GALLAGHER BASSETT | TECHNICAL SERVICES

SITE-SPECIFIC QUALITY ASSURANCE PROJECT PLAN FOR GROUNDWATER SAMPLING

Wallkill Wellfield Site

20 Industrial Place
City of Middletown
Orange County, New York

October 2022

GBTS Project: LM97145

Revision #	*Revision Date*	*Revision Description*

Technical Services Division

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APPENDICES

LIST OF ACRONYMS

AWQS	Ambient Water Quality Standards And Guidance Values
CSM	Conceptual Site Model
CVOC	Chlorinated Volatile Organic Compound
DO	Dissolved Oxygen
DQI	Data Quality Indicator
DQO	Data Quality Objective
DUSR	Data Usability Summary Report
ELAP	Environmental Laboratory Approval Program
FM	Fieldwork Manager
FSP	Field Sampling Plan
GBTS	Gallagher Bassett Technical Services
HASP	Health And Safety Plan
HAZWOPER	Hazardous Waste Operations And Emergency Response
ISCO	In Situ Chemical Oxidation
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LHC	Laurwal Holding Corporation
LOD	Limit Of Detection
LOQ	Limit Of Quantitation
MPC	Measurement Performance Criteria
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NA	Not Applicable
NYSDEC	New York State Department Of Environmental Conservation
PAL	Project Action Limits
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PCE	Tetrachloroethylene
PM	Project Manager
PPB	Parts Per Billion
PPM	Parts Per Million
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
QSM	Quality Systems Manual
RPD	Relative Percent Difference
SOPs	Standard Operating Procedures
TCE	Trichloroethylene
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

Gallagher Bassett Technical Services (GBTS) prepared this Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) in support of groundwater monitoring at the Wallkill Wellfield Site (Site), which is undergoing investigation and remediation under the oversight of the United States Environmental Protection Agency (USEPA). The contaminants of concern at the Site are chlorinated volatile organic compounds (CVOCs) in soil and groundwater.

The purpose of the UFP-QAPP is to be a comprehensive site-specific document for proposed Site groundwater sampling and related fieldwork, and the analysis of media samples by the environmental laboratory. This document shall be utilized by the field sampling team and the laboratory analytical team to ensure that collected environmental data are of the correct type and quality required in order to meet the specified project quality objectives.

The objectives of the proposed fieldwork are to document current groundwater quality in the exterior overburden and bedrock Site monitoring wells (USEPA targeted well locations), and beneath the slab of the Site building (utilizing interior overburden wells install during recent injections of chemical oxidants).

QAPP WORKSHEET #1 & 2 – TITLE AND APPROVAL PAGE

(UFP-QAPP Manual Sections 2.1 and 2.2.4; EPA 2106-G-05 Section 2.2.1)

Project Name: Wallkill Wellfield Site
Property Owner: Laurwal Holding Corporation (LHC)
Area of Concern: Site Groundwater Quality
Environmental Consultant Name: Gallagher Bassett Technical Services (GBTS), for LHC
Lead Regulatory Agency/Program: United Sates Environmental Protection Agency (USEPA)/CERCLA

Wallkill Wellfield, UFP-QAPP For Groundwater Sampling

Document Title

Gallagher Bassett Technical Services

Lead Organization

Scott Spitzer, Technical Director, Environmental Consulting, GBTS

Preparer's Name, Organizational Affiliation, and Contact Information

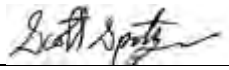
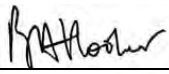
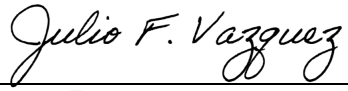
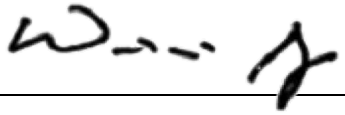
22 IBM Road – Suite 101, Poughkeepsie, NY 12601, (845) 452-1658, scott_spitzer@gbtpa.com

Preparer's Address, Telephone Number, and Email Address

2022-10-04

Preparation Date

Table WS 1 & 2: Approvals

Name, Title, Role/Approval Authority	Signature	Date Signed
Scott Spitzer Technical Director, Environmental Consulting, GBTS **Lead Organization Project Manager**		2022-10-04
Richard Hooker, PhD Manager, Environmental Consulting, GBTS **Lead Organization Quality Assurance Manager**		2022-10-04
Victoria Panico, CHMM Project Manager, GBTS **Lead Organization Fieldwork Manager**		2022-10-04
Julio F. Vazquez Remedial Project Manager, **USEPA (Region 2)**		11/18/2022
William Sy Quality Assurance Officer, **USEPA (Region 2)**		11/18/2022

This UFP-QAPP is a project-specific document to provide detailed information for groundwater sampling at the Wallkill Well Field Site (the Site), to identify data quality objectives (DQOs) and ensure data quality will meet those objectives. This UFP-QAPP was prepared in accordance with the requirements of Optimized UFP-QAPP Worksheets (USEPA; 2012), UFP-QAPP Manual (USEPA 2005), and Guidance for Quality Assurance Project Plans EPA QA/G-5 (USEPA 2002). A scoping session was held on April 6, 2022.

Work plans and reports from previous investigations relevant to this project are shown below:

Table WS 1 & 2: Relevant Previous Work Plans, Reports, and other Documents	
Document Source and Title	**Date**
Ecosystems Strategies, Inc. (ESI), *Interim Summary Data Report of Groundwater Sampling*	2004-01
ESI, *Summary Report of Subsurface Investigation*	2007-05
ESI, *Well Installation and Remedial Selection Report*	2007-10
WCD Group, *Remedial Design Document: Phase I – Soil Remediation*	2018-02-02
Gallagher Bassett Technical Services (GBTS), *Groundwater Sampling Report*	2019-07-24
GBTS, *Phase I Soil Remediation: Well Installation and Baseline Sampling Report*	2021-05-27
GBTS, *Phase I Soil Remediation: Preliminary In Situ Chemical Oxidation Report*	2021-07
GBTS, *Groundwater Sampling Report*	2019-07-24
GBTS, *Phase I Soil Remediation: Well Installation and Baseline Sampling Report*	2021-05-27
GBTS, *Phase I Soil Remediation: Preliminary In Situ Chemical Oxidation Report*	2021-07

Required QAPP information is identified below (no QAPP elements have been excluded):

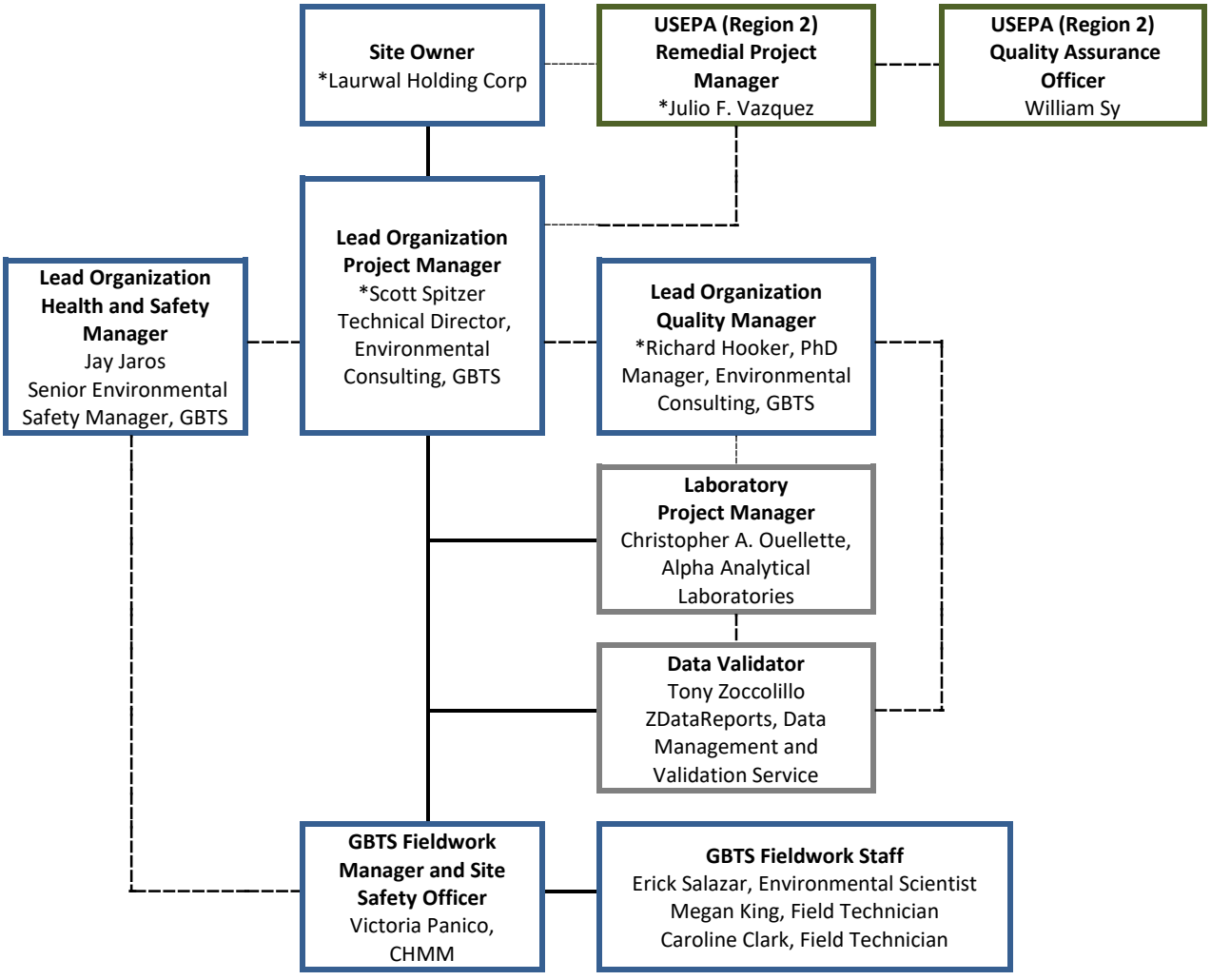
Table WS 1 & 2: Identifying Information	
UFP-QAPP Worksheet	**Required Information**
A. Project Management	
Documentation and Project Organization	
1 & 2	Title and Approval Page
3 & 5	Project Organization and QAPP Distribution
4, 7 & 8	Personnel Qualifications and Sign-off Sheet
6	Communication Pathways
Project Planning/ Problem Definition	
9	Project Planning Session Summary
10	Conceptual Site Model
11	Project/Data Quality Objectives
12	Measurement Performance Criteria
13	Secondary Data Uses and Limitations
14 & 16	Project Tasks & Schedule
15	Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Table WS 1 & 2: Identifying Information	
UFP-QAPP Worksheet	**Required Information**
B. Measurement Data Acquisition	
Sampling Tasks	
17	Sampling Design and Rationale
18	Sampling Locations and Methods/SOP Requirements; Sample Location Map(s)
19 & 30	Sample Containers, Preservation, and Hold Times
20	Field QC Summary
21	Field SOPS
22	Field Equipment Calibration, Maintenance, Testing, and Inspection
Analytical Tasks	
23	Analytical SOPs
24	Analytical Instruments Calibration
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection
Sample Collection	
26	Sample Handling, Custody, and Disposal
Quality Control Samples	
28	Analytical Quality Control and Corrective Action
Data Management Tasks	
29	Project Documents and Records
30	Analytical Services
C. Assessment Oversight	
31, 32, & 33	Assessments and Corrective Action
D. Data Review	
34	Data Verification and Validation Inputs
35	Data Verification Procedures
36	Data Validation Procedures
37	Data Usability Assessment
E. Additional Information	
Appendix A – Figures	
Appendix B – Standard Operating Procedures, Fieldwork	
Appendix C – Field Forms	
Appendix D – Laboratory Performance Criteria	
Appendix E – Standard Operating Procedures, Laboratory	
Appendix F – Resumes	

QAPP WORKSHEET #3 & 5 – PROJECT ORGANIZATION AND QAPP DISTRIBUTION

(UFP-QAPP Manual Section 2.3 and 2.4; EPA 2106-G-05 Section 2.2.3 and 2.2.4)

The chart below details the organizational structure of the project and includes the lead organization, regulating authorities, contractors, subcontractors, and any other organization involved in the project. This structure shows reporting relationships between all entities involved in the project. Lines of authority are shown by a solid line, lines of communication are shown by a dashed line, and * indicates a QAPP recipient.



QAPP WORKSHEET #4, 7 & 8 – PERSONNEL QUALIFICATIONS AND SIGN-OFF SHEET

(UFP-QAPP Manual Section 2.3.2 – 2.3.4; EPA 2106-G-05 Section 2.2.1 and 2.2.7)

This worksheet is used to identify key project personnel for each organization performing tasks defined in this QAPP. Copies of this form are to be signed by key project personnel from each organization to indicate that they have read the applicable QAPP sections and will perform the tasks as described. Each organization should forward signed sheets to the central project file.

Table WS 4, 7 & 8: Project Personnel Sign-Off Sheet

Name, Organization	**Project Title/Role**	**Qualifications** (see Appendix E, Resumes)	**Specialized Training and/or Certifications Applicable to Project Responsibilities**	**Signature/Date**
Scott Spitzer, GBTS	Project Manager	17 yrs. experience in site investigation and remediation within regulatory programs	40 hr. HAZWOPER; 8 hr. HAZWOPER Supervisor	2022-10-04
Richard Hooker, GBTS	Quality Assurance Manager	22 yrs. experience in site investigation and remediation within regulatory programs	40 hr. HAZWOPER	2022-10-04
Jay Jaros, GBTS	Senior Environmental Health and Safety Manager	20 yrs. experience in site investigation and remediation within regulatory programs	Certified Safety Professional; Professional Geologist; 40 hr. HAZWOPER	2022-10-04
Victoria Panico, GBTS	Fieldwork Manager and Site Safety Officer	5 yrs. experience in site investigation and remediation within regulatory programs	Certified Hazardous Materials Manager; 40 hr. HAZWOPER	2022-10-04
Erick Salazar, GBTS	Fieldwork Staff	5 yrs. experience in site investigation and remediation within regulatory programs	40 hr. HAZWOPER	2022-10-04
Megan King, GBTS	Fieldwork Staff	4 yrs. experience in site investigation and remediation within regulatory programs	40 hr. HAZWOPER	2022-10-04
Caroline Clark, GBTS	Fieldwork Staff	5 yrs. experience in site investigation and remediation within regulatory programs	40 hr. HAZWOPER	2022-10-04

Table WS 4, 7 & 8: Project Personnel Sign-Off Sheet				
Name, Organization	**Project Title/Role**	**Qualifications** (see Appendix E, Resumes)	**Specialized Training and/or Certifications Applicable to Project Responsibilities**	**Signature/Date**
Tony Zoccolillo, ZDataReports	Data Validator	25+ yrs. experience as data validator in accordance with USEPA requirements	B.S. Chemistry	

QAPP WORKSHEET #6 – COMMUNICATION PATHWAYS

(UFP-QAPP Manual Section 2.4.2; EPA 2106-G-05 Section 2.2.4)

This worksheet identifies communication pathways between project personnel, required procedures, and mode of communication (assumes telephone communication as needed, and for all urgent/emergency conditions).

Table WS 6: Communication Pathways

Communication Drivers	Responsible Entity/Role	Name and Contact Information	Procedure Communication mode assumes in-person contact, email, and/or telephone, and written documentation per QAPP
Regulatory agency interface	GBTS Project Manager (PM)	Scott Spitzer, GBTS PM scott_spitzer@gbtpa.com (845) 867-4717	GBTS PM: communicate with USEPA PM per project schedule or as needed; consult with GBTS QAM
QAPP changes before or during fieldwork	GBTS Quality Assurance Manager (QAM)	Richard Hooker, GBTS QAM ricard_hooker@gbtpa.com (845) 867-4715	GBTS QAM and PM: Review/approve all changes. GBTS PM: Promptly notify USEPA PM and obtain concurrence before proceeding (as possible); modify QAPP and submit revision to USEPA and distribution list; provide status updates as requested by USEPA PM or stakeholders
Manage all project phases			GBTS PM: Coordinate review/approval of deliverables, correspondence, and communication among project team and consult with GBTS QAM
Field progress reports	GBTS Fieldwork Manager (FM)	Victoria Panico, GBTS victoria_panico@gbtpa.com (212) 631-9000	Regularly communicate fieldwork progress and problems to: GBTS PM and GBTS QAM as warranted
Stop work due to safety issues or injuries	GBTS PM	Scott Spitzer, GBTS PM scott_spitzer@gbtpa.com (845) 867-4717	FM (and field staff, as applicable) will immediately report any safety issues or injuries to GBTS PM, who will consult with the senior GBTS safety managers and the QAM, as required; all response actions to be in conformance with the HASP and an Incident Report will be prepared
Stop work due to quality issues	GBTS FM	Victoria Panico, GBTS FM victoria_panico@gbtpa.com (212) 631-9000	FM (and field staff, as applicable) will report any quality issues to PM, who will consult with the QAM as required; all response actions to be in conformance with the QAPP
Field corrective action (CA)	GBTS QAM	Richard Hooker, GBTS QAM ricard_hooker@gbtpa.com (845) 867-4715	The PM and FM will develop field CAs within 24-hrs. of becoming aware of significant problems/issues and will communicate with all fieldwork staff and the QAM; the PM will notify the GBTS senior Environmental Health and Safety Manager as warranted based on the nature of the CA

Table WS 6: Communication Pathways			
Communication Drivers	**Responsible Entity/Role**	**Name and Contact Information**	**Procedure** Communication mode assumes in-person contact, email, and/or telephone, and written documentation per QAPP
Laboratory analyses, verification, and analytical deliverables	Alpha Analytical Laboratories	Laboratory Manager Christopher A. Ouellette Contact Nadine Yakes nyakes@alphalab.com (201) 812-9037	The Laboratory Manager (LM) or designate will communicate and coordinate with the GBTS PM regarding progress and/or problems
Laboratory CA			The Laboratory Manager (LM) or designate will determine the need for any CA in accordance with laboratory SOPs (correct problem and/or qualify data), communicate with the GBTS PM as warranted, and report on relevant CA in laboratory reports
Data verification/review	GBTS QAM	Richard Hooker, GBTS QAM ricard_hooker@gbtpa.com (845) 867-4715	The GBTS QAM will coordinate and communicate with the GBTS PM and FM to ensure compliance with verification requirements (Worksheets 34 and 35)
Data Validation	ZDataReports	Tony Zoccolillo ZDataReports, data validator tonyzoc@gmail.com (716) 907-2341	Data validator will contact the LM (or designate), and the GBTS PM and QAM, regarding any verification/validation issues, and report all findings in the DUSR (Worksheets 36 and 37)

Notes:

GBTS	Gallagher Bassett Technical Services
USEPA	US Environmental Protection Agency
HASP	Health and Safety Plan
QAPP	Quality Assurance Project Plan
DUSR	Data Usability Report

QAPP WORKSHEET #9 – PROJECT PLANNING SESSION SUMMARY

(UFP-QAPP Manual Section 2.5.1 and Figures 9-12; EPA 2106-G-05 Section 2.2.5))

Date of Planning Session: April 6, 2022

Location: Conference Call

Scoping Session Purpose: Discuss issues related to Site groundwater

Table WS 9: Project Scoping Session Participants

Participant	Organization	Title/Role	Telephone	Email
Scott Spitzer	GBTS	Lead Organization, Project Manager	845-867-4717	scott_spitzer@gbtpa.com
Richard Hooker	GBTS	Lead Organization, Quality Assurance Manager	845-867-4715	richard_hooker@gbtpa.com
Julio Vazquez	USEPA	USEPA Site Team, Remedial Project Manager	212-637-4323	vazquez.julio@epa.gov
Urszula Filipowicz	USEPA	USEPA Site Team, Risk Assessor	212-637-4324	filipowicz.urszula@epa.gov
Liana Agrios	USEPA	USEPA Site Team, Geologist	212-637-4247	agrios.liana@epa.gov
Robert Blake	USACE	Oversight contractor for USEPA	816-389-2387	robert.e.blake@usace.army.mil
Kelly Peterson	USACE	Oversight contractor for USEPA	816-389-2057	Kelly.r.peterson@usace.army.mil

Notes:

GBTS Gallagher Bassett Technical Services
USEPA United States Environmental Protection Agency
USACE United States Army Corps of Engineers

Comments/Decisions/Action Items

It was agreed that:

- GBTS will send USEPA a map showing monitoring wells related to recent (2016 and 2019) groundwater sampling, and any well locations from earlier events that might serve as an upgradient sampling location;
- GBTS will discuss with Laurwal Holding Corporation (GBTS's client) USEPA's request for a modified groundwater remedial design; and,
- GBTS will conduct at least one comprehensive round of sampling and analysis of groundwater wells at the Site (target wells to be determined in consultation with USEPA), and will submit an updated UFP compliant QAPP for the upcoming groundwater sampling to EPA for review and approval (with updated HASP, as needed).

QAPP WORKSHEET #10 – CONCEPTUAL SITE MODEL

(UFP-QAPP Manual Section 2.5.2; EPA 2106-G-05 Section 2.2.5))

Site Description

The Site is an irregularly-shaped, approximately 4.3-acre parcel, occupied by an approximately 40,000-square foot industrial building to the north and undeveloped wooded land to the south. The industrial building is currently occupied by a furniture and household goods distributor. Site maps are provided as Figures 1 and 2 (Appendix A), respectively. Site has overall downward slopes to the south, with surface elevations that range from approximately 640 to 600 feet above mean sea level (the elevation is near the southern edge of the Site, adjacent to the northwestern side of Industrial Place Extension). Fill soils appear to have been imported at the northern portion of the Site prior to construction of the on-site building.

Site Hydrogeology

Hydrogeologic data has been obtained from over 20 monitoring wells and several former residential water supply wells. In the overburden (composed of sand, silt, and glacial till), monitoring wells approximately 10 to 15 feet deep have approximately 5 to 10 feet of standing water and are associated with flow along the overburden-bedrock interface. Groundwater is within 5 to 10 feet of the surface around the Site building, with seasonal fluctuation of about 7 feet, and direction of flow is to the southeast towards Industrial Place Extension. Pumping tests show that the overburden is confined from the bedrock aquifer, with the exception of some leakage under pumping conditions. The bedrock aquifer (consisting of interbedded silty shale and silty-fine sandy siltstone bedrock) has two productive zones. The top of the lower aquifer (most productive zone) is at a depth of approximately 90 feet and averages 40 feet thick, and the top of the higher aquifer is at a depth of 39 feet with an average thickness of 22 feet. Groundwater movement in the aquifer is associated with fractures. Pumping tests demonstrate hydraulic connectivity between bedrock wells throughout the flow field. Hydraulic conductivity testing indicates somewhat uniform flow conditions within the fractures.

History of Contamination and Environmental Investigations

Chlorinated volatile organic compounds (CVOCs), including the solvents tetrachloroethylene (PCE) and trichloroethylene (TCE), were previously used at the Site during production of electrical components. Prior investigations indicated the presence of CVOCs in soil and groundwater as a result of historical on-site discharges (off-site groundwater contamination was identified in the 1980s and investigations conducted in the early 1990s identified PCE, and trace concentrations of TCE, in on-site soils and groundwater).

Subsequent remediation efforts included removal of PCE-impacted soils from hot-spot areas near the northern and southern exterior walls of the building (some inaccessible material was left in place under foundation components), and PCE in groundwater (in the form of DNAPL) from nearby off-Site supply well W-30 (known as the “Parella well”, inactive since 1983), which was shown to be free of any significant impacts during sampling events in 2016 and 2019).

Historical groundwater sampling data from 1992 to 2019 (see Figure 3) generally document decreasing CVOC impacts and a reduction in the number of wells with significant contamination (WCD Group, 2019). The highest levels of PCE in both overburden and bedrock wells are consistently located south of the building at MW-3, MW-4 and MW-5, with an overall decline in CVOCs at peripheral and downgradient areas (to the south). The most contaminated well, MW-5, located in the overburden immediately downgradient of the southern excavation area, exhibited decreasing PCE levels from 41,000 to 5,960 parts per billion (ppb; similar declines were seen in overburden well MW-4 and paired bedrock well MW-204).

A 2006/2007 soil investigation documented elevated PCE contamination (460 parts per million) beneath the building slab at one boring, SB-8 southwest of the northern hot spot (see Figure 2), and only low to trace levels of PCE in seventeen (17) other locations. The data set suggests that there is no significant connection between the northern and the southern areas of soil contamination.

In situ chemical oxidation (ISCO) treatment was performed in the vicinity of SB-8 in 2020 to address sub-slab PCE contamination in soil and groundwater. Pre-treatment sampling of six interior ISCO recirculation wells documented PCE ranging from 332 to 1,240 ppb, and elevated levels of breakdown products. Post-treatment sampling of the interior wells documented an approximate 90% average reduction of dissolved PCE, with a general reduction of PCE breakdown products (GBTS, 2021b). Confirmatory soil sampling in the vicinity of SB-8 has not yet been conducted.

Site environmental history and the results of recent soil and groundwater sampling are summarized in the Remedial Design and related documents (see document list in Table WS 1 & 2).

Conceptual Site Model (CSM)

Contamination conditions appear to be due to historical releases to on-Site overburden soils, which subsequently resulted in impacts within both the overburden and bedrock groundwater systems. Pumping of former off-Site bedrock supply wells resulted in drawdown to the west, spreading the contaminant plume toward residential areas along Highland Avenue; however, with the closure of these supply wells in 1983 the impacted area is now limited to the downgradient zone south of the Site building. Contamination from PCE and breakdown products is found in both the overburden and bedrock aquifers.

Based on existing data: 1) the groundwater hot spot to the south of the building has not expanded and concentrations of dissolved PCE (and breakdown products) are decreasing in perimeter wells; and, 2) the ISCO treatment appears to have substantially reduced CVOC contamination in sub-slab groundwater. A comprehensive sampling event, including targeted exterior wells and the interior ISCO recirculation wells, is proposed to generate current data for CVOCs in groundwater, in order to evaluate the ISCO program and provide guidance for future treatment of groundwater.

QAPP WORKSHEET #11 – PROJECT/DATA QUALITY OBJECTIVES

(UFP-QAPP Manual Section 2.6.1; EPA 2106-G-05 Section 2.2.6)

This section presents data quality objectives (DQOs) following the USEPA Guidance of Systematic Planning Using the DQO Process (USEPA 2006). The DQO process specifies anticipated project decisions, specific data types needed, the data quality required to support decisions, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified.

The DQO process consists of the following seven steps, described in detail below:

1. State the Problem
2. Identify the Goal of the Investigation
3. Identify the Information Inputs
4. Define the Boundaries of the Investigation
5. Develop the Analytic Approach
6. Specify Performance or Acceptance Criteria
7. Develop the Plan for Obtaining Data

The following sections detail each step in the DQO process for this investigation.

State the Problem

The last data sets for CVOCs in groundwater are no longer current (exterior wells were last sampled in 2019 and post-treatment sampling of interior wells was in May 2021). The impact of the ISCO applications beneath the Site building on exterior groundwater quality is unknown.

Investigation Goals

The goal of the investigation is to generate a comprehensive, current data set for dissolved CVOCs in Site groundwater (areal distribution and concentrations), both at exterior and interior wells. These data will be used to provide guidance for the next steps required to implement the RDD for ISCO treatment of soil beneath the Site building, and in support of developing a Remedial Action Work Plan/Remedial Design for the overall remediation of Site groundwater contamination.

Information Inputs

The table below lists the data types and purposes required for the fieldwork event.

Quality control samples are discussed in Worksheet 14 & 16, and the Field Sampling Plan (FSP) including the sampling design and rationale is detailed in Worksheet 17.

Table WS 11: Required Data Type and Purpose	
Data Type	**Data Purpose**
Field observation of existing monitoring wells	Determine if wells are functional/can be sampled; document current depth to groundwater
CVOC concentrations in groundwater	Determine current groundwater quality

Investigation Boundaries

Exterior monitoring wells (USEPA targeted locations) and the interior wells installed during ISCO treatment will be sampled in October 2022. An attempt will be made to locate and sample an upgradient well (either MW-1 or MW-8, which were last sampled in 2008). Proposed well sampling locations are shown on Figure 2.

Analytic Approach

Decision Rules: Data generated during the groundwater sampling event are meant to supplement the existing Site groundwater data set as a whole, and to be evaluated in terms of historical trends and the recent soil ISCO treatment. All targeted wells will be sampled, irrespective of the findings at any individual well. Data will be evaluated as either a) usable and complete or b) not complete, the full data set will be reviewed with USEPA, and the need to either sample additional wells and/or conduct a second round of sampling in light of current findings, will be determined; as such, there are no applicable decision rules for the data generated during fieldwork.

Sample Analytical Parameters and Methods: Analytical parameters for groundwater are presented in Worksheet 23.

Performance and Acceptance Criteria

The purpose of this step is to establish the criteria needed to maximize the ability of the investigation to obtain the data needed to answer the principal investigation question accurately and with confidence.

There are two types of decision errors: sampling design errors and measurement errors. Sampling design errors are a function of the selection of sample locations or analytical methods used to characterize the site. Measurement errors are a function of the procedures used to collect and analyze the samples.

The possible decision errors are presented below:

- Concluding that a contaminant is present in an environmental media when it is not actually present. This error results in investigating or cleaning up a non-impacted site.
- Concluding that a contaminant is not present when it is actually present. This error results in incomplete characterization or incorrectly concluding that a response actions is unnecessary at an impacted site.

The following will reduce the uncertainty associated with these errors:

- The sampling design will be based on historical and current site reconnaissance, previous investigations, and a well-developed Conceptual Site Model (CSM) for the Site.
- Procedures for all field and reporting activities will follow SOPs (Appendix B).
- At a minimum, the analytical laboratories will be certified under the New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP).
- All definitive data will be compared to the measurement performance criteria specified in Worksheet #12 to determine acceptability of analytical laboratory results.
- QA/QC procedures will be applied throughout the study process as detailed in the following Worksheets.

Plan for Obtaining, Assessing, and Managing Data

Table WS 11: QAPP Sections Relating to Obtaining, Assessing, and Managing Data

QAPP Worksheet	Subject Matter
12	MPC (measurement performance criteria)
14 & 16	Project tasks and schedule
15	PAL (project action limits) and laboratory detection/quantitation limits
17	Sampling design and rationale
19, 20, 26 to 30	Specify analysis design requirements
31 to 33	Assessments and corrective actions
34	Data Verification and Validation Inputs
35 and 36	Data Verification and Validation Procedures

QAPP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA

(UFP-QAPP Manual Section 2.6.2; EPA 2106-G-05 Section 2.2.6)

Measurement Performance Criteria (MPC) are defined in this worksheet to provide a data set that will be technically defensible for project decisions. The criteria are related to the Data Quality Indicators (DQI) of precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity.

The following parameters will be used to measure outliers associated with project results.

Precision

For each field duplicate and laboratory duplicate pair (including laboratory control sample [LCS]/ laboratory control sample duplicate [LCSD] and matrix spike [MS]/ matrix spike duplicate [MSD]), the relative percent difference (RPD) will be calculated for each analyte whose original and duplicate values are both greater than or equal to the limit of quantitation (LOQ). The RPDs will be checked against the measurement performance criteria presented in Worksheet #28.

Accuracy/Bias Contamination

Results for all laboratory method blanks and equipment blanks will be reviewed by the data validator. In addition, LCS/LCSDs, MS/MSDs, surrogates, post-digestion spikes, and serial dilutions will be reviewed. The results for each analyte will be checked against the measurement performance criteria presented in Worksheet #28.

Representativeness

Representativeness is the measure of how accurately and precisely data represents a characteristic of a population. Representativeness will be assessed by a review of the precision obtained from the field and laboratory duplicate samples. Representativeness is also assessed through proper sample handling techniques and the use of equipment, material, trip, and method blanks. Existing project data may be employed to assess the representativeness of a population by defining the continuity of data from point to point.

Comparability

Sample data shall be comparable for similar samples and sample conditions. This goal is achieved using standard techniques to collect representative samples, consistent application of analytical method protocols and reporting analytical results with appropriate units.

Sensitivity

Results for all LCS/LCSDs will be reviewed by the data validator for each analysis. The results for each analyte will be checked against the measurement performance criteria presented in Table WS 12 and cross-checked against the limit of detection (LOD) presented in Worksheet #15. Results for analytes that exceed criteria will be identified in the data validation report.

In addition to target analytes, field samples may be analyzed for additional parameters to evaluate the presence of fate and transport and/or geochemical conditions of the subsurface at the site. These data are collected as screening-level data and as such, these data are not validated unless further evaluation is warranted (e.g., review of anomalous data). The following parameters are used for site evaluation purposes only: pH, turbidity, dissolved oxygen (DO), and specific conductivity.

Completeness

A completeness check will be done on all of the data generated by the laboratory. Completeness criteria are presented in Worksheets #34 and #35. Analytical results qualified as rejected during data validation do not meet the measure performance criteria.

MPC for CVOCs in Groundwater

Table WS 12: Measurement Performance Criteria		
Matrix: Groundwater	Analytical Group/Method: VOCs by EPA Method 8260C (low concentration)	
Data Quality Indicator (DQI)	**QC Sample or Measurement Performance Activity**	**Measurement Performance Criteria**
Overall Precision	Field duplicates	RPD ≤30% when compound detected in both samples ≥LOQ
Analytical Precision (laboratory)	Laboratory Control Sample Duplicates	RPD ≤ 20%
Analytical Precision (laboratory)	Matrix Spike Duplicates	RPD ≤ 30%
Analytical Accuracy/Bias (laboratory)	Laboratory Control Samples	Generally, 70-130%R – analyte specific (*laboratory performance criteria are provided in Appendix D*)
Analytical Accuracy/Bias (matrix interference)	Matrix Spike/ Matrix Spike Duplicates	Generally, 40-140%R – analyte specific (*laboratory performance criteria are provided in Appendix D*)
Accuracy/Extraction efficiency	Surrogates	70-130%R
Overall accuracy/bias (contamination)	Method blank	No target compounds ≥ LOQ
Sensitivity	Method Detection Limit	MDL < LOQ
Completeness	See Worksheets #34 and #35	See Worksheets #34 and #35

Notes:

RPD Relative Percent Difference
%R Percent Recovery
LOQ Limit of Quantitation

QAPP WORKSHEET #13 – SECONDARY DATA USES AND LIMITATIONS TABLE

(UFP-QAPP Manual Section 2.7; EPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

This worksheet identifies secondary data sources relevant to project decisions (document citations in Worksheet #2).

Table WS 13: Secondary Data Uses and Limitations Table

Data Type	Data Source (originating organization, title, date)	Data Generator(s) (data types, date of generation/collection)	How data may be used (if deemed usable during data assessment stage)	Factors affecting reliability of data and limitations on data use
Report	GBTS (2021), Phase I Soil Remediation: Preliminary In Situ Chemical Oxidation Report	Provides post-ISCO sub-slab groundwater data (2021)	Provides validated data for groundwater contamination beneath the Site building	None
Report	GBTS (2021), Phase I Soil Remediation: Well Installation and Baseline Sampling Report	Provides pre-ISCO sub-slab groundwater data (2021)	Provides validated data for groundwater contamination beneath the Site building	None
Report	GBTS (2019), Groundwater Sampling Report	Provides sampling data for exterior wells in 2016 and 2019	Provides validated data for exterior groundwater	None
Report	ESI (2008) Letter Report of Groundwater Sampling	Summarizes groundwater sampling and CVOC levels in 2008	Provides information on historical trends for CVOC contamination	Non-validated data set, for general comparison
Report	ESI (2004), Interim Summary Data Report of Groundwater Sampling, January 2004	Summarizes groundwater sampling and CVOC levels through 2003	Provides information on historical trends for CVOC contamination	Non-validated data set, for general comparison

Notes:

GBTS Gallagher Bassett Technical Services
ESI Ecosystems Strategies, Inc.

QAPP WORKSHEET #14 & 16 – PROJECT TASKS & SCHEDULE

(UFP-QAPP Manual Section 2.8.2; EPA 2106-G-05 Section 2.2.4)

Sampling Tasks

All interior monitoring wells, and a targeted list of exterior wells (both overburden and bedrock), will be sampled to document current groundwater quality. The locations of the groundwater monitoring wells to be sampled are described in Worksheet #17, samples to be collected are outlined in Worksheet #18, and the sampling requirements for each type of analysis are listed in Worksheet #19. Each sampling task is described in detail in the SOPs in Appendix B.

Analysis Tasks

Groundwater samples will be submitted for laboratory analysis of halogenated VOCs, which includes all CVOCs that are of primary concern at the Site (PCE and breakdown products). All sample analyses will be performed by Alpha Analytical, Inc. (Alpha). Chemical analyses will be performed in accordance with this UFP-QAPP, and the analytical methods. The laboratory will meet the detection limits specified in Worksheet #15.

Quality Control Tasks

The following field QC samples will be collected: field duplicates and MS/MSDs. Field duplicates will be collected from wells known or suspected to be contaminated. Triple sample volume will be collected for MS/MSDs from relatively clean sampling locations to capture effects of the matrix sampled.

One equipment blank will be collected per day for each submersible sampling pump and related non-disposable equipment.

Trip blanks, prepared by the laboratory using water demonstrated to be free of CVOCs, will be placed in the cooler used to ship groundwater samples.

Worksheet #18 specifies the number and type of field QC sample as well as the frequency of collection.

Secondary/Other Data

Laboratory results for the current sampling round will be compared and evaluated in terms of data provided in historical reports (see report list in Worksheet #13).

Data Management Tasks

Field forms will be electronically generated and reviewed by the Field Team Leader prior to sample shipment. The sample handling and custody requirements, including field logs, sample collection paperwork, sample labeling, etc., is described in Worksheets #26 and #27.

The Quality Assurance Manager (QAM) will track the samples during analysis and through data validation. All final laboratory data will be submitted in a format with Contract Laboratory Program-like deliverables.

Data validation will be performed by the data validator in accordance with the procedures described in Worksheets #35 and #36. The data validator will review all definitive analytical data and will note any validation findings in data validation reports. Data validation reports will be submitted as an appendix of the investigation report.

Documentation and Records

Information regarding field tasks will be recorded on site field logs in accordance with SOPs. Sample collection information will be recorded on individual sample field forms. Any changes that are made to the field logs or the field forms will be initialed and dated. Documents will be maintained in project files and will be submitted as an appendix to the investigation report. Field Forms are provided in Appendix C.

Assessment/Audit Tasks

Worksheet #31 presents a summary table and detailed description of assessment/audits tasks. Worksheet #33 lists the QA Management reports to be completed during the investigation.

Schedule

Project activities as well as the QA assessments that will be performed during the course of the project are shown below.

Table WS 14 & 16: Project Schedule / Timeline

Activity	Responsible Party	Planned Start	Planned Completion	Deliverable(s)	Due Date
Groundwater sampling	GBTS	October 2022	October 2022	Field notes	October 2022
Laboratory analysis	Alpha Analytical Laboratories	October 2022	November 2022	Laboratory data package/report	November 2022
Summarize initial findings	GBTS	November 2022	November 2022	Summary email to USEPA	August 2022
Data validation	ZDataReports	November 2022	January 2023	DUSR	January 2023
Summarize data	GBTS	February 2023	February 2023	Groundwater monitoring Report (draft)	February 2023

QAPP WORKSHEET #15 – PROJECT ACTION LIMITS AND LABORATORY-SPECIFIC DETECTION/QUANTITATION LIMITS

(UFP-QAPP Manual Section 2.6.2.3 and Figure 15; EPA 2106-G-05 Section 2.2.6)

Project action limits (PALs), used to evaluate the presence or absence of contamination, are based on NYSDEC Division of Water Ambient Water Quality Standards and Guidance Values (AWQS) provided in Technical and Operational Guidance Series 1.1.1 (inclusive of 6NYCRR Part 703). Target CVOCs critical to decision-making are highlighted. A Project Quantitation Limit Goal (matrix-specific quantitation limit) has been set lower than the PAL and higher than the generic laboratory-specific quantitation limit. Cases are noted where the quantitation limit is greater than either the project quantitation limit goal or the PAL. The laboratory shall provide documentation that demonstrates precision and bias at the laboratory-specific quantitation limit. The laboratory-specific quantitation limit cannot be lower than the lowest calibration standard for any given method and analyte.

Tables presenting target analytes for groundwater sampling, PALs, Project Quantitation Limit Goals, laboratory-specific limits of detection (LOD) and limits of quantitation (LOQ), recovery criteria (for target analytes, surrogates, and laboratory control and matrix spike samples) and criteria for relative percent differences, are provided in Appendix D.

QAPP WORKSHEET #17 – SAMPLING DESIGN AND RATIONALE

(UFP-QAPP Manual Section 3.1.1; EPA 2106-G-05 Section 2.3.1))

The purpose of the planned groundwater sampling event is to document current groundwater conditions at existing monitoring wells associated with the Site. Monitoring wells are located within the Site building and at exterior locations, at both on-Site and off-Site areas. Exterior locations consist of "shallow" wells installed in the overburden, and "deep" wells installed in bedrock. No new monitoring wells are proposed.

All six (6) interior monitoring wells, nine (9) exterior overburden, and ten (10) exterior bedrock wells will be sampled. The selected exterior wells are consistent with the previous sampling events in 2016 and 2019, with exception that the fieldwork plan includes an additional upgradient well (MW-8, last data reported in 2008), which will be sampled if it can be located and is functional. Selected exterior wells were identified by USEPA in 2016 as priority sampling locations, based on an overall assessment of previous groundwater data (e.g., several upgradient and cross-gradient off-Site wells were excluded based on an absence of any significant contamination over multiple sampling events).

Sampling of the interior wells is intended to document the effectiveness of the previous ISCO treatment and the resulting data will be utilized to provide guidance regarding any need for a second injection event and the timing of confirmatory soil sampling beneath the building slab.

Sampling of the exterior wells is intended to document current conditions for comparison with historical trends, and to investigate potential improvements to groundwater quality resulting from the ISCO event at the Site building.

All groundwater samples will be sampled using approved USEPA low-flow methodology, and will be submitted for laboratory analysis of halogenated VOCs via USEPA Method 8260C, consistent with previous sampling events. Worksheet #18 details sampling locations and methods.

QAPP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS

(UFP-QAPP Manual Section 3.1.1 and 3.1.2; EPA 2106-G-05 Section 2.3.1 and 2.3.2)

The table below lists all monitoring wells to be sampled (see Figure 2 for well locations, and Worksheet #20 for additional information on field QC samples). Groundwater samples will be collected in accordance with GBTS SOP 006 (Appendix B).

Table WS 18: Sampling Locations

Interior Overburden Wells	Exterior Overburden Wells	Exterior Bedrock Wells
EMW-01	MW-1 or MW-8	MW-12
EMW-02	MW-3 (alternative: MW-16)	W-30
IMW-01	MW-4	MW-203
IMW-02	MW-5	MW-204
IMW-05	MW-6	MW-206
IMW-06	MW-7	MW-207
Notes: MW-1 or MW-8 to be sampled if wells are found and are functional; MW-16 to be sampled as alternative to MW-3, if required by encountered field conditions.	MW-8	MW-209
	MW-9	MW-211
	MW-11	MW-219
	MW-19	MW-220

All overburden wells are constructed with a screened lower interval and an upper solid casing. The depth of each well will be reconfirmed prior to sampling, and groundwater will be collected from 1 to 2 feet above the bottom of the screen. All bedrock wells are constructed as open boreholes with an upper solid casing extending through the overburden (anchored within the upper bedrock). Sampling depths will be at approximately 100 feet below grade surface, which corresponds to the likely range of the most productive bedrock fracture zone (identified during previous packer and pumping testing).

Sample IDs will be based on well location ID or type of quality control blank. Duplicates will be identified generically to blind their source to laboratory personnel. Typical identification will be as follows:

Sample Class	Label Template	Example Sample ID(s)
Normal groundwater sample	well ID yyyymmdd	MW-5 20220714
Duplicate	dup yyyymmddx	dup 20220714a
QC Blanks	Blank type yyyymmddx	TB 20220714a, FB202207b

Duplicate samples to be collected from EMW-02, MW-3, and MW-203.

MS/MSD to be collected from each unique groundwater regime (sub-slab, shallow exterior, and deep exterior wells), with the locations chosen at the discretion of field personnel, based on the encountered field conditions, e.g., rate of recharge, turbidity, etc. MS/MSDs are samples with extra volume and which will not have a separate sample ID, but will be noted on the chain-of-custody.

QAPP WORKSHEET #19 & 30 – SAMPLE CONTAINERS, PRESERVATION, AND HOLD TIMES

(UFP-QAPP Manual Section 3.1.2.2; EPA 2106-G-05 Section 2.3.2)

This worksheet summarizes laboratory information, and sample containers, preservation requirements, and holding times for sampling VOCs in groundwater (low-level concentrations). The analytical and preparation method is 8260C (laboratory SOPs are provided in Appendix E).

The laboratory is Alpha Analytical, Inc., a NYSDOH-certified laboratory for chemical analyses.

Matrix: Groundwater

Analytical Group: VOCs (low level)

Sample IDs: See Worksheet #18

Analytical SOP 2108 Volatile Organic Compounds EPA 8260 (#2021-08-03)

Data Package Turnaround 10 business days (maximum)

Laboratory Information (NYSDOH-certified ELAP)

Alpha Analytical, Inc. – ELAP Certification 11148 (expires 2023-04-01)
8 Walkup Drive, Westborough, MA 01581
Contact Nadine Yakes, nyakes@alphalab.com, (201) 812-9037
Laboratory Manager: Christopher A. Ouellette

Backup Laboratory / Organization (NYSDOH-certified ELAP)

York Laboratories, Inc. – ELAP Certification 10854 (expires 2023-04-01)
120 Research Drive, Stratford, CT 06615
Contact Client Services, clientservices@yorklab.com, 203-325-1371
Laboratory Manager: Cassie Mosher

Table WS 19 & 30: Analytical SOP Requirements

Analytical Containers (number, size, type)	Sample Preservation Requirements	Sample Maximum Hold Time (preparation/analysis)
3 x 40-mL glass vials (triple volume for MS/MSD)	No headspace; HCl to pH <2; Cool to 4 ± 2 C	14 days for analysis

QAPP WORKSHEET #20 – FIELD QC SUMMARY

(UFP-QAPP Manual Section 3.1.1 and 3.1.2; EPA 2106-G-05 Section 2.3.5)

This worksheet summarizes the field QC samples to be collected and their collection frequency. All QC samples are groundwater samples to be analyzed for VOCs.

One trip blank will be provided for each cooler shipped to the laboratory. One field blank (equipment rinse blank) will be provided for each non-dedicated sampling pump (up to eight [8] samples are anticipated based on two pumps operating over four fieldwork days).

The table below summarizes the expected number of groundwater quality samples, including duplicates, and collection of groundwater to serve as MS/MSD.

Table WS 20: Field Quality Control Sample Summary

No. of Sampling Locations	No. of Field Duplicate Pairs	No. of MS/MSD	Total Samples
25	3	3	28 (excludes MS/MSD)

QAPP WORKSHEET #21 – FIELD SOPS

(UFP-QAPP Manual Section 3.1.2; EPA 2106-G-05 Section 2.3.2)

This worksheet summarizes all Standard Operating Procedures (SOPs) associated with project sampling including, but not limited to, sample collection, sample preservation, equipment cleaning and decontamination, equipment testing, inspection and maintenance, supply inspection and acceptance, and sample handling and custody. SOPs as provided in Appendix B.

Table WS 21: Project Sampling SOP References

Reference Number*	SOP Title	SOP Source	Equipment Type	Modified for Project Work?
GBTS SOP 001	Record Keeping and Logbooks	GBTS	See SOP	No
GBTS SOP 002	Field Equipment Calibration	GBTS	See SOP	No
GBTS SOP 003	Field Equipment Operation	GBTS	See SOP	No
GBTS SOP 004	Equipment Decontamination	GBTS	See SOP	No
GBTS SOP 005	Sample Handling	GBTS	See SOP	No
GBTS SOP 006	Low-flow Water Sampling	GBTS	See SOP	No

Notes:

* Reference Number for SOP included in Appendix B, Standard Operating Procedures
GBTS Gallagher Bassett Technical Services

QAPP WORKSHEET #22 – FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

(UFP-QAPP Manual Section 3.1.2.4; EPA 2106-G-05 Section 2.3.6)

This worksheet identifies all field equipment and instruments (other than analytical instrumentation) that require calibration, maintenance, testing, or inspection and provides the SOP reference number (see Worksheet #21).

Table WS 22: Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference	Comments
Water-level meter	Test for sound	Prior to use	Obvious beep	Check battery	Field team leader	User manual; GBTS SOP 003	None
Multi-parameter water meter	Calibration (all parameters)	Daily	Within SOP range	If sensor fails to calibrate, the sensor will be cleaned and a span calibration will be performed, or the unit will be returned to a qualified service representative for repairs	Field team leader	User manual; GBTS SOP 002; GBTS SOP 003	Daily calibration prior to start of fieldwork
Photoionization Detector (PID)*	Calibrate to 100 ppm isobutylene	Daily	Isobutylene ppm ±1%	Contact technical support; obtain new meter if problem not resolved	Field team leader	User manual; GBTS SOP 002; GBTS SOP 003	Daily calibration prior to start of fieldwork
Submersible pumps	Test for operation	Daily	Capable of variable speed pumping	Check battery and wiring harness/connections; contact technical support; obtain new pump if problem not resolved	Field team leader	User manual; GBTS SOP 003	Check initial operation prior to start of fieldwork

Notes:

* A function check is first performed on the equipment. The calibration gas is tested to ensure that it falls within manufacturer's criteria. If the function check is acceptable, then the instrument is ready for use. Otherwise, the instrument will be calibrated according to the manufacturer's instructions.

SOP Standard Operating Procedure

ppm Parts per million

QAPP WORKSHEET #23 – ANALYTICAL SOPS

(UFP-QAPP Manual Section 3.2.1; EPA 2106-G-05 Section 2.3.4)

This worksheet documents information about specific sample preparation and analytical procedures to be used by the laboratory under the supervision of the Laboratory Manager, which are provided in the laboratory SOPs in Appendix E.

Table WS 23: Analytical SOPs

SOP Title (date)	Definitive or Screening Data	Matrix/ Analytical Group	Equipment Type	Modified for Project Work?
2108 Volatile Organic Compounds EPA 8260 (2021-08-03)	Definitive	Water/VOCs	Low-level, closed-system purge and trap, or direct injection	N

QAPP WORKSHEET #24 – ANALYTICAL INSTRUMENT CALIBRATION

(UFP-QAPP Manual Section 3.2.2; EPA 2106-G-05 Section 2.3.6)

This worksheet documents information about laboratory analytical instrument calibration procedures.

Instrument: VOA (GC/MS) 8260

Calibration Range: 5 to 1,000 ng

Title/position responsible for Corrective Action: Analyst, under the supervision of the Laboratory Manager

SOP Reference: 2108 Volatile Organic Compounds EPA 8260, Sections 8.5, 9, and 10 (provided in QAPP Appendix E).

Table WS 24: Analytical Instrument Calibration (VOA GC/MS)

Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)
4-bromofluoro benzene (BFB) tune	Prior to each ICAL; at the beginning of analytical sequence; every 12 hours	Perform in full SCAN mode; see SOP for BFB acceptance criteria;	Perform instrument/injection port maintenance as necessary; retune instrument
Initial Calibration (ICAL)	Initial instrument setup; after non-routine instrument service; CCV/ICV criteria are not met	Minimum of 5 standards; low standard must be ≤ LOQ; %RSD ≤ 20 except for 10% of compounds may be > 20% but ≤ 30% RSD; r ≥ 0.99 (linear regression); r2 ≥ 0.99 (non-linear regression)	Review integrations and calculations; perform and document remedial action as required; repeat calibration
Initial Calibration	Immediately after each ICAL	%D ≤ 30; exclusions apply – see SOP; prepared using standard source different than used for initial calibration	Re-analyze ICV if analytical error is suspected; recalibrate as needed
Initial Calibration Verification (ICV)	At the beginning of every analytical sequence; every 12 hours	%D ≤ 20 except for 20% of compounds may be > 20 but ≤ 30%D; area counts of internal standards must be within 50–200% of the mid-level initial calibration standard	Review integrations and calculations; re-analyze samples as needed

Notes: LOQ Limit of Quantitation
RSD Relative Standard Deviation
%D Percent Difference

QAPP WORKSHEET #25 – ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION

(UFP-QAPP Manual Section 3.2.3; EPA 2106-G-05 Section 2.3.6)

This worksheet documents information about analytical instrument and equipment maintenance, testing, and inspection, to be performed by the laboratory. Acceptance criteria and corrective actions are specified in the laboratory SOP (2108 Volatile Organic Compounds EPA 8260) in Appendix E. The laboratory Analyst, under the supervision of the Laboratory Manager, is responsible for required Corrective Actions.

Table WS 25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency
GC/MS	Inlet maintenance: septa, injection port liner, clip column	Passing tune/CCAL; overall chromatogram	Instrument performance and sensitivity	Frequency is dependent on degree of contamination and standard recovery
GC/MS	Column	Passing tune/ICAL/ ICV; overall chromatogram	Instrument performance and sensitivity	Frequency is dependent on degree of contamination and standard recovery
GC/MS	Source cleaning : filaments, insulators	Tuning	Instrument performance and sensitivity	Frequency is dependent on degree of contamination and standard recovery
GC/MS	Pump	Complete MS pump down	Air and water check	Frequency is dependent on vacuum within instrument
GC/ECD/FID	Inlet maintenance: septa, injection port liner, clip column	Passing CCAL; overall chromatogram	Instrument performance and sensitivity	Frequency is dependent on degree of contamination and standard recovery
GC/ECD/FID	Column	Passing CCAL; overall chromatogram	Instrument performance and sensitivity	Frequency is dependent on degree of contamination and standard recovery

Notes:
GC/MS Gas Chromatograph/Mass Spectrometer
CCAL Continuing Calibration
ICAL Initial Calibration
ICV Initial Calibration Verification
ECD Electron Capture Detector
FID Flame Ionization Detector

QAPP WORKSHEET #26 & 27 – SAMPLE HANDLING, CUSTODY, AND DISPOSAL

(UFP-QAPP Manual Section 3.3; EPA 2106-G-05 Section 2.3.3)

This worksheet documents responsibilities for maintaining custody of samples from sample collection through disposal.

Sampling Organization: GBTS

Laboratory: Alpha Analytical, Inc. (Alpha)

Method of sample delivery: Same day laboratory courier

Number of days from reporting until sample disposal: 30

Table WS 26 & 27: Sample Handling, Custody, and Disposal

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	GBTS Field Team Leader	GBTS SOP 005 (Appendix B)
Chain-of-custody form completion	GBTS Field Team Leader	GBTS SOP 005 (Appendix B)
Packaging	GBTS Field Team Leader	GBTS SOP 005 (Appendix B)
Shipping coordination	GBTS Field Team Leader	GBTS SOP 005 (Appendix B)
Sample receipt, inspection, & log-in	Alpha Laboratory Manager	Laboratory SOP 1559 (Appendix E)
Sample custody and storage	Alpha Laboratory Manager	Laboratory SOP 1560 (Appendix E)
Sample disposal	Alpha Laboratory Manager	Laboratory SOP 1728 (Appendix E)

Field Custody Procedures

Field sample custody procedures (collection, labeling, packaging, and transfer to the laboratory courier for delivery to laboratory), to be performed by the GBTS field staff under the direction of the GBTS Field Team Leader, are described in GBTS SOP 001 and GBTS SOP 005, Appendix B.

All samples will be given a unique sample ID, and a record of all sample IDs will be kept with the field records and recorded on a chain-of-custody form. The sample IDs will be used to identify and retrieve analytical results from the laboratory, validation, and upload into the project database.

Additional labeling requirements specific to the proposed fieldwork include:

Groundwater Quality Samples

Sample IDs will include well name followed by sampling date (yyyymmdd), e.g., EMW-02 20220716

Blind duplicate samples will be labeled sequentially, as collected, e.g., DUP-02

Quality Control Samples

Field (equipment) blanks will be labeled sequentially, as collected, and include the fieldwork date, e.g., FB-03 20220718

Trip blanks (one per cooler) will be labeled sequentially, as used, and include the fieldwork date, and the cooler will be identified with an identical sequence number (noted on the chain-of-custody form), e.g., Cooler labeled as "1", trip blank as TB-01 20220716

MS/MSD will be generated in the laboratory from samples specified in the field; such samples will have triple volumes but will not have special labeling (the presence of extra volume for MS/MSD will be identified as a note on the chain-of-custody form).

Laboratory Custody Procedures

A designated sample custodian accepts custody of the samples by the laboratory and verifies that the information on the sample labels matches that on the chain-of-custody. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt at the laboratory. If a sample container is missing, a sample container is received broken, the sample is in an inappropriate container, or the sample has not been preserved by appropriate means, GBTS personnel will be notified as per Worksheet #6.

In accordance with laboratory custody and security requirements, the laboratory sample custodian will be responsible for logging the samples in, assigning a unique laboratory identification number to each sample to assure traceability of samples while in possession of the laboratory, labeling the sample container with the laboratory identification number, and moving the sample to an appropriate storage location to await analysis. The project name, field sample ID/code, date sampled, date received, analysis required, storage location and date, and action for final disposition will be recorded in the laboratory tracking system. Relevant custody documentation will be placed in the project file. The following stages of analysis will be documented by the laboratory: sample extraction/preparation; sample analysis; and data reporting. Laboratory personnel are responsible for the custody of the samples until they are returned to the sample custodian.

The laboratory will archive all relevant documentation, including: chain-of-custody records; sample analysis request forms; laboratory custody forms, and sample preparation and analysis logbooks; final data packages; and other documentation including records, reports, correspondence, logs, pictures, and data review reports.

QAPP WORKSHEET #28 – ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTION

(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6; EPA 2106-G-05 Section 2.3.5)

This worksheet identifies the laboratory QC samples and their respective acceptance limits and required corrective actions for analysis of VOCs in groundwater (low concentrations) using USEPA Method/SOP reference SW-846 8260. The laboratory Analyst, under the supervision of the Laboratory Manager, is responsible for required Corrective Actions.

Table WS 28: Laboratory QC Samples for VOCs

QC Sample (Data Quality Indicator)	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Measurement Performance Criteria
Method Blank (accuracy/bias - contamination)	One per preparatory batch of up to 20 samples	No analyte at or above the reporting limit	Identify source and attempt to eliminate; reanalyze blank and affected samples (if sufficient sample remains); qualify data as needed. Report data if sample results >5x blank or sample results ND. If contamination is widespread or reoccurring, analyses must be stopped, and the source of contamination must be eliminated or reduced before analyses can continue	All analytes in the method blank must be less than ½ the LOQ
LCS (accuracy/bias)	One each per preparatory batch of up to 20 samples	Generally, 70-130%R, 20% RPD (analyte specific)	Correct problem; reanalyze LCS/LCSD and all samples in associated batch for failed analytes. If problem persists, contact Project Manager	Laboratory control limits (WS #15/Appendix D)
MS/MSD (accuracy/bias/precision)	One per preparatory batch of up to 20 samples	Generally, 70-130%R, 20% RPD (analyte specific)	Report if associated with passing LCS/LCSD. Discuss in narrative.	Laboratory control limits (WS #15/Appendix D)

Notes:
LOQ Limit of Quantification
LCS Laboratory Control Sample
LCSD Laboratory Control Sample Duplicate
MS Matrix Spike Sample
MSD Matrix Spike Sample Duplicate
%R Percent Recovery

QAPP WORKSHEET #29 – PROJECT DOCUMENTS AND RECORDS

(UFP-QAPP Manual Section 3.5.1; EPA 2106-G-05 Section 2.2.8)

This worksheet identifies the documents and records deliverables developed and maintained during the project, including sample collection, laboratory analysis, health/safety documentation, communication records, and data assessment records.

Table WS 29: Project Documents and Records

Project Document/Record	Generation	Verification	Storage Location/Archive
Health and safety certifications, training documentation	Project Staff	Site Safety Officer	Project files
Field logbook(s)	Project Staff	FM and QAM	Project files
Data collection sheets (e.g., sampling forms)	Project Staff	FM and QAM	Project files
Sample documentation (e.g., chain-of-custody, data tables)	Project Staff	FM and QAM	Project files
Figures	Project Staff	PM	Project files
Survey data	Project Staff	PM	Project files
Field instrument calibration logs	Project Staff	FM and QAM	Project files
Cooler receipt forms	Project Staff	FM and QAM	Project files
Photographs	Project Staff	FM and QAM	Project files
Waste disposal documentation	Project Staff	PM	Project files
Deviations	Project Staff	FM and QAM	Project files
Corrective Action Reports	Project Staff	PM	Project files
Correspondence	Project Staff	PM	Project files
Field audit documentation	Project Staff	FM and QAM	Project files
Analytical sample records	Project Staff	PM and QAM	Project files
Analytical laboratory data packages	Laboratory	PM and QAM	Project files; laboratory's maintenance records
Electronic data deliverables	Laboratory	PM and QAM	Project files; laboratory's maintenance records
Electronic data files	Project Staff	PM and QAM	Project files
QC Summary Report	Data Validator	PM and QAM	Project files

Notes:

FM Fieldwork Manager
QAM Quality Assurance Manager
PM Project Manager

QAPP WORKSHEET #31, 32 & 33 – ASSESSMENTS AND CORRECTIVE ACTION

(UFP-QAPP Manual Sections 4.1.1 and 4.1.2; EPA 2106-G-05 Section 2.4 and 2.5.5)

This worksheet documents responsibilities for conducting project assessments, responding to assessment findings and implementing corrective action, and indicates relevant periodic QA management reports

Prior to the start of fieldwork, a visit to the Site will be performed to verify existing conditions. The GBTS Quality Assurance Manager (QAM) may schedule surveillance of field activities at any time to evaluate sample collection, identification, and control in the field. Sampling operations may be reviewed and compared to the requirements listed in this UFP QAPP. Use of proper sample containers, proper handling of samples, and adequate documentation of the sampling operation will be verified.

Table WS 31, 32 & 33: Planned Project Assessments

Assessment Type	Responsible Party and Organization	Frequency (est. date)	Assessment Deliverable	Deliverable Due Date
Field Sampling Audit	GBTS QAM	If necessary as determined by GBTS Project Manager (PM)	Checklist including examinations of field sampling and measurement records, field instrument operating and calibration records, sample collection, handling and packaging in compliance with the established procedures, maintenance of QC procedures, COC, field and sample documentation, safety procedures	24 hours following assessment

Table WS 31, 32 & 33: Assessment Findings and Corrective Actions

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
Field Sampling Audit	GBTS PM	Memo	24 hours from receipt of Checklist	GBTS Fieldwork Manager (FM)	GBTS PM

Table WS 31, 32 & 33: QA Management Reports

Type of Report	Frequency	Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Daily Field	Daily	Daily	GBTS FM	GBTS PM and QAM
Monthly Progress	Monthly	Monthly	GBTS PM	GBTS QAM and USEPA PM
DUSR	After data validation	Submit with Final Report	Data validator	GBTS PM and QAM
Final Report	After completion of all fieldwork and DUSR	30 days from receipt of final DUSR	GBTS PM	GBTS QAM and USEPA PM

QAPP WORKSHEET #34 – DATA VERIFICATION AND VALIDATION INPUTS

(UFP-QAPP Manual Section 5.2.1 and Table 9; EPA 2106-G-05 Section 2.5.1)

This worksheet list the inputs that will be used during data verification and validation. Inputs include planning documents, field records, and laboratory records. Data verification is a check that all specified activities involved in collecting and analyzing samples have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is the evaluation of conformance to stated requirements, including those in the contract, methods, SOPs and the QAPP.

Table WS 34: Data Verification and Validation Inputs

Item	Description	Verification (completeness)	Validation (compliance)
PLANNING DOCUMENTS/RECORDS			
1	Approved Work Plan/UFP-QAPP	X	
2	Field/Laboratory SOPs	X	
FIELD RECORDS			
3	Field logbooks	X	X
4	Chain-of-custody forms	X	X
5	Sampling logs	X	X
6	Drilling logs	X	X
7	Change orders/deviations	X	X
8	Field audit checklists	X	X
9	Field corrective action memos	X	X
ANALYTICAL DATA PACKAGE			
10	Cover sheet (laboratory identifying information)	X	X
11	Case narrative	X	X
12	Definition of laboratory qualifiers	X	X
13	Results reporting forms	X	X
14	QC sample results	X	X
15	Raw data	X	X
16	Electronic data deliverable	X	X

QAPP WORKSHEET #35 – DATA VERIFICATION PROCEDURES

(UFP-QAPP Manual Section 5.2.2)

This worksheet documents procedures to verify project data. Data verification is a completeness check to confirm that all required activities were conducted, and records are present and complete.

Table WS 35: Data Verification Procedures

Records Reviewed (required documents)	Process Description	Responsible Person
Field logbook (QAPP, GBTS SOP 001)	• Verify that records are present and complete for each day of field activities. • Verify that all planned samples including field QC samples were collected and that sample collection locations are documented. Verify that meteorological data were provided for each day of field activities. • Verify that changes/exceptions are documented and were reported in accordance with requirements. • Verify that any required field monitoring was performed and results are documented.	Daily – GBTS Project Manager At conclusion of field activities – GBTS QAM
Chain-of-Custody Forms (QAPP, GBTS SOP 005)	• Verify the completeness of chain-of-custody records. • Examine entries for consistency with the field logbook. • Check that appropriate methods and sample preservation have been recorded. • Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). • Verify that all required signatures and dates are present. • Check for transcription errors.	Daily – GBTS Fieldwork Manager At conclusion of field activities – GBTS QAM
Laboratory Deliverable (QAPP)	• Verify that the laboratory deliverable contains all records specified in the QAPP. • Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. • Compare the data package with the CoC to verify that results were provided for all collected samples. • Review the narrative to ensure all QC exceptions are described. • Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. • Verify that necessary signatures and dates are present.	Before release – Laboratory QAM Upon receipt – GBTS QAM
Audit Reports, Corrective Action Reports (QAPP)	• Verify that all planned audits were conducted. • Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	GBTS QAM

QAPP WORKSHEET #36 – DATA VALIDATION PROCEDURES

(UFP-QAPP Manual Section 5.2.2; EPA 2106-G-05 Section 2.5.1)

This worksheet identifies the data validation protocol for groundwater samples. Data validation will be performed on 100% of the groundwater quality sample data (any analytical results for investigation derived wastes will not be validated). All laboratory analytical data will be provided to an experienced third-party data validator.

Data validation is a process that involves the evaluation of analytical data against prescribed quality control criteria to determine the usefulness of the data. The analytical data will be evaluated consistent with USEPA National Functional Guidelines for Superfund Methods Data Review (USEPA-540-R-20-005, November 2020) and the following applicable validation SOPs approved by USEPA Region 2:

Table WS 36: Region 2 Validation SOPs
USEPA SOP No. HW-33A Revision 1 SOM02.2 Low/Medium Volatile Data Validation), September 2016
USEPA SOP No. HW-34A, Revision 1 SOM02.2 Trace Volatile Data Validation), September 2016
USEPA SOP No. HW-24 Revision 4 Validating Volatile Organic Compounds By Gas Chromatography/Mass Spectrometry SW-846 Method 8260B & 8260C, October 2014

Data validation procedures are summarized below

Table WS 36: Data Validation Procedures	
Data Validator	ZDataReports, Data Management and Validation Service 118 Rose Lane Terrace, Syracuse, New York 13219
Analytical Group/Method	Volatile Organics – SW-846 8260
Data deliverable requirements	Level IV (pdf)
Analytical specifications	As per QAPP Worksheet #28
Measurement performance criteria	As per QAPP Worksheet #12
Percent of data packages to be validated	100%
Percent of raw data reviewed	100%
Percent of results to be recalculated	10%
Validation procedure	In accordance with Region 2 Validation SOPs
Validation code (full list in Table WS 36)	S4VM
Electronic validation program/version	NA

The third-party data validator will utilize applicable validation codes and label identifiers in accordance with USEPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (USEPA-540-R-08-005, January 2009), shown in the following table.

Table WS 36: Validation Codes and Label Identifiers

Validation Code	Validation Label
S1VE	Stage 1 Validation Electronic
S1VM	Stage 1 Validation Manual
S1VEM	Stage 1 Validation Electronic and Manual
S2aVE	Stage 2a Validation Electronic
S2aVM	Stage 2a Validation Manual
S2aVEM	Stage 2a Validation Electronic and Manual
S2bVE	Stage 2b Validation Electronic
S2bVM	Stage 2b Validation Manual
S2bVEM	Stage 2b Validation Electronic and Manual
S3VE	Stage 3 Validation Electronic
S3VM	Stage 3 Validation Manual
S3VEM	Stage 3 Validation Electronic and Manual
S4VE	Stage 4 Validation Electronic
S4VM	Stage 4 Validation Manual
S4VEM	Stage 4 Validation Electronic and Manual
NV	Not Validated

The data validator will produce a Data Usability Summary Report (DUSR) that will present a summary of the data validation process, discusses data compliance with established QA/QC criteria, and any qualifications for the sample data. A discussion of the Precision, Accuracy, Representativeness, Comparability, and Completeness (PARCC) will be provided, and the DUSR will include copies of the USEPA Region II Data Validation Checklists as an Appendix.

The following QA/QC parameters will be evaluated, in accordance with the requirements presented in the analytical methodology and the data validation guidelines:

1. Holding Times
2. GC/MS Instrument Tuning Criteria
3. Calibration (initial and continuing)
4. Blank Analysis
5. Surrogate Recovery
6. MS/MSD Analysis
7. Reference Standard Analysis
8. Internal Standards Recovery
9. Compound Identification and Quantification
10. Field Duplicate Analysis
11. System Performance
12. Documentation Completeness
13. Overall Data Assessment

The following qualifiers as specified in the guidance documents will be used for data validation:

U Indicates that the compound was analyzed for, but was not detected. The sample quantification limit is presented and adjusted for dilution. This qualifier is also used to signify that the detection limit of an analyte was raised due to blank contamination.

J Indicates that the result should be considered approximate. This qualifier is used when the data validation procedure identifies a deficiency in the data generation process.

UJ Indicates that the detection limit for the analyte in this sample should be considered approximate. This qualifier is used when the data validation process identifies a deficiency in the data generation process.

R Indicates that the previously reported detection limit or sample result has been rejected due to a major deficiency in the data generation procedure. The data are considered to be unusable for both qualitative and quantitative purposes.

QAPP WORKSHEET #37 – DATA USABILITY ASSESSMENT

(UFP-QAPP Manual Section 5.2.3 and Table 12; EPA 2106-G-05 Section 2.5.2, 2.5.3, and 2.5.4)

This worksheet documents procedures that will be used to perform the data usability assessment. The data usability assessment is performed at the conclusion of data collection activities, using the outputs from data verification and data validation. It is the data interpretation phase, which involves a qualitative and quantitative evaluation of environmental data to determine if the project data are of the right type, quality, and quantity to support the decisions that need to be made.

The usability assessment will consider data from Site sampling activity and laboratory analysis, and the findings of the Data Usability Summary Report (DUSR). The usability assessment will be performed by the GBTS data assessment team (comprised of the Quality Assurance Manager and other relevant project personnel). The data assessment team will:

- Identify project requirements and verify field activities were performed in accordance with the SOPs (Appendix B) detailed in Worksheets #14 and #21.
- Review the project DQOs and data validation process detailed in Worksheet #34, #35, and #36.
- Verify that all samples and analytical data collected meet the DQOs.
- Evaluate validated data to assess if it satisfies DQOs (e.g., tolerable limits on decision errors) and is adequate to make decisions regarding additional Site investigation/remediation.

The impacts for any deviations from the planned procedures (UFP-QAPP, guidance documents, or SOPs) will be assessed relative to:

- Sampling Locations;
- Holding Times;
- SOPs and Methods;
- COC; and,
- Damaged Samples.

In addition, evaluate the possible effects of outliers or anomalous data from the following:

- QC Samples;
- Comparability;
- Background;
- Matrix;
- Completeness;
- Critical Samples; and,
- Meteorological Data and Site Conditions.

The usability assessment will evaluate: DQIs (precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity); impacts from any data gaps (sample not collected or analyzed, unusable data); and overall trends, relationships, or correlations in the data set.

After the data usability assessment has been performed, data deemed appropriate for use will be presented in the Groundwater Monitoring Report.

Table WS 37: Usability Assessment Process Overview
Step 1 Review the project's objectives and sampling design
• Review the site-specific DQOs and MPC to verify that they are still applicable. • Review and evaluate site-specific sampling design for consistency with project objectives. • Identify deviations in procedures and evaluate in the context of project DQOs.
Step 2 Review the data verification and data validation outputs
• Verify and validate project data (Worksheets #12, #34, #35, and #36). • Review and evaluate the DUSR to identify results that did not meet project DQOs or are not usable. • Review deviations from planned activities and determine the effects on the project data. • Identify data not acceptable for use, determine the cause, evaluate the effects on the project, and take appropriate corrective action (e.g., resample or limit the use of data).
Step 3 Verify the assumptions of the selected statistical method
• This QAPP does not require statistical methods to be used for data analysis. Existing historical data will be used during analysis. Uncertainty in measurements will be evaluated for consistency with the project DQOs.
Step 4 Implement the statistical method
• This QAPP does not require statistical methods to be used for data analysis. Existing historical data will be used during analysis. Uncertainty in measurements will be evaluated for consistency with the project DQOs.
Step 5 Document data usability and draw conclusions
• Data usability will be documented in the report; based on the results of deviations, corrective actions, and the impacts of QC failures, it will be determined whether the data can be used as intended. The sampling design will be evaluated, and the results of statistical methods will be documented in the report (if applicable). • Valid data will be used to update the Conceptual Site Model and data needs will be identified.

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United States Environmental Protection Agency (USEPA). 2002. EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS. December.

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USEPA. 2009. Guidance for Labelling Externally Validated Laboratory Analytical Data for Superfund Use. EPA 540-R-08-005, January.

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WCD Group. 2018. *Remedial Design Document: Phase I – Soil Remediation*. February

APPENDIX A - Figures

Figure 1: Site Location

Wallkill Wellfield Site
20 Industrial Place, City of Middletown
Orange County, New York

Legend:

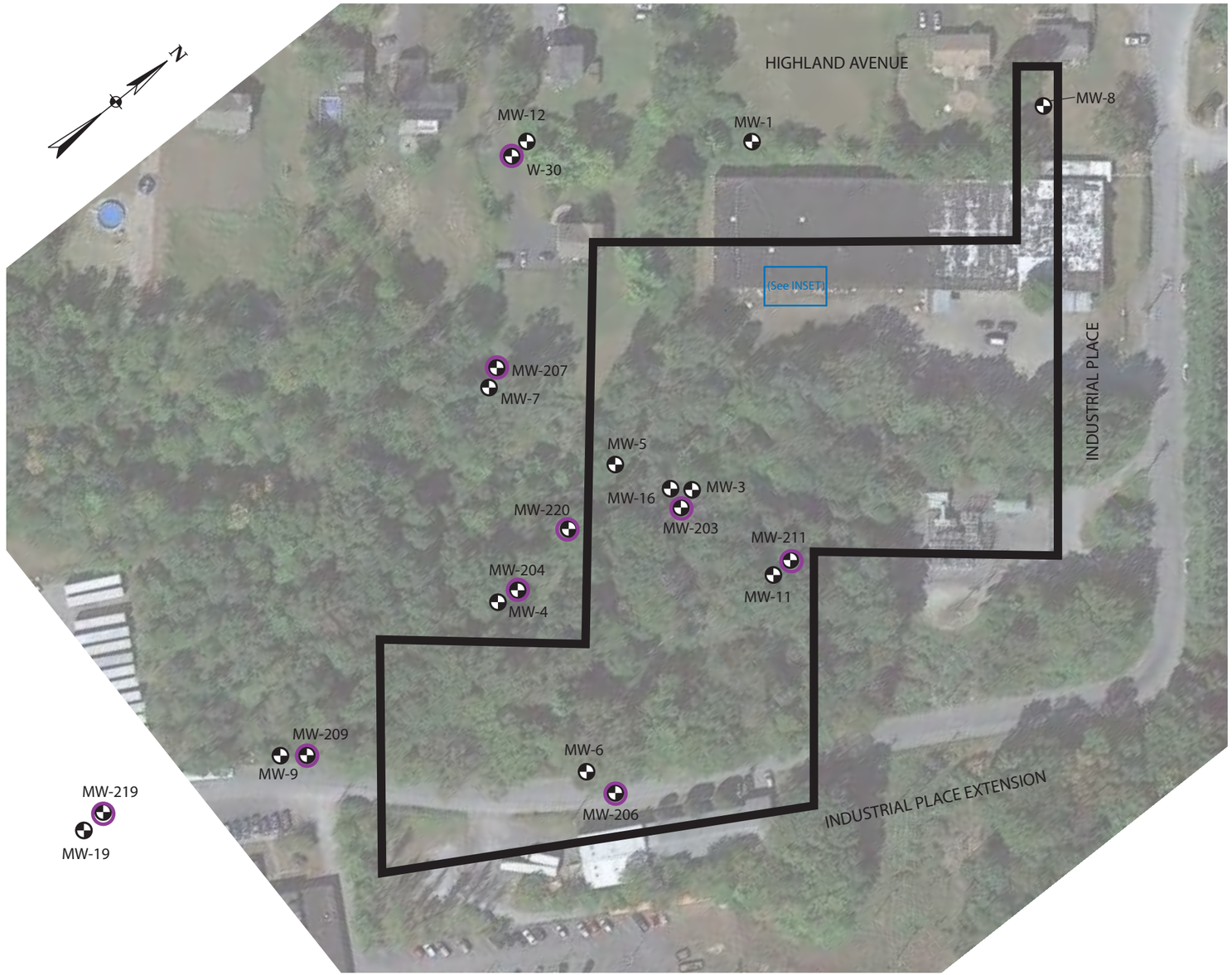
Site border

File: LM97145

October 2022

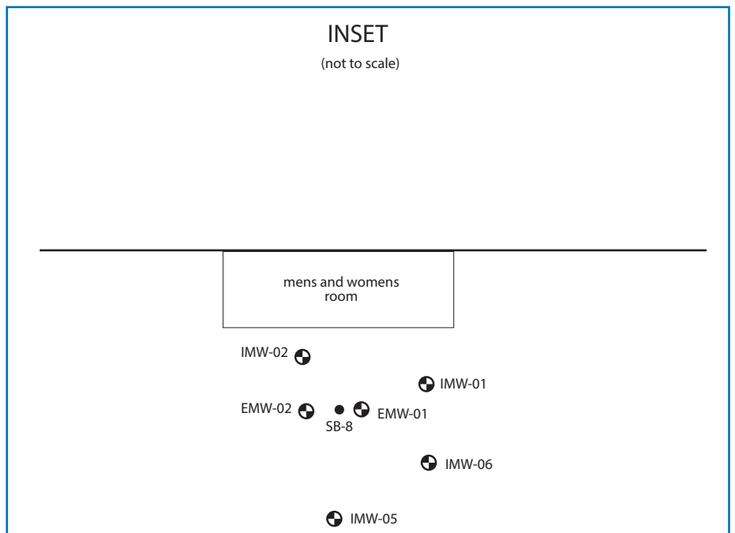
Appendix A

GALLAGHER BASSETT | TECHNICAL SERVICES



INSET

(not to scale)



0 100 200

SCALE IN FEET

All feature locations are approximate. This map is intended as a schematic to be used in conjunction with the associated report, and it should not be relied upon as a survey for planning or other activities.

Legend:

- Site border
- monitoring well location - overburden
- monitoring well location - bedrock
- soil boring location

Notes:
All wells to sampled, except as follows: an attempt will be made to locate and sample either upgradient well MW-1 or MW-8 (last sampled 2008); MW-16 to be sampled as an alternative to MW-3 if required by field conditions.

Figure 2: Site Map

Wallkill Wellfield Site 20 Industrial Place City of Middletown Orange County, New York	File: LM97145
	Scale as shown
	October 2022 | Appendix A

GALLAGHER BASSETT | TECHNICAL SERVICES

MW-207	
Year	PCE
1992	390
2000	2
2003	1.0
2005	ND
2008	ND
2016	0.34
2019	2.95

W-30	
Year	PCE
2005	ND
2008	62
2016	1.4
2019	0.29

MW-12	
Year	PCE
1992	140
2000	ND
2003	7
2005	2
2008	ND
2016	ND
2019	ND

MW-1	
Year	PCE
1992	2.2
2000	ND
2003	ND
2005	ND
2006	ND
2008	ND
2016	NS
2019	NS

MW-8	
Year	PCE
NPS	-
2005	ND
2008	ND
2016	NS
2019	NS

MW-7	
Year	PCE
1992	120
2000	ND
2003	ND
2005	4
2008	ND
2016	8.6
2019	1.28

MW-16	
Year	PCE
1992	2,400
2000	7,000
2003	2300
2005	2,100
2008	450
2016	NS
2019	NS

MW-5	
Year	PCE
1992	41,000
2000	13,000
2003	9,800
2005	26,000
2008	17,000
2016	26,000
2019	5,960

MW-3	
Year	PCE
1992	8,700
2000	7,300
2003	4,300
2005	2,700
2008	430
2016	1,200
2019	462

MW-220	
Year	PCE
2005	380
2008	340
2016	14
2019	8.7

MW-203	
Year	PCE
1992	13,000
2000	6,000
2003	2,100
2005	4,200
2008	1,500
2016	120
2019	555

MW-4	
Year	PCE
1992	20,000
2000	15,000
2003	1,600
2005	7,300
2008	3,200
2016	5,100
2019	4,860

MW-211	
Year	PCE
2005	73
2008	23
2016	11
2019	2.8

MW-209	
Year	PCE
2005	300
2008	190
2016	11
2019	2.9

MW-11	
Year	PCE
1992	PR
2000	PR
2003	740
2005	1,600
2008	DRY
2016	DRY
2019	681

MW-9	
Year	PCE
2000	1,000
2003	770
2005	500
2008	820
2016	320
2019	237

MW-219	
Year	PCE
2005	160
2008	220
2016	120
2019	78.7

MW-19	
Year	PCE
2005	1,300
2008	520
2016	140
2019	365

MW-204	
Year	PCE
1992	1,300
2000	2,400
2003	610
2005	900
2008	680
2016	430
2019	176

MW-6	
Year	PCE
1992	27
2000	18
2003	25
2005	69
2008	45
2016	5.7
2019	52.6

MW-206	
Year	PCE
2005	150
2008	130
2016	26
2019	61

All feature locations are approximate. This map is intended as a schematic to be used in conjunction with the associated report, and it should not be relied upon as a survey for planning or other activities.

Legend:

- Site border
- monitoring well location - overburden
- monitoring well location - bedrock

ND = Not detected
NS = Not sampled
PR = Poor Recovery
TBD = To be determined
all results in µg/L (parts per billion)

Figure 3: Historical PCE Data (1992 - 2019)

Wallkill Wellfield Site
20 Industrial Place
City of Middletown
Orange County, New York

File: LM97145

Scale as shown

October 2022 | Appendix A

APPENDIX B - Standard Operating Procedures, Fieldwork

GALLAGHER BASSETT | TECHNICAL SERVICES

COMPENDIUM
OF
STANDARD OPERATING PROCEDURES

Groundwater Sampling
at
Monitoring Wells

Updated August 2022

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22 IBM Road, Suite 101, Poughkeepsie, NY 12601
(845)-452-1658 www.gallagherbassett.com

This Document Contains:

General Notes Regarding Project Roles and Responsibilities:

Project Manager

The Project Manager (PM) is responsible for providing adequate resources and verifying that field staff have adequate experience and training to successfully comply with and execute project-specific SOPs and implement the project health, safety, and environmental program. The PM will solicit the appropriate technical expertise to verify that the project has identified the best sampling methods and technology for the job given the current understanding of the site and project goals.

Fieldwork Manager

The Fieldwork Manager (FM) is responsible for the coordination and scheduling of daily field activities. In addition, the FM is responsible for verifying compliance with all applicable SOPs, and that field staff are properly trained. The FM, in coordination with the PM, will develop or direct the preparation of a detailed sampling plan, including all fieldwork procedures to be used. The FM, or their designee, should know the requirements for successful fieldwork and should maintain adequate documentation of all activities.

Site Safety Officer

The Site Safety Officer (SSO), in coordination with the PM and the corporate senior Environmental Safety Manager (ESM), will oversee site-specific health and safety requirements, including full implementation of the Health and Safety Plan (HASP). The SSO will ensure proper use of personal protective equipment (PPE), and communicate with field staff to confirm that use of PPE, and other measures specified in the HASP, are being properly implemented and are effective.

Fieldwork Staff

All fieldwork staff will be trained in relevant processes/procedures, and demonstrate required skills and experience necessary to successfully complete planned tasks. The HASP and other project documents will identify other training requirements or access control requirements.

All fieldwork staff are responsible for reviewing applicable Work Plans and other project documentation, including the HASP, and must be trained and be able to safely and properly perform assigned tasks. Fieldwork staff will immediately report unusual conditions or safety concerns they may have to the FM and SSO (staff may also directly communicate with the PM and/or the ESM).

GALLAGHER BASSETT | TECHNICAL SERVICES

GBTS SOP 001

RECORD KEEPING AND LOG BOOKS

1.0 Purpose

This document provides Standard Operating Procedures (SOPs) for use by Gallagher Bassett Technical Services (GBTS) personnel during environmental investigations. General procedures are presented below; detailed protocols, as available, are provided as attachments and/or in manufacturer documentation. Project documents, including all SOPs, checklists, forms, calibration documents, instrument manuals, etc., are maintained at GBTS offices. All SOPs and supporting documentation are periodically updated.

2.0 SOP Scope

This SOP provides procedures for project personnel regarding record keeping and logbooks. This SOP is not designed to specifically address all of the entries that may be required for a given project; it is intended to supplement project-specific documentation, including work plans, sampling and analysis plans, health and safety plans, quality assurance project plans, and additional SOPs, as appropriate, in order to ensure proper documentation.

3.0 General

All aspects of an environmental field project require proper documentation. The primary documentation used to record site data is field log books, which provide a written, permanent record of all field activities and measurements. All written documentation must be factual, complete, accurate, consistent, and clear. Entries should be recorded in waterproof, non-erasable permanent ink.

4.0 Document Sources

Field documents consist of the following hardcopy or electronic media:

- Field log books
- Field datasheets
- Soil boring/test pit/well installation log sheets
- Field calibration sheets
- Photographs and photographic logs
- Global positioning system (GPS) and geographic survey coordinate data
- Field instrument data (such as water-quality instruments, photoionization devices, and test kits)
- Laboratory chain-of-custody (CoC) forms
- Shipping waybill and manifest documents
- Other field activity and/or field data documentation

5.0 Responsibilities

5.1 Fieldwork Manager

The Fieldwork Manager (FM), in conjunction with the Project Manager (PM), is responsible for overall compliance with this SOP. The FM, or designee, is responsible for verifying that:

- Records are present and complete for each day of field activities;
- All planned samples including field QC samples were collected and that sample collection locations are documented;
- Changes/exceptions are documented and were properly reported;
- Required field monitoring was performed and results are documented; and,
- Data entries made in the field log books comply with this SOP.

5.2 Site Personnel

Site personnel who make log book entries are required to read this SOP before engaging in this activity. The FM will inform personnel who will be responsible for log book entries, care, and maintenance.

6.0 Procedures

6.1 Field Log Books

6.1.1 Front Cover

Field log books will be bound with lined, consecutively numbered pages. Record the following information on the outside front cover of the log book:

- Project name
- Log book activity title (e.g., Soil Borings, Groundwater Sampling)
- Company ID and project number (e.g., GBTS LM97145)
- Date of first and last entries in the log book (e.g., August – September, 2022)

6.1.2 Project Reference Pages

Reserve pages and 2 of the Field Log Book for important project reference information, including project-related contacts (such as contact names and phones for subcontractors, site access, project assistance, field team, and emergency use), special instructions, and/or other valuable reference information.

6.1.3 Daily Entries

Detailed entry of field activities, events, data, and other relevant project task information will be documented daily (at minimum) throughout the course of field activities. The following minimum requirements must be followed when entering daily activities within field log books:

- Entries will be made in a composition-type Log Book.
- Field notes are to be photographed/scanned daily.
- Record the project name, client, site name and number, and daily objective at the beginning of each entry.
- The field activity and date must be recorded at the top of each page.
- The top page corner of each page will be consecutively numbered
- Entries in the field log book should be preceded with the time (written in military units). The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged.
- Changes must be made with a single, strike-out line through the deletion. Changes must be initialed and dated. Scribbling or blotting out deletions is unacceptable.
- Entries should be made in waterproof ink (unless inclement weather prevents pens from working).
- Entries must be written clearly and legibly enough so that a reviewer can read and understand the entry.
- A diagonal line or similar must be drawn through space left at the bottom of the last page of field entries at the conclusion of daily site activities.
- The bottom of each page should be signed and dated by the author.
- No pages are to be removed from the Field Log Book.
- A quality control (QC) check of field logs must be completed.

Events and observations that should be recorded should include, but are not limited to, the following:

- The field activities/tasks with date and time.
- The location(s) and field conditions in which the field task will be conducted.
- The names and organization(s) of task field staff and/or visitors, including the FM, subcontractors, clients, and regulators.
- Site conditions (upon arrival and departure) and changes in site conditions.
- Current weather and changing weather conditions that might impact field activities.

- Relevant field observations, major task decisions, comments, or other valuable site investigation information will be documented throughout the course of site activities. Entries will be as specific and detailed as possible and practical.
- If field datasheets, soil boring log sheets, photographs, sample location coordinates, or other documentation types are specified by a procedure, the information need not be duplicated, but the relevant documentation type and/or forms must be referenced in the field log book.
- Documentation of field instrument calibration or reference to appropriate field calibration sheets.
- Field map sketches will be drawn with a north arrow and approximate scale.
- Boring or sample locations with measurements (swing ties) to at least two fixed objects to locate points for mapping, if warranted.
- Changes and/or deviations from task protocols (such as sampling procedures) outlined in governing planning documents.
- Reason(s) for noted deviations, and whom the deviation was discussed with and authorized by.
- Problems, downtime, or delays and the reasons for the problem or delay.
- Upgrade or downgrade of personal protective equipment.
- Equipment make, model, and property numbers or serial numbers used at the site.
- Health and safety monitoring equipment, including calibration procedures and results and actual and background readings.
- Start and end times of sampling.
- Sampling steady-state parameters.
- Decontamination times and methods.
- Type, amount, and disposal methods used for investigation-derived wastes.

When samples are collected, the following should be recorded in the log book or chain-of-custody form:

- Sample identification number, as well as location and depth (as applicable)
- Sample date and time
- Sample methodology
- Sample type and media
- Sample analyses requested
- Sample preservation type
- QC sample numbers and types

- Name of individual to whom the samples are relinquished
- Laboratory service provider in which samples are to be relinquished
- Shipping service(s) or method(s) used for sample delivery
- Date and time of shipment
- Shipping waybill or manifest number

6.2 Field Datasheets and Forms

Unbound data documentation types (including Field Datasheets, Soil Boring/Test Pit Log Sheets, Field Calibration Sheets, Laboratory Forms, Shipping Waybill and Manifest Documents, and similar documents) are part of the field form records. Weatherproof loose-leaf field sheets with fluorochemical coatings are not acceptable. Generally the use of these documentation types are task-specific and when used should be referenced within the field log books. However, specific data entered on these types of documents will not typically be documented in the log books, so document handling, archiving, and QC must be performed in the same manner as for the log books.

6.3 Electronic Data Documents

Electronic data documents consist of photographs, GPS and survey coordinate data, field instrument data, and other electronic data files. Investigation field instruments and tools such as digital cameras, GPS units, water-quality meters, photoionization detectors (PIDs), pressure-transducers, and hand-held computers store investigation data in electronic formats that can be later downloaded and stored electronically for future reference. Take care when retrieving, storing, and managing these electronic data. The FM or designee will be consulted for electronic data management instruction before using unfamiliar electronic instruments or tools requiring electronic data retrieval and storage. At minimum, Electronic Data Documents will be managed as below:

- After collection, retrieve (download) electronic data from the field instrument daily or as determined necessary by the FM.
- After successful electronic data document retrieval, store electronic data files at a digital location specifically reserved for that data document type. The data storage device must be reliable and secure. The data will be stored at a location that can be readily accessed by multiple team members (that is, network project server or file transfer protocol [FTP] site).
- Back up electronic data documents for use in the event of data loss. Backup formats may include, but are not limited to, CDs, DVDs, flash memory cards, USB storage devices, and external hard drives. Whatever data backup format is used, the data backup must be managed for retrieval by the PM, FM, and other responsible team members, if necessary.

- Name data files appropriately to easily identify the content and date of collection or download. It possible, include the following identifying information in data files:
  - Project name and number, with investigation area name (if applicable)
  - Date and time
  - Location(s) of data collection and/or other information unique to the kind of data collected

7.0 Document Control

At the conclusion of a task or when a field log book, datasheet, and/or electronic data document has been completed, it will be reviewed and then submitted for records retention. Project files will be maintained by the PM, FM, or designee. Documents will be securely kept in the project files. Project personnel may keep their own duplicate files; however, original documents will be placed in the official project file. Field logs of boring, sampling, and well installation activities will be maintained by the FM and submitted to the project manager after the field effort.

8.0 Records

Documentation should follow the guidelines contained in this SOP.

GALLAGHER BASSETT | TECHNICAL SERVICES

GBTS SOP 002
FIELD EQUIPMENT CALIBRATION

1.0 Purpose

This document provides Standard Operating Procedures (SOPs) for use by Gallagher Bassett Technical Services (GBTS) personnel during environmental investigations. General procedures are presented below; detailed protocols, as available, are provided as attachments and/or in manufacturer documentation. Project documents, including all SOPs, checklists, forms, calibration documents, instrument manuals, etc., are maintained at GBTS offices. All SOPs and supporting documentation are periodically updated.

2.0 SOP Scope

This SOP provides overall guidance to project personnel for the calibration of field instruments, but does not specifically address all of the required procedures, and is intended to be used in conjunction with operating manuals supplied by equipment manufacturers. Equipment calibration must be performed in accordance with other relevant project-specific documentation, including work plans, sampling and analysis plans, health and safety plans, quality assurance project plans, and additional SOPs, as appropriate.

3.0 General

All measuring and monitoring equipment must be properly calibrated before use. Calibration should be performed in accordance with the manufacturer's manual describing calibration and standard operating procedures for each field instrument. In general, calibrate all instruments daily prior to fieldwork, and during the day as required.

If there are anomalous readings during equipment use, stop the fieldwork activity and re-calibrate the instrument. If the instrument will not calibrate, troubleshoot as described in the manufacturer's manual. Check that any calibration standards have not expired. If the issue cannot be resolved, use a backup instrument; if one is not available, consult with the PM on whether data collection should continue and on other corrective actions to be taken.

Document all calibration activities (on calibration forms, as applicable), and flag data from equipment with calibration issues, in accordance with GBTS SOP 001 (Record Keeping and Log Books).

4.0 Responsibilities

4.1 Fieldwork Manager

The Fieldwork Manager (FM), in conjunction with the Project Manager (PM), is responsible for overall compliance with this SOP. The FM, or designee, is responsible for ensuring that up-to-date manuals, with detailed calibration procedures, are available, and verifying that calibration activities comply with this SOP.

4.2 Site Personnel

Site personnel who calibrate equipment are required to read this SOP before engaging in this activity. The FM will inform personnel who will be responsible for calibration of specific equipment.

5.0 Procedures

5.1 Calibration

Specific calibration procedures are found in manufacturer's manuals, which are maintained at GBTS offices. An up-to-date manual, as well as any required supplies, will be provided to all staff that have duties related to equipment calibration.

As applicable, all instrument probes and cable connections must be cleaned and the battery checked according to the manufacturer's instructions prior to calibration; failure to perform these steps (proper maintenance) can lead to erratic measurements.

If a multi-probe instrument is calibrated, program the instrument to display the parameters to be measured (e.g., temperature, pH, dissolved oxygen, specific conductance).

5.2 Operability Tests

Certain equipment may require periodic operability tests or checks to verify that operating systems are within the allowed range. These tests are in addition to formal calibration and will be performed at specified frequencies, or as part of operational use using reference equipment and standards. If an instrument fails an operability test, and corrective action cannot bring the instrument into tolerance, it must be removed from service.

5.3 Calibration Media

For calibrations requiring standard liquid solutions, fluid volume must be sufficient to cover the probe/sensor (see manufacturer's instructions for the volume to be used). Check the expiration date of all standards; do not use expired materials. All standards (liquids and gasses) must be stored according to manufacturer instructions.

Read all labels on the standards and note any warnings on the labels. Wear appropriate PPE (e.g., gloves, eye shields, etc.) when handling the standards. If necessary, consult the Material Safety Data Sheets (MSDS) for additional safety information on the chemicals in the standards.

6.0 Records

Document equipment calibration in accordance with this SOP and GBTS SOP 001 (Record Keeping and Log Books).

GALLAGHER BASSETT | TECHNICAL SERVICES

GBTS SOP 003

FIELD EQUIPMENT OPERATION

1.0 Purpose

This document provides Standard Operating Procedures (SOPs) for use by Gallagher Bassett Technical Services (GBTS) personnel during environmental investigations. General procedures are presented below; detailed protocols, as available, are provided as attachments and/or in manufacturer documentation. Project documents, including all SOPs, checklists, forms, calibration documents, instrument manuals, etc., are maintained at GBTS offices. All SOPs and supporting documentation are periodically updated.

2.0 SOP Scope

This SOP provides overall guidance to project personnel for the operation of field instruments, but does not specifically address all of the required procedures, and is intended to be used in conjunction with operating manuals supplied by equipment manufacturers. Equipment operation must be performed in accordance with other relevant project-specific documentation, including work plans, sampling and analysis plans, health and safety plans, quality assurance project plans, and additional SOPs, as appropriate.

3.0 General

The following classes of field equipment, typically used during environmental investigations and related activities, are discussed in this SOP (operational details for other equipment types are provided in specific SOPs for sampling of media):

- Photoionization detector (Section 5.1);
- Dust monitor (Section 5.2);
- Water-level and interface meters (Section 5.3);
- Water pumps (Section 5.4); and,
- Water quality multimeter (Section 5.5).

Manufacturer's operation manuals will be reviewed prior to fieldwork, and equipment must be properly calibrated (see GBTS SOP 002), operated, and maintained in accordance with this documentation.

If equipment does not operate within expected parameters, stop the fieldwork activity and re-calibrate and/or troubleshoot as described in the manufacturer's manual. If the issue cannot be resolved, use a backup instrument; if one is not available, consult with the PM on whether data collection should continue and on other corrective actions to be taken.

Document all calibration/troubleshooting activities, and flag data from equipment with operational issues, in accordance with GBTS SOP 001 (Record Keeping and Log Books).

4.0 Responsibilities

4.1 Fieldwork Manager

The Fieldwork Manager (FM), in conjunction with the Project Manager (PM), is responsible for overall compliance with this SOP. The FM, or designee, is responsible for ensuring that up-to-date manuals, with detailed equipment operation procedures, are available, and verifying that equipment is operated in compliance with this SOP.

4.2 Site Personnel

Site personnel who operate equipment are required to read this SOP before engaging in this activity. The FM will inform personnel who will be responsible for operation of specific equipment.

5.0 Procedures

These are standard (i.e., typically applicable) operating procedures, which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented (see GBTS SOP 001).

5.1 Photoionization Detector

5.1.1 General Information

The PID is a portable vapor/gas detector employing the principle of photoionization to detect a variety of chemical compounds in air. The PID is a nonspecific, total vapor detector that cannot be used to identify unknown substances; it can only roughly quantify them. Please note the following:

- The PID must be calibrated to a specific compound (typically isobutylene). Note that transport of calibration gas cylinders must comply with federal regulations.
- The PID does not respond to certain low molecular weight hydrocarbons, such as methane and ethane, and some toxic gases and vapors, such as carbon tetrachloride and hydrogen cyanide, have high ionization potentials and cannot be detected with a PID.
- Certain models of PID instruments are not intrinsically safe.
- Electrical power lines or power transformers may cause interference with the instrument and thus cause measurement errors. Static voltage sources such as power lines, radio transmissions, or transformers may also interfere with measurements.
- High winds and high humidity will affect measurement readings.
- This instrument is not to be exposed to precipitation (rain).
- Do not use this instrument for head space analysis where liquids can inadvertently be drawn into the probe.

5.1.2 Field Operation

1. Perform start-up and shut-down procedures in accordance with the operating manual. Once the screen shows a numerical reading the instrument is fully functional and ready to use.
2. Position the probe assembly close to the area to be monitored (the low sampling rate allows for only very localized readings). Do not allow the probe tip assembly be immersed in fluid.
3. While taking care to prevent the PID from being exposed to excessive moisture, dirt, or contamination, monitor the work activity as specified in the Work Plan and/or Health and Safety Plan (HASP). The PID survey should be conducted at a slow to moderate rate of speed and the intake assembly (the probe) slowly swept from side to side. There is a three to five second delay in read-out depending upon the instruments sensitivity to the contaminant.
4. During drilling activities, PID monitoring should be performed at regular intervals downhole, at the headspace, and in the breathing zone. In addition, where elevated organic vapor levels are encountered, monitoring may be performed in the breathing zone during actual drilling. When the activity being monitored is other than drilling, readings should emphasize breathing zone conditions.
5. When the activity is completed or at the end of the day, carefully clean the outside of the PID with a damp disposable towel to remove any visible dirt.

5.2 Dust Monitor

5.2.1 General Information

Dust monitors are direct-reading instruments that provide accurate, real-time measurement of airborne dust and particulate concentrations. Dust monitors are typically used during implementation of a Community Air Monitoring Plan (CAMP) by placing them in monitoring stations that are both up- and down-wind of fieldwork areas that could potentially generate dust (e.g., boring and test pit locations). Dust monitors require calibration before use, and periodically throughout the day. Dust monitors are typically not used during rain or other conditions that are likely to suppress dust generation.

5.2.2 Field Operation

1. Confirm that the power source is fully charged/operational prior to arrival at the fieldwork area.
2. Perform start-up in accordance with the operating manual. Once the screen shows a numerical reading the instrument is fully functional and ready to use.
3. Determine the recording requirements (e.g., time-weighted average, alarm threshold, etc) and appropriately set the instrument.

4. Operate the dust monitor within an enclosure having a protected air-sampling port. Elevate the enclosure on a tripod (air-sampling port set to approximately 5 feet above the ground).
5. Periodically read the instrument display to confirm proper operation and CAMP compliance.
6. Perform shut-down procedures, and electronically retrieve the data file(s), in accordance with the operating manual.

5.3 Water-level and Interface Meters

5.3.1 General Information

Water-level meters are used to measure depth to groundwater in soil borings, piezometers, temporary wells, and monitoring wells. Oil/water interface (OWI) meters are used in a similar manner, with the additional ability to detect the presence and approximate thickness of light nonaqueous phase liquid (LNAPL) that may be present. Both instruments provide discrete measurements of static levels of water and/or LNAPL (instrumentation for continuous recording is not discussed in this SOP).

5.3.2 Field Operation

1. Before each use, verify that the battery of the water level meter or OWI probe is charged by pressing the test button on the side of the unit, and verify that the unit is operating correctly by testing the probe in distilled or deionized water. Inspect the probe to make sure it is clean and the tip is not damaged, and the tape for abrasions that have may have exposed the wires; replace any equipment that cannot be made fully operational.
2. As applicable, open the protective cover on the well casing, and unlock and remove all monitoring well caps. Instrument measurements should be performed at least 30 minutes after removal of a well cap, in order to allow the groundwater surface to stabilize within the riser.
3. Slowly lower the probe into the monitoring well or soil boring until the probe just contacts the groundwater surface; the unit will respond with a tone or light signal. Make sure that the top of the riser pipe does not have a sharp edge that may damage the protective coating around the wires in the tape.
4. The depth to groundwater shall be noted relative to a reference point indicated on the monitoring well riser pipe. If no reference is clearly visible, reference the northern edge of the riser pipe or soil boring. Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the field logbook.
5. If dedicated sampling equipment is restricting the water level probe from reaching the water surface in the well, an alternate well will be measured. In no case will any of the dedicated sampling equipment below the water level be removed. This will disturb the water in the well, which may cause problems when sampling the well, if using low-flow techniques.

6. Water levels will be measured to the nearest 0.01 foot.
7. If a significant amount of time has passed since the wells were last measured (or if total well depth information is not available to the field team), the total depth of the monitoring well or soil boring should be recorded in the field logbook. The total well depth shall be measured in the same manner as the depth to groundwater.
8. If LNAPL is anticipated or encountered, an OWI probe shall be used to determine the depth to the top of LNAPL and depth to groundwater. If LNAPL is encountered, a solid tone will sound from the OWI probe. The probe must be lowered very slowly through the LNAPL to obtain an accurate depth to groundwater without agitating the LNAPL. When the probe passes through the LNAPL and contacts groundwater, the solid tone will change to a beeping tone. The depths to both media shall be measured in the same manner as previously discussed and recorded in the field logbook.
9. If possible, the color and consistency of the LNAPL also shall be recorded in the field logbook.
10. All equipment must be decontaminated prior to use, between fieldwork locations, and at the end of the day (see GBTS SOP 004).

5.4 Water Pumps

5.4.1 General Information

Water pumps are used to remove water from wells during development, and to collect groundwater samples from boreholes, and temporary or permanent wells. The type of pump used will depend on the characteristics of the well and aquifer, data quality objectives, and sampling parameters, as specified in the applicable project plans. Each pump type has inherent advantages and disadvantages, including decontamination requirements. Typical portable pumps for groundwater sample collection include:

<u>Suction Lift Pumps</u>

- Limited to relatively shallow depths to water.
- May cause unrepresentative volatilization of low-levels of volatile organic compounds (VOCs).

<u>Portable Submersible Pumps</u>

- Relatively large pumping rates can be achieved (shortens sampling time).
- May be limited by size of well casing.

<u>Bladder pumps</u>

- Slow pumping rate
- Acceptable for all groundwater analyses (drive gas does not touch sample)

5.4.2 Field Operation

Pumps must be maintained and operated in accordance with the manufacturer's manual. General considerations for field operation of pumps are provided below (detailed protocols are provided in the SOPs for groundwater sampling).

1. Before fieldwork begins, verify that all pump components and supplies are present. Test pump function using a clean bucket containing distilled or deionized water. Troubleshoot as needed and replace any equipment that cannot be made fully operational.
2. Decontaminate all non-disposable equipment (GBTS SOP 004) prior to the start of fieldwork, between sampling locations, and after the completion of fieldwork
3. Use the pump following the detailed instructions in the operations manual and applicable SOPs for well development and/or groundwater sampling.
4. When not in use, store all equipment within dedicated carrying cases to minimize potential contamination and/or damage.

5.5 Water Quality Multimeter

5.5.1 General Information

Water quality multimeters are used to measure water quality parameters (e.g., temperature, pH, dissolved oxygen, specific conductance, oxidation/reduction potential, and turbidity). For groundwater monitoring, the instrument must be equipped with a flow-through-cell, and the display screen needs to be large enough to simultaneously contain the readouts of each probe in the instrument. Multimeters contain sensitive probes that require calibration before use, and (potentially) during fieldwork.

5.5.2 Field Operation

Water quality multimeters must be maintained and operated in accordance with the manufacturer's manual. General considerations for field operation of multimeters are provided below (detailed protocols are provided in the SOPs for groundwater sampling).

1. Before fieldwork begins, verify that all multimeter components and supplies are present. Test multimeter function using manufacturer's protocols. Troubleshoot as needed and replace any equipment that cannot be made fully operational.
2. Decontaminate the multimeter between sampling locations using manufacturer's protocols
3. Use the multimeter following the detailed instructions in the operations manual and applicable SOPs for well development and/or groundwater sampling.
4. When not in use, store all equipment within dedicated carrying cases to minimize potential contamination and/or damage.

6.0 Records

Document equipment calibration, maintenance, and troubleshooting in accordance with this SOP and GBTS SOP 001 (Record Keeping and Log Books).

7.0 References

See equipment manufacturer's manuals.

GALLAGHER BASSETT | TECHNICAL SERVICES

GBTS SOP 004

EQUIPMENT DECONTAMINATION

1.0 Purpose

This document provides Standard Operating Procedures (SOPs) for use by Gallagher Bassett Technical Services (GBTS) personnel during environmental investigations. General procedures are presented below; detailed protocols, as available, are provided as attachments and/or in manufacturer documentation. Project documents, including all SOPs, checklists, forms, calibration documents, instrument manuals, etc., are maintained at GBTS offices. All SOPs and supporting documentation are periodically updated.

2.0 SOP Scope

This SOP provides overall guidance to project personnel for the decontamination of field equipment, but does not specifically address all of the required procedures, and is intended to be used in conjunction with available operating manuals supplied by equipment manufacturers. Decontamination must be performed in accordance with other relevant project-specific documentation, including work plans, sampling and analysis plans, health and safety plans, quality assurance project plans, and additional SOPs, as appropriate.

3.0 General

Decontamination of sampling and heavy equipment, as well as personal protective equipment (PPE), is performed as a quality assurance measure and a safety precaution. Decontamination prevents cross-contamination between samples, minimizes contaminant transport (it is critical that equipment used in one area not serve as a source of contamination of another), and helps to maintain a clean working environment for the safety of field personnel. General decontamination requirements will be specified in applicable project plans. Note: All decontamination procedures must comply with specific requirements and restrictions when sampling media for per- and polyfluoroalkyl substances (PFAS), which are addressed in specific sampling SOPS.

Field personnel will review and be familiar with required decontamination procedures, including those for cleaning field equipment, proper storage of cleaned field equipment, and for properly disposing of waste generated from decontamination procedures. Decontamination conducted on site will be performed in a designated, controlled location that will not impact collected samples. Decontamination activities will be appropriately documented in the field notes. Wastes generated in the field will be collected, stored, and properly disposed in accordance with applicable project requirements.

Decontamination consists of physically removing contaminants from the surface of equipment and/or materials potentially exposed to contaminants. A decontamination plan assumes that protective clothing and equipment that leave the exclusion zone are contaminated, and a system is established to wash and rinse non-disposable equipment and dispose of disposable equipment.

Decontamination procedures will vary depending on project-specific requirements as listed in the project-specific work plan, type of equipment, and the required analytical parameters. The effectiveness of the decontamination procedure is verified by collecting and analyzing equipment blank samples (as required).

To minimize or eliminate the need for decontamination, it is recommended that dedicated disposable equipment be used whenever possible.

Document all decontamination activities, and flag equipment with decontamination issues, in accordance with GBTS SOP 001 (Record Keeping and Log Books).

4.0 Responsibilities

4.1 Fieldwork Manager

The Fieldwork Manager (FM), in conjunction with the Project Manager (PM), is responsible for overall compliance with this SOP. The FM, or designee, is responsible for ensuring and verifying that all equipment and materials are decontaminated, as required.

4.2 Site Personnel

Site personnel are required to read this SOP before engaging in fieldwork activities. The FM will inform personnel who will be responsible for decontamination of specific equipment.

5.0 Procedures

These are standard (i.e., typically applicable) operating procedures, which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented (see GBTS SOP 001).

Decontaminate non-disposable sampling equipment used at the site both before activities begin and after each sample is collected. Decontaminate drilling and excavation equipment both before activities begin and between each investigation location. Take care that materials and solutions used for decontamination procedures are themselves not hazardous or could potentially contaminate samples (e.g., solvents, acids).

All decontamination procedures are to be modified, as appropriate, when sampling for PFAS (see applicable sampling SOPs).

5.1 Decontamination Area

A localized decontamination area should be establish where decontamination fluids and soil wastes can be managed and controlled with minimal risk to the surrounding environment. Decontamination should be performed in a non-contaminated area (as possible), that is large enough to allow temporary storage of cleaned equipment and materials before use, as well as to stage drums of decontamination investigation-derived waste (IDW).

In the case of large decontamination areas (for example, for hollow-stem-auger decontamination), line each area with a heavy-gauge plastic sheeting and include a collection system designed to capture potential decontamination IDW. Decontamination areas will, in cases, be laid out in such a way as to prevent overspray while performing equipment and personnel decontamination.

Smaller decontamination tasks, such as the cleaning of soil or water sampling equipment, and Geoprobe drive rods and barrels, may take place at the sampling location. In this case, all required decontamination supplies and equipment must be brought to the sampling location. This decontamination will use various containment systems to capture the decontamination IDW, which can then be transferred to larger containers as needed.

5.2 Health and Safety Precautions

Decontamination procedures may involve exposure to contaminants in site media and/or dangerous materials used during decontamination (e.g., solvents or acids), and physical hazards associated with the operation of the decontamination equipment. All work should be performed in accordance with the HASP, including decontamination of PPE. Safety Data Sheets for any solvents/chemical stored or used during fieldwork should be available at the site. At a minimum, eye protection, safety shoes, and gloves are to be worn. There are several types of gloves that may be worn, depending on equipment being cleaned, type and extent of equipment contamination, and cleaning solutions or solvents being used. Nitrile gloves (or similar) may be worn when the equipment to be decontaminated is not heavily coated with constituents such as tars/oils. In cases where heavy accumulations of tars/oils are present on the equipment, neoprene or similar chemically compatible gloves are recommended. If a potential for skin contact exists, protective clothing should be worn.

5.3 General Equipment Decontamination Procedures

All sampling equipment must be decontaminated before use to ensure that contaminants have not been introduced to the sample during the sampling process through contact with the sampling device. Monitoring well riser pipes, screens and drilling augers must also be decontaminated, as appropriate, to prevent the introduction of constituents.

Unless the decontaminated sampling devices that will come in contact with samples are to be used immediately, they should be wrapped in aluminum foil, shiny side out, and stored in a designated “clean” area. Field equipment can also be stored in plastic bags to eliminate the potential for contamination. Larger size equipment, such drill rods, backhoe buckets, etc. need not be wrapped or covered, but must not be stored directly on the ground surface. Field equipment should be inspected and decontaminated prior to use if the equipment has been stored for long periods of time.

5.4 Decontamination Equipment

The following is a list equipment and materials typically needed to perform decontamination:

- Health and safety equipment, including appropriate PPE
- Plastic sheeting (to serve as secondary containment for liquids and protect equipment)
- Brushes and flat-bladed scrapers
- Garden-type water sprayers (without oil-lubricated, moving parts)
- High-pressure washer or portable steam cleaner
- Sump or collection system for contaminated liquid
- Wash basins and buckets
- Spray and rinse bottles
- Potable water, distilled/deionized water (DIW), and laboratory-grade detergent (e.g., Alconox)
- Isopropyl alcohol (free of ketones) or methanol (can be wipes or diluted with DIW)
- Airtight, sealable plastic baggies
- Plastic waste bags
- Leak-tight liquid waste containers (55-gallon drums or similar)
- Bulk solid waste containers (55-gallon drums, or similar)

5.5 Specific Decontamination Procedures

For all procedures, decontamination fluids and other wastes may be transferred from smaller to larger containers (e.g., 55-gallon drums or 5-gallon buckets, with tight fitting lids, and transported to the IDW storage facility.

5.5.1 Sampling Equipment

Conduct consistent decontamination of sampling equipment to ensure the quality of the samples collected. Decontaminate all sampling equipment that comes into contact with potentially contaminated samples. Disposable equipment intended for one-time use that is factory-wrapped generally does not need to be decontaminated before use, unless evidence of contamination is present.

Disposable equipment (e.g., water bailers, plastic scoops, VOC sampling syringes) is preferred over reusable equipment; use wherever appropriate. Decontaminate sampling equipment, including split-spoon samplers, Geoprobe Macro-Core cutting shoes, hand augers, reusable bailers, spoons, trowels, and shovels used to collect samples for chemical analyses before sampling at a new sampling location. All decontamination fluids will be captured in a containment system as appropriate.

Take the following steps to decontaminate non-dedicated, non-disposable sampling equipment:

1. Remove as much gross contamination (such as pieces of soil) as possible off equipment at the sampling site.
2. Wash water-resistant equipment thoroughly and vigorously with potable water containing non-phosphate laboratory-grade detergent such as Liquinox®, Alconox®, or equivalent, and using a bristle brush or similar utensil to remove any remaining residual contamination.
3. Rinse equipment thoroughly with potable water.
4. Repeat the first three steps as necessary until all residue is removed.
5. Rinse equipment thoroughly with DIW.
6. If metals are a constituent of interest, rinse with 10% nitric acid and then with DIW.
7. If organics are constituents of interest, rinse with methanol and allow to air dry on a clean surface.
8. Air dry at a location where dust or other fugitive contaminants may not contact the sample equipment. Alternatively, wet equipment maybe dried with a clean, disposable paper towel to assist the drying process. All equipment should be dry before reuse.
9. If the equipment is not used soon after decontamination, it should be covered or wrapped in new, oil-free aluminum foil or new, unused plastic bags to protect the decontaminated equipment from fugitive contaminants before reuse.
10. Store decontaminated equipment at a secure, unexposed location out of the weather and any potential contaminant exposure.

5.5.2 Groundwater Sampling Pumps

(Note: This procedure does not apply to dedicated submersible pumps which have been permanently installed in wells.)

Proper decontamination between wells is essential to avoid introducing contaminants from the sampling equipment to another well. If peristaltic pumps are being used, it is necessary only to replace the pump head tubing after sampling each well. If sampling with submersible pumps that come into direct contact with groundwater, the equipment must be decontaminated.

The following procedure will be used to decontaminate submersible pumps before and between groundwater sample collection points, as well as the end of each day of use.

Field-site cleaning procedure for submersible pumps and pump tubing:

Preparation

Pre-clean appropriately sized buckets and prepare cleaning solutions (detergent solution, tap water rinse, distilled/deionized water rinse) and field blank water.

Detergent wash and tap water rinse

a) Put on disposable, powderless gloves. Rest pump in a washbasin or pail partially filled with detergent solution and clean exterior of pump and tubing with a soft brush. Rinse thoroughly with tap water. (DIW can be used instead of tap water, but is less efficient in detergent removal and requires a greater volume of water than tap water).

b) Place pump into bucket, add detergent solution to level above pump intake, and route the intake and discharge ends of pump tubing into the bucket. Begin pumping. Circulate detergent solution for several minutes. If possible, pump detergent solution through tubing at alternating high and low speeds.

c) Change gloves. Manually rinse detergent from pump, tubing and bucket with tap water.

d) Place pump into bucket, add tap water to level above pump intake, and route the intake and discharge ends of pump tubing into the bucket. Begin pumping. Circulate tap water for several minutes. If possible, pump tap water through tubing at alternating high and low speeds. Replace water in bucket and repeat cycle until no sudsing is observed. Change gloves as needed.

DIW Rinse

If a pump will be used to collect inorganic samples, manually rinse pump and tubing with DIW, then place in clean bucket, add DIW to level above pump intake, and route the discharge end of pump tubing outside the bucket. Begin pumping to rinse DIW through the equipment without recirculating. Collect water for use as a field blank, as required, from the pump discharge.

Equipment Storage

1. Place pump into a clean, non-contaminating storage bag and tie the bag shut.
2. Cover the pump reel and tubing with plastic bags or sheeting for transport to the next site.
3. On reaching the next monitoring well, place the pump in the well casing and wipe dry the power and discharge lines with a chemical-free paper towel as the pump is lowered.
4. For long-term storage (longer than 3 days), the pump and exterior and interior of the tubing must be dry before being placed into plastic bags.

5.5.3 Measurement Devices & Monitoring Equipment

For water quality instruments, oil-water interface indicators, water level indicators, continuous water level data loggers, and other field instruments that have the potential to come into contact with site media, at a minimum, wash with dilute laboratory-grade detergent (e.g., Alconox) and double rinse with tap water and DIW before and after each use or by using a similar procedure as discussed in Section 5.5.1. All decontamination fluids will be captured in a containment system as appropriate.

5.5.4 Subsurface Drilling Equipment

Drilling equipment and associated materials (drill bits, augers, and drilling stems) will be decontaminated by the drilling contractor prior to any drilling operations and between borings. These decontamination activities should be performed in the defined decontamination area as described in Section 5.1.

All down-hole Geoprobe tools (drive rods, Macro-Core barrels, etc.) that come in direct contact with potentially contaminated soil or groundwater shall be decontaminated between each sampling location, and may take place at the sampling location using a mobile decontamination platform with a containment system or other means to capture the decontamination IDW.

Decontamination will be performed using the following basic sequence:

1. Remove as much gross contamination as possible off equipment at the sampling site.
2. Wash equipment thoroughly and vigorously with potable water using a high-pressure washer and/or steam cleaner. A bristle brush is also suggested to remove any persistent gross contamination.
3. Air dry at a location where dust or other contaminants may not contact the sample equipment. All equipment should be dry before reuse.
4. Store decontaminated equipment at a location away from any potential exposure from fugitive contamination.

5.5.5 Heavy Equipment

Wash earthwork equipment (such as excavators and back-hoes) with high-pressure potable water, if possible, before leaving a contaminated area using similar steps as outlined in Section 5.5.4, otherwise the equipment may be moved to the decontamination area discussed in Section 5.1. Hand washing with a brush and detergent, followed by a potable water rinse, can also be used. In some instances, tires and tracks of equipment maybe only need to be thoroughly brushed with a dry brush. Take particular care with the components in direct contact with contaminants, such as tires and backhoe buckets.

Any part of earthwork equipment that may come in direct contact with analytical samples (that is, sampling from the excavator bucket) must be thoroughly decontaminated before excavation activities and between sample locations.

5.6 Quality Assurance/Quality Control

To ensure that sampling equipment is cleaned properly and sample cross-contamination does not occur, field rinsate blanks may be collected if required by project plans. A rinsate blank will consist of pouring deionized organic-free water over the specific sampling device or pouring it through the device after it has been cleaned. The rinsate sample is collected in the field under the same conditions as occurred for the sampling activity, and is handled exactly like any other samples collected that day.

Generally, one rinsate blank is collected each day of sampling or at a rate of 1 per 20 for each parameter, whichever is less, for each matrix being sampled or for each type of sampling instrument decontaminated and reused per day. The rinsate samples are analyzed for the specific parameters of concern (for each matrix). Rinsate blanks should be labeled like a routine environmental sample, and laboratory analysis instructions should be included on the chain-of-custody form. Rinsate blanks are not required if dedicated sampling equipment is used. Additional quality assurance samples may be collected if deemed necessary by project specific requirements.

6.0 Records

Document equipment decontamination in accordance with this SOP and GBTS SOP 001 (Record Keeping and Log Books).

7.0 References

See equipment manufacturer's manuals for additional information.

GALLAGHER BASSETT | TECHNICAL SERVICES

GBTS SOP 005

SAMPLE HANDLING AND CUSTODY

1.0 Purpose

This document provides Standard Operating Procedures (SOPs) for use by Gallagher Bassett Technical Services (GBTS) personnel during environmental investigations. General procedures are presented below; detailed protocols, as available, are provided as attachments and/or in manufacturer documentation. Project documents, including all SOPs, checklists, forms, calibration documents, instrument manuals, etc., are maintained at GBTS offices. All SOPs and supporting documentation are periodically updated.

2.0 SOP Scope

This SOP provides overall guidance to project personnel for handling and custody of fieldwork samples, but does not specifically address all of the required procedures, and is intended to be used in conjunction with available operating manuals supplied by equipment manufacturers. Sample handling must be performed in accordance with other relevant project-specific documentation, including work plans, sampling and analysis plans, health and safety plans, quality assurance project plans, and additional SOPs, as appropriate.

3.0 General

All media samples must be managed such that the potential for cross-contamination, tampering, misidentification, sample loss, and breakage are minimized. Samples must be maintained in a controlled environment from the time of collection until receipt by the analytical laboratory. This SOP is generally applicable for the collection of aqueous and solid samples (e.g., soil, sediment, or sludge). Detailed handling procedures for soil vapor and air samples are provided in the relevant SOPs (shipment and chain-of-custody procedures for those samples are governed by the requirements of this SOP).

Field personnel will review and be familiar with required sample handling and management procedures presented in this SOP.

Document all sample handling and management activities, and flag all potential issues associated with this activity, in accordance with GBTS SOP 001 (Record Keeping and Log Books).

4.0 Responsibilities

4.1 Fieldwork Manager

The Fieldwork Manager (FM), in conjunction with the Project Manager (PM), is responsible for overall compliance with this SOP. The FM, or designee, is responsible for ensuring and verifying the proper management of all media samples, as required.

4.2 Site Personnel

Site personnel are required to read this SOP before engaging in fieldwork activities. The FM will inform personnel who will be responsible for the handling and management of media samples.

5.0 Procedures

These are standard (i.e., typically applicable) operating procedures, which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented (see GBTS SOP 001).

All sample handling and management procedures must comply with specific requirements and restrictions when sampling media for per- and polyfluoroalkyl substances (PFAS), which are addressed in specific sampling SOPS.

5.1 Health and Safety Precautions

Sample handling and management procedures may involve exposure to contaminants in site media. All work should be performed in accordance with the Health and Safety Plan (HASP), including use of proper PPE. Safety Data Sheets for known contaminants, if applicable, and for preservatives in sample containers, should be available at the site. At a minimum, eye protection, safety shoes, and gloves are to be worn. There are several types of gloves that may be worn, depending on the media being sampled. Although nitrile gloves (property similar) are generally acceptable when handling samples, the HASP must be reviewed for specific requirements. If a potential for skin contact exists, protective clothing should be worn.

5.2 Equipment

Project-specific documents and sampling requirements should be reviewed prior to beginning fieldwork, and field personnel should select appropriate supplies. The following is a generic equipment list:

- Indelible ink pens or markers (fine-tipped) of blue or black ink;
- Chain-of-custody (COC) forms;
- Custody seals or tape;
- Gloves (disposable latex or nitrile);
- Appropriate sample containers, labels, and polyethylene re-sealable bags;
- Insulated coolers, with water ice or freezer packs sufficient to maintain 4° C temperatures during the collection and transfer of samples;
- Shipping materials as required (labels, tape, , shock-absorbent material); and,
- Field log book.

Some sample containers provided by the analytical laboratory contain preservatives. The preservatives must be retained in the sample container and should, in no instance, be rinsed out. Preservatives may be corrosive and standard care should be exercised to reduce the potential contact to personnel skin or clothing. If spillage is observed, project safety procedures should be followed. If the sample container caps are broken or missing, do not use the container for collection and discard the bottle.

Appropriate caution should be used when handling glass sample containers. 40 mL vials can be prone to breakage when tightening lids.

5.3 Chain-of-Custody Procedures

Prior to sample collection, complete the header on the COC by filling in the project number, project name, contact person, sampler name, and other relevant project specific information. An example COC is provided at the end of this SOP. COC entries must be printed legibly using indelible black or blue ink. Use as many forms as needed. Maintain appropriate copies of all forms.

After sample collection, enter the individual sample information on the COC:

1. Enter sample name consistent with the sample identification system established in the project documents. Sample names must exactly match the sample labels.
2. List the date (mm/dd/yyyy) and time (24-hour format) of sample collection
3. Mark in the appropriate column(s) on the COC if the sample is a composite sample (i.e., collected over a period of time or from several different locations and mixed prior to placing in the sample containers) or a grab sample (i.e., a single sample from a single time or location).
4. List all requested analytical parameters, including analyte class and method (e.g., SVOCs 8270). Multiple methods and/or analytical parameters may be combined for each column. The number and type of containers should be noted.
5. Fill in all requested additional information, including media type, sample preservation, and relevant comments.
6. If applicable, note which samples should be used for site-specific matrix spikes.
7. Indicate any special project requirements.
8. Indicate the requested turn-around time.
9. Provide the relevant contact information (name, phone number, and e-mail) in the event problems or questions are encountered by the analytical laboratory.
10. Fill in, date, and sign (as appropriate) the custody transfer areas.
11. Complete as many COCs necessary to properly document the collection and transfer

5.4 Sample Handling

5.4.1 Sample Collection

1. Clean, new, analytical sample containers and appropriate preservatives will be provided by the contracted analytical laboratory. Common preservatives include hydrochloric acid (HCl), sulfuric acid (H_2SO_4), nitric acid (HNO_3), methanol (CH_3OH), and sodium bisulfate ($NaHSO_4$). Samples will be preserved in accordance with method- or project- specific protocols outline.
2. Disposable latex or nitrile gloves should be used to avoid cross-contamination of samples and protect against exposure to either contaminated media or preservatives.
3. Fill the respective sampling containers with the associated sampling material and any necessary preservative, in accordance with the relevant project- or method- specific SOPs.
4. Identify samples by attaching sample container labels, in accordance with the sample identification system established in the project documents. Sample labels must exactly match the sample names on the COC. Different procedures may be required for vapor/air samples (see applicable SOPs).
5. Confirm that all caps on the sample containers are secure and tightly closed. It may be necessary to wrap the sample container cap with clear packing tape to prevent it from becoming loose. If individual custody seals are required, they should be placed on the sample container so that the cap cannot be opened without rupturing the custody seal. The custody seal should be initialed and dated prior to relinquishing the samples.
6. Handle samples only while wearing new, disposable gloves, and keep empty sample containers and collected samples clean, dry, and away from potential cross-contaminant sources (such as vehicle exhausts, fuel sources, and contaminated equipment). Transport collected samples separately from other sampling equipment and tools, and store and transfer samples in an upright position and sealed tightly. Handle and preserve the samples according to the preservation and holding times summarized in project documents.
7. After completing the sample collection procedures and sample labeling, record the following information in the field log book:
    - Project name, number and site name, date;
    - Sample name, location (including duplicates and QC samples), and method;
    - Name of the sampler(s) and time of collection; and,
    - Any pertinent observations or comments.

5.4.2 Sample Storage

If samples cannot be shipped immediately to a laboratory and must be temporarily stored until arrangements can be made for delivery, place the samples in a secured area with sufficient refrigeration or ice in order to maintain 2° to 6° C storage temperatures (if required for preservation of the samples). Verify that a temperature blank and CoC accompanies samples during storage. Samples may be stored in a secure, temperature-controlled refrigerator as long as reliable power is provided to the refrigerator and the refrigerator is designated for environmental samples only (do not store samples in refrigerators potentially used for food storage). Use storage custody seals to maintain sample security in refrigerated storage. Samples temporarily stored overnight must be received by the custodian that placed them in storage, and may in turn be relinquished to the appropriate laboratory, or another sample custodian. Record each transfer of custody on the appropriate CoC form(s).

5.4.3 Packing Procedures

Following collection, all soil and aqueous samples must be placed on water ice or freezer packs to initiate cooling to approximately 4° C without freezing the sample(s). Samples should be kept cold until ready to pack for shipment to the laboratory. When preparing the samples for shipment, the following procedures shall be employed:

- If a drain plug exists on the cooler, it should secured on both the inside and outside with duct tape.
- Plastic bubble wrap or other shock absorbent material shall be placed over the bottom and corners of the cooler or shipping container.
- Wrap glass sample bottles in bubble wrap.
- Place each sample bottle upright inside the cooler. VOC vials for each sample should be rubber-banded together.
- Place cold packs or ice into the cooler. If the cooler is to be shipped via a delivery service, ensure that cold packs and ice are placed in resealable heavy-duty plastic bags.
- Samples placed on ice will be cooled and maintained at a temperature of approximately 4° C without freezing the sample(s).
- Fill the remaining space in the cooler with shock absorbent material such as bubble wrap. The cooler must be securely packed and cushioned in an upright position.
- Place the completed chain-of-custody(ies) in a large resealable bag and place in the cooler.
- If an independent courier service is transporting the cooler or shipping container, mark on the shipping container “Fragile” and “this side up” as appropriate. Place custody seal tape over the front and at least one side of the cooler lid, initial and date then cover with clear packing tape.

Close the cooler lid and fasten the lid with packing or duct tape. Wrap packing, duct or strapping tape around both ends of the cooler.

- If project personnel or laboratory couriers are transporting the shipment directly to the analytical laboratory by automobile, periodic changes of ice may be required. In this case custody seals should not be used and limited tape should be utilized to fasten the lid. However, if the cooler is to be left unattended for any period of time, custody tape should be used.

5.4.4 Shipping Procedures

- All samples will be delivered by an express (overnight) carrier within 48 hours of sample collection or as required by analytical holding times. Alternatively, samples may be delivered directly to the analytical laboratory or a laboratory courier may be used for sample pick up.
- If parameters with short holding times are required, sampling personnel will take the necessary steps to ship or deliver samples to the laboratory so that the holding times will not exceeded.
- Samples must be maintained at 4° ± 2° C without freezing until receipt at the laboratory.
- All shipments must be in accordance with DOT regulations
- Upon receipt, laboratory personnel will complete the COC by recording data and time of receipt, measuring and noting the internal temperature of the shipping container, and ensuring sample IDs on the container labels correspond to the sample IDs and quantities provided on the COC. Deviations between the COC and the sample containers, broken containers, or temperature exceedances will be reported to the project manager immediately by the laboratory.

5.5 Quality Assurance/Quality Control

COC records will be legibly and must be reviewed by the FM for completeness, accuracy, and conformance with the project requirements. Non-conformances will be noted and corrected in a timely manner, and the laboratory will be promptly notified regarding any required corrective actions. Following each day of sample shipment, COC records shall be transmitted to the PM, unless otherwise directed. Copies of the COC forms, and shipping receipts and notifications, whether physical or electronic, will be maintained with the project file. Describe sample packaging and shipping information in the field log book. Laboratory reports will contain COC records.

6.0 Records

Document all sample handling and custody procedures, forms, and transfer documents in accordance with this SOP and GBTS SOP 001 (Record Keeping and Log Books).

7.0 References

See sample chain-of-custody, attached.

CHAIN OF CUSTODY

PAGE_____ OF _____

WESTBORO, MA
TEL: 508-898-9220
FAX: 508-898-9193

MANSFIELD, MA
TEL: 508-822-9300
FAX: 508-822-3288

Date Rec'd in Lab:

ALPHA Job #:

Client Information

Client:

Address:

Phone:

Fax:

Email:

❑ These samples have been previously analyzed by Alpha

Project Information

Project Name:

Project Location:

Project #:

Project Manager:

ALPHA Quote #:

Turn-Around Time

❑ Standard ❑ RUSH *(only confirmed if pre-approved!)*

Date Due: **Time:**

Report Information - Data Deliverables

❑ FAX ❑ EMAIL

❑ ADEx ❑ Add'l Deliverables

Billing Information

❑ Same as Client info PO #:

Regulatory Requirements/Report Limits

State /Fed Program	*Criteria*

Other Project Specific Requirements/Comments/Detection Limits:

ANALYSIS

SAMPLE HANDLING

*Filtration*_____
❑ Done
❑ Not needed
❑ Lab to do

Preservation
❑ Lab to do
(Please specify below)

TOTAL # BOTTLES

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler's Initials	Sample Specific Comments

Container Type	
Preservative	

Relinquished By:	Date/Time	Received By:	Date/Time

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 14-OCT-07)

GALLAGHER BASSETT | TECHNICAL SERVICES

GBTS SOP 006

LOW-FLOW GROUNDWATER SAMPLING

1.0 Purpose

This document provides Standard Operating Procedures (SOPs) for use by Gallagher Bassett Technical Services (GBTS) personnel during environmental investigations. General procedures are presented below; detailed protocols, as available, are provided as attachments and/or in manufacturer documentation. Project documents, including all SOPs, checklists, forms, calibration documents, instrument manuals, etc., are maintained at GBTS offices. All SOPs and supporting documentation are periodically updated.

2.0 SOP Scope

This SOP provides overall guidance to project personnel for "low-flow" groundwater sampling, but does not specifically address all of the required procedures, and is intended to be used in conjunction with the attached reference documentation, as well as available operating manuals supplied by equipment manufacturers. Groundwater sampling must be performed in accordance with other relevant project-specific documentation, including work plans, sampling and analysis plans, health and safety plans, quality assurance project plans, and additional SOPs, as appropriate.

3.0 General

Groundwater samples are collected to gather information regarding inorganic and organic constituents in the groundwater, as well as water quality parameters. Low-flow purging and sampling has the advantages of minimizing the turbidity and mixing between the overlying stagnant casing water and water within the screened interval. Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface, which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used; however, this is dependent on site-specific hydrogeology. Low-flow groundwater sampling is to be performed consistent with this SOP and the attached document specifying detailed USEPA methodology.

Field personnel will review and be familiar with the required groundwater sampling procedures presented in this SOP.

Document all groundwater sampling fieldwork, and flag all potential issues associated with this activity, in accordance with GBTS SOP 001 (Record Keeping and Log Books).

4.0 Responsibilities

4.1 Fieldwork Manager

The Fieldwork Manager (FM), in conjunction with the Project Manager (PM), is responsible for overall compliance with this SOP. The FM, or designee, is responsible for ensuring and verifying the proper performance of groundwater sampling.

4.2 Site Personnel

Site personnel are required to read this SOP before engaging in fieldwork activities. The FM will inform personnel who will be responsible for groundwater sampling.

5.0 Procedures

These are standard (i.e., typically applicable) operating procedures, which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented (see GBTS SOP 001).

All sample handling and management procedures must comply with specific requirements and restrictions when sampling media for per- and polyfluoroalkyl substances (PFAS), which are addressed in specific sampling SOPS.

5.1 Health and Safety Precautions

Groundwater sampling procedures may involve exposure to contaminants in site media. All work should be performed in accordance with the Health and Safety Plan (HASP), including use of proper PPE. Safety Data Sheets for known contaminants, if applicable, and for preservatives in sample containers, should be available at the site. At a minimum, eye protection, safety shoes, and gloves are to be worn. There are several types of gloves that may be worn, depending on the media being sampled. Although nitrile gloves (property similar) are generally acceptable when handling samples, the HASP must be reviewed for specific requirements. If a potential for skin contact exists, protective clothing should be worn.

5.2 Equipment

Project-specific documents and sampling requirements should be reviewed prior to beginning fieldwork, and field personnel should select appropriate supplies. The following is a generic equipment list:

- Water quality multimeter (measurement of temperature, pH, dissolved oxygen, conductivity, oxidation-reduction potential [ORP], and, if necessary, turbidity) and calibration solutions
- Water-level and oil/water interface meters
- Sample pump(s) – see below, and power source

- PPE, including nitrile (or latex) gloves and eye protection
- 5-gallon buckets, paper towels, garbage bags, etc.
- Graduated cylinder and stopwatch
- Sample containers and labels
- Coolers and ice/freezer packs
- Field logbook, sampling/purge sheets, indelible ink pen, and chain-of-custody forms

A number of pump types may be used for the collection of groundwater samples, each having inherent advantages/disadvantages. Pumps for low-flow groundwater sampling are variable speed, submersible pumps, either electric direct displacement or pneumatic bladder pumps (or similar). Bladder pumps are less likely to agitate or aerate a sample, or to increase turbidity. If allowed by the project plans, and water is relatively shallow, variable speed suction lift pumps may be used (these pumps may cause loss of low levels of volatile compounds).

See Section 7.0, References, for additional SOPs that are applicable to the selection, maintenance, and operation of equipment used for low-flow sampling.

- GBTS SOP 002, Field Equipment Calibration
- GBTS SOP 003, Field Equipment Operation
- GBTS SOP 004 Equipment Decontamination
- GBTS SOP 005 Sample Handling and Custody

5.3 Low-Flow Groundwater Sampling

5.3.1 Well Purging

Prior to purging cover the ground surface around the well with plastic sheeting, stage all equipment and supplies, and measure and record the static water level to nearest 0.01 foot. If water levels will be used to determine groundwater flow or hydraulic gradients, all measurements should be taken on the same work day over as short a period of time as possible. Do not attempt to measure the well depth, as this activity may disturb the water column, including re-suspending sediments.

For low-flow, minimal drawdown sampling protocols, an in-line water quality measurement device such as a flow-through cell is used to establish the stabilization time on a well-specific basis for several indicator parameters, as follows:

- pH: ± 0.1 s.u.
- Specific Conductance/Conductivity : ± 3%
- Oxidation-Reduction Potential: ± 10 millivolts
- Turbidity: ± 10% or less than 5 NTU
- Dissolved Oxygen: ± 0.3 mg/L
- Temperature

Measurements should be taken every three to five minutes and recorded on the groundwater sampling/purge log. Stabilization is achieved after all parameters have stabilized for three successive readings (temperature is a useful indicator but has no established stabilization criterion).

Parameters will typically stabilize in the following order: pH, temperature, and specific conductance, followed by ORP, dissolved oxygen, and turbidity. If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. Note that natural turbidity levels in groundwater may exceed 10 nephelometric units (NTU). Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well.

Performance criteria for determining stabilization should be based on water-level drawdown, pumping rate, and specifications for indicator parameters. Check the water level periodically during purging and sampling to monitor drawdown in the well as a guide to any necessary flow rate adjustment. The goal is minimal drawdown (<0.1 meter) during purging. This goal may not be possible to achieve under some circumstances and may require adjustment based on site specific conditions and personal experience.

5.3.2 Sample Collection

Once parameters have stabilized, begin sample collection as soon as possible. Disconnect or bypass the in-line monitoring device that was used to measure field parameters prior to sample collection. The sampling flow rate should remain at the established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates <0.5 liters/minute are appropriate. The same device used for purging should be used for sampling.

Samples will be collected in decreasing order of their volatility. This order is generally as follows:

1. Volatile Organic Compounds (VOCs)
2. Gas sensitive parameters (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity)
3. Total Organic Carbon (TOC)
4. Semi-Volatile Organic Compounds (SVOCs)
5. Pesticides and Polychlorinated Biphenyls (PCBs)
6. Metals
7. Total Phenols
8. Cyanide and other inorganic parameters (e.g., chloride, nitrate, sulfide, radionuclides)

If filtered samples are to be collected, these should be collected last.

Samples collected for volatile organics should be carefully placed into 40 ml glass vials with Teflon® septum lids. No air bubbles should be present in the vial after sealing the septum lid. Extra laboratory provided pre-preserved vials shall be available for the sampler. In the instance that an air bubble is present after sealing the septum lid of the initial sample, the sampler shall collect a new sample to replace the corrupted sample vial.

Sample containers required for the groundwater analytes are presented in project documents.

5.4 Quality Assurance/Quality Control

All data must be documented on field data sheets or within field logbooks. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in project plans. Equipment calibration activities must occur prior to sampling/operation and be documented in the Field Logbook.

Sample management, including chain-of-custody, handling, packing, and shipping procedures shall be in accordance with applicable SOPs. Field QC samples should be collected as required per project plans.

6.0 Records

Document all low-flow groundwater sample activities in accordance with this SOP and GBTS SOP 001 (Record Keeping and Log Books).

7.0 References

USEPA Region 1, Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, July 30, 1996 (Revised September 19, 2017) - ATTACHED

Additional SOPs relevant to low-flow groundwater sampling:

- GBTS SOP 001, Record Keeping and Log Books
- GBTS SOP 002, Field Equipment Calibration
- GBTS SOP 003, Field Equipment Operation
- GBTS SOP 004 Equipment Decontamination
- GBTS SOP 005 Sample Handling and Custody

GROUNDWATER MONITORING WELL PURGE DATA SHEET

GALLAGHER BASSETT | TECHNICAL SERVICES

Project Name: _____ **Well ID:** _____
GBTS PROJECT #: _____ **PID Reading:** _____
Date: _____ **Depth of well:** _____
Field Personnel: _____ **Depth to water:** _____
Weather: _____ **Pump type:** _____

Time	Temp (°C)	pH	ORP (mv)	Specific Conductivity (ms/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Depth to Water (ft)	Purge Rate (mL/m)	Comments (e.g. color/clarity)

***** STABILIZATION CRITERIA*****

Temp +/- 3% **pH** +/- 0.1 **ORP** +/- 10 **Spec Cond** +/- 3% **Turb** +/- 10% **DO** +/- 10%

NOTES:

*****PURGED WATER DETAILS*****

Start/End time: _____
Total purge time: _____
Total volume: _____
Purge rate: _____

CHARACTERISTICS:

Odor: none | slight | moderate | strong

Sheen: none | slight | moderate | strong

L/DNAPL: Yes | No **L/DNAPL thickness (in.)**:_____

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
11 Technology Drive
North Chelmsford, MA 01863

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Prepared by: ROBERT REINHART Digitally signed by ROBERT REINHART Date: 2017.09.19 16:15:38 -04'00' _____ _____
(Robert Reinhart, Quality Assurance Unit) Date

Approved by: JOHN SMALDONE Digitally signed by JOHN SMALDONE Date: 2017.09.20 15:11:00 -04'00' _____ _____
(John Smaldone, Quality Assurance Unit) Date

Revision Page

Date	Rev #	Summary of changes	Sections
7/30/96	1	Finalized	
01/19/10	2	Updated	All sections
3/23/17	3	Updated	All sections
9/20/17	4	Updated	Section 7.0

Table of Contents

1.0 USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Potentiometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the “Monitoring Indicator Field Parameters” section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

2.0 SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase

liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

3.0 BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection

may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

4.0 HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

5.0 CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in

the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

6.0 PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

7.0 EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®) are preferred. PTFE, however, should not be used when sampling for per- and polyfluoroalkyl substances (PFAS) as it is likely to contain these substances.

Note: If extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a "best practice". For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

PTFE (Teflon®) or PTFE-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. As discussed in the previous section, PTFE tubing should not be used when sampling for PFAS. In this case, a suitable alternative such as high-density polyethylene tubing should be used.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

Note: If tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic ”tape”, pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume

cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A "T" connector coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

8.0 EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

9.0 PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed, lay out a sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

10.0 PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the

minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be

changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and

continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). Throughout the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help ensure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods

(e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 µm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a “silting” problem or if confirmation of well identity is needed.

Secure the well.

11.0 DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well, and then following sampling of each subsequent well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

12.0 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

13.0 FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

14.0 DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

15.0 REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, *DNAPL Site Evaluation*; C.K. Smoley (CRC Press), Boca Raton, Florida.

Robert W. Puls and Michael J. Barcelona, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, April 1996 (EPA/540/S-95/504).

U.S. Environmental Protection Agency, 1992, *RCRA Ground-Water Monitoring: Draft Technical Guidance*; Washington, DC (EPA/530-R-93-001).

U.S. Environmental Protection Agency, 1987, *A Compendium of Superfund Field Operations Methods*; Washington, DC (EPA/540/P-87/001).

U.S Environmental Protection Agency, Region 1, *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017 or latest version.

U.S Environmental Protection Agency, EPA SW-846.

U.S Environmental Protection Agency, 40 CFR 136.

U.S Environmental Protection Agency, 40 CFR 141.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.

APPENDIX A

PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases, (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could affect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or discolored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or discolored water is usually from the well-being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to

the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take a while (pump may be removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note:

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note: at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

Turbidity (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

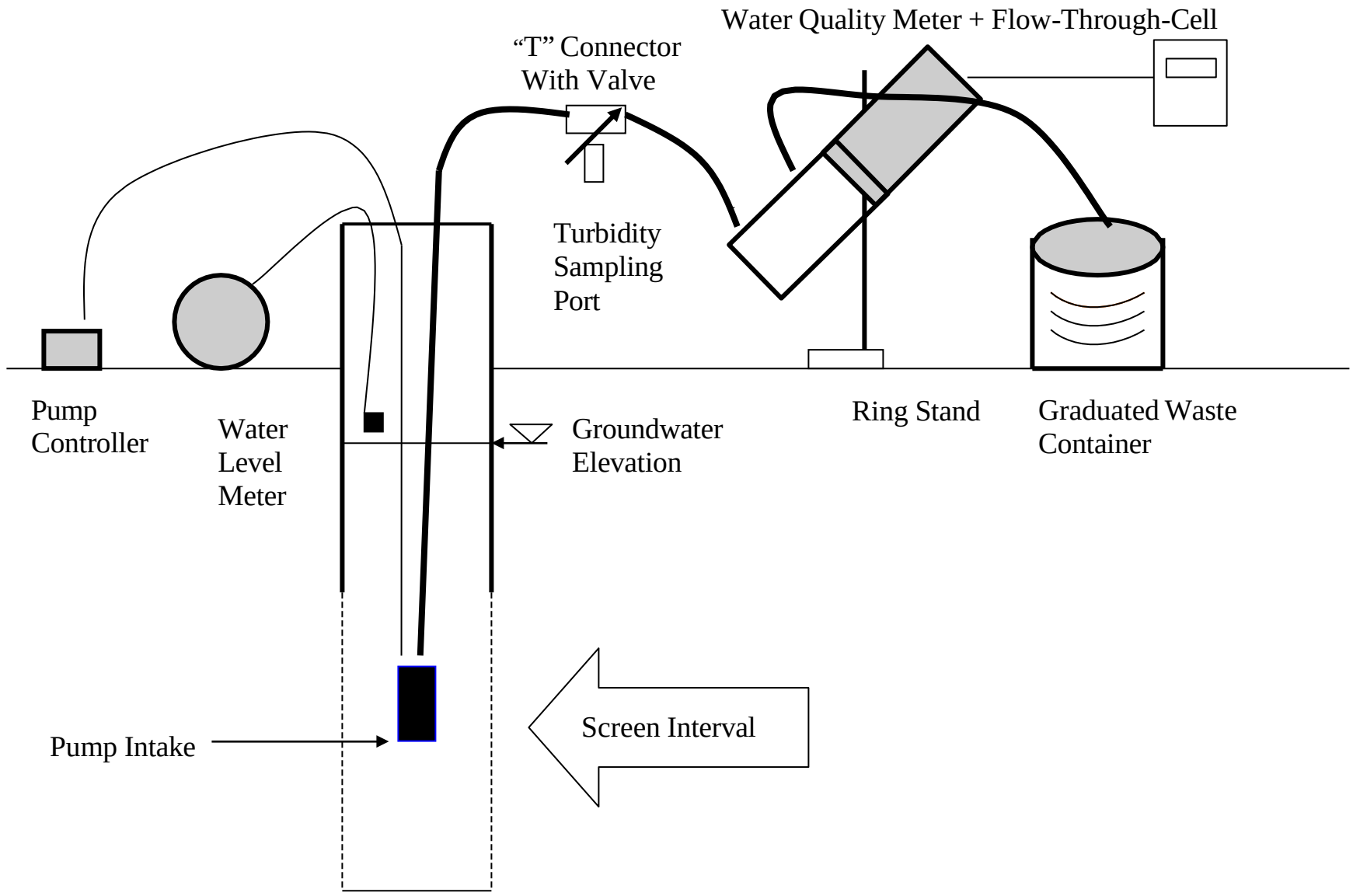
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C

EXAMPLE (Minimum Requirements)

WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)_____ Depth to _____/_____ of screen
Well Number_____ Date_____ (below MP) top bottom
Field Personnel_____ Pump Intake at (ft. below MP)_____
Sampling Organization_____ Purging Device; (pump type)_____
Identify MP_____ Total Volume Purged _____

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. "C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Tur-bidity NTU	Comments
Stabilization Criteria					3%	3%	±0.1	±10 mv	10%	10%	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)

APPENDIX C - Field Forms

CHAIN OF CUSTODY

PAGE_____ OF _____

WESTBORO, MA
TEL: 508-898-9220
FAX: 508-898-9193

MANSFIELD, MA
TEL: 508-822-9300
FAX: 508-822-3288

Date Rec'd in Lab:

ALPHA Job #:

Client Information

Client:

Address:

Phone:

Fax:

Email:

❑ These samples have been previously analyzed by Alpha

Project Information

Project Name:

Project Location:

Project #:

Project Manager:

ALPHA Quote #:

Turn-Around Time

❑ Standard ❑ RUSH *(only confirmed if pre-approved!)*

Date Due: **Time:**

Report Information - Data Deliverables

❑ FAX ❑ EMAIL

❑ ADEx ❑ Add'l Deliverables

Billing Information

❑ Same as Client info PO #:

Regulatory Requirements/Report Limits

State /Fed Program	*Criteria*

Other Project Specific Requirements/Comments/Detection Limits:

ANALYSIS

SAMPLE HANDLING

*Filtration*_____
❑ Done
❑ Not needed
❑ Lab to do

Preservation
❑ Lab to do
(Please specify below)

TOTAL # BOTTLES

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler's Initials	Sample Specific Comments

Container Type	
Preservative	

Relinquished By:	Date/Time	Received By:	Date/Time

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 14-OCT-07)

GROUNDWATER MONITORING WELL PURGE DATA SHEET

GALLAGHER BASSETT | TECHNICAL SERVICES

Project Name: _____ **Well ID:** _____
GBTS PROJECT #: _____ **PID Reading:** _____
Date: _____ **Depth of well:** _____
Field Personnel: _____ **Depth to water:** _____
Weather: _____ **Pump type:** _____

Time	Temp (°C)	pH	ORP (mv)	Specific Conductivity (ms/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Depth to Water (ft)	Purge Rate (mL/m)	Comments (e.g. color/clarity)

***** STABILIZATION CRITERIA*****

Temp +/- 3% **pH** +/- 0.1 **ORP** +/- 10 **Spec Cond** +/- 3% **Turb** +/- 10% **DO** +/- 10%

NOTES:

*****PURGED WATER DETAILS*****

Start/End time: _____
Total purge time: _____
Total volume: _____
Purge rate: _____

CHARACTERISTICS:

Odor: none | slight | moderate | strong

Sheen: none | slight | moderate | strong

L/DNAPL: Yes | No **L/DNAPL thickness (in.)**:_____

YORK ANALYTICAL LABORATORIES
120 RESEARCH DR.
STRATFORD, CT 06615
(203) 325-1371
FAX (203) 357-0166

Field Chain-of-Custody Record

NOTE: York's Std. Terms & Conditions are listed on the back side of this document. This document serves as your written authorization to York to proceed with the analyses requested and your signature binds you to York's Std. Terms & Conditions.

York Project No._____

YOUR Information	**Report to:**	**Invoice To:**	**Your Project ID**	**Turn-Around Time**	**Report/Deliverable Type**
Company: **Gallagher Bassett TS**	**SAME** X	**SAME** X	**LM97145**	RUSH-Same Day	Summary Report X
Address: **22 IBM Rd**		Name:		RUSH-Next Day	QA Report
Poughkeepsie, NY 12603	Company:	Company:	**Purchase Order #**	RUSH-Two Day	CT RCP
Phone.: **845-452-1658**	Address:	Address:		RUSH-Three Day	CT RCP DQA/DUE Pkg
Contact: **Scott Spitzer**		***Brenda***	**LM97145.50**	RUSH-Four Day	NY ASP A Package
E-mail: scott_spitzer@wcdgroup.com		E-mail	Samples from CT__**NY_X**_NJ__	Standard (5-7day) **X**	NY ASP B Package X
					NJDEP Reduced Deliv
					Excel X
					NYSDEC EQuIS
					NJDEP SRP HazSite
					EQuIS
					GIS/KEY (std)
					YORK Regulatory Comp Excel *compared to:*
					OTHER:

Print Clearly and Legibly. All Information must be complete. Samples will NOT be logged in and the turn-around time clock will not begin until any questions by York are resolved.

Samples Collected/Authorized By (Signature)

Name (printed)

Matrix Codes
S - soil
Other - specify(oil, etc.)
WW - wastewater
GW - groundwater
DW - drinking water
Air-A - ambient air
Air-SV - soil vapor

Volatiles		Semi-Vols.	Pest/PCB/Herb	Metals	Misc. Org.	Full Lists
8260 full	TICs	8270 or 625	8082PCB	RCRA8	TPH GRO	Pri.Poll.
624	Site Spec.	STARS list	8081Pest	PP13 list	TPH DRO	TCL Organics
STARS list	Nassau Co.	BN Only	8151Herb	TAL	CT ETPH	TAL Met/CN
BTEX	Suffolk Co.	Acids Only	CT RCP	CT15 list	NY 310-13	Full TCLP
MTBE	Ketones	PAH list	App. IX	TAGM list	TPH 1664	Full App. IX
TCL list	Oxygenates	TAGM list	Site Spec.	NJDEP list	Air TO14A	Part360-Routine
TAGM list	TCLP list	CT RCP list	SPLP or TCLP	Total	Air TO15	Part360-Baseline
CT RCP list	524.2	TCL list	TCLP Pest	Dissolved	Air STARS	Part 360-Expanded No Dioxins/Furans
Arom. only	502.2	NJDEP list	TCLP Herb	SPLP or TCLP	Air VPH	Part 360-Expanded Full List
Halog.only	NJDEP list	App. IX	Chlordane	Indiv. Metals	Air TICs	NYCDEP Sewer
App.IX list	SPLP or TCLP	TCLP BNA	608 Pest	LIST Below	Methane	NYSDEC Sewer
8021B list		SPLP or TCLP	608 PCB		Helium	TAGM

Sample Identification	**Date+Time Sampled**	**Matrix**	**Analysis Requested** (List above includes common analysis)	**Container Description**
MW-123 20221118		water	VOCs, Halogenated (8260)	4 X 40 ml vial (HCl)
DUP-20221118A				
FB-20221118A		field blank		2 X 40 ml vial (HCl)
TB-20221118A	-	trip blank		

Comments:

Wallkill Well Field Site, 20 Industrial Place Ext, Middletown NY 10940

Preservation (check all appliciable) 4°C____ Frozen____ HCl____ MeOH____ HNO_3____ H_2SO_4____ NaOH____ ZnAc Ascorbic Acid Other

Special Instructions
Field Filtered ☐
Lab to Filter ☐

Samples Relinquished By	Date/Time	Samples Received By	Date/Time	Temperature on Receipt
				____°C
Samples Relinquished By	Date/Time	Samples Received in **LAB** by	Date/Time	

APPENDIX D – Laboratory Performance Criteria

Date Created: 07/19/22
Created By: Nadine Yakes
File: PM12808-1
Page: 1

Gallagher Bassett Technical Services

TCL Volatiles - EPA 8260C (WATER)

Holding Time: 14 days
Container/Sample Preservation: 3 - Vial HCl preserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1,1,1,2-Tetrachloroethane	630-20-6	2.5	0.7	ug/l	64-130	20	64-130	20	20			
1,1,1-Trichloroethane	71-55-6	2.5	0.7	ug/l	67-130	20	67-130	20	20			
1,1,2,2-Tetrachloroethane	79-34-5	0.5	0.167	ug/l	67-130	20	67-130	20	20			
1,1,2-Trichloroethane	79-00-5	1.5	0.5	ug/l	70-130	20	70-130	20	20			
1,1-Dichloroethane	75-34-3	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,1-Dichloroethene	75-35-4	0.5	0.169	ug/l	61-145	20	61-145	20	20			
1,1-Dichloropropene	563-58-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,2,3-Trichlorobenzene	87-61-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,2,3-Trichloropropane	96-18-4	2.5	0.7	ug/l	64-130	20	64-130	20	20			
1,2,4-Trichlorobenzene	120-82-1	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,2-Dibromo-3-chloropropane	96-12-8	2.5	0.7	ug/l	41-144	20	41-144	20	20			
1,2-Dibromoethane	106-93-4	2	0.65	ug/l	70-130	20	70-130	20	20			
1,2-Dichlorobenzene	95-50-1	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,2-Dichloroethane	107-06-2	0.5	0.132	ug/l	70-130	20	70-130	20	20			
1,2-Dichloropropane	78-87-5	1	0.137	ug/l	70-130	20	70-130	20	20			
1,3-Dichlorobenzene	541-73-1	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,3-Dichloropropane	142-28-9	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,4-Dichlorobenzene	106-46-7	2.5	0.7	ug/l	70-130	20	70-130	20	20			
2,2-Dichloropropane	594-20-7	2.5	0.7	ug/l	63-133	20	63-133	20	20			
Bromobenzene	108-86-1	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Bromochloromethane	74-97-5	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Bromodichloromethane	75-27-4	0.5	0.192	ug/l	67-130	20	67-130	20	20			
Carbon tetrachloride	56-23-5	0.5	0.134	ug/l	63-132	20	63-132	20	20			
Chlorobenzene	108-90-7	2.5	0.7	ug/l	75-130	20	75-130	20	20			
Chloroethane	75-00-3	2.5	0.7	ug/l	55-138	20	55-138	20	20			
Chloroform	67-66-3	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Chloromethane	74-87-3	2.5	0.7	ug/l	64-130	20	64-130	20	20			
cis-1,2-Dichloroethene	156-59-2	2.5	0.7	ug/l	70-130	20	70-130	20	20			
cis-1,3-Dichloropropene	10061-01-5	0.5	0.144	ug/l	70-130	20	70-130	20	20			
Dibromochloromethane	124-48-1	0.5	0.149	ug/l	63-130	20	63-130	20	20			
Dichlorodifluoromethane	75-71-8	5	1	ug/l	36-147	20	36-147	20	20			
Hexachlorobutadiene	87-68-3	2.5	0.7	ug/l	63-130	20	63-130	20	20			
Methylene chloride	75-09-2	2.5	0.7	ug/l	70-130	20	70-130	20	20			
o-Chlorotoluene	95-49-8	2.5	0.7	ug/l	70-130	20	70-130	20	20			
p-Chlorotoluene	106-43-4	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Tetrachloroethene	127-18-4	0.5	0.181	ug/l	70-130	20	70-130	20	20			
trans-1,2-Dichloroethene	156-60-5	2.5	0.7	ug/l	70-130	20	70-130	20	20			
trans-1,3-Dichloropropene	10061-02-6	0.5	0.164	ug/l	70-130	20	70-130	20	20			
trans-1,4-Dichloro-2-butene	110-57-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Trichloroethene	79-01-6	0.5	0.175	ug/l	70-130	20	70-130	20	20			
Trichlorofluoromethane	75-69-4	2.5	0.7	ug/l	62-150	20	62-150	20	20			
Vinyl chloride	75-01-4	1	0.0714	ug/l	55-140	20	55-140	20	20			
1,2-Dichloroethane-d4	*17060-07-0*									*70-130*		
Toluene-d8	*2037-26-5*									*70-130*		
4-Bromofluorobenzene	*460-00-4*									*70-130*		
Dibromofluoromethane	*1868-53-7*									*70-130*		

Table: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (all values in µg/L)

Analyte	CAS #	PAL	PQLG	LOQ	LOD
1,1,1,2-Tetrachloroethane	630-20-6	5	2.5	2.5	0.7
1,1,1-Trichloroethane	71-55-6	5	2.5	2.5	0.7
1,1,2,2-Tetrachloroethane	79-34-5	5	0.5	0.5	0.167
1,1,2-Trichloroethane	79-00-5	1**	1.5	1.5	0.5
1,1-Dichloroethane	75-34-3	5	2.5	2.5	0.7
1,1-Dichloroethylene	75-35-4	5	0.5	0.5	0.169
1,1-Dichloropropylene	563-58-6	5	2.5	2.5	0.7
1,2,3-Trichlorobenzene	87-61-6	5	2.5	2.5	0.7
1,2,3-Trichloropropane	96-18-4	0.04**	2.5	2.5	0.7
1,2,4-Trichlorobenzene	120-82-1	5	2.5	2.5	0.7
1,2-Dibromo-3-chloropropane	96-12-8	0.04**	2.5	2.5	0.7
1,2-Dibromoethane	106-93-4	5	2	2	0.65
1,2-Dichlorobenzene	95-50-1	3	2.5	2.5	0.7
1,2-Dichloroethane	107-06-2	0.6	0.5	0.5	0.132
1,2-Dichloropropane	78-87-5	1	1	1	0.137
1,3-Dichlorobenzene	541-73-1	3	2.5	2.5	0.7
1,3-Dichloropropane	142-28-9	5	2.5	2.5	0.7
1,4-Dichlorobenzene	106-46-7	3	2.5	2.5	0.7
2,2-Dichloropropane	594-20-7	5	2.5	2.5	0.7
Bromobenzene	108-86-1	5	2.5	2.5	0.7
Bromochloromethane	74-97-5	5	2.5	2.5	0.7
Bromodichloromethane	75-27-4	50	0.5	0.5	0.192
Carbon tetrachloride	56-23-5	5	0.5	0.5	0.134
Chlorobenzene	108-90-7	5	2.5	2.5	0.7
Chloroethane	75-00-3	5	2.5	2.5	0.7
Chloroform	67-66-3	7	2.5	2.5	0.7
Chloromethane	74-87-3	5	2.5	2.5	0.7
cis-1,2-Dichloroethylene	156-59-2	5	2.5	2.5	0.7
cis-1,3-Dichloropropene	10061-01-5	0.4**	0.5	0.5	0.144
Dibromochloromethane	124-48-1	5	0.5	0.5	0.149
Dichlorodifluoromethane	75-71-8	5	5	5	1
Hexachlorobutadiene	87-68-3	0.5**	2.5	2.5	0.7
Methylene chloride	75-09-2	5	2.5	2.5	0.7
o-Chlorotoluene	95-49-8	5	2.5	2.5	0.7
p-Chlorotoluene	106-43-4	5	2.5	2.5	0.7
Tetrachloroethylene	127-18-4	5	0.5	0.5	0.181
trans-1,2-Dichloroethylene	156-60-5	5	2.5	2.5	0.7
trans-1,3-Dichloropropylene	10061-02-6	0.4**	0.5	0.5	0.164
trans-1,4-dichloro-2-butene	110-57-6	5	2.5	2.5	0.7
Trichloroethylene	79-01-6	5	0.5	0.5	0.175
Trichlorofluoromethane	75-69-4	5	2.5	2.5	0.7
Vinyl Chloride	75-01-4	2	1	1	0.0714

Target halogenated VOCs critical to decision-making are highlighted

PAL: Project Action Limit PQLG: Project Quantitation Limit Goal LOQ: Limit of Quantitation LOD: Limit of Detection

** LOQ is greater than PAL (identified analyte is not critical to decision making and is not expected to be present at the Site)

PALs based on NYSDEC Division of Water Ambient Water Quality Standards and Guidance Values (AWQS), provided in Technical and Operational Guidance Series 1.1.1 (inclusive of 6NYCRR Part 703)

Volatile Organics, 8260 - Comprehensive in Water (EPA 8260C)

Preservation: Add HCl to pH<2; Store cool at 4°C

Container: 00_40mL Clear Vial (pre-pres.) HCl; Cool t **Amount Required:** 80 mL **Hold Time:** 14 days

Analyte	MDL	Reporting Limit	Surrogate %Rec	Duplicate RPD	----Matrix Spike---- %Rec	RPD	--Blank Spike / LCS-- %Rec	RPD
1,1,1,2-Tetrachloroethane	0.20	0.50 ug/L			45-161	30	82-126	30
1,1,1-Trichloroethane	0.20	0.50 ug/L			70-146	30	78-136	30
1,1,2,2-Tetrachloroethane	0.20	0.50 ug/L			74-121	30	76-129	30
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	0.20	0.50 ug/L			21-217	30	54-165	30
1,1,2-Trichloroethane	0.20	0.50 ug/L			59-146	30	82-123	30
1,1-Dichloroethane	0.20	0.50 ug/L			54-146	30	82-129	30
1,1-Dichloroethylene	0.20	0.50 ug/L			44-165	30	68-138	30
1,1-Dichloropropylene	0.20	0.50 ug/L			82-134	30	83-133	30
1,2,3-Trichlorobenzene	0.20	0.50 ug/L			40-161	30	40-130	30
1,2,3-Trichloropropane	0.20	0.50 ug/L			74-127	30	77-128	30
1,2,4,5-Tetramethylbenzene	0.20	0.50 ug/L			27-190	30	85-140	30
1,2,4-Trichlorobenzene	0.20	0.50 ug/L			41-161	30	65-137	30
1,2,4-Trimethylbenzene	0.20	0.50 ug/L			72-129	30	82-132	30
1,2-Dibromo-3-chloropropane	0.20	0.50 ug/L			31-151	30	45-147	30
1,2-Dibromoethane	0.20	0.50 ug/L			75-125	30	83-124	30
1,2-Dichlorobenzene	0.20	0.50 ug/L			63-122	30	79-123	30
1,2-Dichloroethane	0.20	0.50 ug/L			68-131	30	73-132	30
1,2-Dichloropropane	0.20	0.50 ug/L			77-121	30	78-126	30
1,3,5-Trimethylbenzene	0.20	0.50 ug/L			69-126	30	80-131	30
1,3-Dichlorobenzene	0.20	0.50 ug/L			74-119	30	86-130	30
1,3-Dichloropropane	0.20	0.50 ug/L			77-119	30	81-125	30
1,4-Dichlorobenzene	0.20	0.50 ug/L			70-124	30	85-130	30
1,4-Dioxane	40	40 ug/L			10-310	30	10-349	30
2,2-Dichloropropane	0.20	0.50 ug/L			10-160	30	56-152	30
2-Butanone	0.20	0.50 ug/L			10-193	30	49-152	30
2-Chlorotoluene	0.20	0.50 ug/L			70-126	30	79-130	30
2-Hexanone	0.20	0.50 ug/L			53-133	30	51-146	30
4-Chlorotoluene	0.20	0.50 ug/L			69-124	30	79-128	30
4-Methyl-2-pentanone	0.20	0.50 ug/L			38-150	30	57-145	30
Acetone	1.0	2.0 ug/L			13-149	30	14-150	30
Acrolein	0.20	0.50 ug/L			10-195	30	10-153	30
Acrylonitrile	0.20	0.50 ug/L			37-165	30	51-150	30
Benzene	0.20	0.50 ug/L			38-155	30	85-126	30
Bromobenzene	0.20	0.50 ug/L			72-122	30	78-129	30
Bromochloromethane	0.20	0.50 ug/L			75-121	30	77-128	30
Bromodichloromethane	0.20	0.50 ug/L			70-129	30	79-128	30
Bromoform	0.20	0.50 ug/L			66-136	30	78-133	30
Bromomethane	0.20	0.50 ug/L			30-158	30	43-168	30
Carbon disulfide	0.20	0.50 ug/L			10-138	30	68-146	30
Carbon tetrachloride	0.20	0.50 ug/L			71-146	30	77-141	30
Chlorobenzene	0.20	0.50 ug/L			81-117	30	88-120	30
Chloroethane	0.20	0.50 ug/L			51-145	30	65-136	30
Chloroform	0.20	0.50 ug/L			80-124	30	82-128	30
Chloromethane	0.20	0.50 ug/L			16-163	30	43-155	30
cis-1,2-Dichloroethylene	0.20	0.50 ug/L			76-125	30	83-129	30
cis-1,3-Dichloropropylene	0.20	0.50 ug/L			58-131	30	80-131	30
Cyclohexane	0.20	0.50 ug/L			70-130	30	63-149	30
Dibromochloromethane	0.20	0.50 ug/L			71-129	30	80-130	30
Dibromomethane	0.20	0.50 ug/L			76-120	30	72-134	30
Dichlorodifluoromethane	0.20	0.50 ug/L			30-147	30	44-144	30
Ethyl Benzene	0.20	0.50 ug/L			72-128	30	80-131	30
Hexachlorobutadiene	0.20	0.50 ug/L			34-166	30	67-146	30
Isopropylbenzene	0.20	0.50 ug/L			66-139	30	76-140	30

Volatile Organics, 8260 - Comprehensive in Water (EPA 8260C) (Continued)

Analyte	MDL	Reporting Limit	Surrogate %Rec	Duplicate RPD	----Matrix Spike---- %Rec	----Matrix Spike---- RPD	--Blank Spike / LCS-- %Rec	--Blank Spike / LCS-- RPD
Methyl acetate	0.20	0.50 ug/L			10-200	30	51-139	30
Methyl tert-butyl ether (MTBE)	0.20	0.50 ug/L			75-128	30	76-135	30
Methylcyclohexane	0.20	0.50 ug/L			70-130	30	72-143	30
Methylene chloride	1.0	2.0 ug/L			57-128	30	55-137	30
Naphthalene	1.0	2.0 ug/L			39-158	30	50-147	30
n-Butylbenzene	0.20	0.50 ug/L			61-138	30	79-132	30
n-Propylbenzene	0.20	0.50 ug/L			66-134	30	78-133	30
o-Xylene	0.20	0.50 ug/L			69-126	30	78-130	30
p- & m- Xylenes	0.50	1.0 ug/L			67-130	30	77-133	30
p-Diethylbenzene	0.20	0.50 ug/L			52-150	30	84-134	30
p-Ethyltoluene	0.20	0.50 ug/L			76-127	30	88-129	30
p-Isopropyltoluene	0.20	0.50 ug/L			64-137	30	81-136	30
sec-Butylbenzene	0.20	0.50 ug/L			53-155	30	79-137	30
Styrene	0.20	0.50 ug/L			69-125	30	67-132	30
tert-Butyl alcohol (TBA)	0.50	1.0 ug/L			10-130	30	25-162	30
tert-Butylbenzene	0.20	0.50 ug/L			65-139	30	77-138	30
Tetrachloroethylene	0.20	0.50 ug/L			64-139	30	82-131	30
Toluene	0.20	0.50 ug/L			76-123	30	80-127	30
trans-1,2-Dichloroethylene	0.20	0.50 ug/L			79-131	30	80-132	30
trans-1,3-Dichloropropylene	0.20	0.50 ug/L			55-130	30	78-131	30
trans-1,4-dichloro-2-butene	0.20	0.50 ug/L			25-155	30	63-141	30
Trichloroethylene	0.20	0.50 ug/L			53-145	30	82-128	30
Trichlorofluoromethane	0.20	0.50 ug/L			61-142	30	67-139	30
Vinyl acetate	0.20	0.50 ug/L			10-87	30	60-130	30
Vinyl Chloride	0.20	0.50 ug/L			31-165	30	58-145	30
Xylenes, Total	0.60	1.5 ug/L						
Chlorodifluoromethane (Freon 22)	0.20	0.50 ug/L				30		30
Surr: SURR: 1,2-Dichloroethane-d4			69-130					
Surr: SURR: Toluene-d8			81-117					
Surr: SURR: p-Bromofluorobenzene			79-122					
ISTD: Fluorobenzene								
ISTD: Chlorobenzene-d5								
ISTD: 1,2-Dichlorobenzene-d4								

APPENDIX E – Standard Operating Procedures, Laboratory

Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)

References: **Method 8260C**, SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, 2006.

Method 5035A, SW-846, Closed System Purge & Trap and Extraction for Volatile Organics in Soil and Waste Samples. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Draft Revision I, July 2002.

Method 5030B, Purge & Trap for Aqueous Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December, 1996.

Method 5030C, Purge & Trap for Aqueous Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update IV, May, 2003.

1. Scope and Application

Matrices: Method 8260 is used to determine volatile organic compounds in a variety of solid waste matrices. This method is applicable to nearly all types of samples, regardless of water content, including various air sampling trapping media, ground and surface water, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments.

Definitions: Refer to Alpha Analytical Quality Manual.

The compounds listed in Table 5 may be determined by this method.

There are various techniques by which these components may be introduced into the GC/MS system. Purge-and-trap, by Methods 5030C (aqueous samples) and 5035A (solid and waste oil samples), is the most commonly used technique for volatile organic analytes. However, other techniques are also appropriate and necessary for some analytes. One technique is direct injection of an aqueous sample (concentration permitting).

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one or more of the following laboratory personnel before performing the modification: Area Supervisor, Department Supervisor, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of analysts experienced in the operation of the gas chromatograph/mass spectrometers and in the interpretation of mass spectra and their use as a quantitative tool. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability.

2. Summary of Method

The volatile compounds are introduced into the gas chromatograph by the purge-and-trap method or by direct injection. The analytes are introduced to a narrow-bore capillary column for analysis. The Gas Chromatograph (GC) is temperature-programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced to the GC.

Analytes eluted from the capillary column are introduced into the mass spectrometer via a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with

the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard, comparing sample response to the calibration standards.

2.1 Method Modifications from Reference

None.

3. Reporting Limits

Table 1 lists our typical reporting limits.

4. Interferences

4.1 Impurities in the purge gas, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be free from contamination under the conditions of the analysis. Running laboratory reagent blanks as described in Section 9.1 and 10.3 demonstrates the system is free of contamination. The use of non-Teflon plastic tubing, non-Teflon thread sealants, or flow controllers with rubber components in the purge and trap system must be avoided.

4.2 Sample contamination occurs by diffusion of volatile organics (particularly fluorocarbons and methylene chloride) through the septum seal into the sample during shipment and storage. A trip blank or a field reagent blank prepared from reagent water and carried through the sampling and handling protocol serves as a check on such contamination.

4.2.1 Storage blanks shall be analyzed if contamination is suspect. If contamination is confirmed by positive detections in the sample storage blanks, all data from samples contained in the relative refrigerator or freezer shall be evaluated for possible contamination. If the samples contain suspected contamination, the Client Services department shall be notified in order to contact the necessary clients regarding the contamination. Samples shall be reanalyzed if so desired by the client. If suspected contamination is not confirmed by storage blanks, no further action shall be pursued concerning said blanks. It is recommended that further action be taken to determine the possible cause of suspected contamination.

4.3 Contamination by carry-over can occur whenever high level and low level samples are sequentially analyzed. Whenever a highly concentrated sample is being encountered, it should be followed by an analysis of reagent water (instrument blank) to check for potential contamination. If carry-over is suspected, then numerous instrument blanks may be required; additionally all affected samples are rerun for confirmation. In case of severe contamination, preventive maintenance of the entire system may be required.

5. Health and Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

The following method analytes have been tentatively classified as known or suspected human or mammalian carcinogens: benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichloroethane, hexachlorobutadiene, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, chloroform, 1,2-dibromoethane, tetrachloroethene, trichloroethene, and vinyl chloride. Pure standard materials and stock standard solutions of these compounds should be handled in a hood. A NIOSH/MESA approved toxic gas respirator should be worn when the analyst handles high concentrations of these toxic compounds.

5.1 Lab coats, safety glasses, and gloves must be worn when handling samples, standards, or solvents.

5.2 All stock solution standard preparation must be performed in the volatiles hood. Initial calibration, continuing calibration, laboratory control sample and client sample dilutions do not need to be performed in the hood.

5.3 All expired standards must be placed into the waste bucket in the lab for future disposal. The container must be labeled properly with hazard warning labels indicating the container contents.

5.4 Bottles containing Methanol must be stored in the flammables cabinet.

6. Sample Collection, Preservation, Storage, Shipping and Handling

6.1 Sample Collection and Preservation

6.1.1 Aqueous Samples

Grab samples are collected in standard 40mL glass screw-cap vials with Teflon lined silicon septa (VOA vial). Two or more VOA vials should be filled per sample location. EPA Method 8260 requires that samples be acidified to eliminate the possibility of biological degradation. Unless otherwise directed for project-specific reasons, all VOA vials are delivered to the client with approximately 2 – 4 drops of 1:1 HCl added to the vial, which is sufficient to adjust the pH of the sample to < 2. Prepared trip blanks are provided to the client to accompany field samples for QC purposes.

Fill the sample vial to the point of overflowing so that no headspace is contained within. Samples must be introduced into the vials gently to reduce agitation, which might drive off volatile compounds or cause loss of the HCl preservative.

Seal the bottle so that no air bubbles are in the VOA vial. If preservative has been added, shake vigorously for one minute. Invert the bottle and tap to check for air bubbles. Recollect the samples if any air bubbles are present.

Maintain the hermetic seal on the VOA vial until time of analysis.

6.1.2 Soil Samples

The recommended sampling method for soil samples is EPA 5035A. Method 5035A provides for two distinct sampling procedures, depending on the required reporting limits and suspected or known concentration levels of target analytes. These methods are referred to as the High Level and Low Level methods. Both are listed below, but depending on the samples only one of the methods may be required. If concentration levels are unknown, it is recommended that samples be collected using both procedures. The Lab will analyze the high level sample first, followed by the low level sample if the

results from the high level analysis show that the sample is clean or contains analytes at low levels. The typical reporting levels of the two methods are listed in Table 1.

6.1.2.1 High Level Soil Samples

Collect sample in a standard 40mL glass screw-cap vial with Teflon lined silicon septa (VOA vial). The vial is provided containing 15mL of Purge and Trap Grade methanol, and is labeled and weighed prior to addition of sample. Record the weight of the vial with methanol on the vial label. Prepared trip blanks are provided to the client to accompany field samples for QC purposes.

Approximately 15g of soil is added to the vial in the field, making sure that the sample is completely covered by the methanol.

Maintain the hermetic seal on the VOA vial until the time of analysis.

An additional sample of the soil must also be obtained (without methanol) to be used for the determination of soil moisture content to allow for the calculation of the dry weight results, and to calculate the methanol dilution effect. (See Sections 11.1.2.2.2 and 11.1.2.2.3)

6.1.2.2 Low Level Soil Samples

Collect sample in a standard 40mL glass screw-cap vials with Teflon lined silicon septa (VOA vial). Two samples should be taken per sample location. Vials are provided containing a magnetic stirring bar and 5 mL of either 200g/L sodium bisulfate solution or water, prepared by a certified vendor. These vials are labeled and weighed prior to addition of sample. Record the weight of the vial with the stirring bar and preservative on the vial label.

Approximately 5g of soil is added to the vial in the field, making sure that the sample is completely covered by the sodium bisulfate solution or water.

Maintain the hermetic seal on the VOA until the time of analysis.

6.1.2.3 Oil Samples

Collect sample in unpreserved 40mL vial or unpreserved jar.

Maintain the hermetic seal on the VOA until the time of analysis.

6.2 Sample Handling and Storage

Document client specific sample handling, preservation and collection criteria in the project file. The laboratory Log-in staff documents sample temperature at the time of receipt.

Record deviations from this SOP or client specific criteria on the chain of custody form.

Record holding time exceedance, improper preservation and observed sample headspace on the nonconformance report form.

6.2.1 Aqueous Samples

Ice or refrigerate all samples from the time of collection until analysis, maintaining the sample temperature between 1 and 4 °C. Sample receiving personnel note on the sample delivery group form when samples received at the laboratory are not within the temperature criteria. If more than one vial is received for a sample the vials are stored in separate refrigerators. Storing the vials apart provides a useful check if laboratory contamination of a sample is suspected. Samples must be analyzed within 14 days of

collection. Unpreserved samples requiring aromatic analysis must be analyzed within 7 days of collection.

6.2.2 High Level Soil and Oil Samples

Ice or refrigerate all samples from the time of collection until analysis, maintaining the sample temperature between 2 and 6 °C. Sample receiving personnel note on the nonconformance report form when samples received at the laboratory are not within the temperature criteria.

6.2.3 Low Level Soil Samples

Ice or refrigerate samples preserved with water or sodium bisulfate from the time of collection until analysis, maintaining the sample temperature between 2 and 6 °C. Samples preserved with water are to be immediately frozen after sampling. Sample receiving personnel note on the nonconformance report form when samples received at the laboratory are not within the temperature criteria.

6.3 Sample Shipping

Samples requiring shipment to the laboratory are shipped in ice-packed coolers via an overnight delivery service in accordance with applicable Department of Transportation regulations.

7. Equipment and Supplies

7.1 Purge and Trap System (For Aqueous samples, High Level Soils and Oils): The purge-and-trap system consists of two separate pieces of equipment: a purging device (autosampler) (Varian Archon/8100, Tekmar Solatek, EST Centurion) coupled to the desorber (concentrator) (Tekmar Velocity or EST Encon).

7.1.1 Purge gas

7.1.1.1 Helium, analytical grade (99.999%).

7.1.1.2 Nitrogen, analytical grade (99.999%).

7.1.2 The purging device is configured with 25 mL sample purge tubes, and the purge gas is introduced at the bottom of the water column as finely divided bubbles

7.1.3 The trap used in the desorber is typically a Supelco “K” trap. Different traps may be used if equivalent performance is demonstrated.

7.1.4 The desorber is capable of rapidly heating the trap to 260^{o}C. The trap is not heated above manufacturer’s specifications

7.2. Purge and Trap System (For Low Level Soil Samples): The purge and trap system consists of two separate pieces of equipment: a purging device (autosampler) coupled to the desorber (concentrator) (Varian Archon/8100, Tekmar Solatek, EST Centurion with EST Encon, Tekmar Velocity, or equivalents).

7.2.1. Purge gas = Helium or Nitrogen, analytical grade (99.999%).

7.2.2. The autosampler purging device is a closed system, designed to accept the 40mL VOA vials. The VOA vial, containing the soil sample, water (or sodium bisulfate), and stirring bar is placed into the autosampler tray. The instrument automatically adds reagent water, internal standards, and surrogates to the unopened VOA vial. The vial

is heated to 40 °C, and the purge gas is introduced into the aqueous portion to purge the volatile components onto the trap.

7.2.3. The trap used in the desorber is typically a Supelco "K" trap. Different traps may be used if equivalent performance is demonstrated.

7.2.4. The desorber is capable of rapidly heating the trap to 260 °C. The trap is not heated above manufacturer specifications.

7.3 Gas Chromatography/Mass Spectrometer/Data System:

7.3.1 Gas Chromatograph, Agilent 6890/7890 or equivalent: An analytical system complete with a temperature-programmable gas chromatograph with appropriate interface for sample introduction device. The system includes all required accessories, including syringes, analytical columns, and gases. The capillary column is directly coupled to the source of the GC/MS system.

7.3.2 Typical Gas Chromatographic Columns:

7.3.2.1 Column 1: Restek 502.2, 40 meter, 0.18mm ID, or equivalent.

7.3.2.2 Column 2: Restek RTX-VMS, 30 meter, 0.25mm ID, or equivalent

7.3.3 Mass Spectrometer, Agilent 5973/5975/5978 or equivalent: Scanning from 35 to 300 amu every 2 seconds or less, using 70 volts (nominal) electron energy in the electron impact ionization mode. The mass spectrometer must be capable of producing a mass spectrum for 4-Bromofluorobenzene (BFB) which meets all of the criteria in Table 3, when 50ng of the GC/MS tuning standard (BFB) are injected through the GC. For all SIM analysis, the mass spectrometer must also be able to acquire data in a dual acquisition mode (SIM and full scan).

7.3.4 Data System: Hewlett-Packard EnviroQuant software is used for data acquisition, and allows the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program.

Thruput Target 4.12 software or EnviroQuant E.02.02 (or equivalent) is used for data processing, and allows searching of any GC/MS data file for ions of a specified mass, and plotting such ion abundances versus time or scan-number.

The most recent version of the EPA/NIST Mass Spectral Library is loaded onto the Target / EnviroQuant data system.

7.4 Wiretrol or Micro syringes: 10µL - 1,000µL.

7.5 Syringes: 5mL, 10mL, or 25mL, glass with Luerlock tip.

7.6 Balances: Top-loading**,** capable of weighing 0.01g.

7.7 Vials: 2mL, 4mL.

7.8 Disposable Pipets.

7.9 Volumetric Flasks: Class A, appropriate sizes, with ground-glass stoppers.

7.10 Eppendorf Pipets.

8. Reagents and Standards

Reagent grade organic chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all organic reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

Great care must be taken to maintain the integrity of all standard solutions. Standards in methanol are stored at –10ºC or less, in amber vials with PTFE-lined screw-caps.

8.1 Organic-free Reagent Water:

All references to water in this method refer to organic-free reagent water, which is tap water passed through activated carbon and air bubbled through.

8.2 Methanol:

Purge and Trap Grade or equivalent. Store in flammables cabinet.

8.3 Stock Solutions:

All stock standard solutions are purchased from commercial vendors as ampule certified solutions. When an ampule stock solution is opened, it is transferred to a labeled amber screw-cap vial with minimal headspace. The expiration date of the stock solution is either the vendor specified expiration date or 6 months from the date the ampule was opened, whichever is sooner. Typical stock standard concentrations are listed in Table 4.

8.4 Intermediate Standards: Intermediate standards are prepared volumetrically by diluting the appropriate stock standard(s) with methanol. Initial Calibration solutions expire 2 months from the date of preparation, or sooner if daily continuing calibration checks do not achieve the method acceptance criteria. If the Intermediate Standards are used as a second source to verify a valid Initial Calibration solution, there is no expiration date.

8.4.1 Internal Standard Solutions:

The internal standards are Fluorobenzene, Chlorobenzene-d_5, and 1,4-Dichlorobenzene-d_4. The intermediate IS solution is prepared by diluting the stock solution(s) with methanol to a concentration of 100 µg/mL. The appropriate amount of IS solution is added to the water or soil sample or QC sample to achieve a final concentration of 100 ng/sample or standard. Internal standard is added at the same concentration to all standards, samples, and QC samples.

8.4.2 Surrogate Standard Solutions:

The surrogate standards are Dibromofluoromethane, 1,2-Dichloroethane-d_4, Toluene-d_8, and 4-Bromofluorobenzene. The intermediate surrogate solution is prepared by diluting the stock solution(s) with methanol to a concentration of 100 µg/mL. The appropriate amount of surrogate solution is added to the water or soil sample or QC sample to achieve a final concentration of 100 ng/sample.

8.4.3 Target Compound Solutions:

The target analytes routinely reported by this method are listed in the beginning of this SOP. The intermediate target compound solutions are prepared by diluting the stock solution(s) with methanol. This set of solutions, at concentrations of 200 µg/mL, is used for preparation of the calibration standards.

8.4.4 4-Bromofluorobenzene (BFB) Tune solution:

A solution containing BFB at a concentration of 50 µg/mL is prepared by volumetrically diluting the BFB stock solution. 1 µL of this solution is direct-injected or purged into the GC/MS system to verify system performance prior to any standard or sample analysis.

8.5 Calibration Standards:

There are two types of calibration standards used for this method – initial calibration standards and calibration verification standards.

8.5.1 Initial Calibration Standards:

Initial calibration standards can be prepared at the levels listed in Table 4 (other/different levels are allowed). The Initial Calibration needs to have a minimum of 5 standards, 6 if a quadratic curve fit is used. Prepare these solutions in organic-free reagent water. The standards correspond to the range of concentrations found in typical samples and do not exceed the working range of the GC/MS system. Initial calibration should be mixed from fresh stock standards and dilution standards when generating an initial calibration curve.

8.5.2 Initial Calibration Verification Standard (ICV):

The initial calibration verification standard is at the same concentration as the level 3 initial calibration standard. This standard is made from a second source than the Initial Calibration Standards.

8.5.3 Continuing Calibration Verification Standard:

The continuing calibration verification standard, or calibration check standard, should be analyzed near the action level of the project. Since most projects are focused on achieving low reporting limits, the continuing calibration verification standard is at the same concentrations as the level 3 initial calibration standard. This standard is run at the beginning of each analytical sequence, following the BFB tune standard, to verify system performance.

9. Quality Control

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

9.1 Blank(s)

Blank samples must be matrix specific, i.e. methanol samples need to have methanol in the blank; sodium bisulfate samples need to have a sodium bisulfate blank analyzed; TCLP samples need a TCLP blank.

Analyze a matrix-specific blank each day prior to sample analysis to demonstrate that interferences from the analytical system are under control. The blank must contain the internal standards and surrogates.

Analyze the reagent water blank from the same source of water used for preparing the standards, QC samples and making sample dilutions. The method blank must not contain any target analytes at or above the compound reporting limits.

9.2 Laboratory Control Sample (LCS)/ Laboratory Control Sample Duplicate (LCSD)

A LCS/LCSD pair is analyzed at the beginning of each analytical sequence. Since the LCS contains the same compounds at the same concentrations as the continuing calibration check standard, the same analysis is used to satisfy both QC elements. The LCS/LCSD acceptance criteria are based on in-house control limits, unless specified by project/regulation.

9.3 Initial Calibration Verification (ICV)

Refer to Section 10.2.5.

9.4 Continuing Calibration Verification (CCV)

Refer to Section 10.4.4.

9.5 Matrix Spike/ Matrix Spike Duplicate

Upon Client Request, a matrix spike/matrix spike duplicate pair may be analyzed with each batch of 20 or less samples. The MS/MSD are sample aliquots spiked with the target compounds at the same concentration as the continuing calibration standard. The MS/MSD acceptance criteria are based on in-house control limits. If the MS/MSD does not meet the criteria, but the LCSD does, the failure may be attributed to sample matrix. Report the MS/MSD, including a narrative sheet for inclusion with the client report.

9.6 Laboratory Duplicate

Not applicable.

9.7 Method-specific Quality Control Samples

9.7.1 Internal Standards

Area counts of the internal standard peaks in all samples and QC samples must be between 50-200% of the areas of the internal standards in the QC check standard.

If any individual percent recovery falls outside the range, that parameter has failed the acceptance criteria. For calibration standards, CCVs, LCS/LCSD or blanks the internal standard must be within the range for data to be reported to the clients. For samples, matrix spikes and duplicates: if the data is not within the range, the sample is rerun to confirm that the failure is due to sample matrix. A nonconformance report form is completed to ensure client notification and reporting if matrix effect is confirmed.

9.7.2 Surrogates

Surrogates are added to each field sample and QC sample. The laboratory must evaluate surrogate recovery data from individual samples versus the surrogate control limits developed by the laboratory. The surrogate acceptance criteria are listed in Table 2. Since the SIM analysis is acquired in dual mode, the surrogates from the full scan are used to evaluate the entire sample (SIM and full scan).

9.8 Method Sequence

In a 12-hour period, the typical analytical sequence is as follows:

- BFB
- QC Check Standard/Laboratory Control Sample/LCSD
- Method Blank
- Samples
- MS/MSD (upon Client request, may be run any time after the Method Blank)

10. Procedure

10.1 Equipment Set-up

Typical instrument operating conditions are listed below. Alternate conditions are allowed, as long as method performance criteria can be met.

10.1.1 GC Conditions:

Temperature 1:	35°C	Carrier gas:	Helium, 99.999%
Hold Time 1:	4 minutes	Carrier mode:	Constant flow
Ramp 1:	6°C/minute	Carrier flow:	1 mL/minute
Temperature 2:	150°C		
Hold Time 2:	0 minutes		
Ramp 2:	8°C/minute		
Temperature 3:	220°C		
Final Time:	1 minute		

10.1.2 MS Conditions:

Mass scan range:	35 – 260 amu
Scan time:	0.5 minutes/scan
Source temperature:	230°C

10.1.3 Velocity Concentrator Purge and Trap Conditions:

Purge time:	11 minutes
Dry purge:	2 minutes
Desorb preheat:	250°C
Desorb temp:	255°C
Desorb time:	2 minutes
Bake temp:	290°C
Bake time:	10 minutes

10.1.4 Encon Concentrator Purge and Trap Conditions:

Purge time:	11 minutes
Dry purge:	1 minute
Desorb preheat:	245°C
Desorb temp:	255°C
Desorb time:	1 minute
Bake temp:	270°C
Bake time:	10 minutes

10.2 Initial Calibration

10.2.1 The initial calibration is performed at a minimum of five (5) concentration levels listed in Table 4, the low level of the either at or below the reporting limit. The calibration is performed using instrument conditions listed in Section 10.1.

BFB must be analyzed prior to analysis of the initial calibration standards, and must pass the criteria listed in Table 3. The mass spectrum of BFB should be acquired in the following manner:

(1) Three scans (the peak apex scan, the scan immediately preceding the apex and the scan immediately following the apex) are acquired and averaged.
(2) Background subtraction is performed using a single scan of no more than 20 scans prior to the elution of BFB.

This is done automatically with the ThruPut Target / Enviroquant software.

10.2.1.1 Low Level/High Level Soil Curve on Archon or Centurion: To prepare a calibration standard, add the appropriate volume of standard solution(s) to a 50mL volumetric flask using a micro syringe. Remove the needle quickly and mix by inverting the flask 3 times. Pour several mLs of the aqueous standard into the waste vessel, then gently fill a 5mL syringe with standard and transfer to a 40mL VOA vial containing a magnetic stir bar. Load the vial onto autosampler.

10.2.1.2 Aqueous/High Level Soil Curve on Solatek or Centurion: To prepare a calibration standard, add the appropriate volume of standard solution(s) to a 100mL volumetric flask using a micro syringe. Remove the needle quickly and mix by inverting the flask 3 times. Pour several mLs of the aqueous standard into the waste vessel, then gently fill a 40mL VOA vial to the top. Load the vial onto the autosampler.

10.2.2 Establish the GC operating conditions by loading the appropriate GC method. Typical instrument conditions are listed in Section 10.1. The same operating conditions are used for calibration and sample analyses. Create the analytical sequence using the HP Enviroquant data acquisition software.

Relative Response Factors: The internal standard calibration technique is used. In each calibration standard, calculate the relative response factor for each analyte and the relative standard deviation (RSD) of the response factors using the Target / Enviroquant data processing software. The response factors are calculated using the areas of the characteristic (quantitation) ion for each target analyte and internal standard. The calculations are performed automatically using the Target / Enviroquant software, using the formulae listed in Alpha's Quality Manual.

10.2.3 Initial Calibration Criteria: The following sections outline the method acceptance criteria for an initial calibration curve. All criteria must be met for the calibration to be deemed acceptable, and for sample analysis to proceed.

10.2.3.1 Relative Standard Deviation Criteria: If the RSD for each target analyte is less than or equal to 20%, then the response for this compound is considered linear over the calibration range and the mean calibration factor can be used to quantitate sample results. If the 20% RSD criterion is not met for an analyte linear regression may be used if **r** $\geq$ 0.990, weighted linear with a weighting factor of 1/SD2 and r > 0.990, or quadratic fit if $\mathbf{r^2} \geq 0.995$. A minimum of six points is required and the low point of the calibration must be re-quantitated and recover within 70-130% to be deemed acceptable. The calibration must be repeated for any compounds that fail. If more than 10% of the compounds exceed the 20% RSD limit and do not achieve the minimum correlation coefficient for alternative curve fits, sample analysis cannot proceed.

10.2.3.2 Minimum Response Factors: Table 1 lists the suggested minimum response factors for the most common analytes. Each calibration level must be evaluated against the specified criteria. Analytes that fall below the criteria, but are greater than or equal to 0.05, are narrated for inclusion on the final report. There are certain very poor purgers (1,4-Dioxane, Acrolein, ketones, alcohols and other water soluble compounds) that should meet a 0.001 response factor. If an analyte falls below 0.05 (or 0.001 for 1,4-Dioxane, Acrolein, ketones, alcohols and other water soluble compounds), then corrective action must be taken to resolve the problem before analysis can proceed.

10.2.4 Evaluation of Retention Times: The relative retention times used for identification of target analytes are +/- 0.06 RRT (Relative Retention Time) units, based on the most recent standard run. It has been determined that these limits work well, being wide enough to eliminate false-negative results while being tight enough to eliminate false positive results. Due to the selectivity of the mass spectrometer, compound identification is more definitive than when using a less selective detector.

10.2.5 Initial Calibration Verification: After each calibration and before the analysis of samples, an ICV must be analyzed at or near the midpoint of the curve. The ICV must be prepared using a different source than the Initial Calibration and must contain all target analytes. The percent recoveries must be between 70% and 130% for target analytes except for “difficult” analytes (Table 7), which must exhibit percent recoveries between 40% and 160%. Corrective action is required if greater than 10% of all analytes are outside the prescribed criteria.

10.3 Equipment Operation and Sample Processing

The same GC, MS, and Purge and Trap conditions used for the initial calibration must be employed for sample analysis. After verification of system performance by analysis of BFB, the continuing calibration standard and method blank, samples are analyzed and processed as described below.

10.3.1 Analysis of Samples

10.3.1.1 All samples are initially screened using Tekmar HT3 Static and Dynamic Headspace System.

10.3.1.2 Retrieve sample VOA vials from the sample refrigerator just prior to loading onto the purge and trap system. High level soil and oil samples must be shaken for 1 – 2 minutes to extract the volatile components into the methanol. Let the

sample settle prior to taking methanol aliquot. Low level soil sample should be shaken briefly to ensure that the stir bar is loose, and will spin on the Archon or Centurion unit.

10.3.1.3 Oil Samples:
Take 1g of sample and dilute to 10mL methanol in a volumetric flask. Invert or shake to ensure proper mixing. Transfer to 40mL VOA vial.

10.3.1.4 Low level soil samples: (Archon or Centurion)
Take the low level VOA vial and place directly into the rack of the Archon sampling unit. Surrogate and internal standards are added automatically by the Archon prior to sample purging.

10.3.1.5 Aqueous samples: (Solatek or Centurion)
Load the VOA vial directly on the sampling rack. Dilutions may be prepared volumetrically and poured into VOA vials ensuring there is no headspace left in the vial. The auto-sampler will then sample 10mL from the VOA vial.

10.3.1.6 High level soil and oil samples: (Archon/Solatek/Centurion)

Shake for 2 minutes, ensuring the methanol has completely penetrated the soil in the vial.

10.3.1.6.1 Through liquid path
Load a maximum of 430µL or appropriate dilution of the methanol into a half-full VOA vial. Fill the VOA vial up to the top with water and cap with no headspace. Allow the auto-sampler to sample 10mL out of the VOA vial which would be equivalent to injecting 100µL of the methanol extract. Prepare dilutions accordingly.

10.3.1.6.2 Through soil path
Into a VOA vial with a stir bar added, load 4.9mL of water plus a maximum of 100 µL of methanol or appropriate dilution of methanol extract from a 5mL luerlock syringe or wiretrol. Cap the vial and load onto the auto-sampler.

10.3.2 Qualitative Analysis:

10.3.2.1 The qualitative identification of each compound is based on retention time and on comparison of the sample mass spectrum with the reference mass spectrum. The reference mass spectrum must be generated by the laboratory on the same GC/MS system. The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum. Compounds are identified as present when the following criteria are met:

10.3.2.1.1 The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. The Target / Enviroquant data system is configured to make this check.

10.3.2.1.2 The relative retention time (RRT) of the sample component is within ±0.06 RRT units of the RRT of the standard component.

10.3.2.1.3 The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum. (Example: For an ion with an abundance of 50% in the reference spectrum, the corresponding abundance in a sample spectrum can range between 20% and 80%.)

10.3.2.1.4 Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs (i.e., m and p-xylene).

10.3.2.1.5 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component (i.e., a broadened peak with shoulder(s) or a valley between two or more maxima), appropriate selection of analyte spectra and background spectra is important.

10.3.2.1.6 Examination of extracted ion current profiles of appropriate ions can aid in the selection of spectra, and in qualitative identification of compounds. When analytes coelute (i.e., only one chromatographic peak is apparent), the identification criteria may be met, but each analyte spectrum will contain extraneous ions contributed by the coeluting compound.

10.3.2.2 For samples containing non-target analytes, a library search will be performed at client request. Compound identification will be classified as “tentative”, and the concentration will be reported as an estimate as no quantitative standards are run for these compounds.

1) Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.
2) The relative intensities of the major ions should agree within ±20%. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30 and 70%.)
3) Molecular ions present in the reference spectrum should be present in the sample spectrum.
4) Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.
5) Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or coeluting peaks.

10.3.3 Quantitative Analysis:

10.3.3.1 Quantitation of a target compound detected in a sample is performed automatically by the EnviroQuant data processing software, using the formulae

found in Alpha's Quality Manual. Either the average response factor or calibration curve will be used for sample quantitation, depending on how the particular analyte was processed in the initial calibration curve.

10.3.3.2 If non-target compounds are to be reported, the quantitation is performed automatically by the EnviroQuant software using the total area of the compound and the nearest internal standard, and assuming a relative response factor of 1.0.

10.4 Continuing Calibration

Calibration verification consists of three steps that are performed at the beginning of each 12-hour analytical shift.

10.4.2 Prior to the analysis of samples or calibration standards, inject or purge 1 µL (50 ng) of the 4-Bromofluorobenzene standard (Section 8.4.4) into the GC/MS system. The resultant mass spectra for the BFB must meet the criteria given in Table 3 before sample analysis begins.

10.4.3 The initial calibration curve for each compound of interest must be verified once every 12 hours prior to sample analysis. This is accomplished by analyzing the continuing calibration check standard (Section 8.5.3).

10.4.4 A method blank must be analyzed prior to any samples, typically immediately following the continuing calibration check standard, to ensure that the analytical system is free of contaminants. The method blank must not contain any target analytes at or above the required compound reporting limits.

10.4.5 The percent difference or drift for each target analyte must be less than or equal to 20% (30% for all SIM compounds). If greater than 20% of target analytes exceed the %D criteria corrective action must be taken prior to the analysis of samples. If less than or equal to 20% of compounds exceed the criteria, corrective action is not required.

10.4.6 The continuing calibration standard must also be evaluated for the suggested minimum response factor criteria, as specified in section 10.2.3.2

10.4.7 Internal Standard Retention Time:

The retention times of the internal standards in the calibration verification standard are evaluated after data acquisition. If the retention time for any internal standard changes by more than 30 seconds from that in the mid-point standard level of the most recent initial calibration sequence, then the chromatographic system must be inspected for malfunctions and corrections must be made, as required. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

10.4.8 Internal Standard Response:

If the area for any of the internal standards in the calibration verification standard changes by a factor of two (-50% to +100%) from that in the mid-point standard level of the most recent initial calibration sequence, the mass spectrometer must be inspected for malfunctions and corrections must be made, as appropriate. When corrections are made, re-analysis of samples analyzed while the system was malfunctioning is required.

10.5 Preventive Maintenance

Routine preventive maintenance should be performed on the analytical system. This includes replacement of GC septa and periodic rinsing or replacement of purge and trap tubes and sparge needles. The trap should be replaced every six months, or sooner if performance criteria cannot be met. Periodic cleaning (typically twice per year) of the mass spectrometer ion source is required. More frequent source cleaning may be needed, especially if dirty samples are analyzed.

If system performance deteriorates, additional maintenance may be required. This includes replacement of injector ports and seals, clipping several inches off of the front end of the GC column, or in extreme cases the replacement of the GC column. Flushing or replacement of purge and trap lines may be necessary if they become contaminated or develop active sites.

Perform routine preventative maintenance as described throughout this SOP. Record all maintenance in the instrument logbook.

11. Data Evaluation, Calculations and Reporting

11.1.1 LIMS Data Corrections

Please note that the Laboratory Information Management System (LIMS) automatically adjusts soil sample results to account for the % Total Solids of the sample (as determined per Alpha SOP/07-38) and the methanol preservation dilution effect.

11.1.2 Data Calculations

11.1.2.1 Results of Aqueous Sample Analysis:

$$Concentration\ (ug/L) = \frac{(Conc.)\ (Vp)\ (DF)}{(Vs)}$$

where:

Conc. = On-column concentration obtained from the quantitation report.
Vp = Volume purged, 10 mL is standard
Vs = Volume of sample purged
DF = Dilution factor, for manually prepared dilutions, not instrumental "dilutions".

11.1.2.2 Results of Sediment/Soil, Sludge, and Waste Analysis:

All solids including soils, sediments, and sludges must be reported on a dry-weight basis.

11.1.2.2.1 Low-Level Samples:

$$Concentration\ (ug/Kg) = \frac{(Conc.)\ (Vp)\ (DF)}{(W)\ (\%S)}$$

11.1.2.2.2 High-Level Samples:

$$\text{Concentration (ug/Kg)} = \frac{\text{(Conc.) (Vp) (5000) (DF)}}{\text{(W) (Ve) (\%S)}}$$

where:

Conc. = On-column concentration obtained from the quantitation report.
DF = Dilution factor, for manually prepared dilutions, not instrumental "dilutions".
Ve = Extract volume, mL
Vp = Volume purged, 5 mL is standard
W = Aliquot of sample (wet), g
%S = Sample % solid
5000 = Constant representing the final volume of the methanol extraction.

11.1.2.2.3 High-Level Samples Corrected for Total Water/Solvent Mixture (V_t):

Samples that are extracted prior to analysis in a water miscible solvent such as methanol are diluted by the total volume of the water/solvent mixture. The total mixture volume can only be calculated based on the sample moisture present as determined by the % moisture calculation.

$$\text{\% moisture} = \frac{\text{g of sample – g of dry sample}}{\text{g of sample}} \times 100$$

$$V_t = \frac{\text{[mL of solvent + (\%moisture x g of sample)]}}{100} \times 1000\text{mL/mL}$$

The calculated V_t value is now added to the volume of methanol in the sample (typically 5000µL), and the corrected concentration is calculated using the equation below:

$$\text{Corrected concentration (mg/Kg)} = \frac{\text{(Conc.) } (V_t + \text{methanol vol.}) \text{ (Vp) (DF)}}{\text{(W) (Ve) (\%S)}}$$

12. Contingencies for Handling Out-of-Control Data or Unacceptable Data

All batch and sample specific QC criteria outlined in section 10 are evaluated by the analyst prior to approval of the data. When any QC criteria fail, the cause for the failure must be identified and corrected. This may include instrument recalibration followed by sample reanalysis, sample cleanup, or sample re-extraction. If it is determined that the failure is due to sample matrix effects, a project narrative report is written by the analyst for inclusion in the data report. If there is insufficient sample volume to perform the re-analysis for confirmation, this is also noted in the narrative and included in the client report.

13. Method Performance

13.1 Method Detection Limit Study (MDL) / Limit of Detection Study (LOD) / Limit of Quantitation (LOQ)

The laboratory follows the procedure to determine the MDL, LOD, and/or LOQ as outlined in Alpha SOP/08-05. These studies performed by the laboratory are maintained on file for review.

13.2 Demonstration of Capability Studies

Refer to Alpha SOP/08-12 for further information regarding IDC/DOC Generation.

13.2.1 Initial (IDC)

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method, prior to the processing of any samples.

13.2.2 Continuing (DOC)

The analyst must make a continuing, annual, demonstration of the ability to generate acceptable accuracy and precision with this method.

14. Pollution Prevention and Waste Management

Refer to Alpha's Chemical Hygiene Plan and Waste Management and Disposal SOP for further pollution prevention and waste management information.

15. Referenced Documents

Chemical Hygiene Plan

SOP/08-05 MDL/LOD/LOQ Generation

SOP/08-12 IDC/DOC Generation

SOP/14-01 Waste Management and Disposal SOP

16. Attachments

TABLE 1: 8260 REPORTING LIMITS

TABLE 2: 8260 QC ACCEPTANCE CRITERIA

TABLE 3: BFB TUNING CRITERIA

TABLE 4: STANDARD SOLUTIONS and ICAL Levels

TABLE 5: 8260C Volatile Internal Standards with Corresponding Target Compounds and Surrogates Assigned for Quantitation

TABLE 6: 8260C Quantitation Ions

TABLE 7: Difficult Analytes

Table 1
Standard Reported Detection Limits
US EPA METHOD 8260C and 5035A/8260C

Analyte	Recommended Minimum Response Factor	RDL (µg/L)	RDL(µg/KG)(1)	RDL (µg/KG) (2)
Acetone (3,4,5)	0.100	5.0	10	250
Acrolein (5)		5.0	25	1250
Acrylonitrile (3,4)		5.0	5	200
Allyl Chloride (7)		N/A	5	250
Benzene (3,4,5)	0.500	0.5	1	50
Bromobenzene (3,4)		2.5	5	250
Bromochloromethane (3,4,5)		2.5	5	250
Bromodichloromethane (3,4,5)	0.200	0.5	1	50
Bromoform (3,4,5)	0.100	2.0	4	200
Bromomethane (3,4,5)	0.100	1.0	2	100
2-Butanone (3,4,5)	0.100	5.0	10	500
Butyl acetate (7)		N/A	5	50
n-Butyl benzene (3,4)		0.5	1	50
sec-Butyl benzene (3,4)		0.5	1	50
tert-Butyl benzene (3,4)		2.5	5	250
Carbon disulfide (3,4,5)	0.100	5.0	10	500
Carbon tetrachloride (3,4,5)	0.100	0.5	1	50
Chlorobenzene (3,4,5)		0.5	1	50
Chlorodifluoromethane (7)		N/A	5	250
Chloroethane (3,4,5)	0.100	1.0	2	100
2-Chloroethylvinyl ether (3)		10.0	20	1000
Chloroform (3,4,5)	0.200	0.75	1.5	75
Chloromethane (3,4,5)	0.100	2.5	5	250
o-Chlorotoluene (3,4)		2.5	5	250
Cyclohexane (5)	0.100	10	20	1000
Cyclohexanone		10	20	1000
p-Chlorotoluene (3,4)		2.5	5	250
cis-Decahydronaphthalene (7)		N/A	5	250
trans-Decahydronaphthalene (7)		N/A	5	250
n-Decane (7)		N/A	5	250
Dibromochloromethane (3,4,5)	0.100	0.5	1	50
1,2-Dibromo-3-chloropropane (3,4,5)	0.050	2.5	5	250
1,2-Dibromoethane (3,4,5)	0.100	2.0	5	250
Dibromomethane (3,4)		5.0	10	500
1,2-Dichlorobenzene (3,4,5)	0.400	2.5	5	250
1,3-Dichlorobenzene (3,4,5)	0.600	2.5	5	250
1,4-Dichlorobenzene (3,4,5)	0.500	2.5	5	250
1,4-Dichlorobutane (3,4)		5.0	10	500
trans-1,4-Dichloro-2-butene (3,4)		2.5	5	250

Dichlorodifluoromethane (3,4,5)		5.0	10	500
1,1-Dichloroethane (3,4,5)	0.200	0.75	1.5	75
1,2-Dichloroethane (3,4,5)	0.100	0.5	1	50
1,1-Dichloroethene (3,4,5)	0.100	0. 5	1	50
cis-1,2-Dichloroethene (3,4,5)	0.100	0.5	1	50
trans-1,2-Dichloroethene (3,4,5)	0.100	0.75	1.5	75

Table 1 (continued)

Standard Reported Detection Limits

US EPA METHOD 8260C and 5035A/8260C

Analyte	Recommended Minimum Response Factor	RDL (µg/L)	RDL(µg/KG)(1)	RDL (µg/KG) (2)
1,2-Dichloropropane (3,4,5)	0.100	1.75	3.5	175
1,3-Dichloropropane (3,4)		2.5	5	250
2,2-Dichloropropane (3,4)		2.5	5	250
1,1-Dichloropropene (3,4)		2.5	2.5	250
cis-1,3-Dichloropropene (3,4,5)	0.200	0.5	1	50
p-Diethylbenzene (4)		2.0	4	200
Diisopropyl Ether (6)		2.0	4	200
1,4-Dioxane (5) (non-SIM)		250	100	5000
trans-1,3-Dichloropropene (3,4,5)	0.200	0.5	1	50
Ethanol (7)		N/A	1000	50000
Ethyl acetate		10.0	20	1000
Ethylbenzene (3,4,5)	0.100	0.5	1	50
Ethyl ether (3,4)		2.5	5	250
4-Ethyltoluene (4)		2.0	4	200
Ethyl methacrylate (3,4)		5.0	10	500
Ethyl-Tert-Butyl-Ether (6)		2.0	4	200
Freon-113 (5)		10.0	20	1000
n-Heptane (7)		N/A	5	250
Hexachlorobutadiene (3,4)		0.5	5	250
Hexachloroethane (7)		N/A	5	250
Hexane		1.0	1.0	50
2-Hexanone (3,4,5)	0.100	5.0	10	500
Iodomethane		5.0	5.0	250
Isopropyl Alcohol (IPA)		25		
Isopropylbenzene (3,4,5)	0.100	0.5	1	50
p-Isopropyltoluene (3,4)		0.5	1	50
Limonene (7)		N/A	5	250
Methyl Acetate (5)	0.100	20	20	1000
Methylene chloride (3,4,5)	0.100	3.0	10	500
Methyl Cyclohexane (5)	0.100	20	4	200
Methyl isothiocyanate (7)		N/A	5	250
Methyl Methacrylate		1.0	5	250

4-Methyl-2-pentanone (3,4,5)	0.100	5.0	10	500
Methyl-tert-butyl-ether (3,4,5)	0.100	1.0	2	100
Naphthalene (3,4)		2.5	5	250
Nitrobenzene (7)		N/A	5	250
2-Nitropropane (7)		N/A	5	250
n-Nonane (7)		N/A	5	250
n-Octane (7)		N/A	5	250
n-Butanol (5)		100	200	10000
n-Propylbenzene (3,4)		0.5	1	50
n-Propyl bromide		5.0		
Pentachloroethane		2.0	N/A	N/A
Styrene (3,4,5)	0.300	1.0	2	100
Tert-Butyl Alcohol (5)		30	100	5000
Tertiary-Amyl Methyl Ether (6)		2.0	4	200
Analyte	**Recommended Minimum Response Factor**	**RDL (µg/L)**	**RDL(µg/K**	**RDL(µg/K**
1,1,1,2-Tetrachloroethane (3,4)		0.5	1	50
1,2,4,5-Tetramethylbenzene (4)		2.0	4	200
1,1,2,2-Tetrachloroethane (3,4,5)	0.300	0.5	1	50
Tetrachloroethene (3,4,5)	0.200	0.5	1	50
Tetrahydrofuran (3)		10.0	20	1000
Toluene (3,4,5)	0.400	0.75	1	75
1,2,3-Trichlorobenzene (3,4,5)		2.5	5	250
1,2,4-Trichlorobenzene (3,4,5)	0.200	2.5	5	250
1,3,5-Trichlorobenzene (6)		2.0	5	250
1,1,1-Trichloroethane (3,4,5)	0.100	0.5	1	50
1,1,2-Trichloroethane (3,4,5)	0.100	0.75	1.5	75
Trichloroethene (3,4,5)	0.200	0.5	1	50
Trichlorofluoromethane (3,4,5)	0.100	2.5	5	250
1,2,3-Trichloropropane (3,4)		5.0	10	500
1,2,4-Trimethylbenzene (3,4)		2.5	5	250
1,3,5-Trimethylbenzene (3,4)		2.5	5	250
n-Undecane (7)		N/A	5	250
Vinyl acetate (3,4)		5.0	10	500
Vinyl chloride (3,4,5)	0.100	1.0	2	100
m/p-Xylenes (3,4,5)	0.100	1.0	2	100
o-Xylene (3,4,5)	0.300	1.0	2	100
1,4-Dioxane (5) SIM		3.0		
1,1,2,2-Tetrachloroethane SIM		0.1		

(1) Detection Limits are for Low-level Aqueous preserved samples.

(2) Detection Limits are for High-level Methanol preserved samples.
(3) Analyte reported by standard 8260 reporting list.
(4) Analyte reported by New York TCL reporting list.
(5) Analyte reported by New Jersey TCL reporting list.
(6) Analyte reported for New Hampshire in addition to standard 8260 reporting list.
(7) Analyte only reported for New York TCL report upon client request.

Note: Reporting Limits are based on standard 8260 reporting list, RL's may vary for New York and New Jersey reporting lists.

Table 2

QUALITY CONTROL ACCEPTANCE CRITERIA

Surrogate Spike Percent Recovery	Aqueous Limits		Soil Limits	
	Lower Control Limit	Upper Control Limit	Lower Control Limit	Upper Control Limit
1,2-Dichloroethane-d_4	70%	130%	70%	130%
4-Bromofluorobenzene	70%	130%	70%	130%
Toluene-d_8	70%	130%	70%	130%
Dibromofluoromethane	70%	130%	70%	130%

Table 3

BFB (4-BROMOFLUOROBENZENE) MASS INTENSITY CRITERIA

m/z	Required Intensity (relative abundance)
50	15 to 40% of m/z 95
75	30 to 60% of m/z 95
95	Base peak, 100% relative abundance
96	5 to 9% of m/z 95
173	Less than 2% of m/z 174
174	Greater than 50% of m/z 95
175	5 to 9% of m/z 174
176	Greater than 95% but less than 101% of m/z 174
177	5 to 9% of m/z 176

Table 4

Stock Standard Concentrations and Suggested Calibration Concentration Levels

Soil	Stock (µg/mL)	Level 0 (ug/kg)	Level 1 (ug/kg)	Level 1.5 (ug/kg)	Level 2 (ug/kg)	Level 3 (ug/kg)	Level 4 (ug/kg)	Level 5 (ug/kg)	Level 6 (ug/kg)	Level 7 (ug/kg)	Level 8 (ug/kg)
Fluorobenzene	2500	20	20	20	20	20	20	20	20	20	20
Dichlorodifluoromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Chlorodifluoromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Chloromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Vinyl chloride	2000	0.5	1	2	4	20	40	60	100	200	300
Bromomethane	2000	0.5	1	2	4	20	40	60	100	200	300
Chloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
Trichlorofluoromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Ethyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
Ethanol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
1,1-Dichloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
Carbon disulfide	2000	0.5	1	2	4	20	40	60	100	200	300
Freon-113	2000	0.5	1	2	4	20	40	60	100	200	300
Iodomethane	2000	0.5	1	2	4	20	40	60	100	200	300
Acrolein	2000	0.5	1	2	4	20	40	60	100	200	300
Allyl chloride	2000	0.5	1	2	4	20	40	60	100	200	300
Methylene chloride	2000	0.5	1	2	4	20	40	60	100	200	300
Isopropyl alcohol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
Acetone	2000	0.5	1	2	4	20	40	60	100	200	300
trans-1,2-Dichloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
Methyl acetate	2000	0.5	1	2	4	20	40	60	100	200	300
Hexane	2000	0.5	1	2	4	20	40	60	100	200	300
Methyl tert-butyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
tert-Butyl alcohol	2000	2.5	5	10	20	100	200	300	500	1000	1500
Diisopropyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
1,1-Dichloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
Halothane	2000	0.5	1	2	4	20	40	60	100	200	300
Acrylonitrile	2000	0.5	1	2	4	20	40	60	100	200	300
Ethyl tert-butyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
Vinyl acetate	2000	0.5	1	2	4	20	40	60	100	200	300
cis-1,2-Dichloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
2,2-Dichloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
Bromochloromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Cyclohexane	2000	0.5	1	2	4	20	40	60	100	200	300

Soil	Stock (µg/mL)	Level 0 (ug/kg)	Level 1 (ug/kg)	Level 1.5 (ug/kg)	Level 2 (ug/kg)	Level 3 (ug/kg)	Level 4 (ug/kg)	Level 5 (ug/kg)	Level 6 (ug/kg)	Level 7 (ug/kg)	Level 8 (ug/kg)
Chloroform	2000	0.5	1	2	4	20	40	60	100	200	300
Ethyl acetate	2000	0.5	1	2	4	20	40	60	100	200	300
Carbon tetrachloride	2000	0.5	1	2	4	20	40	60	100	200	300
Tetrahydrofuran	2000	0.5	1	2	4	20	40	60	100	200	300
Dibromofluoromethane	2500	20	20	20	20	20	20	20	20	20	20
1,1,1-Trichloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
2-Butanol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
2-Butanone	2000	0.5	1	2	4	20	40	60	100	200	300
1,1-Dichloropropene	2000	0.5	1	2	4	20	40	60	100	200	300
Heptane	2000	0.5	1	2	4	20	40	60	100	200	300
Benzene	2000	0.5	1	2	4	20	40	60	100	200	300
tert-Amyl methyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dichloroethane-d4	2500	20	20	20	20	20	20	20	20	20	20
1,2-Dichloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
Isobutyl alcohol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
2-Methyl-2-butanol	2000	2.5	5	10	20	100	200	300	500	1000	1500
Methyl cyclohexane	2000	0.5	1	2	4	20	40	60	100	200	300
Trichloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
n-Butanol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
Dibromomethane	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dichloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
4-penten-2-ol	2000	2.5	5	10	20	100	200	300	500	1000	1500
2-Chloroethyl vinyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
Bromodichloromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Ethyl acrylate	2000	0.5	1	2	4	20	40	60	100	200	300
Methyl methacrylate	2000	0.5	1	2	4	20	40	60	100	200	300
1,4-Dioxane	2000	N/A	40	80	200	1000	2000	3000	5000	10000	15000
cis-1,3-Dichloropropene	2000	0.5	1	2	4	20	40	60	100	200	300
Chlorobenzene-d5	2500	20	20	20	20	20	20	20	20	20	20
Octane	2000	0.5	1	2	4	20	40	60	100	200	300
Toluene-d8	2500	20	20	20	20	20	20	20	20	20	20
Toluene	2000	0.5	1	2	4	20	40	60	100	200	300
4-Methyl-2-pentanone	2000	0.5	1	2	4	20	40	60	100	200	300
Tetrachloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
2-Nitropropane	2000	0.5	1	2	4	20	40	60	100	200	300

Soil	Stock (µg/mL)	Level 0 (ug/kg)	Level 1 (ug/kg)	Level 1.5 (ug/kg)	Level 2 (ug/kg)	Level 3 (ug/kg)	Level 4 (ug/kg)	Level 5 (ug/kg)	Level 6 (ug/kg)	Level 7 (ug/kg)	Level 8 (ug/kg)
Chloropicrin	2000	N/A	50	N/A	100	200	300	400	500	600	700
trans-1,3-Dichloropropene	2000	0.5	1	2	4	20	40	60	100	200	300
Methyl isothiocyanate	2000	0.5	1	2	4	20	40	60	100	200	300
4-Methyl-2-pentanol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
Ethyl methacrylate	2000	0.5	1	2	4	20	40	60	100	200	300
1,1,2-Trichloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
Chlorodibromomethane	2000	0.5	1	2	4	20	40	60	100	200	300
1,3-Dichloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dibromoethane	2000	0.5	1	2	4	20	40	60	100	200	300
n-Butyl Acetate	2000	0.5	1	2	4	20	40	60	100	200	300
2-Hexanone	2000	0.5	1	2	4	20	40	60	100	200	300
Nonane	2000	0.5	1	2	4	20	40	60	100	200	300
Chlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Ethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,1,1,2-Tetrachloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
p/m Xylene	2000	1	2	4	8	40	80	120	200	400	600
o Xylene	2000	1	2	4	8	40	80	120	200	400	600
Styrene	2000	1	2	4	8	40	80	120	200	400	600
1,4-Dichlorobenzene-d4	2500	20	20	20	20	20	20	20	20	20	20
Bromoform	2000	0.5	1	2	4	20	40	60	100	200	300
Butyl acrylate	2000	0.5	1	2	4	20	40	60	100	200	300
Isopropylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
4-Bromofluorobenzene	2500	20	20	20	20	20	20	20	20	20	20
Bromobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Decane	2000	0.5	1	2	4	20	40	60	100	200	300
n-Propylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,4-Dichlorobutane	2000	0.5	1	2	4	20	40	60	100	200	300
1,1,2,2-Tetrachloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
4-Ethyltoluene	2000	0.5	1	2	4	20	40	60	100	200	300
2-Chlorotoluene	2000	0.5	1	2	4	20	40	60	100	200	300
1,3,5-Trimethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,3-Trichloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
trans-1,4-Dichloro-2-butene	2000	0.5	1	2	4	20	40	60	100	200	300
4-Chlorotoluene	2000	0.5	1	2	4	20	40	60	100	200	300

Soil	Stock (µg/mL)	Level 0 (ug/kg)	Level 1 (ug/kg)	Level 1.5 (ug/kg)	Level 2 (ug/kg)	Level 3 (ug/kg)	Level 4 (ug/kg)	Level 5 (ug/kg)	Level 6 (ug/kg)	Level 7 (ug/kg)	Level 8 (ug/kg)
tert-Butylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Pentachloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
n-Butyl methacrylate	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,4-Trimethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Limonene	2000	0.5	1	2	4	20	40	60	100	200	300
sec-Butylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
p-Isopropyltoluene	2000	0.5	1	2	4	20	40	60	100	200	300
1,3-Dichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,4-Dichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
trans-Decahydronaphthalene	2000	0.5	1	2	4	20	40	60	100	200	300
Undecane	2000	0.5	1	2	4	20	40	60	100	200	300
p-Diethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
n-Butylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Hexachloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
cis-Decahydronaphthalene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,4,5-Tetramethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dibromo-3-chloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
1,3,5-Trichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Nitrobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Hexachlorobutadiene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,4-Trichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Naphthalene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,3-Trichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,3-Dioxolane	2000	N/A	25	N/A	50	100	250	500	1000	1500	2000

Stock Standard Concentrations and Suggested Calibration Concentration Levels

Water	Stock (µg/mL)	Level 11 (ug/L)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L)	Level 6 (ug/L)	Level 7 (ug/L)	Level 8 (ug/L)	Level 9 (ug/L)	Level 10 (ug/L)
							Optional		Optional		Optional	
Fluorobenzene	2500	10	10	10	10	10	10	10	10	10	10	10
Dichlorodifluoromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Chloromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Vinyl chloride	2000	0.2	0.5	2	10	30	50	80	100	120	160	200
Bromomethane	2000		0.5	2	10	30	50	80	100	120	160	200
Chloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
Trichlorofluoromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Ethyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
Ethanol	2000		0.5	2	10	30	50	80	100	120	160	200
1,1-Dichloroethene	2000		0.5	2	10	30	50	80	100	120	160	200
Carbon disulfide	2000		0.5	2	10	30	50	80	100	120	160	200
Freon-113	2000		0.5	2	10	30	50	80	100	120	160	200
Iodomethane	2000		0.5	2	10	30	50	80	100	120	160	200
Acrolein	2000		0.5	2	10	30	50	80	100	120	160	200
Methylene chloride	2000		0.5	2	10	30	50	80	100	120	160	200
Isopropyl alcohol	2000		2.5	10	50	150	250	400	500	600	800	1000
Acetone	2000		0.5	2	10	30	50	80	100	120	160	200
trans-1,2-Dichloroethene	2000		0.5	2	10	30	50	80	100	120	160	200
Methyl acetate	2000		0.5	2	10	30	50	80	100	120	160	200
Methyl tert-butyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
tert-Butyl alcohol	2000		2.5	10	50	150	250	400	500	600	800	1000
Diisopropyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
1,1-Dichloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
Halothane	2000		0.5	2	10	30	50	80	100	120	160	200
Acrylonitrile	2000		0.5	2	10	30	50	80	100	120	160	200
Ethyl tert-butyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
Vinyl acetate	2000		0.5	2	10	30	50	80	100	120	160	200
cis-1,2-Dichloroethene	2000		0.5	2	10	30	50	80	100	120	160	200
2,2-Dichloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
Bromochloromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Cyclohexane	2000		0.5	2	10	30	50	80	100	120	160	200
Chloroform	2000		0.5	2	10	30	50	80	100	120	160	200
Ethyl acetate	2000		0.5	2	10	30	50	80	100	120	160	200

Water	Stock (µg/mL)	Level 11 (ug/L)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L)	Level 6 (ug/L)	Level 7 (ug/L)	Level 8 (ug/L)	Level 9 (ug/L)	Level 10 (ug/L)
							Optional		Optional		Optional	
Carbon tetrachloride	2000	0.2	0.5	2	10	30	50	80	100	120	160	200
Tetrahydrofuran	2000		0.5	2	10	30	50	80	100	120	160	200
Dibromofluoromethane	2500	10	10	10	10	10	10	10	10	10	10	10
1,1,1-Trichloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
2-Butanol	2000		2.5	10	50	150	250	400	500	600	800	1000
2-Butanone	2000		0.5	2	10	30	50	80	100	120	160	200
1,1-Dichloropropene	2000		0.5	2	10	30	50	80	100	120	160	200
Benzene	2000	0.2	0.5	2	10	30	50	80	100	120	160	200
tert-Amyl methyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dichloroethane-d4	2500	10	10	10	10	10	10	10	10	10	10	10
1,2-Dichloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
Isobutyl alcohol	2000		2.5	10	50	150	250	400	500	600	800	1000
2-Methyl-2-butanol	2000		2.5	10	50	150	250	400	500	600	800	1000
Methyl cyclohexane	2000		0.5	2	10	30	50	80	100	120	160	200
Trichloroethene	2000	0.2	0.5	2	10	30	50	80	100	120	160	200
n-Butanol	2000		2.5	10	50	150	250	400	500	600	800	1000
Dibromomethane	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dichloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
4-penten-2-ol	2000		2.5	10	50	150	250	400	500	600	800	1000
2-Chloroethyl vinyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
Bromodichloromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Ethyl acrylate	2000		0.25	1	5	15	25	40	50	60	80	100
Methyl methacrylate	2000		0.25	1	5	15	25	40	50	60	80	100
1,4-Dioxane	2000		100	400	500	600	1000	800	1000	1200	1600	2000
cis-1,3-Dichloropropene	2000		0.5	2	10	30	50	80	100	120	160	200
Chlorobenzene-d5	2500	10	10	10	10	10	10	10	10	10	10	10
Toluene-d8	2500	10	10	10	10	10	10	10	10	10	10	10
Toluene	2000		0.5	2	10	30	50	80	100	120	160	200
4-Methyl-2-pentanone	2000		0.5	2	10	30	50	80	100	120	160	200
Tetrachloroethene	2000		0.5	2	10	30	50	80	100	120	160	200
Chloropicrin	2000		30	50	80	120	200	160	400	200	320	400
trans-1,3-Dichloropropene	2000		0.5	2	10	30	50	80	100	120	160	200
4-Methyl-2-pentanol	2000		2.5	10	50	150	250	400	500	600	800	1000

Water	Stock (µg/mL)	Level 11 (ug/L)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L)	Level 6 (ug/L)	Level 7 (ug/L)	Level 8 (ug/L)	Level 9 (ug/L)	Level 10 (ug/L)
							Optional		Optional		Optional	
Ethyl methacrylate	2000		0.5	2	10	30	50	80	100	120	160	200
1,1,2-Trichloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
Chlorodibromomethane	2000		0.5	2	10	30	50	80	100	120	160	200
1,3-Dichloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dibromoethane	2000		0.5	2	10	30	50	80	100	120	160	200
2-Hexanone	2000		0.5	2	10	30	50	80	100	120	160	200
Chlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
Ethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,1,1,2-Tetrachloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
p/m Xylene	2000		1	4	20	60	100	160	200	240	320	400
o Xylene	2000		1	4	20	60	100	160	200	240	320	400
Styrene	2000		1	4	20	60	100	160	200	240	320	400
1,4-Dichlorobenzene-d4	2500	10	10	10	10	10	10	10	10	10	10	10
Bromoform	2000		0.5	2	10	30	50	80	100	120	160	200
Butyl acrylate	2000		0.25	1	5	15	25	40	50	60	80	100
Isopropylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
4-Bromofluorobenzene	2500	10	10	10	10	10	10	10	10	10	10	10
Bromobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
n-Propylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,4-Dichlorobutane	2000		0.5	2	10	30	50	80	100	120	160	200
1,1,2,2-Tetrachloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
4-Ethyltoluene	2000		0.5	2	10	30	50	80	100	120	160	200
2-Chlorotoluene	2000		0.5	2	10	30	50	80	100	120	160	200
1,3,5-Trimethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2,3-Trichloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
trans-1,4-Dichloro-2-butene	2000		0.5	2	10	30	50	80	100	120	160	200
4-Chlorotoluene	2000		0.5	2	10	30	50	80	100	120	160	200
tert-Butylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
Pentachloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
n-Butyl methacrylate	2000		0.25	1	5	15	25	40	50	60	80	100
1,2,4-Trimethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
sec-Butylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200

Water	Stock (µg/mL)	Level 11 (ug/L)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L)	Level 6 (ug/L)	Level 7 (ug/L)	Level 8 (ug/L)	Level 9 (ug/L)	Level 10 (ug/L)
							Optional		Optional		Optional	
p-Isopropyltoluene	2000		0.5	2	10	30	50	80	100	120	160	200
1,3-Dichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,4-Dichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
p-Diethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
n-Butylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2,4,5-Tetramethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dibromo-3-chloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
1,3,5-Trichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
Hexachlorobutadiene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2,4-Trichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
Naphthalene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2,3-Trichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,3-Dioxolane	2000		10	40	100	250	N/A	500	N/A	750	N/A	1000
Pentachloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
1,4-Dioxane (SIM)	100		0.5	2	10	20	30	50	100	200	N/A	N/A
1,1,2,2-Tetrachloroethane (SIM)	100		0.05	0.1	0.2	0.5	1	2	5	10	N/A	N/A

- For Low Level Soil analysis, the calibration levels are the same in µg/Kg units.
- For High Level Soil and Oil analysis, the calibration levels are at 50x the levels listed due to sample preparation requirements.

TABLE 5
8260C Volatile Internal Standards with Corresponding Target Compounds and Surrogates Assigned for Quantitation

Fluorobenzene	Chlorobenzene-d5	1,4-Dichlorobenzene-d4
Dichlorodifluoromethane	Toluene-d8 (surr)	Isopropylbenzene
Chloromethane	Toluene	Bromoform
Vinyl Chloride	Ethyl Methacrylate	1,4-dichloro-2-butane
Bromomethane	Trans-1,3-dichloropropene	1,1,2,2,-tetrachloroethane
Chloroethane	1,1,2-trichloroethane	4-bromofluorobenzene (surr)
Trichlorofluoromethane	2-hexanone	1,2,3-trichloropropane
Ethyl Ether	1,3-dichloropropane	trans-1,4-dichloro-2-butene
Freon 113	Tetrachloroethene	n-propylbenzene
Acrolein	Chlorodibromomethane	Bromobenzene
Acetone	1,2-dibromoethane	4-ethyltoluene
Ethanol	Chlorobenzene	1,3,5-trimethybenzene
1,1,-dichloroethene	1,1,1,2-tetrachloroethane	2-chlorotoluene
Tert-Butyl Alcohol	Ethylbenzene	4-chorotoluene
Methyl Acetate	p/m xylene	tert-butylbenzene
Carbon Disulfide	o xylene	1,2,4-trimethylbenzene
Methylene Chloride	Styrene	sec-butylbenzene
Acrylonitrile	Octane	p-isopropyltoluene
Methyl Tert Butyl Ether	2-Nitropropane	1,3-dichlorobenzene
Halothane	Methyl isothiocyanate	1,4-dichlorobenzene
Trans-1,2-dichloroethene	n-Butyl acetate	n-butylbenzene
Diisopropyl Ether	Nonane	p-diethylbenzene
Vinyl Acetate		1,2-dichlorobenzene
1,1-dichloroethane		1,2,4,5-tetramethylbenzene
Ethyl-Tert-Butyl-Ether		1,2-dibromo-3-chloropropane
2-butanone		1,3,5-trichlorobenzene
2,2-dichloropropane		1,2,4-trichlorobenzene
Cis-1,2-dichloroethene		Hexachlorobutadiene
Chloroform		Naphthalene
Bromochloromethane		1,2,3-trichlorobenzene
Tetrahydrofuran		Cyclohexanone
Dibromofluoromethane		Nitrobenzene

(surr)		
1,1,1-trichloroethane		Pentachloroethane
Cyclohexane		Decane
1,1-dichloropropene		Limonene
Carbon Tetrachloride		Trans-Decahydronaphthalene
Tertiary-Amyl Methyl Ether		Undecane
1,2-dichloroethane-d4 (surr)		Hexachloroethane
1,2-dichloroethane		Cis-Decahydronaphthalene
Benzene		
Trichloroethene		
Methyl Cyclohexane		
1,2-dichloropropane		
Bromodichloromethane		
1,4-Dioxane		
Dibromomethane		
2-Chloroethylvinyl Ether		
4-methyl-2-pentanone		
Cis-1,3-dichloropropene		
Iodomethane		
Methyl methacrylate		
n-Butanol		
Ethyl acetate		
Isopropyl Alcohol (IPA)		
Hexane		
n-Propyl bromide		
Chlorodifluoromethane		
Allyl chloride		
Heptane		

TABLE 6
8260C Quantitation Ions

Analyte	Quantitation Ion	Analyte	Quantitation Ion
Dichlorodifluoromethane	85	Ethyl Methacrylate	69
Chloromethane	50	Trans-1,3-dichloropropene	75
Vinyl Chloride	62	1,1,2-trichloroethane	83
Bromomethane	94	2-hexanone	43
Chloroethane	64	1,3-dichloropropane	76
Trichlorofluoromethane	101	Tetrachloroethene	166
Ethyl Ether	74	Chlorodibromomethane	129
Freon 113	101	1,2-dibromoethane	107
Acrolein	56	Chlorobenzene	112
Acetone	43	1,1,1,2-tetrachloroethane	131
1,1,-dichloroethene	96	Ethylbenzene	91
Tert-Butyl Alcohol	59	p/m xylene	106
Methyl Acetate	43	o xylene	106
Carbon Disulfide	84	Styrene	104
Methylene Chloride	76	Isopropylbenzene	105
Acrylonitrile	53	Bromoform	173
Methyl Tert Butyl Ether	73	1,4-dichloro-2-butane	55
Halothane	117	1,1,2,2,-tetrachloroethane	83
Trans-1,2-dichloroethene	96	1,2,3-trichloropropane	75
Diisopropyl Ether	45	Trans-1,4-dichloro-2-butene	53
Vinyl Acetate	43	n-propylbenzene	91
1,1-dichloroethane	63	Bromobenzene	156
Ethyl-Tert-Butyl-Ether	59	4-ethyltoluene	105
2-butanone	43	1,3,5-trimethybenzene	105
2,2-dichloropropane	77	2-chlorotoluene	91
Cis-1,2-dichloroethene	96	4-chorotoluene	91
Chloroform	83	tert-butylbenzene	119
Bromochloromethane	128	1,2,4-trimethylbenzene	105
Tetrahydrofuran	42	sec-butylbenzene	105
1,1,1-trichloroethane	97	p-isopropyltoluene	119
Cyclohexane	56	1,3-dichlorobenzene	146
1,1-dichloropropene	75	1,4-dichlorobenzene	146
Carbon Tetrachloride	117	n-butylbenzene	91
Tertiary-Amyl Methyl Ether	73	p-diethylbenzene	119
1,2-dichloroethane	62	1,2-dichlorobenzene	146
Benzene	78	1,2,4,5-tetramethylbenzene	119
Trichloroethene	95	1,2-dibromo-3-chloropropane	75
Methyl Cyclohexane	83	1,3,5-trichlorobenzene	180
1,2-dichloropropane	63	1,2,4-trichlorobenzene	180
Bromodichloromethane	83	Hexachlorobutadiene	225
1,4-dioxane	88	Naphthalene	128
Dibromomethane	93	1,2,3-trichlorobenzene	180
2-Chloroethylvinyl Ether	63	Ethanol	45
4-methyl-2-pentanone	58	Cyclohexanone	55
Cis-1,3-dichloropropene	75	Ethyl acetate	43

TABLE 6
8260C Quantitation Ions (continued)

Analyte	Quantitation Ion	Analyte	Quantitation Ion
Toluene	92	Iodomethane	142
Methyl methacrylate	69	n-Butanol	56
Pentachloroethane	167	Isopropyl Alcohol (IPA)	45
Hexane	57	n-Propyl bromide	43
Chlorodifluoromethane	51	Iodomethane	142
Allyl chloride	76	Heptane	71
Octane	85	2-Nitropropane	41
Methyl isothiocyanate	73	n-Butyl Acetate	43
Nonane	57	Decane	57
Limonene	68	Undecane	57
trans-Decahydronaphthalene	138	cis-Decahydronaphthalene	138
Hexachloroethane	117	Nitrobenzene	77

Table 7

List of 8260 Difficult Analytes:

1,1,2,2-Tetrachloroethane
1,2-Dibromo-3-chloropropane (DBCP)
1,4-Dioxane
2-Butanone
2-chloroethylvinyl ether
2-Hexanone
2,2-dichloropropane
4-Methyl-2-pentanone
Acetone
Bromoform
Bromomethane
Carbon disulfide
Chloroethane
Chloromethane
cis-1,3-Dichloropropene
Dichlorodifluoromethane (Freon 12)
Ethanol
Iodomethane
Isobutyl Alcohol
Naphthalene
Nitrobenzene
n-butanol
Styrene
Tert-Butyl Alcohol
Trichlorofluoromethane (Freon 11)
Isopropyl Alcohol (IPA)

Standard Operating Procedure

Analysis of Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry in Aqueous and Soil Samples by EPA SW-846 8260C, CTDEEP RCP, NJDEP DKQP, and EPA Method 624 Protocols

Approvals

Laboratory Director _____
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Controlled Copy No. GCMS VOC 011700-Rev 3.6- ____

Issued to: _____

Volatile Organics by GC/MS

1.0 SCOPE AND APPLICATION

This method is applicable to common types of environmental samples. It can be used to quantitate most volatile organic compounds with boiling points below 220^{o}C.

1.1 The method detection limits (MDL) are 0.1-6 µg/L for most compounds in an aqueous sample, and 0.1-6 µg/kg in a soil sample. The Limits of Detection (LOD) are approximately 0.2-2.5 ppb for aqueous samples and 2.5 ppb for undiluted soil samples. Reporting limits are 0.5-200 µg/L for most species in water and 5-200 µg/kg in soils. Soils run as medium level preparations have reporting limits from 500-20000 ug/kG, and higher with dilution. This method is also applicable to oils by waste dilution with reporting limits of 2500 ug/kG and higher.

1.2 This method is to be performed only by a trained analyst who has completed a Demonstration of Capability within the last 12 months. Please refer to York SOP Adm080206 for additional training instructions.

2.0 SUMMARY

This procedure is based upon EPA SW-846 methods 8260C, 5030C, and 5035A, and EPA Method 624. It also includes the related criteria for VOCs by CTDEEP RCP and NJDEP DKQP protocols.

2.1 The volatile organic compounds (VOC) are introduced into a gas chromatograph (GC) by purge and trap techniques. The GC oven is temperature programmed to separate the analytes using a capillary column. Analytes eluted from the column are introduced into a mass spectrometer (MS). Identification of target analytes is accomplished by comparing characteristic masses of their electron impact ionization (EI) spectra to those of known standards and NIST libraries. Quantitation is accomplished by comparing the response of a major quantitation ion relative to an internal standard using a minimum of five calibration levels.

3.0 DEFINITIONS

3.1 **Analytical Batch** Client samples (20 or fewer) of the same matrix, and their associated QC samples (LCS, method blank, matrix spike, sample duplicate) analyzed at one time.

3.2 **Calibration Curve** The relationship between response and analyte concentration determined for a series of calibration standards. The calibration curve is made by graphing the response-vs-concentration and performing a regression analysis of the data.

3.3 **Calibration Standards** A series of solutions containing the target analyte at known concentrations used by the analyst for preparation of the calibration curve.

3.4 **CCV (Continuing Calibration Verification)** A calibration standard (ideally at the midpoint of the curve) run at the beginning of each 12-hour instrument period to confirm the validity of the curve.

3.5 **ICV (Initial Calibration Verification)** A second-source calibration standard, run immediately following a calibration to confirm the validity of the curve.

3.6 **Internal Standard** A known quantity of compound, added to both client and QC samples, which is similar to but distinct from all analytes in an analysis. It provides a basis for comparison in quantitation and increases precision by correcting for differences mainly in extract or injection volumes.

3.7 **LCS (Laboratory Control Sample)** A standard which must be a second-source standard, added to a blank matrix (also called Blank Spike, or BS in the LIMS), treated exactly as a sample, and run with each analytical batch. According to EPA Method 8260 this can be from the same source as the materials used for calibration if all target compounds in the ICAL pass per the method.

3.8 **LOD (Limit of Detection)** The lowest concentration at which an analyte can be qualitatively identified.

3.9 **Matrix Spike** A specific amount of solution containing known concentrations of target analytes added to a sample before processing, to determine recovery efficiency of the technique. This can be from the same source material as that used for calibration.

3.10 **Method Blank** An analyte-free matrix which is treated exactly as a sample and run with each analytical batch. It is used to document contamination resulting from the analytical process.

3.11 **Method Detection Limit (MDL)** The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the concentration is greater than zero.

3.12 **Quadratic Regression** A process by which the equation of a parabola of “best fit” is found for a calibration

3.13 **Linear Regression** A process which attempts to model the relationship between two variables by fitting a linear equation to observed data. One variable is considered to be an explanatory variable, and the other is considered to be a dependent variable.

3.14 **Reporting Limit (RL)** The lowest point of quantitation. This ideally is less than or equal to desired regulatory action levels.

3.15 **Response Factor (Rf)** The ratio between a signal produced by an analyte, and the quantity of analyte which produces the signal

3.16 **Sample Duplicate** A client sample analyzed a second time in the same analytical batch. This is used to determine method reproducibility and matrix homogeneity.

3.17 **Surrogate Standard** A solution containing known concentrations of deuterated or other unique compounds not found in environmental samples. A specific amount of this solution is added to every sample, (including QC) before processing, to determine recovery efficiency for each sample.

4.0 INTERFERENCES

4.1 Special precautions must be taken to manage methylene chloride, acetone and hexane contamination from the VOC laboratories. All samples are isolated from sources of these solvents. In addition, purged VOC free water must be utilized in all autosampler applications and standard preparations. It is noted that the VOC laboratories are maintained under positive pressure at all times. These VOC laboratories are at a pressure greater than all other areas of the building which is also fully maintained under positive pressure by a make-up air introduction system. In order for the system to be effective, doors to these laboratories must remain closed at all times. The analysis and storage of these samples must be isolated from atmospheric sources of these compounds.

The Queens, NY facility performs all VOC analyses in a solvent free environment. Acetone, being ubiquitous in the ambient environment may present in blanks at low levels.

4.2 Other less common sources of laboratory related contamination frequently include non-PTFE thread sealants, plastic tubing, or flow controllers with rubber components. Only PTFE tape and stainless-steel lines or lines coated internally with fused silica are to be used.

4.3 Carryover from a prior sample containing high concentrations of VOCs may occur, resulting in the appearance of target analytes in a sample where none or lower concentrations are actually present. If this is suspected, the sample in question must be rerun.

4.4 VOCs may diffuse or enter through the septum of the sample vial during storage or shipment. A trip blank made from organic free water and carried through the sampling, handling and storage protocols to monitor this contamination should be prepared and provided to the client. This water must be taken from the VOC lab purged water only. In Queens, blank water is commercially delivered Poland Spring water that has been shown to contain no detectable VOCs.

4.5 As an additional quality control measure, internal refrigerator blanks for VOC are monitored every 14 days in Stratford, CT due to the use of methylene chloride, hexane and acetone in that facility.

4.6 Some samples may foam when purged due to surfactants present in the sample. When this kind of sample is encountered an antifoaming agent (Antifoam B) can be used. A blank and blank spike with this agent must be analyzed for every new bottle of antifoaming agent opened.

5.0 SAMPLE HANDLING

5.1 All vials for aqueous samples are commercially purchased from Industrial Glassware, Millville, NJ. Both unpreserved and pre-preserved vials are purchased. No vials are opened in either laboratory prior to use by a client. Trip Blanks for VOCs are prepared using organic free water in a solvent free environment.

5.2 All 5035 vials, are commercially purchased from QEC (Quality Environmental Containers), Beaver, WV. York provides clients with 4 vials for each 5035 set for use as a Terracore VOA soil sampling kit. Of the 4 vials, 2 are pre-tared 40 mL vials containing 5 ml organic free water. One is a pre-tared medium level methanol vial containing 10 mL Methanol. The 4^{th} vial is an empty vial utilized for total solids determination by the laboratory to report all soil data on a dry weight basis. The sampling kit also includes a Terracore device.

5.3 York discourages the use of Encore sampling devices due to the handling in the laboratory and possible cross contamination. When such devices are employed they are extruded by the Log-in group into appropriate commercially purchased vials as above.

5.4 Any sample received in an incorrect VOA container (i.e. preserved or unpreserved vials, or 5035 compliant containers) creates a corrective action communication to the client to advise them of the non-compliant sample(s) and if the laboratory is directed to analyze, the sample is flagged with a VOA-CONT flag by the Log-in group.

5.5 Aqueous samples must be taken and stored in commercially purchased 40 ml VOA vials and be preserved to pH <2 with hydrochloric acid. There are certain exceptions to this for acid sensitive compounds. The EPA recommended holding time from sampling to analysis of preserved samples is 14 days. Unpreserved aqueous samples may be held for 7 days before analysis (3 days if the target list includes acrolein).

5.6 Solid samples must be taken by the client in EPA 5035 approved containers including preserved 40 ml VOA vials, or Encore or Terracore samplers. All soils received in Encore samplers must be extruded into pre-cleaned VOA vials at Log-in within 48 hours of SAMPLING.

5.7 Solid samples received in jars which must undergo additional analyses are split at Log-in by adding approx. 10 g to a pre-cleaned 40ml VOA vial. Although this is not acceptable practice, clients may insist. Such samples are flagged in LIMS accordingly by login, per 5035 protocol, to indicate possible low bias. Log-in also requires Client Services to contact the client

5.8 Samples must be stored at 4 ± 2° C or frozen in accordance with 5035 protocol until analysis.

5.9 Specifics for Method 624

5.9.1 Water samples are taken by clients in preserved (pH< 2) with 1:1 HCl in commercially purchased vials provided by York.

5.9.2 If residual chlorine is suspected, sodium thiosulfate is to be added by the client. Holding time for acid preserved samples is 14 days from sample collection. Non-preserved samples need to be analyzed within 3-7 days from sample collection. Non-preserved vials are required for the following target analytes: Acrolein, Acrylonitrile and 2-Chloroethylvinyl ether (2-CEVE): Acrolein-3 days; Acrylonitrile-7 days; 2-CEVE-7days

5.9.3 Any hold time exceedances related to analysis of unpreserved samples must be flagged in Element so they appear on the final report.

6.0 APPARATUS

- Encon and Encon Evolution Systems
- Encon-E70300-K03 VOCARB 3000, P/T K
- Moisture reduction trap for Encon Evolution-cat. no. E700300-L03
- Centurion Autosamplers (with heating block and stirring capabilities for soils)
- Hewlett Packard 6890 series gas chromatograph (capabilities include: split/splitless injection, constant flow controllers
- ZB-624-Volatiles capillary column, 25m X 0.20 mm ID, 1.12um film thickness (Zebron/Phenomenex - part no.: 7GE-G005-54-C10904) or equivalent. For the Agilent 5973 systems the column used is Zebron/Phenomenex ZB-624 capillary column: 30 m x 0.25 mm id x 1.40 um film thickness, part no. 7HG-G005-27.
- Hewlett Packard/Agilent 5973 Mass Spectrophotometers (scanning from 35-270 amu) with Hewlett Packard/Agilent MS Chemstation software version GA1701BA.02.05 or later
- Microsyringes 5, 10, 25, 50, 100, 250, and 1000 µl
- Syringes 5, and 25 ml
- Injection port liners
- Balance (0.01g), Spatula- stainless steel
- Balance (0.0001 g) for neat material preparation
- Glass vials, pre-cleaned 40ml with PTFE-lined screw caps, with and without HCl
- Volumetric Flasks, Class A; 10, 25, 50 and 100ml

7.0 REAGENTS AND STANDARDS

ALL STANDARDS MUST BE LOGGED INTO THE ELEMENT LIMS SYSTEM. All standards are prepared in 2 ml amber vials with PFTE crimp tops. Immediately after use, all standards must be re-crimped and stored cold to maintain standard integrity.

7.1 Calibration, LCS and Matrix Spike Standards

7.1.1 77 Compound Mix (2000 µg/ml) – Absolute Standards 11481CQ-33001 modified (no diethyl ether) (or equivalent)

7.1.2 Gases Mix (2000 µg/ml) – Absolute Standards 30058 (or equivalent)

7.1.3 Custom Mix-9 component (2000 µg/ml) – Absolute Standards 97222 (or equivalent)

7.1.4 Vinyl Acetate Stock (20,000 µg/ml) – Absolute Standards 82472 (or equivalent)

7.1.5 Acrolein Stock (20,000 µg/ml) – Absolute Standards 91318 (or equivalent)

7.1.6 1,4-Dioxane (neat) – Supelco 44-2251 (or equivalent)

7.1.7 1,4-Dioxane Stock (80,000 µg/ml) – Add 77.7 µl *neat 1,4-dioxane* to 922 ul methanol.

7.1.8 3 Compound Mix (2000, 40,000 µg/ml) – Add 100 µl *vinyl acetate stock 7.1.4*, 100 µl *acrolein stock 7.1.5* and 500 µl *1,4-Dioxane stock 7.1.7* to 300 µl methanol.

7.1.9 Oxygenates Mix (2000, 20,000 µg/ml) – ECS-B-York7 (or equivalent)- contains di-isopropyl ether (2000), Ethanol (20000), Ethyl-tert-butyl ether(2000), tert-amyl alcohol (20000) and tert-amyl methyl ether (2000)

7.1.10 Ethanol (99.5% Pure), Sigma Aldrich 459844-500ml)

7.1.11 Ethanol Supplemental Mix -- 80,000 ug/mL-take 100 uL of neat ethanol and add to 900 uL Methanol.

7.1.12 1,2,3-Trimethylbenzene (91.7% Purity)- Fluka 45935-250MG. Make a 2000 ug/mL standard in methnaol as follows: take 24.4 uL of neat 1,2,3,TMB liquid and add to 10 mL methanol (remove 24.4 uL of methanol before adding TMB). Note this amount adjusts for the purity and density of the 1,2,3-Trinethylbenzene.

7.1.13 Methanol (Purge and Trap grade) and HPLC grade- Honeywell 232-1L. When used for rinsing stir bars for re-use-SEE APPENDIX A for procedure.

7.1.14 Combine above mixes according to Table 1.0 to create calibration standards for regular level and low level applications.

7.1.15 TBA, Absolute Standards Part #90782

Table 1.0 VOC Calibration Standards-Levels 1 through 6 and 7-9[1]

Std. Mix conc.	5 ug/ml*	10ug/ml *	20ug/ml*	**50ug/ml*#**	100ug/ml*	200ug/ml*
Cal Mix Level ID	1	2	3	**4**	5	6
Final conc. in purge vessel-5 mL Purge-see 7.1.13 below	5/50/250 ppb	10/100/500 ppb	20/200/1000 ppb	**50/500/2500 ppb**	100/1000/5000 ppb	200/2000/10000 ppb
Final conc. in purge vessel-25 mL purge-see 7.1.14 below	0.5/5/25 ppb	2/20/100 ppb	4/40/200 ppb	10/100/500 ppb	20/200/1000 ppb	40/400/2000 ppb
Mixtures	*uL to mix*	*uL to mix*	*uL to mix*	*uL to mix*	*uL to mix*	*uL to mix*
TBA – 7.1.15	10.0	20.0	40.0	**100.0**	150.0	200.0
77 Cpds (µL) -7.1.1	2.5	5.0	10.0	**25.0**	50.0	100.0
Gases (µL) - 7.1.2	2.5	5.0	10.0	**25.0**	50.0	100.0
Custom (µL) - 7.1.3	2.5	5.0	10.0	**25.0**	50.0	100.0
3 Cmpds (µL)- 7.1.8	2.5	5.0	10.0	**25.0**	50.0	100.0
Oxys (uL)** **7.1.9**	2.5	5.0	10.0	**25.0**	50.0	100.0
Ethanol*** Mix (uL) **7.1.10**	2.5	5.0	10.0	**25.0**	50.0	100.0
1,2,3-Trimethylbenzene-7.1.12	2.5	5.0	10.0	**25.0**	50.0	100.0
Methanol (µL)	972.5	945	890	**725**	500	100.0

*1,4-Dioxane is present at: 100, 200, 400, 1000, 2000, 4000 ppb in 5.0 mL purge and at 25 mL purge these values are: 10, 40, 80, 200, 400, 800 ppb

** Oxygenates are at these levels: 5.0/50, 10/100, 20/200, 50/500, 100/1000, 200/2000 ppb in the 5.0 mL purge and in the 25.0 mL purge: 0.5/5.0, 2.0/20.0, 4.0/40.0, 10.0/100.0, 20.0/200.0, 40.0/400.0 ppb.

*** Ethanol is 250, 500, 1000, 2500, 5000, 10000 in the 5.0 mL purge; and at 25, 100, 200, 500, 1000, 2000 ppb in the 25.0 mL purge.

1. Levels 7 through 9 are for low level aqueous extended calibration and are nominally 80, 120, and 160 ppb. These are prepared by injecting 20, 30 and 40 uL of the 200 ppm mix to 50 mL organic free water.

- For 5ml purge add 5.0 uL if each Cal level mix to 5 ml water to yield the ppb shown in Table 1.0. FOR MEDIUM LEVEL Curve add 100 uL MeOH to 5 mL DI for curve. This is the maximum amount of MeOH that we add for ML work. For low level soils, 5 g. of Ottawa sand is used as the matrix with 5 mL DI added.
- For 25 mL purge, make 50 mL volume by adding 5.0 uL of the 5.0 ppm level 1 mix and 10 uL of the other levels to yield the final conc. shown in Table 1.0.

#Also used for the continuing calibration verification and matrix spike. If for LCS and ICV, must be from a separate lot or different manufacturer.

7.2 Initial Calibration Verification (ICV)

ALL STANDARDS MUST BE LOGGED INTO THE ELEMENT LIMS SYSTEM. All standards are prepared in 2 ml amber vials with PFTE crimp tops. Immediately after use, all standards must be re-crimped and stored cold to maintain standard integrity.

7.2.1 Custom VOA Additions Mix - 9 Component (2000/20000 µg/ml) – Phenomenex AL0-130191

7.2.2 Ketones Standard (2000 µg/ml) – Phenomenex AL0-101211

7.2.3 Gases Mix (2000 µg/ml) – Phenomenex AL0-101206

7.2.4 8260B Calibration Standard (2000 µg/ml) – Phenomenex AL0-101487

7.2.5 Oxygenates Standard (2000/10000 µg/ml) – Phenomenex AL0-101208

7.2.6 1,4-Dioxane (neat) – Supelco 44-2251 (or equivalent)

7.2.7 1,4-Dioxane Stock (80,000 µg/ml) – Add 77.7 µl *neat 1,4-dioxane* to 922 ul methanol.

7.2.8 1,4-Dioxane Working Standard (40,000 µg/ml) – Add 500 µl 1,4 Dioxane Stock to 1000 µl

7.2.9 Vinyl Acetate Stock (2000 µg/ml) – Phenomenex AL0-101228

7.2.10 Acrolein Standard (5,000 µg/ml) – Phenomenex AL0-101224

7.2.11 Combine above mixes according to Table 2.0 to create ICV standards for regular level and low level applications.

Table 2.0 VOC ICV Standard

Final conc. in purge vessel-5 mL Purge-see 7.2.12 below	50/100/250/500/1000 ppb
Final conc. in purge vessel-25 mL purge-see 7.2.13 below	10/20/50/100/200 ppb
Mixtures	***uL to mix***
VOA Custom Mix -7.2.1	25.0
Ketones Standards - 7.2.2	25.0
Gases Mix - 7.2.3	25.0
8260B Cal Std - 7.2.4	25.0
Oxygenates* - 7.2.5	25.0
1,4-Dioxane** - 7.2.8	25.0
Vinyl Acetate Standard – 7.2.9	25.0
Acrolein Standard - 7.2.10	10.0
Methanol (µL)	815

*Oxygenates are present at:
**1,4-Dioxane is present at: 1000 ppb in 5.0 mL purge and at 25 mL purge these values are 200 ppb

- For 5 mL purge, 5.0 µl is added to all ICVs for aqueous and soil for a final concentrations of 50/100//250/500/1000ppb in the ICV. For medium level ICV add 100 uL MeOH to the vessel as well.

- For 25 mL purge, 5.0 uL is added to the aqueous ICV to yield 10/20/50/100/200 ppb in the ICV

7.3 Additional Reagents

7.3.1 Antifoam B Silicone Emulsion – J.T. Baker B531-07

7.3.2 Ottawa Sand Mix – Fisher Scientific S25-10
PCI Scientific Lot #141670
Sodium Sulfate Lot#0000108639

7.4 Standards Shelf Life-Expiration Dates are in Element

ALL manufacturer expiration dates should be followed.

ALL mixes except gases – Make Monthly or sooner

Gases- Make Weekly or sooner
Internal Standard Mix – Make Monthly or sooner
Matrix Spike – Make Monthly or sooner
Laboratory Control Spike – Make Monthly or sooner
Combined Calibration mix with oxygenates-prepare on use until more stability data is derived.

7.5 Internal Standards, Surrogates and Tuning Compound

7.5.1 Internal standards:

- **Fluorobenzene (neat) –** Sigma Aldrich F6001-5G
- **d5-Chlorobenzene (neat) –** Sigma Aldrich 176605-5G
- **d4-1,2-Dichlorobenzene (neat) –** Sigma Aldrich 331511-5G

7.5.2 Surrogates:

- **d4-1,2-Dichloroethane (neat) –** Sigma Aldrich 396540-5G
- **d8-Toluene (neat) –** Sigma Aldrich 434388-5G
- **p-Bromofluorobenzene (neat) –** Sigma Aldrich B67201-25G

7.5.3 In six separate aluminum weighing dishes weigh 2.5000 g. (+/- 0.0001 g.) of each neat material. Subsequent to weighing each individual compound, add 5 ml of purge and trap grade methanol to the dish and allow to dissolve. Immediately transfer to a 100 ml Class A volumetric flask. Be sure to rinse the dish twice with small portions of methanol into the volumetric flask. Cap the flask.

Do this same procedure for the remaining compounds and add methanol to make up to 100 ml. Cap and mix by inversion.

7.5.4 Transfer this solution to a screw cap, air tight amber vessel. This will result in a mixture containing 25000 ug/mL of each component. Record all weights on the Internal Standard/Surrogate preparation log sheet. The shelf life of this 25000 ppm stock stored in the freezer is 7 years.

7.5.5 For tuning, stock solution of p-BFB in methanol are prepared at 5000 and 1000 ug/mL. This is done by weighing 0.500 g. into 100 mL MeOH. This is then diluted **1:20** to yield a 250 ng/uL standard and 1:100 for 50 ng for 8260 and 624 tuning. 1 uL is used for injection into the system (50ng). Alternatively, this tuning concentration in the purge vessel of 250 ng can be used with a 1 uL injection into 5 mL water.

The methods all require the tuning to be evaluated with 25 or 50 ng of BFB "on column"*. For purposes of clarification, if we inject 1 uL of a 250 ng/uL BFB standard using a split ratio of 20:1, this means that we have injected 12.5 ng "on column". Similarly, if we purge 250 ng of BFB and again in our normal split mode, the same amount gets "on column"-12.5 ng theoretically. This amount on column will meet all VOA method requirements. * 25 ng is for EPA 524.2.

7.5.6 If the purity of any neat compound is less than 97%, the amount weighed must be corrected as follows:

Weight (g.) x 100/P = Corrected Weight (g)

P= Purity

For example- 2.5000g x 100/95 = 2.6316 g.

Where 100 is 100% purity and 95 is the purity of the actual material being weighed.

The expiration of these neat materials stored in the dark in their original containers is 10 years from opening date.

Make a 1:100 dilution of this stock solution by taking a clean 100 ml volumetric flask containing approx. 50 ml purge and trap grade methanol and adding 1.0 ml of the stock solution. Add the 1.0 ml using a Class A pipet only. Bring to the mark with methanol. This will yield a 250 ug/ml (working standard) solution which will be added directly to the Archon or Centurion systems. This solution should be stored in 2 or more air tight vials and kept away from the light.

8.0 PROCEDURE

Various methods are provided for sample introduction into the GC/MS system. This SOP only covers that of Method 5030 for aqueous samples and Method 5035 for solid samples.

- *For ALL aqueous samples and SPLP Extracts*, 25 mL is purged to meet client action levels
- *For ALL TCLP Extracts*, 5 mL is purged

- *For soil samples* received in proper 5035 vessels, 5.0 g. nominally is supplied by the client. Soil dilutions are to be run from the methanol-containing vials. For soils received in non-5035 vessels, the samples are to be flagged "VOA CONT, NON COMPLIANT- the container(s) provided by the client for soil volatiles do not meet the requirements of EPA SW-846 5035A or NYSDOH ELAP. Results reported below 200 ug/kg may be biased low due to samples not being collected according to EPA SW-846 5035A."

- *For oil samples*, 1.0 g. of oil is weighed into a 40 mL VOA vial and 10.0 mL of Methanol is added. An aliquot of the methanol extract is then injected into 5 mL water for analysis. No more than 100 µL of extract can be used due to suppression of early eluters. All weights used are entered in the ELEMENT LIMS system bench sheets.

- ALL VOA ANALYSES, Soil or Aqueous ARE CONDUCTED USING HEATED PURGE AT 40 degrees C. The pH of all aqueous samples must be measured and documented in the LIMS bench sheet or the Sample Screening Log. Use short range pH paper for this and this may be done during Dynamic Headspace/GC/FID screening.

NOTE: 1 drop of Antifoam B is added to samples that display excessive foaming during the purging process.

8.1 GC Conditions

- Injector Temperature: 180 degrees C
- Detector (Mass Spectrometer) Temperature: 220 degrees C
- Carrier Gas: UHP Helium at 0.70 ml/min, constant flow (EPC) for 0.20 mm id columns and 1.1 ml/min for 0.25 mm id columns.
- Initial Temperature: 40 degrees C, hold for 2 minutes, then 13 degrees C /min to 206 degrees C, **split injection 15:1-20:1** ratio depending upon the instrument.

8.2 Mass Spectrometer Conditions

- Mass Range: 35-270 amu - Electron Impact Ionization
- Scan Time: 0.6 – 2 sec/scan (more than 2 scans/sec is acceptable as well)
- Tune File: BFB.u or other tuning file that will yield acceptable BFB data.
- Scan Start time: 1.10 minutes

8.3 Encon (Method 1)

- Transfer Line Temperature: 130 degrees C
- Bottom Line Temperature: 130 degrees C
- Valve Oven Temperature: 130 degrees C
- Ambient Trap: 0 degrees C
- Line Temperature: 130 degrees C
- Valve Temperature: 130 degrees C
- Purge Ready: 30 degrees C
- Purge Temperature: 0 degrees C
- Mount Temperature: 40 degrees C
- Turbo Cool Temperature: -20 degrees C
- MCS Line Temperature: 40 degrees C
- Sample Heater: off
- Prepurge Time : 0 minutes
- Preheat Time: 0 minutes
- Sample Temperature: 40 degrees C
- Sample Fill: 0 mL
- Purge Time: 11 minutes

- Dry Purge: 2 minutes
- GC Start: Desstart
- Cryo-focuser: Off
- GC Cycle Time: 0 minutes
- Cryo-standby: 100 degrees C
- Cryofocus Temperature: -150 degrees C
- Inject Time: 1 minute
- Cryo-Inject Temperature: 180 degrees C
- Desorb Preheat: 250 degrees C
- Desorb Time: 2 minutes
- Desorb Temperature: 250 degrees C
- Sample Drain: On
- Bake Time: 10 minutes
- Bake Temperature:260 degrees C(see manufacturer's recommendation)
- BGB off Delay: 2 minutes
- MCS Bake Temperature: 300 degrees C
- Purge Flow @ 45 ml/min Aqueous

8.4 Centurion Autosampler Conditions

- Water Sample Volume added: 10mL (for Soils)
- Dilution Factor: No
- # Rinses: 0
- Standard 1: Yes
- Standard 2: No
- Stir: No
- Preheat: Yes (Solid)
- Preheat Temp (solid): 40 degrees C
- Preheat Time (solid): 3.0 minutes
- Purge Time(solid): 11 minutes
- W. Stir Time: 0 minutes
- W. Settle Time: 0 minutes
- Syringe Flushes: 0
- Desorb Time: 2 minutes
- Oper. Mode : Remote
- Cycle Timer: 0 minutes
- Aux. Timer: 0 minutes
- Purge Flow-soils- 25 ml/min

8.5 Analysis Sequence Summary-8260/CTDEEP RCP/NJDEP DKQP and 624
BFB tune
CCV (50 ppb , 10 ppb for 8260 or 20 ppb for 624)

LCS (50 ppb or 10 ppb for 8260 or 20 ppb for 624-needs to be prepared in an acidified matrix
LCS duplicate (Optional)
Unspiked sample duplicate (if no MSD)
Matrix spike
Matrix spike duplicate (if no unspiked sample duplicate)
Method blank
Samples to fill 12-hour clock (24 hour clock acceptable for EPA 624)

8.6 Data Generation and Archival

After data is finalized and uploaded into the LIMS, the directory is transferred from the local C drive to that instrument's associated "Daily Data" file located on the Backup server. Every two to three weeks, all data from the "Daily Data" file is transferred to that instrument's associated "Data" file.

9.0 CALIBRATION

9.1 Initial calibration.

Prepare a 6-point or more calibration curve as outlined in section 7.1. The RSD of the response factors should be $\leq$ 20% for each target compound. If more than 10% of the compounds included with the initial calibration exceed the 20% RSD limit **and** do not meet the minimum correlation coefficient (0.99) for alternate curve fits, then the chromatographic system is considered too imprecise for analysis to begin.

It is recommended that the minimum response factors for the most common target analytes be demonstrated for each calibration level. To demonstrate that the desired sensitivity is attained, it is important that the lowest calibration standard meet the minimum response factor shown in **Attachment 1**. (This does not apply to compounds not suited for analysis by this methodology including but not limited to ethanol, 1,4-dioxane, 2-chloroethylvinyl ether, tetrahydrofuran, and certain other water soluble or acid hydrolyzed species.)

Due to the large number of compounds analyzed by this method, the above criteria may not be met. The analyst should strive to place emphasis on meeting the calibration criteria for those compounds important to a specific project.

- For any compounds failing initial calibration criteria, this must be noted on the 8260C Flag Worksheet in the SCAL-E column. If any of these failing compounds are subsequently found in client samples, they must be flagged "Cal-E" in the LIMS. A copy of the worksheet is to be placed with all QB file data quantitated with this calibration.

9.2 ICV

A second-source ICV must be run immediately following initial instrument calibration. The concentration of this standard should be in the middle of the calibration range. Unless project-specific data quality objectives are required, the values from the second-source check should be **within 30%** of the expected concentration.

> **Corrective Action**: Quantitative sample analyses should not proceed for any analytes that fail the initial calibration verification. For any compounds with recoveries exceeding 30% of the expected concentration, this must be noted on the 8260C Flag Worksheet in the ICV-E column. If any of these failing compounds are subsequently found in client samples, they must be flagged "ICV-E" in the LIMS. A copy of the worksheet is to be placed with all QB file data quantitated with this calibration.

For Method 624, the initial calibration is verified daily by the analysis of 20 µg/l second source standard. All criteria for 624 must be met.

9.3 CCV

A mid-level continuing CCV (10 ppb for aqueous low level, 50 ppb for 5ml purge/soils) is to be run at the beginning of each 12-hour clock. For 624, this is at 20 ppb by method requirement.

The most common target analytes should meet the same minimum response factors as the initial calibration. (**Attachment 1**)

All target analytes should have $\leq$20%D. No more than 20% of compounds may have greater than 20% difference (Average Rf). Evaluate compounds that use Average RRF by comparison of the Avg. RRF to the ICAL RRF for % difference. For compounds that use linear or quadratic regression for calibration, evaluate the response using concentration not RRF. These evaluations are done is the Chemstation software and kept in the QB folder.

> **Corrective Action**: If any of the required calibration check criteria fail, the system must be evaluated. Re-inject the standard, if the calibration check standard still fails, system maintenance must be performed and logged. System recalibration may be required (See Section 14.6).
>
> For any compounds exceeding 20%D, this must be noted on the 8260C Flag Worksheet in the CCV-E column. These compounds may be reported as non-detects as long as they meet the minimum Rf requirement. If any of these failing compounds are subsequently found in client samples, they must be flagged "CCV-E" in the LIMS. A copy of the worksheet is to be placed with all QB file data quantitated with this CCV.

10. QA/QC- See Figures 1.0 and 2.0 which summarizes all of the QA criteria of the various protocols for VOA. These criteria are for EPA 8260C.

10.1 MS Tuning

At the beginning of each analytical batch (12 hours), the GC/MS system must be checked to see if acceptable performance criteria are achieved for 4-Bromofluorobenzene (BFB). To meet this requirement, 50 ng of BFB is injected directly on the column, or added to reagent water and purged. See section 7.3.4 for details.

The following tune criteria ***must*** be met:

m/z	**Required Intensity (relative abundance)**
50	15 to 40% of m/z 95
75	30 to 60% of m/z 95
95	Base peak, 100% relative abundance
96	5 to 9% of m/z 95
173	Less than 2% of m/z 174
174	Greater than 50% of m/z 95
175	5 to 9% of m/z 174
176	Greater than 95% but less than 101% of m/z 174
177	5 to 9% of m/z 176

10.1.1 The spectrum of BFB should preferably be extracted using the HP Chemstation Autofind BFB function which automatically subtracts background. Alternatively, the analyst can average the BFB peak and manually subtract one scan before the BFB peak at least 20 scans before the peak.

10.1.2 All standards, samples, MS, MSDs, LCSs and blanks must use the same GC/MS instrument conditions. These criteria must be accomplished per each 12 hour time period. Samples analyzed outside this 12 hour window must be rerun. The BFB tuning criteria is to be evaluated BEFORE and independently from the calibration check standard run.

Corrective Action: If BFB tune fails, retune the MS and save the tune values to BFB.U. Rerun the BFB standard, if it passes BFB criteria, proceed. If not, see your department supervisor.

10.2 **Each analytical batch** must contain an LCS, a method blank, a matrix spike and either a matrix spike duplicate or an unspiked sample duplicate. A matrix spike duplicate should be included if requested by the client or if samples are not expected to contain target analytes. An unspiked sample duplicate should be included if samples are expected to contain target analytes. If sufficient client sample is not available for a duplicate or matrix spike, an additional LCS may be substituted.)

10.3 **A method blank** is to be run **after** the initial QC runs including the BFB, CCV and LCS to ensure that the system is clean. Trace level contamination of common laboratory solvents including methylene chloride, and acetone are virtually unavoidable due to trace

airborne contamination from other areas of the laboratory in the Stratford, CT Lab. **A medium method blank must also be run in any batch where a medium level methanolic extract is run.** This is identified as a medium level blank in the bench sheet-(BLK2) and applied to those samples prepared for medium level analysis. This blank is prepared by adding 5 g. of volatile-free Ottawa sand to a VOA vial containing 10 mL of MeOH. 100 uL of this extract are then used as the medium level method blank (100x DF).

Corrective Action: If acetone or methylene chloride are found in the method blank at greater than 5 times the RL (25 ppb), rerun the blank until levels < 5x the RL (25 ppb) are achieved. If there are still contaminants present, investigate the problem. Any other target compounds must be less than 5 times the MDL.

Certain heavy volatiles (Trichlorobenzenes, naphthalene and hexachlorobutadiene) may exhibit carryover. This is acceptable since it is a limitation of the method up to levels 4x the LOD but must be B-flagged accordingly.

10.4 **Matrix Spike and Duplicate or Matrix Spike Duplicate** recovery limits are generally 70-130% and RPDs should be ≤30% or the laboratory generated criteria specified in the LIMS.

Corrective Action: If any compounds fall outside these limits, they must be flagged in the LIMS.

10.5 **The LCS compound recoveries** should fall between 70 to 130% or laboratory generated criteria specified in the LIMS. Up to 10% of compounds may exceed these limits as long as none exceed 40-160% recovery.

Corrective Action: Some compounds, due to their reactivity and behavior in the sampling/analysis system may not meet this range and if not, must be flagged. These compounds are THF, vinyl acetate, ethyl acetate, acrolein, 2-chloroethyl vinyl ether, ethanol, tert-amyl alcohol and 1,4-Dioxane. If the LCS fails, recalibration is necessary. No analysis can proceed or be used with a failed LCS. All compounds with recoveries exceeding 70-130% must be called out in the project narrative.

10.6 **Internal standard** areas of all samples must be –50 to +200% of the area of the individual internal standard in the 12-hour CCV standard. Retention times may not change by more than 10 seconds from those in the initial mid-level calibration standard.

Corrective Action: If any internal standard area is not acceptable **the sample must be rerun.** Dilute the sample if necessary and/or rerun to prove matrix effects. If retention times are not acceptable, perform necessary system corrections and reanalyze sample. Place data in project file as documentation of matrix effects.

10.7 **Surrogate recoveries** must fall between 70-130% for CTDEEP RCP, or within the laboratory-generated control limits for other samples in the LIMS system.

Corrective Action: If **any** of the surrogates lie outside of the control limits, **reanalysis of the sample is required.** Rerun the sample and place in the project file as documentation of matrix effects.

11. REQUIREMENTS FOR EPA METHOD 624

This method is applicable to the determination of the compounds in municipal and industrial wastewater provided under 40 CFR136.1. The standard analyte list and reporting limits are listed in Table A-1

- Tune period for this method is defined as 24 hours after passing 50 ng BFB. We will default to a 12 hour clock to be consistent within the protocols.
- The spiking level for four replicate initial demonstration proficiency is 20 µg/l. The acceptance criteria are listed in Table A-2.
- MDLs need to be prepared in an acidified water, for all compounds except Acrolein, and 2-CEVE
- All samples, due to permit action levels are to be run at a 25 mL purge

11.1 Initial Calibration Curve criteria:

- The RSD of the response factors should be <35% for each target compound.
- If this requirement cannot be met, a regression curve must be constructed for the non-compliant compounds. There is no correlation coefficient requirement for the regression curve, although it is common practice to use $\geq$0.99 as a criterion.
- Separate initial calibration needs to be run for Acrolein, Acrylonitrile, and 2-CEVE using water without acid preservation.
- The initial calibration is verified daily by the analysis of a 20 µg/l second source QC Check Standard

11.2 Continuing Calibration Verification requirements:

- The continuing calibration standard is the batch CCV. The acceptance criteria are listed in Table A-2.

11.3 LCS and MS/MSD requirements:

- Concentration 20 µg/l for all compounds.
- LCS has to be acidified to match sample matrix.
- The recovery limits are listed in Table A-2
- Minimum of 1 per 20 (5%) of samples need to be spiked to monitor data quality.

12. Tentatively Identified Compounds (TICs)

The non-target compounds detected in a sample are preliminarily identified using a forward search of the NIST 2008 Mass Spectral Database. This search selects closest matches based upon characteristics from the spectra of the TIC and compares to spectra of known compounds analyzed by Electron Impact Ionization MS that have been archived in the mass spectral database. Compounds in the database whose spectra most closely resemble the spectra of the TIC are listed in order of their "match quality" in the search results. This match quality is based upon the McLafferty U+A algorithm.

Interpreting library search data is complex, subjective and dependent upon the analyst's interpretation. Subjectivity increases as spectral complexity increases due complex mass spectra and co-eluting compounds with different fragments.

Qualitative identifications of TICs must be evaluated carefully to determine if their suspected chemical identifications are consistent with the compound classes that can be determined by the method in use, for example, heavy molecules with boiling points >210C are most likely not volatiles in nature. If the chemical (and physical properties) of the suspect compound indicate that presence is possible, the library search data provides the basis for further investigation. For purposes of reporting the following rules must be followed:

12.1. The hit quality as shown on the Chemstation output may not be of value. Examine the spectra carefully and compare to the database hits. If there is a perfect match (this is a spectra that contains all important masses of a compound in similar ratios) then qualitative assignment can be made with caution.

12.2 Never assign an exact name to a compound <u>unless you are certain based upon mass spectrum and retention time knowledge</u> that the identity is fully certain. For example, if you find 2-methyl hexane, and the spectrum matches closely with the database hit, you do not know if it is really 2-methyl hexane or other methyl-hexane isomer. In this case call it "methyl hexane isomer". Also, if you encounter a number of isomers that have similar mass spectra, then you should add up the results and name them "Unknown methyl hexane isomers".

12.3 When complex spectra are complicated by co-eluting chromatographic peaks one cannot assign a clear identity to a TIC, unless you have knowledge of which masses are due to specific compounds. For example a mass spectrum where two TICs co-elute such as a methyl indene isomer (117 and 132 characteristic masses) and a substituted benzene isomer (mass 105 and 120 characteristic masses), all four masses will be in the spectrum. In this case if it is clear you can assign the two identities and split the concentration in half. In cases where it is not clear, call it an "unknown aromatic hydrocarbon".

12.4 In cases where there is no clear match at all, and the mass spectrum is unfamiliar, simply label the TIC as "Unknown", Try assigning a class of compound such as unknown hydrocarbon (masses 43, 57 major); unknown aromatic hydrocarbon (105, 120, 119, 91).

12.5 Examine blank chromatograms to verify that TIC peaks present in samples are not found in blanks. When a low-level, non-target compound that is a common artifact or laboratory contaminant is detected in a sample, a thorough check of blank chromatograms may require looking for peaks which are less than 10% of the internal standard height, but present in the blank chromatogram at a similar Relative Retention Time (RRT).

12.6 In all cases, Element automatically assigns a "J" flag to the concentration (estimated). For TICs also affix the flag "N"-The Tentatively Identified Compound reported indicates the presence of an possible analyte or class of analyte that has been ‘tentatively identified’ and the associated numerical value represents its estimated concentration. If you simply call it an "Unknown" with no class assignment, do not "N" flag it.

13.0 CALCULATIONS AND REPORTING

13.1 Samples concentrations are determined using either the average response factor or regression methods. Extract concentrations greater than the highest standard must be diluted ideally to the midpoint of the curve.

13.2 All sample data calculations are performed by the HP software and the LIMS system.

13.3 Limits of Quantitation -The reporting limits (Limits of Quantitation) for volatiles are based upon the lowest standard used for initial calibration. This LOQ is verified annually by running a standard at 1-2 x this level which must recover within laboratory control limits. Blanks of aqueous and solid matrices are spiked with levels of analyte equivalent to 1x, 2x and 4x their concentrations in the lowest calibration standard. The LOQs of most analytes are verified by recoveries within 3 SD of the average recovery in Element, or narrower. Certain compounds, such as alcohols, ketones, naphthalene, methylene chloride and tetrahydrofuran which do not recover well using the specified methods, are verifiable within 4 SD. It may be necessary to determine laboratory acceptance ranges at reporting limit levels for some analytes, as certain compounds recover poorly at low levels.

13.4 Limits of Detection (LOD)- An LOD is verified by the compound being *qualitatively* present. Blanks of aqueous and solid matrices are spiked with levels of analyte equivalent to one half the low standard used for calibration, if not detected at this level than the low point verified in 13.3 is used for the LOD.

13.5 MDLs are determined for EPA 624 according to EPA Document “Definition and Procedure for the Determination of the Method Detection Limit, Revision 2” December 2016.

Current MDLs are in the LIMS database.

14. REQUIRED MAINTENANCE PROCEDURES

Due to the nature of this method's reliance on auto samplers, purge and trap systems and GC/MS systems, special attention to maintenance details is critical to the operational continuity of each system. The required maintenance items are detailed by component. All maintenance must be entered in the Element Maintenance module (see Figure below in Section 14.3).

14.1 GC/MS Systems- (Do this concurrently with 14.1 above to save time)

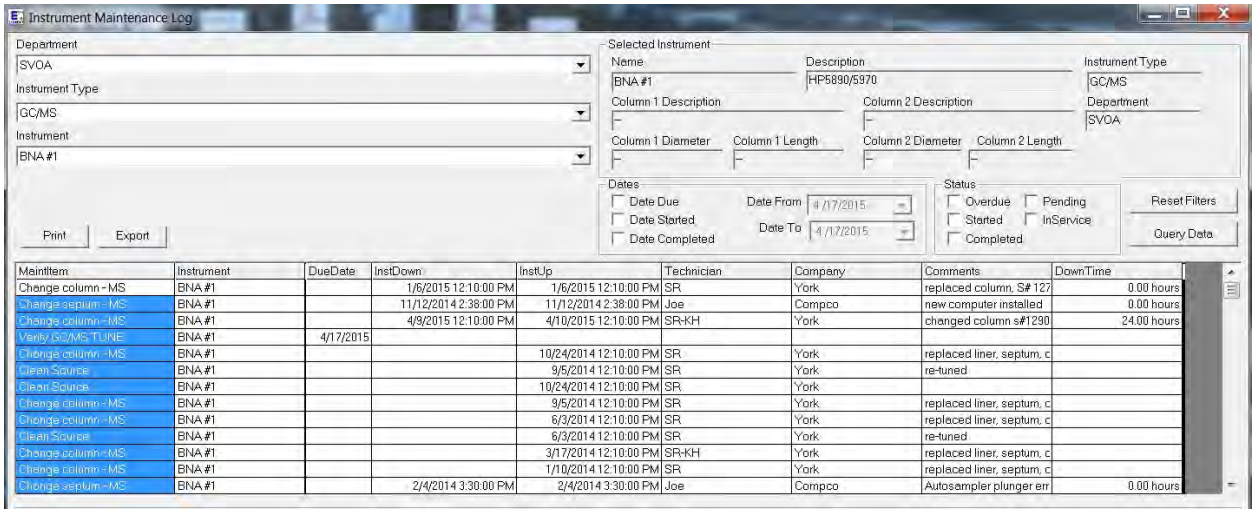
- On each Monday morning, go into the manual tuning file and load the tuning file in use by the system (BFB.u). Execute a repeat profile scan and allow to equilibrate for 2-5 minutes (until m/z 69 is stable). At this point, print the Profile and then take a spectrum scan…wait 30 seconds and print this spectrum scan.
- These hard copies must be filed in the associated MS maintenance tuning file. Examine the spectrum scan to be certain no water or air (masses 18, 28, and 32). Examine the profile scan to be sure the response (abundance of mass 69) is within 20% of the last tune printed.
- Also examine the peak widths in the profile scan to be certain they are close to where they were in the last profile (0.49-0.55 amu wide). If not, see your supervisor. If these are different, the mass spectrometer has changed and the likelihood of passing a BFB or CCV is reduced significantly. Also these data are important to follow trends of source or electron multiplier degradation.

14.2 Purge and Trap systems-After 14.1 is performed

- On each Monday morning a minimum of one conditioning run of a 50 ppb CCV must be run to condition the P&T systems. This is as valuable in assessing changes that may have occurred, and conditions the trap, moisture management system and the GC inlet/column.

14.3 Document your routine maintenance in Element under the Instrument Maintenance Section for each Archon, Purge and Trap and GC/MS system. An example of this is shown in the Figure below.

Element Instrument Maintenance Log



MaintItem	Instrument	DueDate	InstDown	InstUp	Technician	Company	Comments	DownTime
Change column - MS	BNA #1		1/6/2015 12:10:00 PM	1/6/2015 12:10:00 PM	SR	York	replaced column, S# 127	0.00 hours
Change septum - MS	BNA #1		11/12/2014 2:38:00 PM	11/12/2014 2:38:00 PM	Joe	Compco	new computer installed	0.00 hours
Change column - MS	BNA #1		4/9/2015 12:10:00 PM	4/10/2015 12:10:00 PM	SR-KH	York	changed column s#1290	24.00 hours
Verify GC/MS TUNE	BNA #1	4/17/2015						
Change column - MS	BNA #1			10/24/2014 12:10:00 PM	SR	York	replaced liner, septum, c	
Clean Source	BNA #1			9/5/2014 12:10:00 PM	SR	York	re-tuned	
Clean Source	BNA #1			10/24/2014 12:10:00 PM	SR	York		
Change column - MS	BNA #1			9/5/2014 12:10:00 PM	SR	York	replaced liner, septum, c	
Change column - MS	BNA #1			6/3/2014 12:10:00 PM	SR	York	replaced liner, septum, c	
Clean Source	BNA #1			6/3/2014 12:10:00 PM	SR	York	re-tuned	
Change column - MS	BNA #1			3/17/2014 12:10:00 PM	SR-KH	York	replaced liner, septum, c	
Change column - MS	BNA #1			1/10/2014 12:10:00 PM	SR	York	replaced liner, septum, c	
Change septum - MS	BNA #1		2/4/2014 3:30:00 PM	2/4/2014 3:30:00 PM	Joe	Compco	Autosampler plunger err	0.00 hours

14.5 Method Items Requiring Subsequent Recalibration:

Performing certain instrument maintenance may alter instrument performance thus requiring recalibration and tuning. The following maintenance procedures will require instrument recalibration: Trap Replacement, Ion Source Cleaning, EM Tube Replacement, Column Change, MS Vent, and Filament Change.

Carry Over and/or lower response will indicate instrument maintenance is necessary.

Routine preventive maintenance should be performed on the analytical system. This includes replacement of GC septa and periodic rinsing or replacement of purge and trap tubes and sparge needles. The trap should be replaced every six months, or sooner if performance criteria cannot be met. Periodic cleaning (typically twice per year) of the mass spectrometer ion source is required. More frequent source cleaning may be needed, especially if dirty samples are analyzed. If system performance deteriorates, additional maintenance may be required. This includes replacement of injector ports and seals, clipping several inches off of the front end of the GC column, or in extreme cases the replacement of the GC column. Flushing or replacement of purge and trap lines may be necessary if they become contaminated or develop active sites. Perform routine preventative maintenance as described throughout this SOP.

15. HEALTH AND SAFETY

General safety considerations and requirements are detailed in the York Laboratory Safety and Health Standard Operating Procedure No. ADMINSafety010494.

Specific safety rules applying to the conduct of this analysis for volatile organics require the following:

- When handling standards, latex gloves are required.
- Also, when handling neat materials, a fume hood and safety glasses are required.
- When handling samples, gloves and glasses are required.
- Highly odorous samples must be handled in a fume hood.
- Refer to MSDSs for specific safety/health information

16. WASTE MANAGEMENT/POLLUTION PREVENTION

Waste management procedures require the prudent use of neat materials. The ordering of neat standards must be done to minimize unused material which would result in storage of excess material. Quantities ordered should be sufficient to provide for necessary standards with consideration to shelf life.

All methanol rinses of syringes and glassware and expired standards used for VOC procedures are disposed of in a glass waste container. Syringe rinsings containing methanol and/or VOC standards are also transferred to a glass waste container. These waste containers are then consolidated and transferred to a waste solvent drum located in the waste containment area of the laboratory for ultimate disposal by our licensed waste disposal firm.

Unused or remaining soil and water samples are returned to the sample control room for continued storage for proper disposal by the sample control group.

Use of Archon autosampler systems minimizes sample waste. These autosamplers do, however, rinse purge vessels, syringes and lines. This aqueous waste generated from these rinses is transferred daily to the appropriate drum in the waste containment area of the laboratory**.**

17.0 REFERENCES

1. USEPA SW-846 Test Method 8260C Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) (2006).

2. USEPA SW-846 Test Method 5030C Purge-and-Trap for Aqueous Samples (2003).

3. USEPA SW-846 Test Method 5035A Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples (1996).

4. USEPA SW-846 Test Method 3585-Waste Dilution for Volatile Organics (1996).

5. EPA Methods for Chemical Analysis of Water and Wastes, Method 624.

18.0 REVISION HISTORY

Revision 1.1	Apr. 4, 2000	Added drinking water standards preparation, clarified LCS and MS preparation
Revision 1.2	Nov. 4, 2000	Added Safety and Waste Management/Pollution Prevention

Revision 1.3	Jan. 14, 2001	Added preparation of GRO standards, Modified Archon operating conditions to include drinking water purge @ 25 ml.
Revision 1.4	Nov. 30, 2001	Modified preparation of GRO standards Section 5.10
Revision 1.5	Feb. 25, 2002	Modified standards preparation- Section 5.0 et seq.
Revision 1.6	Oct. 17, 2005	Added section on the in-house preparation of ISTDS/Surr
Revision 1.7	Nov. 14, 2005	Modified Section 6.0 to add pH measurement requirement for aqueous samples. Modified Init. Cal and Cont. Cal criteria to reflect tighter requirements. Modified sections 5.3.3 and 5.4 for 524.2 requirements
Revision 1.8	Jun. 23, 2007	Clarify TPH-GRO calibration standard preparation and calibration procedure.
Revision 1.9	Sep. 11, 2007	Clarify standards traceability in GCMS headers
Revision 2.0	Jan. 15, 2010	Added current updates to standards prep.
Revision 2.1	Apr. 29, 2010	Added purity calculations when preparing neat materials. Added a typical sequence as Attachment 1. Clarified tuning criteria in Section 7.1.0. Added typical sequence reference in Section 7.7.0
Revision 2.2	Jan. 26, 2011	Modified/added sections to address fuel oxygenates. Added Attachment 2 addressing fuel oxygenate standards preparation.
Revision 2.3	Jun. 1, 2011	Modified BFB criteria section 7.0 to reflect GC/MS VOA No. 5 tuning parameters.
Revision 2.4	Feb. 27, 2012	Modified Tekmar temps (6.3); Delete analytes below RL in method blank flag (7.5); Analytes over curve must be flagged (8.1)
Revision 2.5	Jun. 29, 2012	Modified standards prep. Added VOA6 tune criteria.
Revision 2.6	Oct. 19, 2012	Updated format, modified calibration curve prep, added corrective actions, made single tune criterion for all instruments, modified GRO range of measurement
Revision 2.7	Nov. 09, 2012	Added oil waste dilution
Revision 2.8	Feb. 13, 2013	GRO stock std to be made from purchased 20mg/ml std
Revision 2.9	Oct. 09, 2013	Updated various sections to include 8260C requirements, added Appendix A-Cleaning of stir bars for re-use
Revision 3.0	Dec. 12, 2014	Modified Section 5.0 for acid sensitive compounds; modified Section 7.3 to reflect BFB std. prep; modified Section 7.4 to add GRO marker compound preparation, modified section 8.5 analysis sequence; modified Section 9.3 CCV %Diff/%Drift; modified section 10.3 method blank requirements; added section 11 for EPA 624 requirements.
Revision 3.1	Jan 29, 2015	Initial Calibration criteria updated- Section 9.1, Added TICs section- Section 12
Revision 3.2	Apr. 20, 2015	Redefined Standards Section 7.1 et seq.; Redefined TICs section 12; Added Section 14 on required maintenance
Revision 3.3	Sep.20, 2015	NEVER ISSUED, remained draft due to modifications in process
Revision 3.4	Mar.16, 2016	Redefined Standards Section 7.0 to consolidate all into one set of working standards Added alternate column for HP 5973 systems in Section 6.0 Clarified BFB amount to meet method requirements for tuning in Section 7.3.4 and 10.1.

		Corrected Internal Standard upper limit criteria to reflect +200% in Section 10.6. Added Figure 1.0-Summary of all VOA method QA requirements
Revision 3.5	June 12, 2017	Added detail on Sample Handling/vials provided to clients
Revision 3.6	Feb. 23, 2018	Anitfoam agent added to reagent list
Revision 3.7	July 25, 2019	Updated headers and footers. Removed outdated equipment. Added TBA to reagents and Table 1, adjusted methanol volumes in Table 1. Updated QA Officer. SBW/RS 07/25/2019

Attachment 1 Minimum Response Factors-8260

Compound	**Minimum RF**
Dichlorodifluoromethane	0.100
Chloromethane	0.100
Vinyl chloride	0.100
Bromomethane	0.100
Chloroethane	0.100
Trichlorofluoromethane	0.100
1,1-Dichloroethene	0.100
1,1,2-Trichloro-1,2,2-trifluoroethane	0.100
Acetone	0.100
Carbon disulfide	0.100
Methyl acetate	0.100
Methylene chloride	0.100
trans-1,2-Dichloroethene	0.100
cis-1,2-Dichloroethene	0.100
Methyl tert-butyl ether	0.100
1,1-Dichloroethane	0.200
2-Butanone	0.100
Chloroform	0.200
1,1,1-Trichloroethane	0.100
Cyclohexane	0.100
Carbon tetrachloride	0.100
Benzene	0.500
1,2-Dichloroethane	0.100
Trichloroethene	0.200
Methylcyclohexane	0.100
1,2-Dichloropropane	0.100
Bromodichloromethane	0.200
cis-1,3-Dichloropropene	0.200
trans-1,3-Dichloropropene	0.100
4-Methyl-2-pentanone	0.100

Toluene	0.400
1,1,2-Trichloroethane	0.100
Tetrachloroethene	0.200
2-Hexanone	0.100
Dibromochloromethane	0.100
1,2-Dibromoethane	0.100
Chlorobenzene	0.500
Ethylbenzene	0.100
meta-/para-Xylene	0.100
ortho-xylene	0.300
Styrene	0.300
Bromoform	0.100
Isopropylbenzene	0.100
1,1,2,2-Tetrachloroethane	0.300
1,3-Dichlorobenzene	0.600
1,4-Dichlorobenzene	0.500
1,2-Dichlorobenzene	0.400
1,2-Dibromo-3-chloropropane	0.050
1,2,4-Trichlorobenzene	0.200

Appendix A-Procedure for Cleaning of Stir Bars for Re-use

Stir bars used for VOA samples may be re-used subsequent to proper cleaning procedures. The stir bars are transferred to a liter beaker and methanol (HPLC grade) is allowed to cover all stir bars to soak. The beaker is placed in a sonic bath for a period of approx. 1 hour. Remove the Methanol by decanting into a waste container. Rinse three times with DI/Organic free water and decant the water as much as possible. Place the beaker in the WET CHEM drying oven at approx. 100C a minimum of 4 hours. Upon removal, allow the beaker contents (clean stir bars) to cool in the VOA lab environment. When cool enough to handle, transfer to a clean labeled storage container until use.

Table A-1
Method 624 Analytes and Reporting Limit

Analytes	CAS Number	Max. Reporting limit
Benzene	71-43-2	0.5
Bromodichloromethane	75-27-4	1
Bromoform	75-25-2	1
Bromomethane	74-83-9	1
Carbon Tetrachloride	56-23-5	1
Chlorobenzene	108-90-7	1
Chloroethane	75-00-3	1
2-Chloroethylvinyl ether	110-75-8	2
Chloroform	67-66-3	1
Chloromethane	74-87-3	1
Dibromochloromethane	124-48-1	1
1,2-Dichlorobenzee	95-50-1	1
1,3-Dichlorobenzene	541-73-1	1
1,4-Dichlorobenzene	106-46-7	1
1,1-Dichloroethane	75-34-3	1
1,2-Dichloroethane	107-06-2	1
1,1-Dichloroethene	75-35-4	1
Trans-1,2-Dichloroethene	156-60-5	1
1,2-Dichloropropane	78-87-5	1
Cis-1,3-Dichloropropene	10061-01-5	1
Trans-1,3-Dichloropropene	10061-02-6	1
Ethylbenzene	100-41-4	1
Methylene Chloride	75-09-2	1
1,1,2,2-Tetrachloroethene	79-34-5	1
Tetrachloroethene	127-18-4	1
Toluene	108-88-3	1
1,1,1-Trichloroethene	71-55-6	1
1,1,2-Trichloroethene	79-00-5	1
Trichloroethane	79-01-6	1
Trichlorofluoromethane	75-69-4	1
Vinyl Chloride	75-01-4	1

Table A-2
Method 624 QC Acceptance Criteria

Analytes	Daily QC Check acceptance criteria %Recovery	Mean Recovery, 4 replicates initial demonstration acceptance criteria (20 µg/l spike)	Standard deviation. 4 replicates initial demonstration acceptance criteria (20 µg/l spike)	Matrix spike acceptance criteria (% Recovery)
Benzene	64-136	15.2-26.0	6.9	37-151
Bromodichloromethane	65-135	10.1-28.0	6.4	35-155
Bromoform	71-129	11.4-31.1	5.4	45-169
Bromomethane	14-186	D-41.2	17.9	D-242
Carbon Tetrachloride	73-127	17.2-23.5	5.2	70-140
Chlorobenzene	66-134	16.4-27.4	6.3	37-160
Chloroethane	38-162	8.4-40.4	11.4	14-230
2-Chloroethylvinyl ether	D-224	D-50.4	25.9	D-305
Chloroform	67-133	13.7-24.2	6.1	51-138
Chloromethane	D-204	D-45.9	19.8	D-273
Dibromochloromethane	67-133	13.8-26.6	6.1	53-149
1,2-Dichlorobenzee	63-137	11.8-34.7	7.1	18-190
1,3-Dichlorobenzene	73-127	17.0-28.8	5.5	59-156
1,4-Dichlorobenzene	63-137	11.8-34.7	7.1	18-190
1,1-Dichloroethane	72-128	14.2-28.5	5.1	59-155
1,2-Dichloroethane	68-132	14.3-27.4	6.0	49-155
1,1-Dichloroethene	50-150	3.7-42.3	9.1	D-234
Trans-1,2-Dichloroethene	69-131	13.6-28.5	5.7	54-156
1,2-Dichloropropane	34-166	3.8-36.2	13.8	D-210
Cis-1,3-Dichloropropene	24-176	1.0-39.0	15.8	D-227
Trans-1,3-Dichloropropene	50-150	7.6-32.4	10.4	17-183
Ethylbenzene	59-141	17.4-26.7	7.5	37-162
Methylene Chloride	60-140	D-41.0	7.34	D-221
1,1,2,2-Tetrachloroethene	60-140	13.5-27.2	7.4	46-157
Tetrachloroethene	73-127	17.0-26.6	5.0	64-148
Toluene	74-126	16.6-26.7	4.8	47-150
1,1,1-Trichloroethene	75-125	13.7-30.1	4.6	52-162
1,1,2-Trichloroethene	71-129	14.3-27.1	5.5	52-150
Trichloroethane	66-134	18.6-27.6	6.6	71-157
Trichlorofluoromethane	48-152	8.9-31.5	10.0	17-181
Vinyl Chloride	4-196	D-43.5	20.0	d-251

Figure 1.0 VOA Protocol Criteria Summary

Master Spreadsheet for Method QA Criteria for MASTER VERSIONS
VOCs

QA Item	EPA SW846-8260C	CTDEEP RCP 8260	NJDEP DKQP 8260C	EPA 624	EPA 524.2
Tuning, BFB	50 ng on-column	50 ng on-column	50 ng on-column	50 ng on-column	25 ng on-column
Mass 50	15-40% of mass 95	15-40% of mass 95	15-40% of mass 95	15-40% of mass 95	15-40% of mass 95
Mass 75	30-60% of mass 95	30-60% of mass 95	30-60% of mass 95	30-60% of mass 95	30-80% of mass 95
Mass 95	Base Peak=100%	Base Peak=100%	Base Peak=100%	Base Peak=100%	Base Peak=100%
Mass 96	5-9% of mass 95	5-9% of mass 95	5-9% of mass 95	5-9% of mass 95	5-9% of mass 95
Mass 173	<2% of mass 174	<2% of mass 174	<2% of mass 174	<2% of mass 174	<2% of mass 174
Mass 174	>50 % of mass 95	>50 % of mass 95	>50 % of mass 95	>50 % of mass 95	>50 % of mass 95
Mass 175	5-9% of mass 174	5-9% of mass 174	5-9% of mass 174	5-9% of mass 174	5-9% of mass 174
Mass 176	>95% <101 % of mass 174	>95% <101 % of mass 174	>95% <101 % of mass 174	>95% <101 % of mass 174	>95% <101 % of mass 174
Mass 177	5-9% of mass 176	5-9% of mass 176	5-9% of mass 176	5-9% of mass 176	5-9% of mass 176
ICAL Criteria	Low STD = RL; RSD≤ 20% or use regression with > 0.990 R value. If >10% of the compounds do not meet either criteria then unacceptable.	Low STD=RL; RSD≤ 15% or use regression with > 0.990 R value; No CCC can be > 30% or <0.990 R; no more than 20% RSD >30% or R <0.990	Low STD = RL; RSD≤ 20% or use regression with > 0.990 R value. ALL (inlcuding surrogates) MUST PASS THIS or invalid CAL	<35% RSD or regression ≥0.990; separate IAL for Acrolein, Acrylonitrile and 2-CEVE with no acid	<20% RSD for Rfs for ALL; alternatively apply Regression with >0.990 R
ICV/SCV Criteria	≤ 30% Difference	≤ 20% Diff- but allowed to have up to 20% out but none outside 65-135%	Not Specified	Not Specified	Not Specified
Internal Standard Criteria	-50% to +200% of CCV	-50% to +200% of CCV	-50% to +200% of CCV	-50% to +200% of CCV	± 30% from CCV ± 50% from ICAL
Minimum RRf Criteria	Range from 0.05 to 0.6 SEE SOP-Attachment 1	0.05	Range from 0.05 to 0.6 SEE SOP-Attachment 1	Not Specified	Not Specified
CCV Criteria	≤ 20% Diff.from ICAL ; no more than 20% of compounds over this	≤ 20% Diff.for CCCs from ICAL ; other cmpds < 30% Diff.; Other than CCCs, 10% of compounds < 30%Diff	≤ 20% Diff.from ICAL	Specific limits -See table A-2 of SOP	± 30% of RF or conc. for regression
Retention Time Criteria	ISTD < 10 sec.(0.167') DIFF from ICAL midpoint STD	ISTD < 30 sec.(0.5') diff from ICAL/CCV	ISTD < 30 sec.(0.5') diff from ICAL/CCV	ISTD < 30 sec.(0.5') diff from ICAL/CCV	ISTD < 30 sec.(0.5') diff from ICAL/CCV
Method Blank Criteria	All targets < RL except methylene chloride and acetone up to 5x RL	All targets < RL except methylene chloride and acetone up to 3x RL	All targets < RL except methylene chloride and acetone up to 5x RL	No targets > RL	Called LRB-no targets
LCS Criteria	Within Lab Control Limits; up to 10% of compounds over is OK but these can't exceed 40-160% range	Within 70-130%R; up to 10% of compounds over is OK but these can't exceed 40-160% range	Within 70-130%R; Difficult Analytes can't exceed 40-160% range	Run at 20 ug/L REQUIRED-See Table A-2 of SOP for Recovery limits	Called LPC- Lab limits; also called LFB-±30% R
LCS/LCSD Criteria	Within Lab Control Limits-~30%	Not specified-Lab Controls	Not specified-Lab Controls	Not specified-Lab Controls	Not required (LCSD)
MS Recovery Criteria	Within Lab Contro Limits	70-130% R	70-130% R; except for difficult analytes*-40-160%R	See Table A-2 of SOP	Called LFM-No limits specified required-lab limits
MS/MSD RPD Criteria	Within Lab Control Limits	≤ 30% R	≤20% AQ; ≤30% Soils	Not specified	Not specified use lab limits
Surrogate Criteria	Within Lab control Limits	70-130% R or Lab limits if tighter	70-130% R	Lab Control Limits	Lab control limits
Analysis "CLOCK"	12 hour from Tune check injection	12 hour from Tune check injection	12 hour from Tune check injection	24 hour CLOCK	12 Hour from Tune injection

* NJDEP Difficult Analytes: acetone, 2-butanone, 4-methyl-2-pentanone, 2-hexanone, dichlorodifluoromethane, bromomethane, chloromethane, carbon disulfide, 1,2-Dibromo-3-chloropropane, chloroethane, naphthalene, trichlorofluoromethane, an 1,4-Dioxane

Figure 2.0- CCC and SPCC Compounds for CT DEEP RCP Criteria in Figure 1.0

Calibration Check Compounds (CCC)	System Performance Check Compounds(SPCC)
1,1-Dichloroethylene	Chloromethane
Chloroform	1,1-Dichloroethylene
1,2-Dichloropropane	Bromoform
Toluene	Chlorobenzene
Ethyl benzene	1,1,2,2-Tetrachloroethane
Vinyl Chloride	

APPENDIX F – Resumes

RICHARD HOOKER, PH.D.

GALLAGHER BASSETT | TECHNICAL SERVICES

CURRENT POSITION: SENIOR PROJECT MANAGER

PROFESSIONAL SUMMARY

Richard Hooker serves as Senior Project Manager for investigative and remedial projects including NYSDEC and OER Brownfields sites, Phase II investigations, and environmental management of construction projects. He also prepares and evaluates interdisciplinary, comprehensive environmental impact assessment reviews (NEPA, SEQR and CEQR) and has a particular expertise in noise issues. Mr. Hooker develops investigative and remedial work plans, health and safety plans, performs fieldwork, and prepares technical reports. He works with regulatory authorities and subcontractors including construction personnel, waste repositories and haulage contractors, laboratories and drillers. His responsibilities include: designing noise studies, investigating site histories, and document reviews, cost benefit analysis of remedial alternatives, overseeing excavations and in situ remediation, sampling, sample data evaluation, report preparation, and obtaining regulatory closure. He has extensive experience of sampling and sample collection protocols for soil, vapor, indoor air, sediment, and groundwater and has worked to remediate a wide range of environmental contaminants including petroleum, heavy metals, PCBs, and solvents.

Mr. Hooker holds a Ph.D. from the University of St. Andrews, St. Andrews, Scotland and a BA from Staffordshire University, Stoke-on-Trent, England. Prior to relocating to the Hudson Valley, he served as an Assistant Professor at the University of Glasgow, Scotland.

PROFESSIONAL EXPERIENCE

3475 Third Avenue, Bronx, NY—Investigated and remediated this former manufacturing facility to NYSDEC Brownfields to Track 1 cleanup standards. This site was the first project in the OER Jumpstart program established to assist cleanup on government supported affordable and supportive housing projects in NYC. Under this program OER sponsored enrollment in the NYS Brownfield Cleanup Program. Work on this trailblazing project required liaising with OER and NYSDEC Region 2 to ensure documentation met the requirements of both agencies. Certificate of Completion secured in 2016.

Former A.C. Dutton Lumber Yard, Dutchess County, NY—Documented hazardous concentrations of arsenic and chromium in soils and concrete surfaces at this NYSDEC Brownfields site contaminated by the historical pressure treatment of lumber. Developed a Workplan for site remediation and directed environmental restoration activities, including: characterization, excavation and removal of hazardous soils, scarification concrete warehouse floors, removal aboveground and underground chemical and petroleum storage tanks.

Lincoln Place, Brooklyn, NY—performed CEQR, SEQR and NEPA reviews including shadow and noise studies for this site prior to development. Prepared Remedial Workplan and oversaw remediation of metals-contaminated soils during construction and implemented remedy for the site including SSDS system installation, vapor barrier, and installation of composite cover system. Prepared FER and obtained NYCHPD and NYCDEP closeout for the site.

Grace Terrace, Mount Vernon, NY—oversaw remediation and obtained NTSDEC Spill file closure after a previously unknown UST and associated petroleum contaminated soil were encountered during construction

excavations. Coordinated with the GC to ensure appropriate cleanup was performed without delaying the construction schedule. Remedial actions included characterization and appropriate off-site disposition of petroleum contaminated soil and groundwater, application of chemical oxidation treatment, installation vapor barrier and active SSDS system.

Former Fur Processing Facility, Bronx, NY—Documented the presence of chlorinated hydrocarbon, petroleum, and metals contamination beneath and/or near a former industrial structure. Coordinated the sampling and removal of multiple drums of hazardous and non-hazardous material from the structure and secured NYCDEP approval. Developed a Workplan for site remediation and directed environmental restoration activities, including: excavation and removal of both aboveground and underground storage tanks, removal of contaminated soils, installation of a barrier layer soil cap, and pre-demolition removal of asbestos materials.

Jamaica Hospital Medical Center, Queens, NY—Coordinated and supervised the removal of two, large underground storage tanks and documented site conditions through soil and groundwater sampling. Secured NYSDEC approval of PBS tank closure and registration requirements.

EDUCATION:

- Ph.D., University of St. Andrews, Scotland
- BA, Staffordshire University, England

REGISTRATIONS / CERTIFICATIONS

- OSHA-40 Hazwoper
- OSHA-10 Construction
- OSHA Hazardous Waste Site Operations
- OSHA Emergency Response Training
- OER TurboTraining Gold Certified Professional

SCOTT SPITZER

GALLAGHER BASSETT | TECHNICAL SERVICES

CURRENT POSITION: DIRECTOR OF ENVIRONMENTAL INVESTIGATIONS

PROFESSIONAL SUMMARY

Scott Spitzer serves as Director of Environmental Investigations, overseeing the technical elements of Phase I and Phase II technical environmental investigations and remedial projects, including Brownfield sites. Mr. Spitzer supervises all GBTS field staff and reviews all documents prepared by GBTS to ensure consistency and technical accuracy.

His responsibilities associated with the preparation of site assessments include: investigating site histories, conducting facility inspections, reviewing regulatory agency records, documenting facility compliance with relevant State and Federal regulations, and preparing reports. As project manager for complex technical environmental investigations (including sites currently on the NYSDEC Registry of Inactive Hazardous Waste Sites), Mr. Spitzer is involved with: coordinating subcontractors; overseeing fieldwork; designing and implementing material, soil, and water sampling plans, preparing technical reports and interfacing with regulatory agency personnel.

Mr. Spitzer has 15 years' experience in the preparation of Phase I, Phase II and Brownfields investigations and in the management of complex remediation projects. He is knowledgeable in both New York State and Federal environmental regulations and has an understanding of a broad range of remedial technologies. Mr. Spitzer studied environmental science at SUNY Purchase and holds a BS in Biology from SUNY at Stony Brook, Stony Brook, New York.

PROFESSIONAL EXPERIENCE

Former NuHart Plastics Manufacturing Site, Brooklyn, NY: GBTS conducted a complex remedial investigation of a NYSDEC Class 2 Inactive Hazardous Waste Disposal ("Superfund") site, where a plume of liquid phthalates and chlorinated solvents had impacted groundwater. Extensive sampling was conducted of both on- and off-site soil, soil vapor and groundwater, and phthalates were removed from recovery wells as an interim remedial measure. A Remedial Investigation Report was completed, allowing the site owner to move create a Remedial Design Document.

Scenic Hudson Land Trust, Inc., Beacon Waterfront Project, Beacon, NY: GBTS conducted soil and groundwater investigations on a former MOSF and adjacent scrap yard. Projects involved soil remediation of both petroleum and PCB-contaminated soils and long-term groundwater monitoring. Both projects were classified as Voluntary Clean-Up projects by the NYSDEC and closure status was attained.

Sakmann Restaurant Corporation Site, Fort Montgomery, NY: Conducted Phase I Environmental Site Assessment and Phase II Subsurface Investigations for former filling station and automotive repair garage contaminated by solvent and waste-oil discharges to an on-site drywell. Designed and implemented a sampling plan for soils impacted by chlorinated hydrocarbons, petroleum, and metals. Created Work Plan (in coordination with the NYSDEC Voluntary Cleanup Program) for remediation of on-site contamination and long-term sampling of on-site groundwater monitoring wells.

Staten Island Marina Site, Staten Island, NY: Conducted Phase I Environmental Site Assessment and Phase II Subsurface Investigation for an active marine facility engaged in boat painting and engine maintenance activities. Coordinated the delineation of metals contamination over a three-acre area and analyzed potential impacts from onsite fill materials. Submitted remedial and budgetary analysis in support of regulatory agency approval for conversion of boatyard into a public park.

Octagon House Development Site, Roosevelt Island, NY: Conducted Phase I Environmental Site Assessment and Phase II Subsurface Investigations at the former site of a large, urban hospital. Interpreted the results of geotechnical studies, extended test pits, and conducted extensive soil sampling, to document subsurface soil conditions in support of client's application to the U.S. Housing and Urban Development Agency (HUD). Created Work Plan (in coordination with the NYCDEP Office of Environmental Planning and Assessment) for site-wide remediation of contaminated soils and secured NYCDEP approval for site remediation as required by HUD.

Camp Glen Gray Boy Scout Facility, Mahwah, NJ: Conducted Phase I Environmental Site Assessment and Phase II Subsurface Investigations at an approximately 800-acre campground containing numerous structures. Documented subsurface soil conditions at the locations of aboveground and underground storage tanks, and delineated lead contamination at a former firing range. Assisted in design and implementation of remediation plans for removal of petroleum and lead contaminated soils, and obtained NJDEP approvals.

EDUCATION:

- BS, Biology, SUNY at Stony Brook, NY

REGISTRATIONS / CERTIFICATIONS

- OSHA, 40-hr. Hazardous Waste Operations & Emergency Response Health & Safety Certification
- OSHA, 10-hr. General Construction Industry Training and Certification

VICTORIA PANICO

GALLAGHER BASSETT | TECHNICAL SERVICES

CURRENT POSITION: ASSISTANT PROJECT MANAGER

PROFESSIONAL SUMMARY

Victoria Panico serves as an Assistant Project Manager for environmental site assessments, Phase II environmental investigations and NYC OER remediation projects. Ms. Panico develops investigative and remedial work plans, performs fieldwork, prepares technical reports, and coordinates with subcontractors including construction personnel, laboratories and drillers. Her responsibilities include: investigating site histories, conducting facility inspections, reviewing regulatory agency records, communications with stakeholders (client, construction manager, and regulatory agencies), preparation, submission and approval of reports, and obtain regulatory closure. She conducts Phase II technical environmental investigations and fieldwork including implementation of community air monitoring plans (CAMP), and sampling of soil, soil vapor and groundwater.

Ms. Panico has experience preparing Remedial Action Reports, conducting Site Management Plan annual inspections and reporting, evaluating the effectiveness of SSD systems and providing oversight of site remedial activities on rural properties.

PROFESSIONAL EXPERIENCE

Gallagher Bassett Technical Services
Phase I Environmental Site Assessments (ESAs)

Completed over 75 Phase I ESAs including residential, commercial, industrial and agricultural properties. Responsibilities include: investigating site histories, conducting facility inspections, reviewing regulatory agency records, documenting facility compliance with relevant State and Federal regulations, and preparing reports.

Phase II ESAs and Site Investigations

Completed/assisted with over 15 Phase II sub-surface investigations. Experience sampling and sample collection for soil, soil vapor and groundwater. Ms. Panico works with regulatory authorities and subcontractors including construction personnel, waste repositories, laboratories and drillers. She has also experience conducting waste characterization sampling and collection of end-point samples.

NYC Voluntary Cleanup Program (VCP) Sites

Serves as Assistant Project Manager for NYC Voluntary Cleanup Program (VCP) remediation and redevelopment projects, which includes assisting in the design of remedial actions, oversight of remedial activities, and implementing remedies including installation of SSD systems, vapor barriers, and composite cover systems. Responsibilities include: preparation of RIRs and RAWPs, on-going project management and remedial oversight, ensuring compliance with the remedial action, communications with stakeholders (client, construction manager, and regulatory agencies), facilitation of spill closure, preparation and submission of daily, weekly, and monthly status reports, client updates and satisfaction, preparation of RARs, and obtaining regulatory closure.

EDUCATION

- BS, Environmental Science, Science Emphasis, Marist College, Poughkeepsie, NY

REGISTRATIONS / CERTIFICATIONS

- 40-hour OSHA HAZWOPER & annual refresher training
- 30-hour OSHA Construction
- 8-hour Fall Prevention
- 4-hour Supported Scaffold User & refresher

CAROLINE CLARK

GALLAGHER BASSETT | TECHNICAL SERVICES

CURRENT POSITION: ASSISTANT PROJECT MANAGER

PROFESSIONAL SUMMARY

Caroline Clark serves as Assistant Project Manager for environmental site assessments and Phase II technical environmental investigations. Her responsibilities include: investigating site histories, conducting facility inspections, reviewing regulatory agency records, documenting facility compliance with relevant State and Federal regulations, and preparing reports. She assists with Phase II technical environmental investigations and fieldwork including implementation of community air monitoring plans (CAMP), collecting soil and water samples and tank removal oversight.

PROFESSIONAL EXPERIENCE

- Consult Title 6 of the New York Codes, Rules and Regulations Part 375 subpart 1.8(c) [6 NYCRR 375-1.8(c)], 6 NYCRR 375-1.8(d), or the RCRA Corrective Action Program to create remedial action work plans (RAWP)
- Apply the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to properly dispose of waste from Superfund Sites
- Collect samples, complete inspections, and generate reports to maintain State Pollution Discharge Elimination System (SPDES) Permits
- Conduct Phase II and III Environmental Site Assessments
- Design and manage the installation of remediation systems
- Collect soil, groundwater, and air samples in accordance with state and federal regulations
- Conduct soil classification and logging in conjunction with subsurface investigation projects
- Write Remedial Action Completion Reports (RACP) which include figures, tabulated data, and graphs
- Create and manage contractual agreements with subcontractors
- Create Health and Safety Plans (HASP) in accordance with state and federal guidelines
- Develop schedules for projects and communicate progress with management, clients, and state officials

EDUCATION

- Bryn Mawr College, Bachelors of Arts – Geology

REGISTRATIONS / CERTIFICATIONS

- OSHA 40-Hour HAZWOPER 29 CFR 1910.120

ERICK SALAZAR

GALLAGHER BASSETT | TECHNICAL SERVICES

CURRENT POSITION: ASSISTANT PROJECT MANAGER

PROFESSIONAL SUMMARY

Erick Salazar serves as Assistant Project Manager for environmental site assessments and Phase II technical environmental investigations. His responsibilities include: investigating site histories, conducting facility inspections, reviewing regulatory agency records, documenting facility compliance with relevant State and Federal regulations, and preparing reports. He assists with Phase II technical environmental investigations and fieldwork including implementation of community air monitoring plans (CAMP), collecting soil and water samples and tank removal oversight.

Mr. Salazar has experience in the implementation of CAMP monitoring, personal sampling for lead and dust of workers, coordinating pre-demolition C&D waste inventory as part of Sandy relief work on Staten Island, and providing oversight of site remedial activities on rural properties.

PROFESSIONAL EXPERIENCE

Mr. Salazar has experience in the implementation of CAMP monitoring, personal sampling for lead and dust of workers, coordinating pre-demolition C&D waste inventory as part of Sandy relief work on Staten Island, and providing oversight of site remedial activities on rural properties.
Mr. Salazar's experience with Health and Safety services include:

- Complete OSHA training and three years' experience of Sites handling regulated materials as well as hazardous and non-hazardous wastes.
- Preparation of Environmental Health & Safety Plan for (EHASP) for debris removal and soil sampling project in Ulster County, New York.
- Assistance in the preparation of EHASPs for NYSDEC sites in Dutchess and Westchester Counties.
- Implementation of CAMP at sites in Dutchess, Ulster, Bronx and Queens Counties, including preparation of status reports, preparation of incident reports, and communication with involved regulatory agencies.
- Collection/analysis of media samples (air, water and soil) per requirements of the EHASP and/or remedial work plans.

EDUCATION

- BS, Biology, State University at New Paltz, NY

REGISTRATIONS / CERTIFICATIONS

- OSHA, 40-hr Hazardous Waste Operations & Emergency Response Health & Safety Certification
- OSHA, 10-hr General Construction Industry Training & Certification

MEGAN KING

GALLAGHER BASSETT | TECHNICAL SERVICES

CURRENT POSITION: ASSISTANT PROJECT MANAGER

PROFESSIONAL SUMMARY

Megan King serves as Assistant Project Manager for environmental site assessments, and Phase II technical environmental investigations. Her responsibilities include: investigating site histories, conducting facility inspections, reviewing regulatory agency records, documenting facility compliance with relevant State and Federal regulations, and preparing reports. She assists with Phase II technical environmental investigations and fieldwork including collecting soil, soil vapor, and water samples and tank removal oversight.

Ms. King additionally has experience performing CEQR, SEQR and NEPA reviews including shadow, traffic, socioeconomic, hazardous material, and noise studies, and thermal explosive assessments.

PROFESSIONAL EXPERIENCE

Ms. King has experience in the preparation of various city, state, and federal environmental reviews; Phase I and II Environmental Site Assessments; coordinating and overseeing tank removals and subsequent soil management and trucking activities; and providing oversight of site remedial activities on urban and rural properties.

Ms. King's experience includes:

- Complete OSHA training and three years' experience of Sites handling regulated materials as well as hazardous and non-hazardous wastes.
- Preparation of CEQRs for development sites in King's, Queens, and Manhattan Counties.
- Preparation of SEQR for a development site in Dutchess County.
- Preparation of NEPA EAs for development sites in Ulster, King's, Bronx, Queens, Westchester, and Herkimer Counties.
- Preparation of RWCDS for a development site in New York County.
- Collection/analysis of media samples (air, water and soil) per requirements of the EHASP and/or remedial work plans.
- Preparation of Phase II Work Plans in coordination with the New York City Mayor's Office of Environmental Remediation.

EDUCATION

BS, Geology, State University at New Paltz, NY

REGISTRATIONS / CERTIFICATIONS

- OSHA, 40-hr Hazardous Waste Operations & Emergency Response Health & Safety Certification
- OSHA, 30-hr General Construction Industry Training & Certification
- OSHA, 10-hr Drug and Alcohol Awareness Training & Certification

JAMES M. JAROS, CSP, PG

GALLAGHER BASSETT | TECHNICAL SERVICES

CURRENT POSITION: SR. LOSS CONTROL CONSULTANT

PROFESSIONAL SUMMARY

James Jaros has 16 years of comprehensive health, safety, and environmental program management experience with a diverse background in industrial and consulting roles. Mr. Jaros' unique skillset includes experience in a variety of industrial settings such as refineries, nuclear facilities, and mining/natural resources in both construction and decommissioning situations in the construction, demolition, restoration, energy, petrochemical, and nuclear arenas.

Mr. Jaros' subject matter expertise includes systematic safety management and customized program development, implementation, and compliance. His uncommon approach infuses critical aspects of process safety management (PSM), human performance improvement (HPI), and contractor safety management processes with business objectives and best practices.

PROFESSIONAL EXPERIENCE

Senior Loss Control Consultant **2019 - Present**
Gallagher Bassett Technical Services Division

Mr. Jaros is the Senior Consultant responsible for providing high level loss control services to Gallagher Bassett's current clients. In addition, he is responsible for growing the loss control service base with additional clients, expanding loss control service offerings, and the professional development of staff.

President, Chief Consultant **2019**
JAROS Health, Safety, & Environment LLC

Launched a full-service safety management and consulting corporation designed to support industrial clients, construction, and demolition, industrial, petrochemical, and nuclear decommissioning industries.

Capitalized on nearly two decades of safety management experience and industry certifications to assemble a sustainable portfolio of safety program management, risk assessment, employee training, and compliance products; developed marketing collateral and initiated prospecting.

Consulting Services – Outlined key industry challenges and needs assessment strategies; designed service options in areas of audits and inspections, compliance, health and safety plans and procedures, accident investigation, contracting, and organization development across business segments and functions.

Professional Development – Produced a versatile training platform to accommodate immediate and future training needs related to safety management and workforce competencies. Topics include 10-30 Hour OSHA Construction, Behavior-Based Safety Training, Bloodborne Pathogens, Confined Space, Electrical Safety

Awareness, Emergency Action Plans, Ergonomics, Back Safety, Fall Protection, Fire Protection, Hazard Communication (SDS), Introduction to OSHA, Lockout/Tagout, Machine Guarding, Personal Protective Equipment (PPE), Recordkeeping, Walking Working Surfaces, Welding, Cutting, and Brazing.

Manager, Industrial Safety & Hygiene **2008 – 2018**
Energy Solutions LLC, Zion, IL

EnergySolutions is an international nuclear services company providing a full range of nuclear power plant (sites and facilities) decommissioning and decontamination (D&D). Specialties include management of spent nuclear fuel, the transportation of nuclear material, and environmental cleanup of nuclear legacy sites.

Partnered with leadership to build a strong safety culture; provided technical guidance, health, and safety leadership to senior management and project personnel; outlined key performance indicators (KPI) and metrics for business unit safety functions.

Zion Restoration Project **2008 – 2018**
Subsidiary of EnergySolutions

Charged with safety management in decommissioning the Zion Nuclear Power Station in Zion, IL, a project valued at $1B over a period of eight years.

- Supported the world's largest commercial nuclear decommissioning project. Managed Industrial Safety and Hygiene, and Occupational Health Service departments to improve the return on investment (ROI) and protect an average of 600 personnel;
- Supervised several direct reports; performed formal performance reviews; recruited new staff; delivered high-level presentations and collaborated with executive-level stakeholders, senior managers, and project management team leaders to embed the full spectrum of safety into project production goals and site activities;
- Exercised fiduciary and P&L responsibility in the projection and allocation of a $7M safety budget; experienced no major injuries and completed more than 1.2M hours without a lost time injury;
- Integral in rollout of the Human Performance Improvement Safety Program, an initiative presented to more than 1,000 personnel during the lifetime of the project.

GE Hitachi **2008 – 2010**
Subsidiary of EnergySolutions

Developed health and safety plans to support the radioactive cleanup for two separate GE Hitachi projects: GE Morris Operation, Morris, IL and Vallecitos Nuclear Center (VNC), Sunol, CA. Verified project compliance and developed project-specific safety training; performed safety audits, conducted hazard evaluations, and led incident investigations.

Health and Safety Manager **2002 – 2008**
Trihydro Corporation, Lockport, IL

Trihydro specializes in providing clients with advanced technical and regulatory knowledge in areas of air quality, process management, engineering, environmental, health and safety, information management, and water resources. Industries encompass petroleum, government operations, mining and natural resources, industrial and commercial applications, and infrastructure.

Augmented the development of project requirements and ensured compliance for projects including active oil refineries, oil pipeline projects, and a former refinery (demolition and environmental remediation).

Project Management of plan, including: generating bids, proposals, and cost estimates; which led the safety program for projects ranging in value from $100K to $60M; with no major injuries experienced.

- Chaired safety meetings; managed the Fit for Duty program supporting 60 personnel, and led the implementation of a behavior-based health and safety system;

Infused Process Safety Management (PSM) tools into business processes; implemented quality systems management (QSM) and project training programs for new site personnel.

Key Projects included: Former Texaco Lockport Refinery Environmental Cleanup (6 years), Citgo Refinery (3 years), and Enbridge Pipeline (2 years). Recognized for safe work place by Three Rivers Manufacturing Association.

- Rolled out the nationwide Behavior-Based Safety Program; trained hundreds of employees and contractors;
- Managed an Environmental Monitoring Program on behalf of major petroleum pipeline companies;
- Subsequent to a petrochemical release, managed the investigation and cleanup of contaminants for a major oil company;
- Member of a remediation team tasked to remediate a former petroleum refinery under a Resource Conservation and Recovery Act (RCRA) permit; kept the project in regulatory compliance while moving forward with remediation activities.

Geologist / Environmental Consultant / Project Manager **1994 - 2002**
Various Environmental Consulting Firms

Managed diverse environmentally impacted property portfolios, developed site background profiles, investigated subsurface conditions, determined site classifications, and proposed and implemented remedial action measures.

- Evaluated soil and groundwater analytical data to determine site-specific hydro-geologic properties for contaminant fate and transport modeling.
- Performed Phase 1 and Phase 2 Environmental Site Assessments

- Developed site-specific remediation objectives aligned with reducing remedial costs, without compromising the risks of contaminant exposure.
- Compiled analytical data and produced technical reports to regulatory agencies, clients, and property owners; trained new employees.
- Initiated project planning, coordinated and communicated the scope of work (SOW); supervised contractors/subcontractors/personnel in remediation activities.
- Collected samples for anthrax using Department of Defense (DOD) safety protocol.
- Managed contractors performing installation activities for Geosynthetic Environmental Liner Systems and methane gas collection systems, and groundwater monitoring wells at municipal landfills; an initiative designed to prevent the migration of liquids and gases from solid or hazardous waste into the environment.
- Conducted groundwater sampling and slug tests, performed in-situ soil and hydrogeological evaluations on compacted clay liners and the natural subbase.

EDUCATION

- MBA in Entrepreneurship and Managing Innovation, Benedictine University, Lisle, IL
- Bachelor of Science, Geology Northern Illinois University, DeKalb, IL

REGISTRATIONS / CERTIFICATIONS

- Certified Safety Professional (CSP), Board of Certified Safety Professionals
- Licensed Professional Geologist (PG), State of Illinois, #196- 001071
- Certified OSHA Authorized Construction Trainer
- Certified in Fire Extinguisher Inspection
- Certified in Mold Recognition, Prevention, and Remediation
- Certified in Hazardous Waste Operations and Emergency Response (HAZWOPER)

PROFESSIONAL AFFILIATIONS

- American Society of Safety Professionals (ASSP)
- Board of Certified Safety Professionals (BCSP)
- National Safety Council (NSC)
- Great Lakes Construction Association