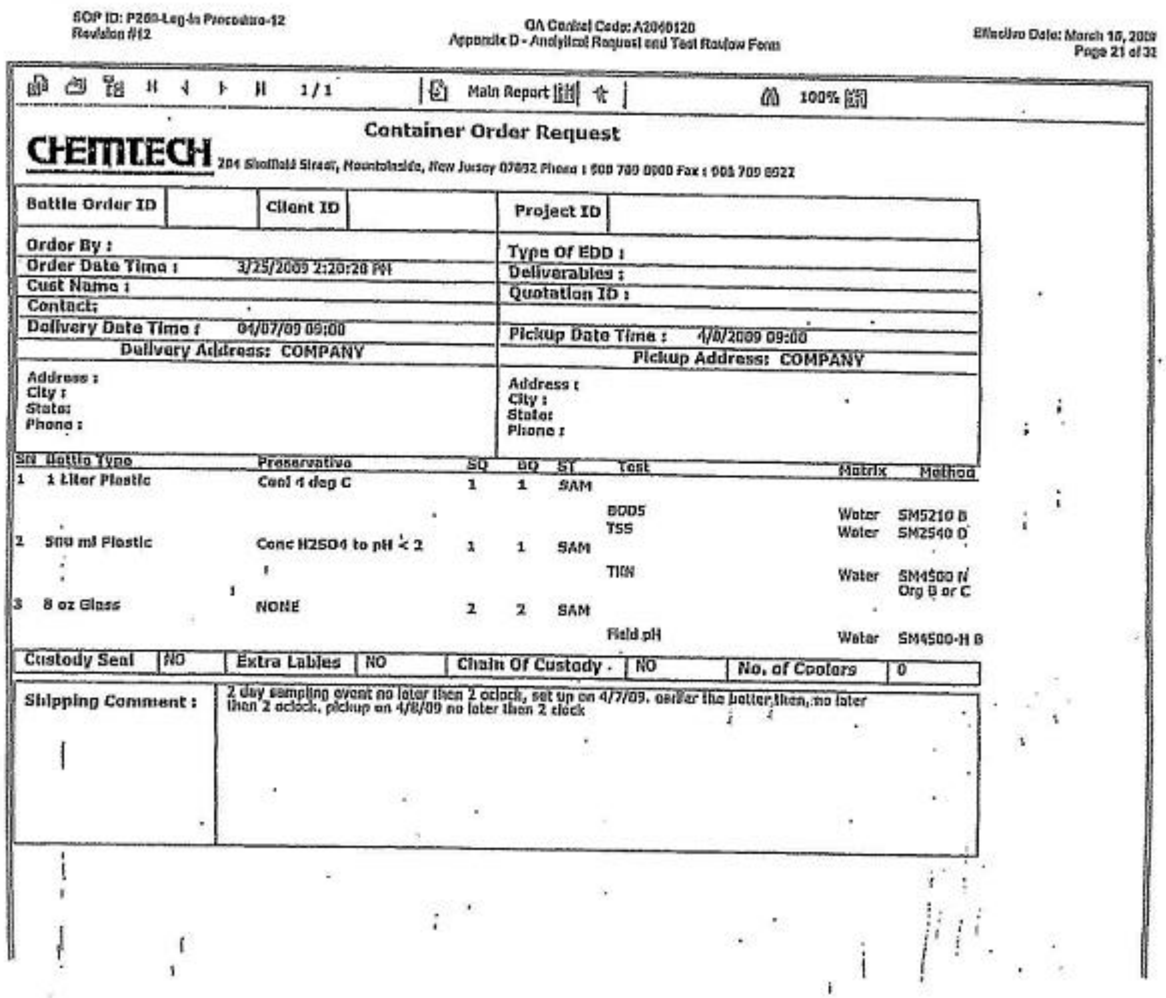
Parameter	EPA Method	Preservation	Container	Holding Time	Minimum Volume
METALS (aqueous)	ILM05.3 ILM05.4 ISM01.2	HNO_3 to pH<2, Cool 4deg C	P	180 Days from VTSR	1000ml
CYANIDE (aqueous)	ILM05.3 ILM05.4 ISM01.2	NaOH to pH>12, Cool 4deg C	P	12 Days from VTSR	1000ml
MERCURY (aqueous)	ILM05.3 ILM05.4 ISM01.2	HNO_3 to pH<2, Cool 4deg C	P	26 Days from VTSR	1000ml
VOLATILE ORGANICS (aqueous)	OLM04.3, SOM01.X	HCL pH < 2, Cool 4deg C	G	10 Days from VTSR with preservative, 7 Days from VTSR without preservative	40ml
SEMI-VOLATILE ORGANICS (aqueous)	OMLO4.3, SOM01.X	Cool 4deg C	G	5 Days from VTSR for extraction 40 Days after extraction	1000ml
PESTICIDES (aqueous)	OLM04.3, SOM01.X	Cool 4deg C	G	5 Days from VTSR for extraction 40 Days after extraction	1000ml
PCBs (aqueous)	OLM04.3, SOM01.X	Cool 4deg C	G	5 Days from VTSR for extraction 40 Days after extraction	1000ml
METALS (solid/soils)	ILM05.3 ILM05.4 ISM01.2	Cool 4deg C	G	180 Days from VTSR	8 oz
*CYANIDE	ILM05.3 ILM05.4 ISM01.2	Cool 4deg C	G	12 Days from VTSR	8 oz
MERCURY (solid/soils)	ILM05.3 ILM05.4 ISM01.2	Cool 4deg C	G	26 Days from VTSR	8 oz
VOLATILE ORGANICS (solid/soils)	OLM04.3, SOM01.X	Cool 4deg C	G	10 Days from VTSR	4 oz
SEMI-VOLATILE ORGANICS (solid/soils)	OLM04.3, SOM01.X	Cool 4deg C	G	10 Days from VTSR for extraction 40 Days after extraction	8 oz
PESTICIDES (solid/soils)	OLM04.3, SOM01.X	Cool 4deg C	G	10 Days from VTSR for extraction 40 Days after extraction	8 oz
PCBs (solid/soils)	OLM04.3, SOM01.X	Cool 4deg C	G	10 Days from VTSR for extraction 40 Days after extraction	8 oz

*When chlorine is present ascorbic acid is used to remove the interference (0.6 g ascorbic acid)

Note: Unpreserved soil samples must be refrigerated at a temperature of –7 degC (±2 degC)

APPENDIX D

Analytical Request and Test Review Form



SOP ID: P250-Log-in Procedure-12
Revision #12

QA Control Code: A2040128
Appendix D - Analytical Request and Test Review Form

Effective Date: March 16, 2009
Page 21 of 32

Container Order Request

CHEMTECH 204 Sheffield Street, Mountainside, New Jersey 07092 Phone : 908 789 8900 Fax : 908 789 8922

Bottle Order ID		Client ID		Project ID	

Order By :		Type Of EDD :	
Order Date Time :	3/25/2009 2:20:28 PM	Deliverables :	
Cust Name :		Quotation ID :	
Contact:			
Delivery Date Time :	04/07/09 09:00	Pickup Date Time :	4/8/2009 09:00
Delivery Address:	COMPANY	Pickup Address:	COMPANY
Address : City : State: Phone :		Address : City : State: Phone :	

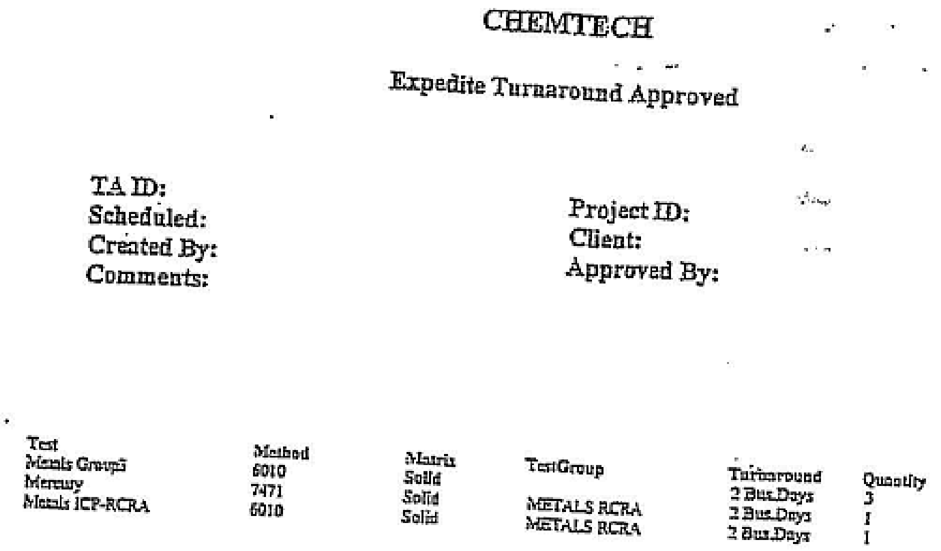
SN	Bottle Type	Preservative	SQ	BQ	ST	Test	Matrix	Method
1	1 Liter Plastic	Cool 4 deg C	1	1	SAM			
						BOD5	Water	SM5210 B
						TSS	Water	SM2540 D
2	500 ml Plastic	Conc H2SO4 to pH < 2	1	1	SAM			
						TKN	Water	SM4500 N Org B or C
3	8 oz Glass	NONE	2	2	SAM			
						Field pH	Water	SM4500-H B

Custody Seal	NO	Extra Lables	NO	Chain Of Custody .	NO	No. of Coolers	0

Shipping Comment :	2 day sampling event no later then 2 oclock, set up on 4/7/09. earlier the better,then, no later then 2 oclock, pickup on 4/8/09 no later then 2 clock

APPENDIX E

Rush Approval Form



CHEMTECH

Expedite Turnaround Approved

TA ID:
Scheduled:
Created By:
Comments:

Project ID:
Client:
Approved By:

Test	Method	Matrix	TestGroup	Turnaround	Quantity
Metals Group5	6010	Solid		2 Bus.Days	3
Mercury	7471	Solid	METALS RCRA	2 Bus.Days	1
Metals ICP-RCRA	6010	Solid	METALS RCRA	2 Bus.Days	1

APPENDIX F

Internal
Record of Communication
Login Change Form

Order Number: **X**	**Today's Date:**
Client:	**Sample Date:**
Project:	**Form Initiated by:**
Client Contact:	**Project Manager:**
General Comments/Special Instructions:	

Call Initiated by ☐ Client ☐ Chemtech

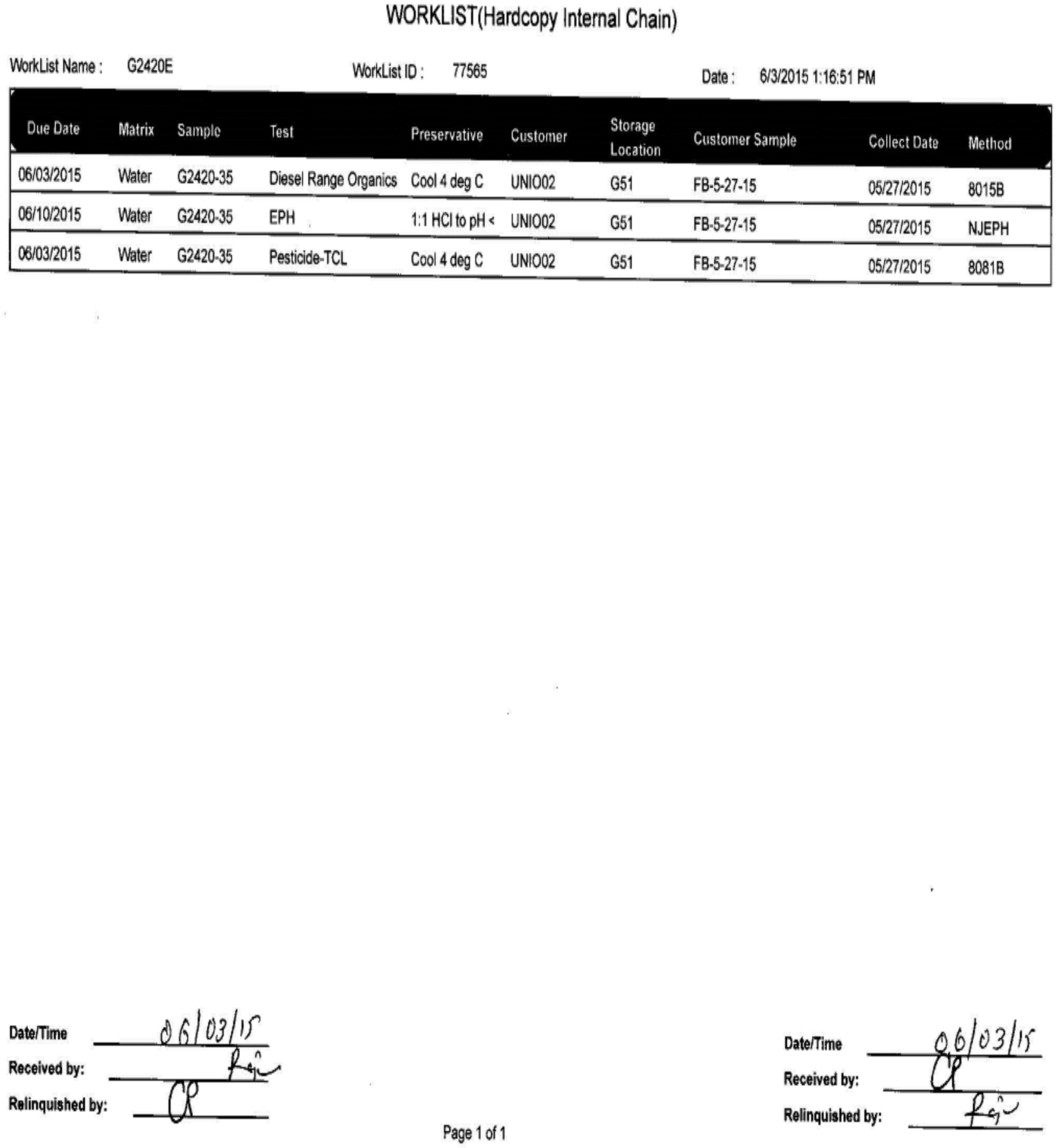
Login Changes

SAMPLE NUMBER	Add Test	Delete Test	Change TAT

Signature ______________________ Date __________

APPENDIX G

Sample Request Form



WORKLIST(Hardcopy Internal Chain)

WorkList Name : G2420E WorkList ID : 77565 Date : 6/3/2015 1:16:51 PM

Due Date	Matrix	Sample	Test	Preservative	Customer	Storage Location	Customer Sample	Collect Date	Method
06/03/2015	Water	G2420-35	Diesel Range Organics	Cool 4 deg C	UNIO02	G51	FB-5-27-15	05/27/2015	8015B
06/10/2015	Water	G2420-35	EPH	1:1 HCl to pH <	UNIO02	G51	FB-5-27-15	05/27/2015	NJEPH
06/03/2015	Water	G2420-35	Pesticide-TCL	Cool 4 deg C	UNIO02	G51	FB-5-27-15	05/27/2015	8081B

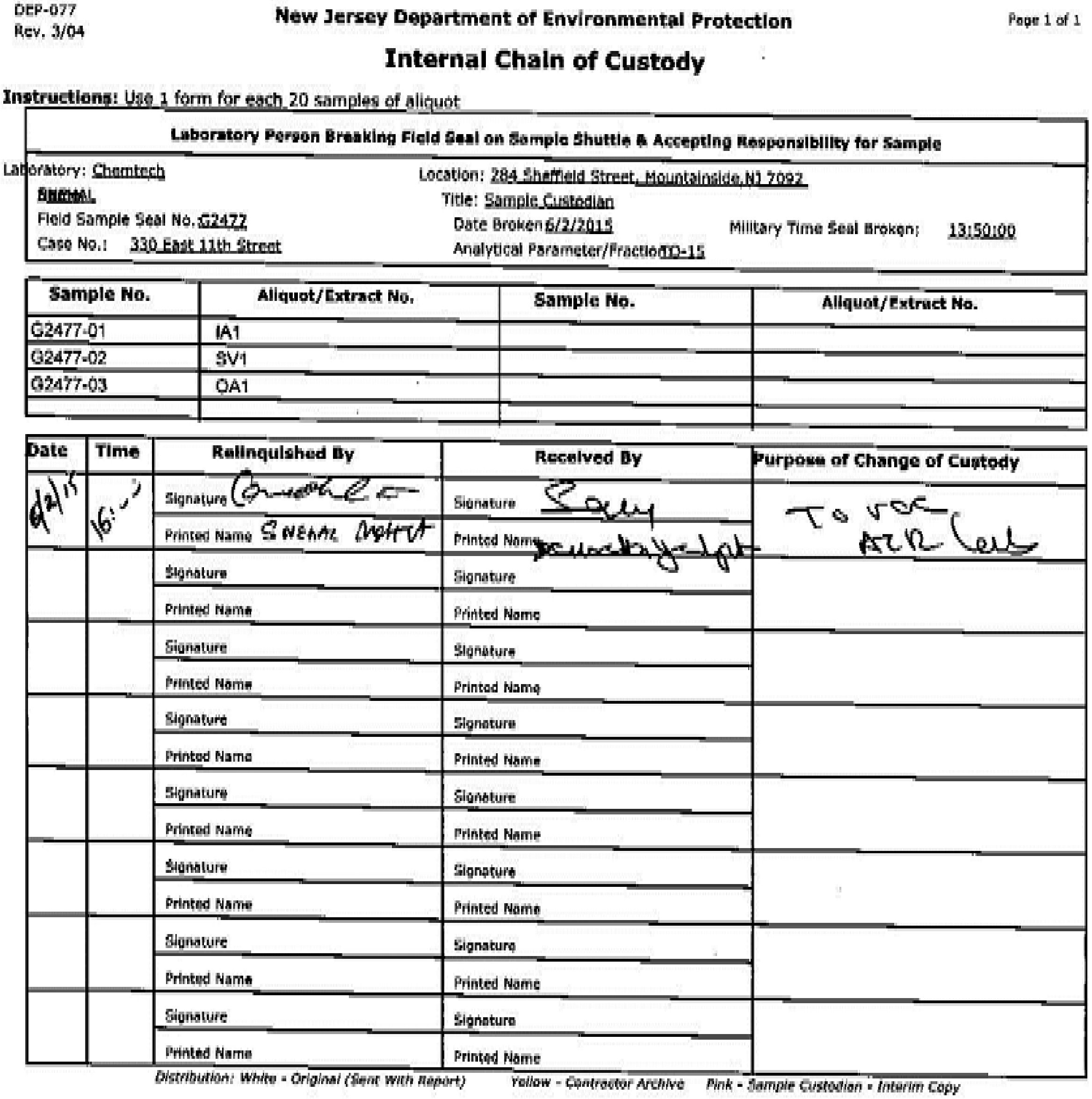
Date/Time 06/03/15
Received by:
Relinquished by: CR

Date/Time 06/03/15
Received by: CR
Relinquished by:

Page 1 of 1

APPENDIX H

Sample Retrieval and Return Logbook Page



DEP-077
Rev. 3/04

New Jersey Department of Environmental Protection

Page 1 of 1

Internal Chain of Custody

Instructions: Use 1 form for each 20 samples of aliquot

Laboratory Person Breaking Field Seal on Sample Shuttle & Accepting Responsibility for Sample

Laboratory: Chemtech
SNEHAL
Field Sample Seal No. G2477
Case No.: 330 East 11th Street

Location: 284 Sheffield Street, Mountainside,NJ 7092
Title: Sample Custodian
Date Broken 6/2/2015
Analytical Parameter/Fraction TO-15
Military Time Seal Broken: 13:50:00

Sample No.	Aliquot/Extract No.	Sample No.	Aliquot/Extract No.
G2477-01	IA1		
G2477-02	SV1		
G2477-03	OA1		

Date	Time	Relinquished By	Received By	Purpose of Change of Custody
6/2/15	16:[illegible]	Signature	Signature	To VOC AIR Lab
		Printed Name SNEHAL [illegible]	Printed Name	
		Signature	Signature	
		Printed Name	Printed Name	
		Signature	Signature	
		Printed Name	Printed Name	
		Signature	Signature	
		Printed Name	Printed Name	
		Signature	Signature	
		Printed Name	Printed Name	
		Signature	Signature	
		Printed Name	Printed Name	
		Signature	Signature	
		Printed Name	Printed Name	
		Signature	Signature	
		Printed Name	Printed Name	

Distribution: White - Original (Sent With Report) Yellow - Contractor Archive Pink - Sample Custodian - Interim Copy

APPENDIX I

Authorized Sample Custodians

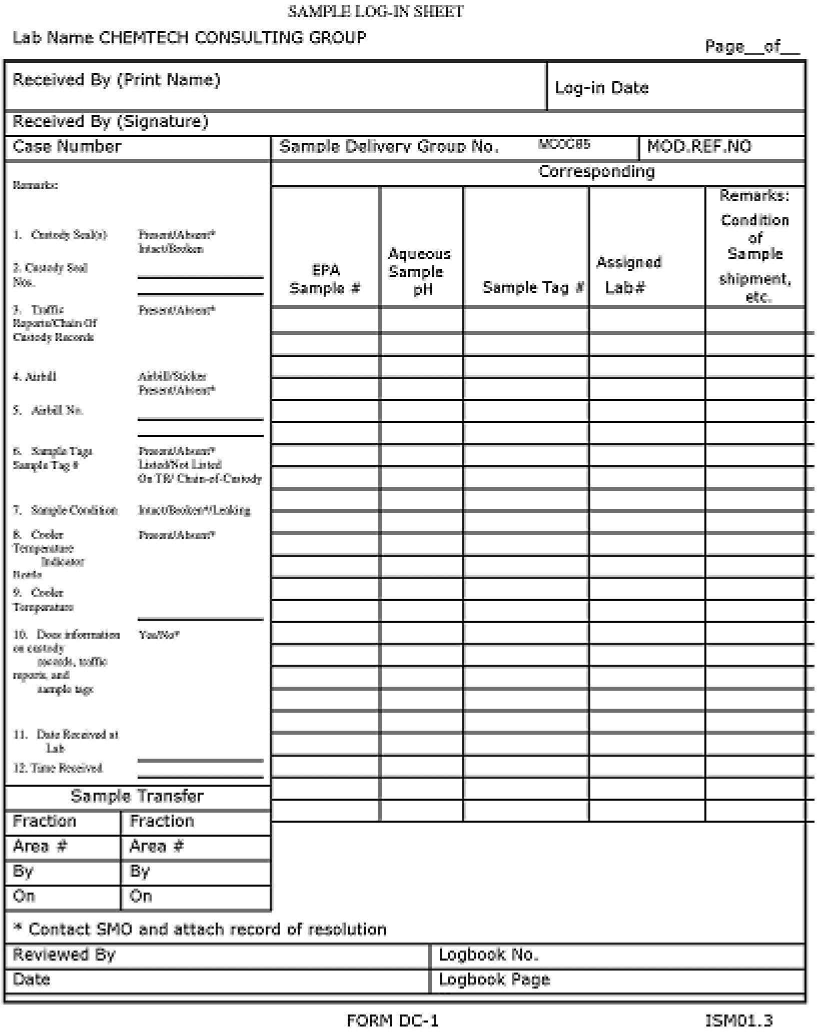
PERSONS AUTHORIZED AS SAMPLE CUSTODIAN

NJ: SNEHAL MEHTA

DESIGNATED SAMPLE CUSTODIAN

APPENDIX J

DC-1 form



SAMPLE LOG-IN SHEET

Lab Name CHEMTECH CONSULTING GROUP

Page__of__

Received By (Print Name)

Log-in Date

Received By (Signature)

Case Number

Sample Delivery Group No. MOOC85

MOD.REF.NO

Remarks:

1. Custody Seal(s) Present/Absent* Intact/Broken
2. Custody Seal Nos.
3. Traffic Reports/Chain Of Custody Records Present/Absent*
4. Airbill Airbill/Sticker Present/Absent*
5. Airbill No.
6. Sample Tags Sample Tag # Present/Absent* Listed/Not Listed On TR/ Chain-of-Custody
7. Sample Condition Intact/Broken*/Leaking
8. Cooler Temperature Indicator Bottle Present/Absent*
9. Cooler Temperature
10. Does information on custody records, traffic reports, and sample tags Yes/No*
11. Date Received at Lab
12. Time Received

		Corresponding		
EPA Sample #	Aqueous Sample pH	Sample Tag #	Assigned Lab#	Remarks: Condition of Sample shipment, etc.

Sample Transfer

Fraction	Fraction
Area #	Area #
By	By
On	On

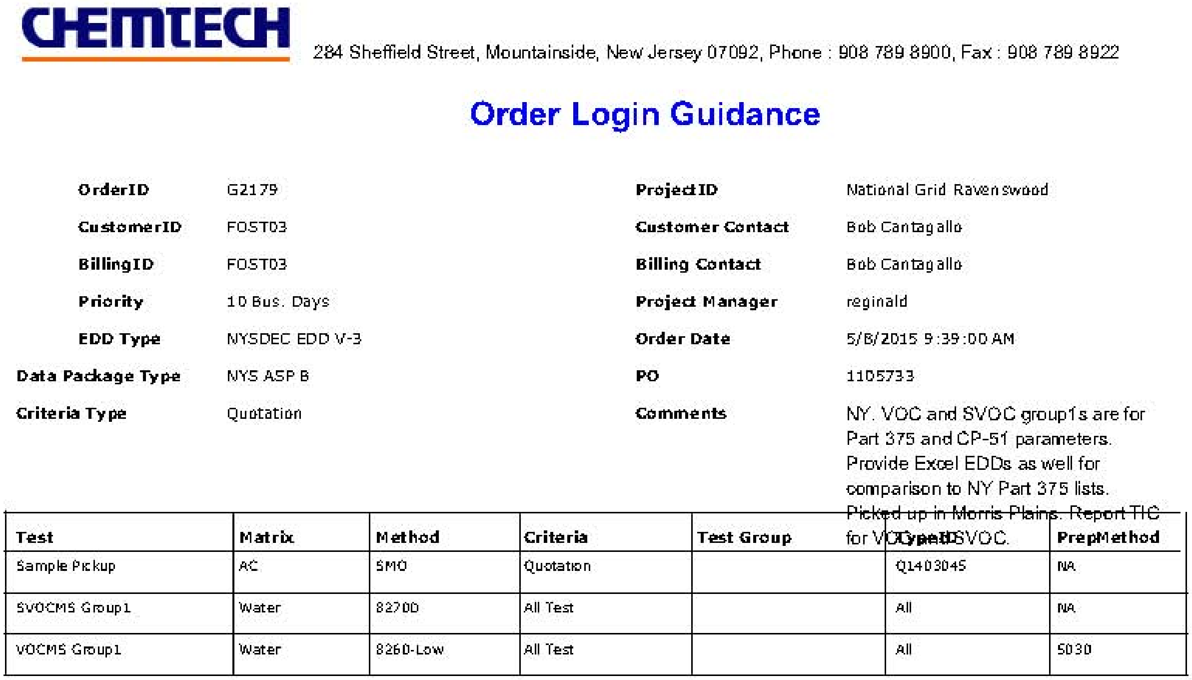
* Contact SMO and attach record of resolution

Reviewed By	Logbook No.
Date	Logbook Page

FORM DC-1 ISM01.3

APPENDIX K

Login Guidance



CHEMTECH

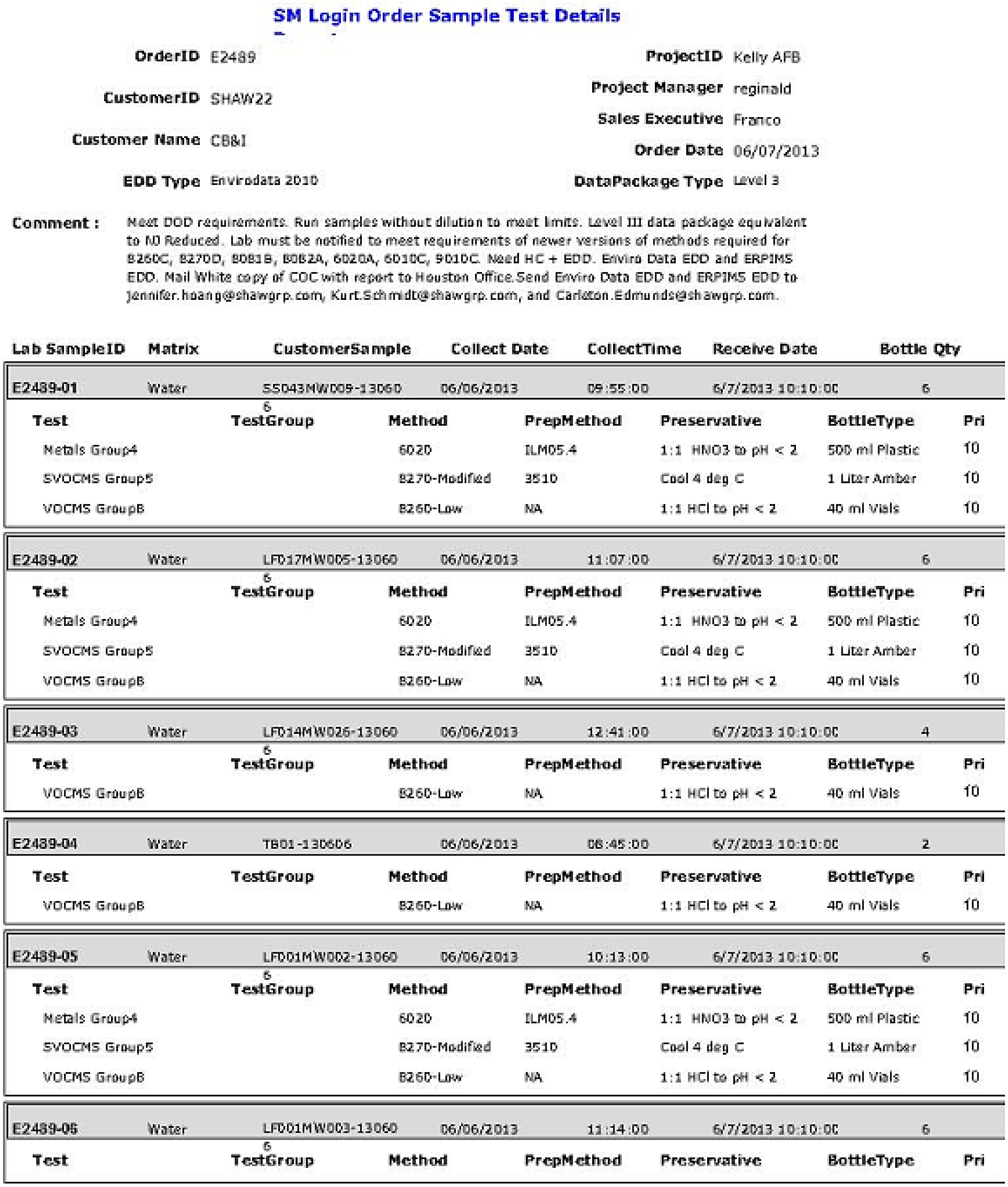
284 Sheffield Street, Mountainside, New Jersey 07092, Phone : 908 789 8900, Fax : 908 789 8922

Order Login Guidance

OrderID	G2179	**ProjectID**	National Grid Ravenswood
CustomerID	FOST03	**Customer Contact**	Bob Cantagallo
BillingID	FOST03	**Billing Contact**	Bob Cantagallo
Priority	10 Bus. Days	**Project Manager**	reginald
EDD Type	NYSDEC EDD V-3	**Order Date**	5/8/2015 9:39:00 AM
Data Package Type	NYS ASP B	**PO**	1105733
Criteria Type	Quotation	**Comments**	NY. VOC and SVOC group1s are for Part 375 and CP-51 parameters. Provide Excel EDDs as well for comparison to NY Part 375 lists. Picked up in Morris Plains. Report TIC for VOC and SVOC.

Test	**Matrix**	**Method**	**Criteria**	**Test Group**	**TypeID**	**PrepMethod**
Sample Pickup	AC	SMO	Quotation		Q1403045	NA
SVOCMS Group1	Water	8270D	All Test		All	NA
VOCMS Group1	Water	8260-Low	All Test		All	5030

APPENDIX L
SM Login Sample Test Detail



SM Login Order Sample Test Details

OrderID	E2489	**ProjectID**	Kelly AFB
CustomerID	SHAW22	**Project Manager**	reginald
		Sales Executive	Franco
Customer Name	CB&I	**Order Date**	06/07/2013
EDD Type	Envirodata 2010	**DataPackage Type**	Level 3

Comment : Meet DOD requirements. Run samples without dilution to meet limits. Level III data package equivalent to NJ Reduced. Lab must be notified to meet requirements of newer versions of methods required for 8260C, 8270D, 8081B, 8082A, 6020A, 6010C, 9010C. Need HC + EDD. Enviro Data EDD and ERPIMS EDD. Mail White copy of COC with report to Houston Office.Send Enviro Data EDD and ERPIMS EDD to jennifer.hoang@shawgrp.com, Kurt.Schmidt@shawgrp.com, and Carlton.Edmunds@shawgrp.com.

Lab SampleID	Matrix	CustomerSample	Collect Date	CollectTime	Receive Date	Bottle Qty
E2489-01	Water	SS043MW009-130606	06/06/2013	09:55:00	6/7/2013 10:10:0C	6

Test	TestGroup	Method	PrepMethod	Preservative	BottleType	Pri
Metals Group4		6020	ILM05.4	1:1 HNO3 to pH < 2	500 ml Plastic	10
SVOCMS Group5		8270-Modified	3510	Cool 4 deg C	1 Liter Amber	10
VOCMS GroupB		8260-Low	NA	1:1 HCl to pH < 2	40 ml Vials	10

Lab SampleID	Matrix	CustomerSample	Collect Date	CollectTime	Receive Date	Bottle Qty
E2489-02	Water	LFD17MW005-130606	06/06/2013	11:07:00	6/7/2013 10:10:0C	6

Test	TestGroup	Method	PrepMethod	Preservative	BottleType	Pri
Metals Group4		6020	ILM05.4	1:1 HNO3 to pH < 2	500 ml Plastic	10
SVOCMS Group5		8270-Modified	3510	Cool 4 deg C	1 Liter Amber	10
VOCMS GroupB		8260-Low	NA	1:1 HCl to pH < 2	40 ml Vials	10

Lab SampleID	Matrix	CustomerSample	Collect Date	CollectTime	Receive Date	Bottle Qty
E2489-03	Water	LFD14MW026-130606	06/06/2013	12:41:00	6/7/2013 10:10:0C	4

Test	TestGroup	Method	PrepMethod	Preservative	BottleType	Pri
VOCMS GroupB		8260-Low	NA	1:1 HCl to pH < 2	40 ml Vials	10

Lab SampleID	Matrix	CustomerSample	Collect Date	CollectTime	Receive Date	Bottle Qty
E2489-04	Water	TB01-130606	06/06/2013	08:45:00	6/7/2013 10:10:0C	2

Test	TestGroup	Method	PrepMethod	Preservative	BottleType	Pri
VOCMS GroupB		8260-Low	NA	1:1 HCl to pH < 2	40 ml Vials	10

Lab SampleID	Matrix	CustomerSample	Collect Date	CollectTime	Receive Date	Bottle Qty
E2489-05	Water	LFD01MW002-130606	06/06/2013	10:13:00	6/7/2013 10:10:0C	6

Test	TestGroup	Method	PrepMethod	Preservative	BottleType	Pri
Metals Group4		6020	ILM05.4	1:1 HNO3 to pH < 2	500 ml Plastic	10
SVOCMS Group5		8270-Modified	3510	Cool 4 deg C	1 Liter Amber	10
VOCMS GroupB		8260-Low	NA	1:1 HCl to pH < 2	40 ml Vials	10

Lab SampleID	Matrix	CustomerSample	Collect Date	CollectTime	Receive Date	Bottle Qty
E2489-06	Water	LFD01MW003-130606	06/06/2013	11:14:00	6/7/2013 10:10:0C	6

Test	TestGroup	Method	PrepMethod	Preservative	BottleType	Pri

APPENDIX M

SM Login Question Report

Shipment Verification Detail

OrderID	E2489	**ProjectID**	Kelly AFB
CustomerID	SHAW22	**Project Manager**	reginald
Customer Name	CB&I	**Sales Executive**	Franco
Customer Contact	Jennifer Hoang	**Order Date**	06/07/2013

Are samples submitted with a chain of custody? Yes ________ No ________ NA _____

Are the number of samples the same as stated on the chain of custody? Yes ________ No ________ NA _____

Are bottle caps tight and securely in place? Yes ________ No ________ NA _____

Were all containers intact when received? Yes ________ No ________ NA _____

Were samples submitted in an ice chest? Yes ________ No ________ NA _____

Were samples received cold? Yes ________ No ________ NA _____

Were samples within the holding time for the requested test(s)? Yes ________ No ________ NA _____

Is the volume of sample submitted sufficient for the requested test(s)? Yes ________ No ________ NA _____

Are all samples for volatile organic analyses free of headspace? Yes ________ No ________ NA _____

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: ______________________________

Department: ______________________________

_________________________ **P250-Log-in Procedure** _________________________

Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above mentioned method or document.

_____________________________________ __________________

Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____________________________________ __________________

Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, see QA/QC Director.

Appendix C
Responses to USEPA Comments, USEPA and TDEC Approval Letters

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
MEMPHIS ENVIRONMENTAL FIELD OFFICE
8383 WOLF LAKE DRIVE
BARTLETT, TN 38133-4119
PHONE (901) 371-3000 STATEWIDE 1-888-891-8332 FAX (901) 371-3170

February 6, 2018

James C. Foster
BRAC Program Manager
Headquarters Department of the Army,
Assistant Chief of Staff for
Installation Management (DAIM-ODB)
Army Pentagon,
2530 Crystal Drive,
Arlington, VA 22202-3934

Subject: **MI Vapor Intrusion Soil Gas Sampling QAPP**
Defense Depot Memphis, Tennessee
TDoR ID # 79-736

Mr. Foster,

TDEC-DoR has reviewed the contents of the **MI Vapor Intrusion Soil Gas Sampling QAPP** for the Memphis Defense Depot, as compiled by T. Holmes (HDR Inc), and approves of the proposals described in the document. If there are questions or concerns, please contact me at (901) 371-3041 or at jamie.woods@tn.gov .

Regards,

A Wood

Jamie A. Woods, P.G.
Project Manager
Division of Remediation
Memphis Environmental Field Office

cc: Tom Holmes (HDR Inc)
D. Lloyd (EPA-PM)
Joan Hutton (CALIBRE)
TDoR NCO: file 79-736
TDoR MEFO: file 79-736

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

June 12, 2018

UPS NEXT DAY AIR
RETURN RECEIPT REQUESTED
Mr. James Foster
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Dear Mr. Foster:

The U.S. Environmental Protection Agency (EPA) has received and reviewed the U.S. Department of the Army's Responses to EPA Comments dated May 11, 2018 (EPA/TSS Comments) for the Defense Depot of Memphis, Tennessee Main Installation Vapor Intrusion Soil Gas Sampling Quality Assurance Project Plan (QAPP), dated October 2017.

EPA provides approval for the above mentioned report with the understanding that EPA Scientific Support Section (SSS) Comments #2 and #6 be considered in future Vapor Intrusion investigations. EPA appreciates the Army's ongoing efforts to address and investigate the potential for vapor intrusion on the DDMT in a proactive manner.

EPA would also like to remind and direct the Army's attention to a specific section of EPA's *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (OSWER Publication 9200.2-154, June 2015); Section 7.2, Weigh and Assess Concordance among the Lines of Evidence, Page 121 and 122. This section discusses the need for multiple lines of evidence for a VI investigation. EPA expects and strongly recommends that multiple lines of evidence be considered going forward in the present and future VI investigations.

Should you have any questions or concerns, please feel free to call me at on my cell number 404-229-9500.

Sincerely,

Diedre Lloyd
Remedial Project Manager
Restoration & Sustainability Branch
Region 4, Superfund Division

cc: Mr. James Foster, (Signed Original), United Parcel Service, Return Receipt
Mr. Jamie A. Woods, PG, Tennessee, Department of Environment and Conservation, Memphis
Environmental Field Office, 8383 Wolf Lake Drive, Bartlett, TN 38133-4119
Ms. Joan Hutton, CALIBRE, 3898 Mountain View Road, Kennesaw, GA 30152
Mr. Thomas Holmes, HDR Environmental, P.O. Box 728, Highlands, NC 28741

Responses to Comments from
U.S. Environmental Protection Agency (EPA) Region 4 on:
Main Installation Vapor Intrusion Soil Gas Sampling
Quality Assurance Project Plan, Revision 0, October 2017
Defense Depot Memphis, Tennessee
Comments Received: 24 February 2018

EPA General Comments:

1. Review of the Main Installation Vapor Intrusion Soil Gas Sampling Quality Assurance Project Plan Revision 0, dated October 2017 (QAPP) indicates that in addition to the use of EPA's Vapor Intrusion Screening Level (VISL) Calculator to estimate risk and hazard to current/future commercial workers, the Johnson and Ettinger Model (JEM) was also used. It should be noted that EPA no longer supports the use of the JEM to contraindicate vapor intrusion (VI) potential where concentrations of contaminants in contributing media (e.g., groundwater, soil gas) exceed generic VI-based screening levels. It is noted the JEM may be used as a supporting line of evidence, but is more often used as a prioritization tool when selecting locations for a VI assessment. Ensure that the JEM is not used as a sole line of evidence to contraindicate VI potential in the forthcoming VI human health risk assessment when contributing source concentrations exceed health-based VI screening criteria.

Response: Army agrees that JEM should not be used as a sole line of evidence for VI potential. JEM was used with EPA's VISL calculator to provide a comparison incorporating site-specific information (e.g. depth to water, soil lithology). Use of JEM was discussed with EPA and included in the VI study statement of work (SOW). JEM identified potential VI risk at the MI, although up to an order of magnitude lower than indicated by the VISL calculator results.

JEM will also be used with the VISL calculator to evaluate VOC concentrations in soil gas samples in accordance with the SOW.

   a. EPA strongly recommends that the US Army pursue alternate supporting lines of evidence to investigate vapor intrusion investigations on the DDMT site.

Response: Army plans to develop lines of evidence to evaluate potential VI at DDMT. The QAPP reviewed by EPA describes the soil gas sampling to be conducted as the next step in the VI evaluation. The soil gas sample analytical results will be used with the VISL calculator and JEM to estimate the VI risk.

2. According to the QAPP, land use controls have been implemented to prevent residential use for the majority of the Main Installation (MI), except the eastern parcel, which is available for unrestricted use (i.e., Functional Unit 6). It is noted that EPA recommends that site managers also evaluate whether subsurface vapor sources that remain have the potential to pose unacceptable human health risks due to vapor intrusion in the future if site conditions were to change. However, it is not clear whether an assessment of VI potential predicated on residential exposure assumptions has been conducted for the eastern parcel to address future potential use conditions. Additionally, it is noted that groundwater concentrations detected on and within 100 feet of the eastern parcel exceed unrestricted residential-use based on screening criteria [e.g., trichloroethene has been detected in well MW-50 at a concentration of 3.58 micrograms per Liter (µg/L), which exceeds the residential vapor intrusion screening level (VISL) of 1.2 µg/L]. As such, since the eastern parcel of the MI is available for unrestricted exposure and unlimited land use an evaluation the VI potential using residential-use based screening criteria is warranted. Revise the QAPP to address this issue to ensure the actual and potential risks to human health posed by VI under current and reasonably expected future conditions is fully understood.

Response: The initial soil gas samples will be collected at locations considered most likely to contain VOCs in soil and/or groundwater at concentrations that may present a VI human health risk. The soil gas concentrations will be evaluated based on consideration of VOC concentrations in soil and/or groundwater at that location and other factors such as depth to water and soil layering between the water table and the ground surface. Correlation of soil gas and groundwater concentrations should indicate whether additional soil gas samples in areas with lower groundwater concentrations is necessary.

Worksheet # 11, Step 5 will be revised to state potential for VI risk will be evaluated based on current and reasonably expected future conditions including use of residential-use based screening criteria.

Responses to Comments from
U.S. Environmental Protection Agency (EPA) Region 4 on:
Main Installation Vapor Intrusion Soil Gas Sampling
Quality Assurance Project Plan, Revision 0, October 2017
Defense Depot Memphis, Tennessee
Comments Received: 24 February 2018

EPA Specific Comments:

1. QAPP Worksheet #10: Conceptual Site Model Table 1, Soil Samples Exceeding Remediation Goals, Page 10: The table presents the 2008 investigation results for five soils samples that exceeded remediation goals (RGs) established for chlorinated volatile organic compounds (CVOCs) at Dunn Field. The text further indicates the CVOC concentrations are low and not considered to warrant remedial action. However, the concentration of carbon tetrachloride measured in sample TTA2-W-B1-SB-27 was 22.9 milligrams per kilogram (mg/Kg) and exceeded the RG of 0.2150 mg/Kg. Based on the text, the 2008 investigation was conducted to identify potential source areas for the observed groundwater plumes. As such, the carbon tetrachloride detection of 22.9 mg/Kg detected in soil sample TTA2-W-B1-SB-27 would not be considered low as it is 100x the respective RG indicating a potential leachability or contaminant migration issue. Revise the QAPP to address this issue to ensure the current understanding of site conditions is clearly presented and supporting the conceptual site model (CSM).

Response: Army agrees that the carbon tetrachloride concentration in soil sample TTA2-W-B1-SB-27 is not "low". The QAPP will be revised to clarify the site conditions.

The revision will note that soil samples were collected at locations with the full range of MIP readings but were biased to collect more samples at locations with high MIP readings. Only 5 of 70 soil samples had CVOC concentrations above an RG, and 3 of those samples only slightly exceeded an RG for a single CVOC. One of the two remaining samples (TTA2-W-B2-SB-17) contained methylene chloride at 17 times the RG, but methylene chloride is not a common groundwater contaminant at the MI. One sample (TTA2-W-B1-SB-27) exceeded the RG for carbon tetrachloride by a factor of 100, but the sample collected 2 feet deeper in the same boring (TTA2-W-B1-SB-29) did not exceed the RG for any CVOC. The limited extent of soil with CVOC concentrations above the RGs was not considered to warrant remedial action of soil.

As noted in Worksheet #17, one soil gas sample (SG-04) will be collected adjacent to the referenced soil sample (TTA2-W-B1-SB-27).

2. Worksheet #11: Project Data Quality Objectives, Step 1: State the Problem, Page 12: The text in Department of Defense (DoD) Step 2 states "There have been no reports of suspected vapor intrusion from the businesses operating at the Memphis Depot Industrial Park. Therefore, no immediate risk to building occupants from VI is indicated." However, the text does not state how it was determined there have been no reports of suspected vapor intrusion to support the assertion that no immediate risk from VI is indicated. For example, it is not known whether community outreach and involvement activities were performed as a means of educating the community about the need to assess, mitigate, and monitor the potential vapor intrusion pathway. The text does not discuss whether building-by-building contact and one-on-one communication with each property owner or renter was conducted. Revise the QAPP to address this issue.

Response: The statement was based on no reported VI concerns from property owners during regular contacts including interviews during the annual LUC inspection and discussion of planned field activities on the MI. Property owners have contacted Army regarding other site issues including building conditions (asbestos, lead-based paint and mold) and land use restrictions.

Army will contact property owners to inform them of the VI study and ask specifically whether employees or tenants have expressed concerns. The QAPP will be revised to include the responses from building owners and any changes to sample locations or sampling procedures based on the responses.

Responses to Comments from
U.S. Environmental Protection Agency (EPA) Region 4 on:
Main Installation Vapor Intrusion Soil Gas Sampling
Quality Assurance Project Plan, Revision 0, October 2017
Defense Depot Memphis, Tennessee
Additional Comments Received 4 June 2018

Comments from Ben Bentkowski, P.G., Scientific Support Section, Superfund Division

Specific Comments:

1. QAPP Worksheet #9: The Vapor Intrusion Screening Level calculator has been replaced with an online version. This version is easier to update the toxicity values and is found at this link: https://epa-visl.ornl.gov/cgi-bin/visl_search

Response: Army will use the referenced online version in future calculations for DDMT and will include the link in Worksheet #9.

2. Worksheet #10, pg.10: The compounds listed in Table 1 appear to have been screened for potential direct contact and potential for leaching to groundwater. However, these are all volatile compounds and there are likely soil gas concentrations associated with these soil concentrations. Should this investigation go forward to a Vapor Intrusion Investigation, areas such as these will need to be evaluated as part of the vapor intrusion pathway.

Response: Table 1 on page 10 of Worksheet #10 lists the soil samples and CVOCs detected above remediation goals in the 2008 source area investigation. There was no other screening of these compounds.

The 'worst-case' location will be investigated during the planned soil gas sampling. Three of the listed samples with the highest concentrations (TTA2-W-B1-SB-27, TTA2-W-B2-SB-17 and TTA2-W-A2 26-27) were collected from adjacent borings (see Figure 1 of the QAPP). Soil gas sample SG-04 was located in this area adjacent to TTA2-W-B1-SB-27, which had the highest concentration detected. Army will consider additional evaluation of these areas based on the soil gas sample results. No revision to the QAPP is required.

3. Worksheet #11, 4th paragraph: The summary risk statement needs to be revised to be specific about the potential for acute risk or the risk due to explosion. This statement could be taken out of context and misrepresented.

Response: The last sentence of the paragraph will be revised to: "Based on the available information, no immediate risk to building occupants from VI is suspected. However, further investigation is planned as described in this QAPP."

4. Worksheet #11, last paragraph: EPA R4 risk assessors have performed the calculations to generate a soil gas/sub-slab gas screening value for 1,2-DCE of 120,000 µg/m3. It is not likely that this screening value will be exceeded but it may be included for an informal comparison.

Response: The comment is assumed to refer to the last paragraph on page 12 in Worksheet #11. 1,2-DCE will be included as an analyte in the vapor sample analyses, and Army will compare the results to the current screening values from EPA Region 4. The screening level will be noted on Worksheet #11 and added as the project action limit on Worksheet #15.

5. Worksheet #15: The project action limit for Vinyl Chloride should be 93 µg/m3.

Response: The vinyl chloride project action limit on Worksheet #15 will be corrected to 93 $\mu g/m^3$.

6. General: It is unclear just where in this document this requirement might be but during the collection of sub-slab samples the thickness of the concrete should be recorded for later potential use in the J&E model.

Response: Will add the following statement in Worksheets 11 and 17: "Thickness of the concrete slab will be measured at each sub-slab sample location."