FINAL

Sampling and Analysis Plan

In Situ Thermal Remediation
(Electrical Resistance Heating)
East Gate Disposal Yard
Ft. Lewis, Washington
DACA67-02-C-0218

US Army Corps
of Engineers

THERMAL REMEDIATION SERVICES, INC.

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Table of Contents

Page

List of Tables

List of Appendices

Abbreviations and Acronyms

ASIL	ambient source impact level
ASTM	American Society for Testing and Materials
BACT	best available control technology
BFB	4-bromofluorobenzene
CAS	Columbia Analytical Services, Inc.
CCAL	continuing calibration
CCCs	calibration check compounds
CCV	continuing calibration verification
CD	condenser
CDFR	Chemical Data Final Report
CLP	Contract Laboratory Program
CO	Contracting Officer
COC	chain of custody
COC VOCs	contaminants of concern volatile organic compounds
CQC	Contractor Quality Control
CQCP	Contractor Quality Control Plan
CRM	certified reference materials
DCDQCR	daily chemical data quality control report
DCE	cis-l,2-dichloroethene
DNAPL	dense nonaqueous phase liquid
DO	dissolved oxygen
DQIs	data quality indicators
DQOs	data quality objectives
EDD	electronic data deliverables
EDMS	electronic data management system
EGDY	East Gate Disposal Yard
ERH	Electrical Resistance Heating
ERSH	electrical resistance soil heating
FPA	Field Portable Analytical, Inc.
FSP	Field Sampling Plan
GAC	granular activated carbon
GC/MS	gas chromatography/mass spectrometry
GC/MSD	gas chromatograph with mass selective detector
gpm	gallons per minute
HCl	hydrogen chloride
HCW	hydraulic control wells
HPLC	high performance liquid chromatography
ICAL	initial calibration
ICV	initial calibration verification
ID	identification
IDW	investigation-derived waste

LCS/BS	laboratory control samples/blank spikes
LIMS	Laboratory Information Management System
LWMS	Liquid Waste Management System
MDL	method detection limit
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MPE	multi-phase extraction
MQOs	measurement quality objectives
MRL	method reporting limit
MS/MSD	matrix spike/matrix spike duplicates
NAPL	nonaqueous phase liquid
NC	northcentral
NE	northeast
NIST	National Institute of Standards and Technology
NST	NAPL Sparge Tank
NW	northwest
ORP	oxygen reduction potential
OVM-PID	organic vapor meter-photoionization detector
OWS	oil-water separator
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCOPCs	preliminary constituents of potential concern
PE	performance evaluation
PID	photoionization detector
PMOM	Process Monitoring and Operations and Maintenance Plan
PPE	personal protective equipment
ppm	parts per million
ppmv	parts per million by volume
PSCAA	Puget Sound Clean Air Agency
QA	quality assurance
QAMs	quality assurance manuals
QAP	quality assurance plan
QAPP	Quality Assurance Project Plan
QC	quality control
RAMP	Remedial Action Management Plan
RCRA	Resource Conservation and Recovery Act
RPDs	relative percent differences
SAP	Sampling and Analysis Plan

SC	southcentral
SCFM	standard cubic feet per minute
SE	southeast
SOP	Standard Operating Procedure
SPCCs	system performance check compounds
SQL	sample quantitation limit
SRL	sample-reporting limit
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SVOCs	Semivolatile organic compounds
SW	southwest
TAT	turnaround time
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TDS	total dissolved solids
TIC	tentatively identified compound
TMP	temperature monitoring point
TPH	total petroleum hydrocarbons
TRS	Thermal Remediation Services
TVOC	Total VOCs
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
VC	vinyl chloride
VLS	vapor liquid separator
VOCs	volatile organic compounds
VTSR	verified time of sample receipt

FIELD SAMPLING PLAN

F1.0 INTRODUCTION

This Field Sampling Plan (FSP) has been prepared pursuant to and in accordance with Specification 01450 of the Contract DACA67-02-C-0218 between the United States Army Corps of Engineers (USACE) and the Thermal Remediation Services (TRS) project team, for In-Situ Thermal Remediation at the East Gate Disposal Yard (EGDY), Ft. Lewis, Washington.

The Triad approach, which uses systematic planning, dynamic work plans, and quick turnaround data measurements will be used to optimize project activities. Data will be reviewed daily by the project team, who will make decisions regarding increasing, decreasing, or modifying the sampling and analysis strategy with the goal of providing the data required to control uncertainty as required for specific project decisions. Data quality requirements will be assessed in relation to the specific data use.

Specification 01450, Chemical Data Quality Control, provides the requirements for data collection, shipping, chemical analysis, interpretation, and reporting for air, groundwater, wastewater, and solid waste samples. This FSP has been developed in support of the Remedial Action Management Plan (RAMP). The FSP constitutes one section of the Sampling and Analysis Plan (SAP); the other section is the Quality Assurance Project Plan (QAPP).

F1.1 Project Overview

The following sections provide pertinent background, project organization, and project objectives.

F1.1.1 Background

The EGDY was used historically for the disposal of chemical materials and other wastes generated by the Ft. Lewis Logistics Center. Primary chemicals of concern for In-Situ remediation at the EGDY include petroleum and chlorinated hydrocarbons, including trichloroethylene (TCE). Nonaqueous phase liquid (NAPL) has been detected at three areas of the EGDY. These areas are identified as NAPL Area 1, Area 2, and Area 3.

Additional background information, such as previous investigations, descriptions of subsurface materials, site hydrogeology, and a summary of existing site analytical data can be found in the Final Investigation Report (URS, 2002) for the site.

F1.1.2 Organization and Responsibilities

Information on the project organization, contractors, and their responsibilities is described in the RAMP and the Contractor Quality Control Plan (CQCP).

F1.1.3 Scope and Objectives

The primary objective of the In-Situ Thermal Remediation is to maximize the removal of NAPL and associated volatile organic chemicals from each of the three NAPL Areas, as directed by the USACE. The purpose of this FSP is to describe the sampling program rationale and procedures chosen to produce project data of suitable quality and quantity to determine that the primary project objective has been achieved.

F1.2 Sampling and Monitoring Strategy

Eleven specific data quality objectives (DQOs) have been established for this project and are listed below.

1. Have the temperature performance requirements of the contract been met?
2. Is heating contained within the NAPL treatment area?
3. Does the multi-phase extraction (MPE) system control vapor migration?
4. Is gradient control across the NAPL treatment area demonstrated?
5. What is the mass and composition of volatile organic compounds (VOCs) and the recovered vapor, water and NAPL streams? Also what is the mass and composition of total petroleum hydrocarbons (TPH) in the recovered NAPL stream?
6. Are NAPL and dissolved phase VOC concentrations in the subsurface declining?
7. Should the treatment area or depth be decreased or expanded?
8. Should the treatment be suspended or continued?
9. Are system operations within the regulatory requirements for water and vapor treatment?
10. Are the system operations within health & safety requirements?
11. Do system components require maintenance?

A sampling/monitoring strategy has been developed to address each DQO in support of decision-making during treatment, as discussed below.

The nature and frequency of chemical data collected during treatment will be determined based a collaborative effort involving project stakeholders. Near-real time analytical data will be provided by an on-site analytical service provider, Field Portable Analytical, Inc. (FPA); and an off-site (fixed) laboratory, Columbia Analytical Services, Inc. (CAS), will provide analytical data for samples that require extremely low detection limits, target analytes other than contaminants of concern volatile organic compounds (COC VOCs) or other special handling. CAS will also analyze split samples selected to evaluate on-site laboratory performance, or to answer specific questions that may arise based on data generated by FPA.

FPA will analyze samples and submit preliminary results within 24 hours of sample collection. CAS will analyze samples and submit preliminary results within 72 hours of sample receipt at the laboratory. Final data packages from both FPA and CAS will be due within 20 days of sample receipt.

Samples collected for on-site analysis will be tested by FPA for the COC VOCs (trichloroethene [TCE], cis-1,2-dichloroethene [DCE], 1,1,1-trichlorethane [TCA], tetrachloroethene [PCE], vinyl chloride [VC]) and for Total VOCs (TVOC). While analyzing samples for COC VOCs, FPA will inform the technical team when other significant compounds are present and will provide quantitative information on total petroleum hydrocarbons (TPH) content to aid in the evaluation of vapor phase mass removal.

F1.2.1 Water Data Quality Objectives

DQOs 2, 4, 5, 6, 7, 8, 9, and 10 involve the monitoring, sampling, and analysis of groundwater and wastewater, defined as liquids recovered from the subsurface and passed through the remediation treatment system. The overall source action performance assessment will be based on consideration of total reduction in source strength relative to the plume's assimilative capacity.

DQO 2 (verifying temperature performance requirements) will be tracked by monitoring subsurface temperatures using Type T thermocouples. Readings will be taken at set subsurface intervals above, across, and below the treatment volume. Thermocouples will be read electronically each hour allowing for near real-time analysis of subsurface temperatures, heating patterns, and heating trends. Subsurface temperatures will change very slowly and the main project database will store a set of temperature measures every eight hours in order to reduce data storage requirements. Temperatures measured at locations outside of the treatment region will also assist in evaluating DQO 3.

DQO 4 (gradient control) will be evaluated by collecting groundwater elevation data electronically at pressure transducers placed near the bottom of 12 groundwater monitoring wells placed inside the treatment area (nine within the treatment region and three below) and eight wells placed adjacent to the treatment area. This data will allow for near real-time analysis of the hydraulic gradient across the treatment area. Additionally, pumping rates from the hydraulic control wells (HCWs) will be measured daily to allow a correlation between hydraulic gradient and operating parameters to be established in near real-time.

DQOs 5 through 8 relate to the effectiveness of the In-Situ Thermal Remediation process in meeting the primary object of maximizing the removal of NAPL and associated VOCs from the treatment areas. DQO 5 concerns the composition and mass of VOCs being removed from the subsurface as liquids. The DQO will be assessed by totalizing the volume of groundwater and NAPL recovered from the subsurface and analyzing NAPL composition prior to disposal. DQO 6 involves tracking decreases in NAPL and dissolved VOC concentrations in the subsurface. The on-site analyses of samples from the 20 groundwater monitoring wells will provide this information on a near real-time basis. DQO 8 will be evaluated using estimated rates of removal, time required, groundwater data, and dollars spent.

The flow of wastewater through the system will be monitored at multiple locations and at multiple frequencies to assess DQOs 9 (regulatory requirements) and 10 (health and safety requirements). These readings will be provided on a near real-time basis.

Section F2.1 of the FSP presents groundwater sampling, monitoring and decontamination procedures while Section F2.2 details the sampling procedures for wastewater.

A more detailed presentation of the Water DQOs is presented in Appendix A. Monitoring frequencies for groundwater and wastewater samples as they relate to the specifications are presented in Table 1 “Physical Monitoring Parameters” and Table 2 “Chemical Monitoring Parameters”.

F1.2.2 Air Data Quality Objectives

DQOs 3, 5, 9, and 10 involve the monitoring, sampling, and analysis of air. DQO 3 (control of vapor migration) will be addressed using weekly measurements of vacuum at each of the 20 monitoring well and 20 temperature monitoring points (TMPs). DQO 5 (composition and mass of recovered VOCs) relates to assessing the progress of the thermal treatment based on the analyses of air samples collected at multiple locations

and frequencies from the vapor recovery system before vapor treatment. Both near real-time and definitive data will be used to address these questions.

DQO 9 (regulatory requirements) will be addressed by the analyses of air samples collected before and after vapor abatement devices. Both near real-time and definitive data will be used to address these questions.

DQO 10 (health & safety requirements) will be addressed using daily data, collected manually using a PID, to determine if VOCs present in breathing zone air exceed the established action levels for various portions of the project site. Section F2.3 of the FSP presents sampling, monitoring and decontamination procedures for use during air sampling.

A more detailed presentation of the Air DQOs is presented in Appendix A. Monitoring frequencies for air/vapor samples as they are related to the specifications are presented in Table 1 "Physical Monitoring Parameters" and Table 2 "Chemical Monitoring Parameters".

F1.2.3 Solid Waste Data Quality Objective

DQO 9 involves the sampling and analysis of solid waste from the remediation process. The only solid waste generated by the project requiring analysis will be Nonaqueous phase Liquid (NAPL). NAPL will be analyzed at CAS for VOCs, semivolatile organic compounds (SVOCs), metals, pH, flashpoint, and total halogens (TX) in order to meet requirements of the Fort Lewis waste disposal contractor. NAPL waste characterization will be completed once per NAPL treatment area, however, additional sampling of NAPL may be required to calculate analyte-specific NAPL mass removal. The frequency of sampling will be determined by the Project Team (i.e., USACE and the TRS team). Section F2.4 of the FSP presents sampling procedures for use during waste sampling.

A more detailed presentation of the Solid Waste DQOs is presented in Appendix A. Monitoring frequencies for solid waste samples as they relate to the specifications are presented in Table 1 "Physical Monitoring Parameters" and Table 2 "Chemical Monitoring Parameters"..

F1.2.4 Electricity and Heat Monitoring and General System Operations Data Quality Objectives

DQOs 1, 2, and 10 involve the monitoring of electricity and heat. DQOs 1 (temperature performance requirements) and 2 (containment of heating) will be

addressed using data collected electronically by automatic data collection systems recording thermocouple information at the 20 groundwater monitoring wells and 20 TMPs. This data will be provided on a near real-time basis. Additionally, the amount of electrical energy input to the subsurface will be recorded electronically and manually to provide a near real-time correlation between operating conditions and subsurface heating results.

DQO 10 (health and safety) will be assessed by data collected manually and electronically throughout the vapor treatment train as well as at multiple locations on the Liquid Waste Management System (LWMS).

Additional discussion of the electricity and heat monitoring and general system operations activities is presented in the Process Monitoring and Operations and Maintenance Plan (PMOM). A more detailed presentation of the Electricity and Heat Monitoring and General System Operation Monitoring DQOs are presented in Appendix A. Monitoring frequencies for the remediation system as they are related to the specifications are presented in Table 1 "Physical Monitoring Parameters" and Table 2 "Chemical Monitoring Parameters".

F2.0 SAMPLING PROCEDURES

The quality of data collected during an environmental remediation project depends on the diligence of the sampling activities. Field Quality Control (QC) begins with a rigorous standardization protocol such that the field data are reported in an identical manner regardless of the sample location, sampling time, or sampler. The data are entered into the project database, and electronic and original field sheet data are compared to assure consistency and accuracy. During remediation of NAPL Treatment Area 1, groundwater monitoring and hydraulic control wells will be sampled at the set initial frequencies identified in Table 1 "Physical Monitoring Parameters" and Table 2 "Chemical Monitoring Parameters". However, based on evaluation of data generated by FPA, the initial sampling frequencies may be modified as determined by the project team in order to allow the technical team to understand variability in groundwater concentrations. The rationale for well placement, screened interval, and purpose for the monitoring wells is discussed in the Work Plan.

F2.1 Groundwater

Detailed descriptions of the groundwater sampling procedures are specified and documented in the Standard Operating Procedures (SOPs) found in Appendix B of this FSP. General requirements and procedures are presented below.

F2.1.1 Monitoring Well Installation and Development

Twenty monitoring wells will be constructed at NAPL Area 1 (Figure 2a of the RAMP WP). Twelve monitoring wells will be constructed within the heated treatment zone. Nine of these wells will be constructed with a screened interval to the depth of heating and three will be constructed with a screened interval below the heated zone. Eight wells will be constructed around the perimeter of the heated zone. All twenty wells will be sampled prior to beginning the remediation and then twice a month after heat-up. The samples will be submitted to FPA for VOC analysis.

Monitoring wells will be installed using standard drilling techniques as dictated by conditions at the Site and detailed in the RAMP. Monitoring well construction also is described in the RAMP. The normal precautions will be followed during drilling to protect the monitoring wells from contamination (clean drilling equipment, no oils or lubricants). Well construction materials will be selected that are appropriate for each well's location and can withstand Site conditions. Screen size and material will be selected based on the VOC concentrations, lithology, and subsurface conditions (i.e., heaving sands).

Monitoring wells will be allowed to stabilize a minimum of 48 hours prior to groundwater development. Well development will be performed using a surge block and a pump that will achieve 5 to 10 gallons per minute (gpm) and will be capable of pumping 5 to 10 well volumes. Development will be documented with turbidity measurements before, during, and after development and a record will be made of the volume of water purged from the well. Development may take up to four hours per each well location and will be considered complete when the turbidity measurements have stabilized to within +/-10 percent and the water is sufficiently clear in the opinion of the on-site geologist or field technician. The well will be allowed to sit for a minimum of 24 hours prior to groundwater sampling

F2.1.1.1 Field Screening

During monitoring well installation at locations outside the treatment area, soil samples will be screened for both dense and light NAPL. This screening will be done using the following screening methods in a stepped approach. Visual observation will be used first. If NAPL is not noted visually, a portion of the soil sample will be screened with a PID and UV light. If there is a positive identification (ID) using the first three methods, then no further testing will be done. If no NAPL is found using the above methods, field screening for NAPL will include a sheen test method and the "Oil-in-Soil™" kit.

A PID will be located in the drilling work area for health and safety screening of the breathing zone air above the boring during drilling. In addition, the PID will be used to screen soil samples collected during drilling. A portion of each sample will be collected in a sealed plastic bag and placed in the sun, or other warm location, allowing volatilization to occur. The tip of the PID will be inserted into the bag and the measurement recorded on the boring log.

Ultraviolet (UV) fluorescence is an alternative technique for identification of DNAPL in soil samples. A dark box, with a UV light source will be set up. A representative soil sample will be put in the box and viewed under the UV light.

If NAPL is identified using any of the above three methods, no further testing will be necessary. The results of the testing will be recorded in the boring log. If NAPL was not identified using the above three methods, further testing will be performed, as outlined below.

A small portion of the soil sample will be placed in a jar with distilled water and shaken. If a sheen is observed on the water, this will be a positive sign of NAPL. Results are recorded on the boring log. If there is no sheen on the water, the next test will be performed.

A portion of the soil sample will be placed in an "Oil in Soil" container. Suspected petroleum- or NAPL-contaminated soil is added to the sample bottle, to which potable water is also added and the contents shaken vigorously. A rapidly dissolving cube is attached to the cap. The cube has a Sudan IV-based, red, oil-soluble dye and a fluorescing-green, water-soluble dye disbursed throughout its surface. The red dye highlights petroleum products or dense nonaqueous phase liquid (DNAPL) by turning them red. The green dye turns the water a green shade, providing a visual contrast between the two colors. The results of this test will also be recorded on the boring log and in the field notebook.

F2.1.2 Groundwater Sampling Procedures

The procedures discussed below are for obtaining groundwater samples from monitoring wells. Adjustments have been made to standard procedures for the collection of water samples from HCWs and the MPE headers. Sample designation, handling, and shipment will be the same for all points. Details of the sampling protocol presented below are included in the appropriate SOPs presented in Appendix B.

F2.1.2.1 Groundwater Levels

Water level measurements will be collected and used to evaluate the general direction of groundwater flow, vertical hydraulic gradients, and other hydraulic characteristics of the hydrogeologic units. Also, information from the HCWs will be used to evaluate groundwater containment within the heated zone at the Site but as actively pumping wells will not be used to develop groundwater elevation contours. The locations of the monitoring wells are depicted on Figures 2a and 2b of the RAMP WP.

Methodology for manual groundwater level measurements will follow the procedures outlined in the appropriate SOP in Appendix B. Water level measurements at HCWs will be collected weekly and before groundwater samples are collected. All 20 groundwater monitoring wells will be equipped with pressure transducers and data loggers programmed to collect water levels once every 12 hours. The data loggers will be checked once a day and downloaded each week. Field personnel will note any potential anomalies (e.g., significant changes in water level) for inclusion in the weekly report. Potential anomalies may indicate problems with the hydraulic control system that will require review of its operational status. The collection of water levels inside the heated zone will be accomplished using heat-resistant transducers. If water levels cannot be measured automatically within the heated zone, then no water level measurements will be collected due to safety concerns. However, the transducers have a life expectancy of 20 years and no failures are anticipated during the remediation.

An electronic interface probe will be used to measure the groundwater levels manually at the HCWs. In the unlikely event that the probe indicates evidence of NAPL, the approximate thickness of the NAPL will be measured with the interface probe and confirmed using a disposable bailer. The interface probe will be decontaminated between measurements according to the applicable SOPs. The water level measurements and time of measurement will be recorded on the appropriate data sheet or electronic device.

F2.1.2.2 Monitoring Well Purging and Field Measurements

Purging monitoring wells prior to sampling will be done according to low-flow sampling protocol. This includes connecting the discharge cooling coil tubing from each well to a peristaltic pump and a flow-through cell (flow cell) equipped with a water analyzer which can measure temperature, pH, specific conductance, dissolved oxygen (DO), total dissolved solids (TDS), and oxidation reduction potential (ORP). Because the majority of the monitoring wells at NAPL Area 1 are within the treatment area, they are subject to heating and, consequently, the groundwater within the wells

will eventually boil. As such, achieving stabilization of water quality parameters in such a dynamic environment is difficult and the ability to do so unlikely. The monitoring wells will be purged and the water quality parameters; pH, specific conductance, temperature, DO, ORP, and turbidity will be monitored and recorded every three to five minutes. If parameters do not stabilize within a 30-minute period the final reading will be recorded and the well sampled. Temperature readings collected during sampling will be reflective of the cooling process, not the temperature within the well. As a matter of consistency this process will also apply to monitoring wells located outside the treatment area. Step-by-step purging and field parameter monitoring instructions can be found in SOP 6 in Appendix B. Excess water from sampling events (i.e., purge water) will be collected in a five-gallon bucket for transfer to the LWMS. Information regarding any purge (waste) water from the sampling event will be documented on the Waster Water Sampling Field Form identified in Section F4.1.2.3.

F2.1.2.3 Collecting the Sample

Methodology for groundwater sampling will follow the procedures outlined in the SOP included in Appendix B. The groundwater samples will be collected with low flow sampling methodologies, using the appropriate pump with chemically inert components. The well will be purged and sampled using disposable tubing and peristaltic pump.

The tubing intake will be placed approximately at the mid-point of the saturated screen interval of the well. To promote stability for a representative groundwater sample, field parameters including: temperature, pH, specific conductance, DO, TDS, and ORP will be measured using a flow cell while purging. The purge/sample rate will be selected to provide a sample temperature less than 20°C and preferably near 4°C. The groundwater sample will be collected after reaching stability and removing the flow cell from the tubing. The sample tubing will be disposed of after sampling and will not be reused for sampling another monitoring well.

Groundwater samples will be collected in the appropriate containers, labeled, logged on a chain of custody (COC), in the field notebook and stored in the appropriate cooler. Sampling of groundwater wells is to occur twice a month and the samples turned in to FPA for analysis.

F2.1.3 HCW and MPE Headers

Because the HCWs are anticipated to pump continuously at a throttled rate, there is no need to follow standard groundwater sampling procedures for purging. A sampling valve will be located in each line coming from each of the HCWs. A meter will be inline, indicating the flow from the pump and should be checked to verify that the pump is operating at the time of sample collection. The sample valve will be opened and purged into a 5-gallon bucket for 10 to 15 seconds before collecting a groundwater sample. The groundwater sample will be collected in the appropriate containers, labeled, logged on a COC, in the field notebook and stored in the appropriate cooler. This sampling method is the same as collecting water samples from the LWMS and will use the same standard operating procedures. This sampling is to occur twice a month and the samples turned in to FPA for analysis.

On a weekly basis, the combined water from the three HCWs will be checked for water quality parameters: pH, DO, conductivity, and TDS. Water from the appropriate sample valve will be connected with tubing to a flow cell and a water parameter instrument (i.e., YSI 556). Water will be run through the cell until parameters stabilize, approximately 5 minutes or less, and then measurements will be recorded.

MPE wells, co-located with electrodes, will be connected together into six regions labeled northwest (NW), north central (NC), northeast (NE), southwest (SW), south central (SC), and southeast (SE). These regions will be combining the effluent from several MPE wells and may contain flowing water, vapor, steam, and possibly NAPL. Each region run will be sampled for both water and vapor at the beginning of treatment and then on a weekly basis. Two valves will be installed at each regional location, after influent from all the wells from the region have been combined. A valve at the top of the pipe will be configured for air sampling, collected in a Tedlar bag. A valve at the bottom of the pipe will be configured to attach to Teflon tubing, attached to a glass container, such as a sealed Mason jar. The valve would be opened and the liquid collected in the jar. Figure 2c of the RAMP WP provides the MPE region sample station detail. The purpose of the sampling would be qualitative and the on-site laboratory would conduct any testing as requested by the project team.

If any region requires samples collected from individual MPE wells, then they will be fitted with similar sampling ports and sampled as appropriate in the same manner. Figure 3a of the RAMP WP provides a detail that depicts the MPE well liquid sampling method.

F2.1.4 QC Sample Collection Requirements

A variety of QC samples are required in order to assess performance of the project team in collection and analysis of the groundwater samples. Groundwater will be treated as a distinct media, separate from the wastewater and remediation system waters. The QC samples required for this groundwater sampling and analysis program include:

Field Replicate/Duplicate:	One field duplicate, to be submitted in blind fashion, per 10 samples for both on-site and off-site laboratories.
Split Samples:	Approximately one water sample for 10 on-site laboratory samples will be split and sent to the off-site laboratory. Samples for split analysis will be selected by the project team to specifically address questions regarding uncertainty with the data set, or to answer specific questions that arise through evaluation of data generated by FPA.
Rinsate Blanks:	One rinsate blank at one/day/media, to be analyzed for VOCs when not using disposable or dedicated sampling equipment (including disposable tubing with a submersible pump).
Trip Blanks:	For aqueous or NAPL samples, one aqueous trip blank per cooler containing vials for VOC analysis. For gas phase samples, one ultrapure nitrogen filled Tedlar bag will be submitted to FPA for every 20 air samples collected, and one laboratory prepared and zero-air filled Summa canister will be submitted to CAS with each group of field samples shipped to them.
Performance Evaluation (PE) Samples:	One PE sample will be submitted initially, and then 5 PE samples per treatment area will be submitted to each laboratory throughout the project duration.
Laboratory QC Samples:	One laboratory QC sample per 20 samples for each analytical procedure, with a minimum of one per procedure. This will require additional volume to be collected from the sample location.

Field duplicates are replicate samples collected at the same location during the same sampling session (roughly at the same time) and submitted to the contract laboratory. Field duplicates provide an indication of the reproducibility of the sampling and analysis procedures for a given sample matrix, including heterogeneity of the sample itself. Field duplicate samples will be collected by alternating between the sample and the replicate as each bottle is filled. The field duplicates will be collected in the same container types and handled and analyzed in the same manner as the other groundwater samples. The field duplicates will be labeled with a label reserved for duplicates and the well being duplicated will be recorded in the field notes.

Split samples will be collected in the same manner as a replicate but labeled identically and sent to the off-site laboratory. Samples for split analysis will be selected by the project team to specifically address questions regarding uncertainty with the data set.

A rinsate blank serves as an indicator of potential contamination resulting from inadequate decontamination of sampling equipment. Deionized water or distilled deionized water is passed through (or across) the sampling equipment after the decontamination procedure is complete, and collected in the same containers as the field samples.

A trip blank is a container filled by the laboratory with analyte-free water for aqueous samples, or analyte-free gas for air samples. Trips are never opened in the field, and are used to assess possible contamination during transport, storage and analysis of samples. Trip blanks and associated sample containers should remain in the same cooler the laboratory shipped them in or in the on-site refrigerator and should not be intermingled with bottles from different batches. The trip blank will be kept with samples planned for VOC analysis and will be analyzed for VOCs only. The trip blank will remain in the field cooler and then turned into the laboratory at the end of the day. Trip blanks for air samples will be filled at the beginning of the day, and turned in to FPA at the end of the day.

Single blind PE samples are certified reference materials (CRMs) that are purchased from a CRM vendor, labeled the same way as project field samples, and submitted to the laboratory as a field sample. Reported results are compared to the acceptance ranges provided by the CRM vendor, and can be used to assess the ability of the laboratory to perform the analysis on an interference free matrix.

Laboratory QC samples are field samples that are designated for laboratory QC procedures such as duplicate analysis or matrix spike analysis. Extra volume must be collected for laboratory QC samples so that the laboratory has sufficient volume to

perform the required analyses. The bottles will have the same sample ID and a note is added to the COC "Extra Volume for Lab QA/QC". QC sample volume requirements are listed in Table 3.

F2.1.5 Equipment Decontamination

All equipment used during sampling that is not dedicated or disposable will need to be decontaminated prior to using it at the next sample location. Decontamination procedures include washing the instrument or equipment with a non-phosphatic soap (i.e., Alconox) and distilled water followed by a double rinse with distilled or deionized water. A complete SOP is included in Appendix B.

F2.1.6 Sample Handling

Groundwater sample handling and designation procedures were developed to provide sufficient project-specific quality assurance (QA) and QC measures. Specific QA/QC procedures are described in this section including:

- Sample labeling,
- Sample container requirements and preservation,
- Sample Storage, Packaging and Transport, and
- COC.

F2.1.6.1 Sample Labeling

The purpose of sample designation and labeling is to enable discrete sample tracking. Each sample will be labeled with the location ID as shown on Tables 1 and 2. These tables provide a breakdown of each unique sample location identification scheme. The samples will be tracked using the COC and a manually or electronically completed groundwater sampling field form by well name, sample date and time. The well ID with no hyphens or spaces will designate each sample ID. Since the samples have a unique date and time, consecutive samples from the same well will be identified using the three fields. For example, the primary sample collected from OXIN01A1 on October 30, 2003 will be labeled OXIN01A1103003 and the primary sample collected on October 31, 2003 will be labeled OXIN01A1103103 with the duplicate labeled OXIN02A1103103. The monitoring well being duplicated will be recorded on the groundwater sampling field forms. The duplicate sample ID is also identified for each location in Table 2. Please refer to Tables 1 and 2 for examples of the unique sample identification for each location.

QC samples are named in blind fashion using the following convention. For example, AQQC indicates an aqueous quality control sample and GPQC indicates a gas-phase quality control sample. The last digit in the numbering sequence designates a trip blank, performance evaluation sample, or rinsate sample. The three zeroes prior to last digit for QC samples are simply placeholders necessary for the sample ID nomenclature. The QA/QC designation for each type of field QC sample is described below:

- AQQC0001(date) indicates an aqueous trip blank
- AQQC0002(date) indicates an aqueous Performance Evaluation (PE) sample
- AQQC0003(date) indicates an aqueous rinsate blank
- GPQC0001(date) indicates a gas-phase trip blank
- GPQC0002(date) indicates a gas-phase PE sample

Laboratory QA/QC will involve collecting a double volume in the appropriate containers and marking in the note section of a groundwater sampling field form and COC "double volume for lab QA/QC".

Sample labels may be preprinted with project name and number. Items including sample ID, date and time of collection, and sample collector will be indicated on the sample label and will be filled out in the field.

F2.1.6.2 Sample Containers

The contract laboratory will supply pre-cleaned, certified bottles appropriate for the required analysis. Sample container quality protocols will be strictly enforced and assured by the laboratory. Bottles supplied by the laboratory shall contain required chemical preservative, except when necessary for field preservation. Field preservation will be conducted under specific direction from the laboratory. Sample containers will be kept closed until used. Required sample containers, preservation, and holding time requirements for this project are described in Table 3.

F2.1.6.3 Sample Preservation and Holding Times

The use of proper chemical and thermal preservation is critical to maintain validity of project groundwater samples. Field personnel will verify that the correct laboratory-supplied bottles are used for each sample and labeled with the corresponding intended analysis.

All groundwater samples will be placed in a cooler with blue ice or double bagged wet ice immediately after collection. The target temperature for the cooler is 4°C or less. Groundwater samples will be transported to the on-site laboratory as soon as possible after collection. Split samples and other off-site laboratory samples will be packaged for transportation and arrangements made for delivery to the off-site laboratory as soon as possible. This will allow rapid transfer of the groundwater samples into controlled, refrigerated storage, and allow the contract laboratory adequate time to meet required analytical holding times as described in Table 3. A temperature blank, when provided by the laboratory with the sample bottles, will be included in each cooler so the laboratory can verify sample temperature upon receipt.

F2.1.6.4 Sample Storage, Packaging, and Transport

Proper groundwater sample handling procedures will be followed so sample quality is not compromised after the collection of the groundwater sample and prior to submitting the groundwater sample to the laboratory.

All samples will be in possession of a designated team member until custody is relinquished to the laboratory (in person or through shipment), or until the samples are placed in a secure storage location. Samples will be placed into coolers at a target temperature of 4°C. Ice will be added, as necessary, to maintain the target temperature.

Samples will be transported in the same coolers used for sample storage. Each cooler or daily set of coolers will be accompanied by a COC form. The COC form will be completed, sealed in a Ziploc® bag to prevent damage to the document, and taped to the top of each cooler. Sample coolers will be placed at a designated pick-up location for the off-site laboratory, in the vehicle of a field person for transport to the laboratory, or taken directly to the on-site laboratory.

F2.1.6.5 Sample Documentation

All samples collected will be entered on a COC. The COC is an integral component of the sampling process as it stands as a permanent record of sample holding and shipment. Sample custody is documented from collection through transport, analysis, and reporting.

Samples will remain in the custody of an appropriate project team member until receipt by the laboratory. For off-site laboratory analysis, the corresponding COC form is in physical possession of the field personnel or in a locked location where no tampering will occur. Samples to be turned into the on-site laboratory will be recorded on a COC at the laboratory as each sample is turned in during a day. At the end of the day, both

the field and laboratory personnel will sign the COC and then a copy given to the field personnel for the project files. Errors on the COC will have a single strikethrough, with the change dated and initialed.

Samples will be hand-delivered, transferred by courier, or picked up by an off-site laboratory representative. A laboratory representative will check coolers with their respective COC form(s) into the laboratory, and the COC form will be signed and dated appropriately. The project team member will retain one copy of the signed COC form for the project files.

F2.2 Wastewater

Wastewater sample collection will be done at multiple designated ports across the Electrical Resistance Heating (ERH) treatment system and the LWMS. Purging of stagnant water in the sample valve will be necessary and will be conducted by purging water into a five-gallon bucket. As specified, some water streams will be run through a flow through cell to obtain water quality parameters in the field. The sample handling will be the same as for groundwater sampling with the exceptions noted below. Sample frequencies are indicated below but will be changed as needed, based on system operation and results from analytical testing.

F2.2.1 Oil/Water Separator

A sampling valve will be located just downstream of the oil/water separator and consist of a 0.25 inch check valve (V-105). The valve should be opened and allowed to purge briefly (10 to 15 seconds) before collecting a sample. Water will be collected in the appropriate containers, labeled, logged in the field notebook and appropriate field sheet, and stored in the appropriate cooler. This is to be done on a weekly basis and transported to the on-site laboratory. The sample will be logged on a COC kept by the on-site laboratory prior to turning over the sample.

F2.2.2 Influent/Effluent Sampling

System influent sampling will occur at a sample port on each HCW line prior to entering the LWMS. In addition, water parameters will also be collected from this location, including turbidity.

System effluent sampling will occur at three locations within the LWMS. One sample location is at a port on the effluent line from the oil-water separator (OWS) (V-105). The second location is at a sample port (V-109) will be on the effluent line from the NAPL Sparge Tank (NST). The third location is on the treated water stream prior to

entering the infiltration gallery/injection wells, where the water is allowed to re-enter the groundwater system (V-222). Water parameters will also be collected of the treated water stream prior to re-injection/infiltration.

Water samples will be collected in the appropriate containers, labeled, logged in the field notebook and appropriate field sheets, and stored in the appropriate cooler. Influent and Effluent sampling will be performed on a weekly basis and samples will be transported to the on-site laboratory.

F2.2.3 Oxidizer Scrubber Blow Down

The oxidizer scrubber will blow down salt water to reduce TDS in the recirculating water loop. The scrubber has a conductivity sensor and maintains constant recirculation conductivity by opening its blowdown valve as necessary, with water make-up from low conductivity groundwater. The mass of chlorides discharged to the sanitary sewer is blowdown conductivity setpoint (proportional to chloride content) multiplied by the volume discharged (measured by a flow totalizing meter). Some limited laboratory sampling of the blowdown water may be required to double-check these calculations.

F2.2.4 QC Sample Collection Requirements

A variety of QC samples are required in order to assess performance of the project team in collection and analysis of the wastewater samples. Wherever possible, field QC samples will be submitted to the laboratory in blind form. This will be accomplished using the blind labeling scenario presented in the section on sample labeling below. QC samples required for this water sampling and analysis program include:

Field Replicate/Duplicate:	One field duplicate per 10 wastewater samples collected or one per week.
Split Samples:	Approximately one wastewater sample for 10 field laboratory samples will be split and sent to the off-site laboratory.
Rinsate Blanks:	Not needed for wastewater sampling.
Trip Blanks:	One trip blank per cooler containing vials for VOC analysis. May be the same trip blanks as is used for groundwater sample QC.

PE Samples:	One PE sample will be submitted initially, and then 5 PE samples per treatment area will be submitted to each laboratory throughout the project duration.
Laboratory QC Samples:	One laboratory QC sample per 20 samples for each analytical procedure, with a minimum of one per procedure. This will require a double volume to be collected from the sample location, with the same sample designation and the "Double volume for lab QA/QC" designated on the COC.

Field duplicates are replicate samples collected at the same location during the same sampling session (roughly at the same time) and submitted to the on-site laboratory. Field duplicates provide an indication of the reproducibility of the sampling and analysis procedures for a given sample matrix, including heterogeneity of the sample itself. Field duplicate samples will be collected by alternating between the sample and the replicate as each bottle is filled. The field duplicates will be collected in the same container types and handled and analyzed in the same manner as the other groundwater samples. The field duplicates will be labeled with a designated sample label and in the same manner as the original sample so that it will be a blind duplicate to the laboratory.

Split samples will be collected in the same manner as a replicate but labeled identically and sent to the off-site laboratory. Samples for split analysis will be selected by the project team to specifically address questions regarding uncertainty with the data set.

A rinsate blank will not be necessary when collecting the wastewater samples since they will be collected using a sample port and disposable or dedicated tubing at each location.

A trip blank is a container filled by the laboratory with analyte-free water and never opened in the field. It is used to assess possible contamination during transport and storage of sample containers. Trip blanks and associated sample containers should remain in the same cooler the laboratory shipped them in or in the on-site refrigerator and should not be intermingled with bottles from different batches. The trip blank will be kept with samples planned for VOC analysis and will be analyzed for VOCs only.

Single blind PE samples are certified reference materials (CRMs) that are purchased from a CRM vendor, labeled the same way as project field samples, and submitted to the laboratory as a field sample. Reported results are compared to the acceptance

ranges provided by the CRM vendor, and can be used to assess the ability of the laboratory to perform the analysis on an interference free matrix.

Laboratory QC samples are field samples that are designated for laboratory QC procedures such as duplicate analysis or matrix spike analysis. Extra volume must be collected for laboratory QC samples so that the laboratory has sufficient volume to perform the required analyses. QC sample volume requirements are listed in Table 3.

F2.2.5 Equipment Decontamination

All equipment used during sampling that is not dedicated or disposable will need to be decontaminated prior to using it at the next sample location. Decontamination procedures include washing the instrument or equipment with a non-phosphatic soap (i.e., Alconox) and distilled water, followed by a double rinse with distilled or deionized water. A complete SOP is included in Appendix B.

F2.2.6 Sample Handling

Wastewater sample handling procedures are the same as they are for the groundwater sampling. Sample labeling is only slightly different, because of the type of sample label assigned. The container requirements, preservation, sample storage, packaging, and transport are identical as in the above section for groundwater.

F2.2.6.1 Sample Labeling

The purpose of sample designation and labeling is to enable discrete sample tracking. The samples will be tracked by location ID, sample date and time. Each sample ID will be designated by the location ID with no hyphens or spaces. Duplicate samples will have a designated sample ID. For instance, the effluent from the oil water separator will be labeled “OWSDW01A1” and the duplicate sample will be “OWSDW02A1”. The location ID labels have been predetermined and so have the duplicate sample IDs. This method will insure that the duplicate samples will be blind duplicates to the laboratory. The sample ID for each wastewater location is included in Tables 1 and 2.

Split samples will have identical sample labels and times as the original sample, but sent to a different laboratory (off-site versus on-site). Trip blanks will be labeled “Trip Blank” and be dated with the day of sampling activity.

Laboratory QA/QC will involve collecting a double volume in the appropriate containers and marking in the notes section of the Sampling Field Log and COC “double volume for lab QA/QC”.

Sample labels may be preprinted with project name and number. Items including sample ID, date and time of collection, and sample collector will be indicated on the sample label and will be filled out in the field.

F2.3 Air Sampling

Air sampling will be done as part of the remedial system evaluation and for health and safety purposes. Samples will be collected on a daily, weekly, or periodic basis as indicated below. Detailed sampling procedures are included in the SOPs in Appendix B. There are two types of air samples that will be collected. A grab sample will be a limited duration exposure, indicating the concentrations from that sampling location at that specific time. A sample collected over an eight-hour period will involve using a flow controller attached to a Summa canister, which allows the canister to be slowly filled over an eight-hour period.

F2.3.1 Perimeter Air Monitoring

Ambient air samples will be collected from approximately 4 to 5 feet off the ground, in the breathing zone, from the locations labeled as PAM01 through PAM06 on Work Plan Figure 2e (EGDY Plot Plan). The locations shown on the figure are subject to change based on review by the project team of the collected data and conditions in the field. Changes would only be made to enhance the monitoring of the perimeter air conditions present during operations. These samples will be collected once each day during the first three days of oxidizer operation, then monthly thereafter. Summa canisters will be used to collect these eight-hour integrated samples and samples will be sent to the off-site laboratory for contaminant of concern VOC (COC VOC) analysis. These samples may be analyzed with the GC/MS in SIM mode in order to meet the PSCAA ASIL for vinyl chloride (see Appendix D: Table D-1). In addition, at the same location of the perimeter samples, a PID reading will be taken and recorded from approximately the same elevation as the air sample. Wind speed and direction will be recorded at the time of ambient air sampling. Wind direction will be recorded from a wind sock mounted at the site. Wind speeds will be obtained from an anemometer mounted at the weather station at Fort Lewis.

PID readings also will be collected from the treatment compound on a weekly basis. If PID readings are sustained at 1 part per million (ppm) or greater, then a grab sample will be collected in a Tedlar bag and submitted to the on-site laboratory for COC VOCs. Compound ambient air monitoring may change in frequency if VOCs are detected.

F2.3.2 System Air Sampling

Three areas of the treatment system will be sampled for VOC concentrations in air:

- VOC Oxidizer Inlet,
- VOC Oxidizer Scrubber Stack, and
- Main Sparge Tank Stack.

Air samples from the VOC Oxidizer Inlet and the VOC Oxidizer Scrubber Stack will be collected daily and weekly, respectively, using a Tedlar bag, and submitted to the on-site laboratory for COC VOCs. In addition, at each of the above locations, a PID reading will be taken and recorded. The air sample from the Main Sparge Tank Stack will be collected weekly using Tedlar bags and a vacuum box. The use of a vacuum box is necessary because the vapor stream is at atmospheric pressure. An empty Tedlar bag will be placed into a vacuum box, which will be attached to the sampling valve (V-223). A vacuum will be created in the vacuum box that will draw the air sample into the Tedlar bag. The vacuum box will then be opened and the gas sample in the Tedlar bag will be analyzed. Analysis of target VOCs and TVOCs will be conducted in the on-site laboratory.

The sensitivity requirement for the treated stream will be 10% of the air emission limit. For untreated streams, the sensitivity requirement will be 10% of the typical or expected concentration range during remediation. The expected or typical treatment rate for the VOC oxidizer inlet (OXIN) will be tens or hundreds of kilograms of VOCs per day. The minimum oxidizer inlet sensitivity should equate to 1 kg/day at a flow rate of 1,000 scfm. Therefore, the minimum oxidizer inlet sensitivity should be 0.024 mg/L or 24,000 $\mu g/m^3$. This sensitivity requirement will also apply to MPE region samples, which combine to form OXIN.

The scrubber stack (OXSS) emission limit by PSCAA permit is an average of 1.27 kg/day. The minimum scrubber stack sensitivity should equate to 10% of the emission limit, 0.127 kg/day, at a flow rate of 1,000 scfm. Therefore, the minimum scrubber stack sensitivity should be 0.003 mg/L or 3,000 $\mu g/m^3$.

The main sparge tank stack emission limit by PSCAA permit is an average of 0.63 kg/day. The minimum main sparge tank stack sensitivity should equate to 10% of the limit, 0.063 kg/day, at a flow rate of 1,500 scfm. Therefore, the minimum scrubber stack sensitivity should be 0.0010 mg/L or 1,000 $\mu g/m^3$. Sensitivity requirements can be found in Appendix D, Table D-2.

F2.3.3 HCl Scrubber Stack

Sampling of the hydrogen chloride (HCl) emitted from the scrubber stack will occur once per treatment area. Am Test-Air Quality, LLC (Am Test) will sample for HCl and send it to CAS for analysis. The sampling and analysis will be conducted according to the procedures laid out by Puget Sound Clean Air Agency (PSCAA).

F2.3.4 QC Sample Collection Requirements

A variety of QC samples are required in order to assess performance of the project team in collection and analysis of the groundwater samples. QC samples required for this air sampling and analysis program include:

Field Replicate/Duplicate:	One field duplicate per 10 air samples collected or one per week.
Split Samples:	Approximately one air sample for 10 field laboratory samples will be split and sent to the off-site laboratory.
Rinsate Blanks:	Not needed for air sampling.
Trip Blanks:	One trip blank per batch of VOC analyses.
PE Samples:	One PE sample will be submitted initially, and then 10 PE samples per treatment area will be submitted to each laboratory throughout the project duration.

Field duplicates are replicate samples collected at the same location during the same sampling session (roughly at the same time) and submitted to the contract laboratory. Field duplicates provide an indication of the reproducibility of the sampling and analysis procedures for a given sample matrix, including heterogeneity of the sample itself. Field duplicate samples will be collected using the identical set-up and at the same time as the original air sample. The field duplicates will be collected in the same container types and handled and analyzed in the same manner as the other air samples. The field duplicates will be labeled with a designated sample label.

Split samples will be collected in the same manner as a replicate but in a summa canister, labeled identically, and sent to the off-site laboratory. Samples for split analysis will be selected by the project team to specifically address questions regarding uncertainty with the data set.

A rinsate blank will not be necessary when collecting the air water samples since they will be collected using dedicated equipment at each location.

A trip blank is a container filled by the laboratory with analyte-free air and never opened in the field. It is used to assess possible contamination during transport and storage of sample containers and may also assist in identifying laboratory contamination. Trip blanks should travel out in the field and then be returned with the field air samples. The trip blank will be kept with a single batch of air samples and will be analyzed for a specific list of VOCs.

Single blind PE samples are certified reference materials (CRMs) that are purchased from a CRM vendor, packaged and labeled the same way as project field samples, and submitted to the laboratory as a field sample. Reported results are compared to the acceptance ranges provided by the CRM vendor, and can be used to assess the ability of the laboratory to perform the analysis on an interference free matrix.

F2.3.5 Sample Handling

Air sample handling and designation procedures were developed to provide sufficient project-specific QA and QC measures. Specific QA/QC procedures are described in this section including:

- Sample labeling,
- Sample container requirements and preservation,
- Sample Storage, Packaging and Transport, and
- COC.

F2.3.5.1 Sample Labeling

The purpose of sample designation and labeling is to enable discrete sample tracking. Samples will be tracked by location ID, sample date and time. Each sample ID will be designated by the location ID with no hyphens or spaces. Duplicate samples will have a designated sample ID. For instance, the effluent from the Main Sparge Tank Stack will be labeled “MSTS01A1” and the duplicate sample will be “MSTS02A1”. A list of the Sample IDs and Duplicate IDs for the air sample locations is included in Tables 1 and 2.

Split samples will have identical sample labels and times as the original sample, but sent to a different laboratory (off-site versus on-site). Trip blanks will be labeled “Trip Blank” and be dated with the day of sampling activity.

Sample labels will be provided with the Summa canisters and must be attached with a plastic tie. Labels cannot be taped or glued on the Summa canister surface and the surface cannot be marked with a permanent pen. The Tedlar bag samples may be labeled with a self-adhesive sample label, preprinted with project name and number. Items including sample ID, date and time of collection, and sample collector will be indicated on the sample label and will be filled out in the field prior to sample collection.

F2.3.5.2 Sample Containers

The contract laboratory will supply pre-cleaned, certified Summa canisters, appropriate for the required analysis. Flow controllers will also be supplied for the appropriate containers and set for 24 hours. Tedlar bags or other grab sample containers will be supplied by the on-site laboratory and be used just once and thrown away or decontaminated by the laboratory prior to reuse. Sample container quality protocols will be strictly enforced and assured by the laboratory. Sample containers will be kept closed until used. Required sample containers, preservation, and holding time requirements for this project are described in Table 3.

F2.3.5.3 Sample Integrity and Holding Times

Holding times for project samples are presented in Table 3, but several important points concerning air samples are presented in text form below.

The Tedlar bags are designed to be a short-term air sample container and should be given to the on-site laboratory as soon as possible. No media holding time has been established for Tedlar bags (i.e. media holding time may be considered indefinite) but sample holding time from collection until analysis for purposes of this project will be 24 hours. If the Tedlar bag appears to be leaking, another bag should be used and the leaking bag thrown away. If the Tedlar bag is discovered to have leaked at or after the time of analysis, data associated with that Tedlar bag will be qualified, and FPA will immediately contact the project Environmental Consultant to apprise him of the situation.

Summa canisters should be transported to the off-site laboratory within one day of sample collection. The recommended media holding time is less than 30 days but the sample hold time from collection until analysis is 14 to 30 days, depending on analyte concentrations.

Holding time recommendations were taken from a “Guide to Air Sampling and Analysis, Canisters and Tedlar Bags, Fourth Edition”, published by Air Toxics Limited.

F2.3.5.4 Sample Storage, Packaging, and Transport

Proper air sample handling procedures will be followed so sample quality is not compromised after the collection of the sample and prior to submitting the sample to the laboratory.

All samples will be in possession of a designated team member until custody is relinquished to the laboratory (in person or through shipment), or until the samples are placed in a secure storage location.

A COC form will accompany each batch of air samples. The COC will contain only air samples. If samples are to be shipped, each Summa canister will be in an individual box. If more than one sample is being shipped, the individual boxes can be included a bigger box. The COC is to be attached to the box exterior in a marked envelope.

F2.3.5.5 Sample Documentation

The COC is an integral component of the sampling process as it stands as a permanent record of samples collected, date, time, analyses, and transportation or shipment to the laboratory. If samples are to be turned into the on-site laboratory then the samples will be delivered several times during the day and logged on a COC as they are turned over to the laboratory. At the end of each day, a copy of the COC will be given to the field person for project files. Sample custody is documented from collection through transport, analysis, and reporting.

Samples will remain in the custody of project team staff until receipt by the laboratory. Samples being sent to the off-site laboratory will be kept with the corresponding COC form, in physical possession, or in a locked location where no tampering will occur. The COC form will be checked for errors and signed. Errors will not be erased, but will have a single strikethrough, with the change dated and initialed. The field representative will retain one copy of the signed COC form for the project files.

F2.4 Solid Waste

All materials and procedures used to handle solid wastes are detailed in the Waste Management Plan. In general, solid waste generated during the remediation process will consist of sludges from the bottom of various tanks in the system and NAPL. The sludges will be cleaned out and be handled in the same manner as the soil cuttings generated during drilling.

NAPL may either be collected from NAPL Storage Tank T-002 through valve V-122, or a composite sample may be collected from the top of the tank. A Bacon-Bomb sampler (used for sampling the bottom of gas tanks) or other appropriate sampler (e.g., well bailer) may be used to collect a composite sample that would be better representative of the whole contents of the NAPL storage tank. If valve V-122 is used for sampling, NAPL will be drained into a chemically resistant container to flush the valve and stagnant lines prior to sample collection. NAPL samples will then be collected in approved sample containers for the required analyses. The samples will then be shipped to a laboratory for analysis. NAPL collected in the chemically resistant container will be placed back in NAPL Storage Tank T-002.

F2.5 Remediation System Operations

Multiple data sets will be collected during the heating process. Examples of the types of data sets to be collected include the power usage, voltage, amperage, subsurface temperatures, pressures, temperatures, noise levels, water levels, total flow, flow rates, and total NAPL recovered. The information will be collected either manually or automatically, and recorded on field sheet or on an electronic handheld device, as appropriate, and included in the project database.

Monitoring of the LWMS located in the compound at the Site will include both air and water samples (Sections F2.2 and F2.3). Monitoring locations and procedures are presented in the PMOM.

F2.6 Calculation Of Mass Removal By Media

F2.6.1 Mass Removal In Air

Data collected during operations will be used to calculate the mass of COC VOCs, TPH and total COC VOCs removed per media (air, water, and NAPL). Over the course of the remediation, the rate of mass removal and the cumulative mass removed with time will be calculated and reported for each COC VOC, TPH, and total COC VOCs in each extracted media.

Data for the calculation of the mass of COC VOCs and TPH removed in the air stream will be collected at the inlet to the thermal oxidizer (sampling point OXIN). This sampling location was selected because all of the air recovered from the MPE wells is routed to the sampling point, steam has been separated from the air stream, and the sampling point is near atmospheric pressure.

The diameter of the system piping at OXIN is constant at 6-inches and temperature, line pressure, and air stream flow rate are measured each time a vapor sample is taken. The on-site laboratory will analyze the vapor samples from OXIN for COC VOCs and for TPH and analytical results will be converted to mg/l of sample.

The flow reading taken at each vapor-sampling event is converted to standard cubic feet per minute (SCFM) using the published flow coefficient for the pipe diameter, the pressure measurement, and the air stream temperature measurement. The analytical results for each COC VOC and TPH are converted from mg/l to mg/ft^3 and multiplied by the flow to produce the rate of contaminant recovered in mg per minute of flow. This result can be converted to any required weight and time variable for data presentation. Using the system run time data, the rates of COC VOC and TPH recovery can be converted to mass recovered over a given time interval.

F2.6.2 Mass Removal In Water

Data for the calculation of the mass of COC VOCs and TPH removed in the water stream will be collected from the main sparge tanks inlet (sampling point MSTINW). This sampling location was selected because all of the water collected from the MPE wells and hydraulic control wells is routed to this location regardless if it was diverted at the vapor liquid separator (VLS) or the condenser (CD). The on-site laboratory will analyze the water samples from MSTINW for COC VOCs and for TPH and analytical results will be converted to mg/l of sample. The mg/l results of the chlorinated COC VOCs will be totaled to achieve a total chlorinated VOC concentration. If other chlorinated compounds are found to have a significant concentration (over 10% of the concentrations of TCE) they will be identified and included in the calculation of total chlorinated VOCs.

The volume of water recovered by the system is measured by flow totalizers at the outlet to the VLS, condenser, and each hydraulic control well. Analytical data for COC VOCs and TPH, in mg/l, is multiplied by the liters of water recovered since the previous sampling event to arrive at the cumulative mass recovered between sampling events in milligrams. This unit of mass can then be converted to the most appropriate unit for data presentation. By adding the mass of COC VOCs and TPH recovered between each sampling event, the cumulative mass recovered can be calculated. Using system run time data and the mass of COC VOCs and TPH recovered, mass recovery rates can be calculated.

Some dissolved VOC mass is removed from the MPE groundwater at the NAPL sparge tank (NST). This VOC mass transitions to the vapor phase and joins the flow heading

to the oxidizer. Measurement of the water dissolved VOCs downstream of the NST (at MSTIN) prevents double-accounting for some VOC mass as both water dissolved and as vapor phase at OXIN.

F2.6.3 Mass Removal In NAPL

Data for the calculation of the mass of COC VOCs and TPH removed in the NAPL stream will be collected from NAPL storage tank. The dimensions of the NAPL storage tank will be measured when it arrives on-site and the thickness of NAPL in the tank will be recorded over time. From this data, the volume of NAPL can be calculated. Additionally, the density of the NAPL will be determined. The off-site laboratory will analyze NAPL samples for COC VOCs and TPH and the analytical results will be converted to mg/l using the measured NAPL density. The concentrations of the COC VOCs and TPH can then be multiplied by the volume of NAPL to arrive at a mass that can be converted to the most appropriate unit for data presentation. By adding the mass of COC VOCs and TPH recovered between each sampling event, the cumulative mass recovered can be calculated. Using system run time data and the mass of COC VOC recovered, mass recovery rates can be calculated.

F3.0 COMMUNICATION

Communication between team members, and particularly between field personnel and project management personnel in the office, is important to ensure that the most current scope of work is implemented in the field. Since this is a dynamic project, subject to changes as data from the field is reviewed, communication is very important. It is also important to communicate when problems are encountered or unexpected results are received from daily monitoring of the wastewater or thermal remediation system. Again, changes need to be communicated quickly to those who are making the decisions and to those performing the work.

F3.1 Field Planning Meeting

Prior to implementing this FSP in NAPL Area 1, there will be a meeting of those performing the field activities and the people responsible for coordination of these activities. Items to be discussed at this meeting will include the scope of work, SOPs, site procedures, the health and safety plan and its implementation, documentation control and data management. Lines of communication during field work should be verified, to ensure information is communicated quickly and effectively to those involved. Contact numbers will be made available.

Once work has begun, there will be daily meetings, either by phone or in person, of the technical team to discuss operations and the DWP. The results of this meeting will be documented in the daily field report. This meeting will be expanded once a week to include other interested parties represented in USACE and Fort Lewis to keep them apprised of progress. Other meetings will be called at major milestones as necessary.

The field manager will communicate daily with the field crews, the on-site laboratory, system operations and maintenance personnel and Fort Lewis personnel as necessary. This person will bring issues and problems from the field to the technical team to discuss during their daily meeting. All resulting decisions, changes or additions made by the technical team to the work scope will be communicated back to the field crews and on-site laboratory.

F3.2 Health and Safety Tailgate Meetings

As described in the Site Safety and Health Plan (SSHP), safety meetings will be held on a daily basis with the Site Safety and Health Officer (SSHO). These meetings will be documented on the Daily Quality Control Reports (daily activity forms), and will include all personnel and subcontractors working on the site that day. Issues to be discussed may include, but are not limited to, scope of work and health and safety concerns associated with those tasks. Emergency procedures and contacts must be reviewed anytime there are new personnel on the site. In addition, issues or concerns that come up from the previous days' work will be addressed. Further details of the health and safety tailgate meetings are presented in the SSHP.

F3.3 Communication of Problems in the Field

During the implementation of this FSP, there are two types of problems that may evolve. There may be a problem in completing the sampling as outlined by the FSP, or a health and safety issue may be identified that prevents the safe completion of the FSP sampling tasks. Sampling problems may include the inability to take a sample because of insufficient water, problems with the on-site laboratory, or sampling equipment that is not functioning properly. These concerns are to be addressed through the Site Manager who will direct the information via the daily QC report to the USACE QA representative. A corrective action strategy for nonconformance with specifications and missing data points applicable to the physical and environmental measurements is described in the QAPP. Any immediate health and safety issues need to be addressed by the SSHO.

F3.4 Field Audits

Audits of field sampling activities, as outlined in this FSP, will be conducted on a scheduled basis and at the discretion of the QA officer. The specific date of the audit will not be communicated to the field personnel. At a minimum, there will be two field audits, each covering the sampling procedures for each media being sampled (groundwater, wastewater and air). One audit will be conducted within the first month of sampling activities to make sure field personnel are following SOPs included in the FSP. The second audit will occur toward the middle of the project to make sure that procedures continue to be followed.

Any problems or deviations from the SOPs observed during the audit will be communicated to the field personnel immediately and documented in a field evaluation form. If problems noted in the field are severe, the Environmental Consultant has the option to suspend field activities until the problems are resolved.

Random audits of field sampling procedures may also occur at the discretion of the Project or Site Manager, especially when the Database Specialist receives questionable data from the field or questionable sample results.

F4.0 DOCUMENTATION

Verifiable sample custody is of primary importance during field and laboratory procedures. Such practices are in place so that the samples have been properly acquired, preserved, and identified. This information will be collected in a variety of formats that will be specific to the function they perform in the sampling procedure (e.g., field logbooks, groundwater sampling forms, sample labels, COC forms). Accurate sampling records create a complete record of field procedures, including circumstances of collection and integrity of the sample. This will allow for detailed tracking of the samples from collection through transport and laboratory analysis and facilitate the import of field data and laboratory analyses into the database system. The following information outlines specific procedures that will be implemented during field sampling activities.

F4.1 Field Data Management

The Data Management Plan is described in detail in the RAMP. Field sampling and monitoring assignments will be coordinated by the Site Manager and the Project Manager. The Contractor is responsible for providing the appropriate equipment and data forms to accompany the task, and will collect the data forms at the completion of the task or day. The forms should be up-to-date with respect to samples to be collected,

sample IDs, QA/QC sample collection requirements and where the samples are to be turned in for analysis. A copy of the completed data forms will be supplied to the Database Manager and appropriate project staff. Originals will be filed appropriately.

F4.1.1 Field Logbooks

Field logbooks will be a key source of documenting the field activities, although the actual data collection might be done on a data form or electronically. The books will be permanently bound, with waterproof pages, chosen for their secure binding and durability in adverse field conditions. Pages will be numbered consecutively. Pages will remain intact and no page will be removed for any reason. Notes will be taken in indelible, waterproof blue or black ink. The front and inside of each field logbook will be marked with the project name, USACE contract number, and team member company name. The field logbooks or copies of the field notes will be stored in the project files when not in use.

The first entry at the beginning of each day will include the date and time, weather conditions, and the purpose of field activity. Each subsequent page will be started with the date. The bottom of each page will have the date and the initials of personnel entering information onto that page. Remaining unused lines will be crossed through. Errors will not be erased. Errors will have a single strikethrough with an initial and date next to the strikethrough and the subsequent change made.

Information included in the field logbooks may include, but not be limited to, the following items:

- Reasons for collecting samples (e.g., quarterly groundwater sampling);
- Field observations relevant to the sampling event, including weather (wind direction and approximate speed, air temperature, sky cover) and events that may have occurred previous to sampling that may influence the integrity or the representative nature of the sample;
- Observations of site activities not covered under regular activities, including presence of persons on-site not related to the sampling activities (subcontractors, agency representatives, members of the press, and others), and actions by those people affecting task performance;
- Sketches of relevant information;
- Information relevant to a change in scope or change in procedure, with documentation of subsequent approval from the USACE;

- Type and/or level of health and safety equipment used;
- References to information on other field forms, such as the Groundwater Sampling Field Form (discussed below); and
- All information compiled in the field logbook will be written legibly in language that is clear and concise, without allowing for interpretation.

If sample collection information is being collected on a data sheet, a minimal entry must be made in the field logbook, such as sample ID and time, number of containers, and problems with equipment or the sample collection.

The field logbooks will be used by the Site Superintendent or Chemical Quality Control Manager to complete the Daily Chemical Data Quality Control Report (DCDQCR) and the Daily Contractor Quality Control (CQC) Report.

F4.1.2 Field Data Sheets

Data collected in the field will be recorded manually on paper or through a handheld portable computer. The field data to be collected will be listed on the form or computer program and will be filled out as directed with the correct information. Should there be a problem with electronic data recording, paper forms will be available as a backup. Forms and electronic files will be submitted to the Site Manager who will forward the information to the Database Manager for input into the database on a regular basis. The Site Manager will also make sure that field information, electronic or paper forms, is kept on file at the Site as required by the specifications for the project.

F4.1.2.1 Water Level Measurement Form

A Water Level Measurement Form will be used as needed to record water levels for monitoring wells, and HCWs. The information recorded will include the depth to water, date, and time of measurement (Appendix C). Errors will not be erased. Errors will have a single strikethrough with an initial and date next to the strikethrough and the subsequent change made. Observations made during water levels measurements may be added to the bottom of the form or in the field logbook.

F4.1.2.2 Groundwater Sampling Field Form

A separate and complete Groundwater Sampling Field Form will be created for each monitoring point sampled (Appendix C). Errors will not be erased. Errors will have a single strikethrough with an initial and date next to the strikethrough and the

subsequent change made. Information collected during sampling will be marked on the Groundwater Sampling Field Form in addition to notes taken in the field logbook.

Information may include, but will not be limited to:

- Date and time of sampling for each sample, including QA/QC samples and Duplicates;
- Well ID;
- Sample ID or naming system, including each unique sample name/number;
- Method of sampling, including procedures and equipment, as well as variance from the methods described in this FSP;
- Volume of sample collected per sample container, type of sample container, and number of aliquots per sample;
- Sample preservation techniques and analyses requested;
- Results of field measurements (e.g., DO, pH, conductivity and TDS);
- Information relevant to quality control (e.g., sampling discrepancies or difficulties, unexpected conditions, abnormal sampling procedures);
- Weather conditions;
- Depth to water; and
- Purge method, time, and volume.

The fields within the form allow pertinent information to be documented appropriately.

F4.1.2.3 Wastewater Sampling Field Form

A separate and complete Wastewater Sampling Field Form will be created for each sample port (Appendix C). Errors will not be erased. Errors will have a single strikethrough with an initial and date next to the strikethrough and the subsequent change made. Information collected during sampling will be marked on the Wastewater Sampling Field Form in addition to notes taken in the field logbook.

Information may include, but will not be limited to:

- Date and time of sampling for each sample, including QA/QC samples or duplicates;
- Sample port ID;

- Sample ID or naming system, including each unique sample name/number;
- Method of sampling, including procedures and equipment, as well as variance from the methods described in this FSP;
- Volume of sample collected per sample container, type of sample container, and number of aliquots per sample;
- Sample preservation techniques and analyses requested;
- Results of field measurements (e.g., pH, DO, conductivity and TDS);
- Information relevant to quality control (e.g., sampling discrepancies or difficulties, unexpected conditions, abnormal sampling procedures);
- Weather conditions;
- Purge method, time, and volume (if necessary);
- Purge water disposal method; and
- Decontamination method.

The fields within the form allow pertinent information to be documented appropriately.

F4.1.2.4 Air Sampling Form

A separate and complete Air Sampling Field Form will be created for each sample location (Appendix C). Errors will not be erased. Errors will have a single strikethrough with an initial and date next to the strikethrough and the subsequent change made. Information collected during sampling will be marked on the Air Sampling Field Form in addition to notes taken in the field logbook.

Information may include, but will not be limited to:

- Date and time of sampling for each sample, including QA/QC samples or duplicates;
- Sample Location;
- Sample ID or naming system, including each unique sample name/number;
- Method of sampling, including procedures and equipment, as well as variance from the methods described in this FSP;
- Volume of sample collected per sample container, type of sample container, and number of aliquots per sample;
- Sample preservation techniques and analyses requested;

- Results of field measurements (e.g., temperature, wind speed, and direction);
- Information relevant to quality control (e.g., sampling discrepancies or difficulties, unexpected conditions, abnormal sampling procedures);
- Weather conditions; and
- Purge method, time, and volume (if necessary).

The fields within the form allow pertinent information to be documented appropriately.

F4.1.3 Electronic Data Collection

Some information may be collected electronically using data loggers with transducers. Transducers will be installed where possible to record water levels and temperatures on a regular set interval throughout the project. These files will be downloaded on a regular basis and placed in a designated data management location. The information regarding programming, location and downloading for each transducer will be kept in a dedicated field logbook.

F4.1.4 Photographic Record

Photographs that are taken in association with FSP activities will be used to document the equipment and procedures used during sampling. Pictures will be taken of equipment and sampling setup for each type of media.

As stated in Specification 1788, photographs will be digital and in jpeg format, with a resolution of 1024 x768 pixels or better and size of the files limited to less than 300 kB. Photos shall be submitted individually and in a Microsoft Word Document, with a caption under each photo. The captions should include date taken, direction photographer is facing, project location, contact title and number, and a brief description of what the photograph depicts. Photographs will be submitted on CD-ROM and posted to the project website.

A log of the photographs will be kept as a Microsoft Excel spreadsheet and contain the following items for each photograph:

1. Unique ID number
2. Electronic file name
3. Description
4. Direction facing

5. Location
6. Date

In addition, photographs will be taken of unusual circumstances encountered during sampling activities. Photographs will be formatted and logged as described above.

F4.1.5 Chain of Custody Records

The COC is an integral component of the sampling process as it stands as a permanent record of sample holding and shipment. Sample custody is documented from collection through transport, analysis, and reporting.

Samples will remain in the custody of project team staff until receipt by the laboratory. The corresponding COC form is in plain view, in physical possession, or in a locked location where no tampering will occur. The COC will be cross-checked for errors and signed. Errors will not be erased, but will have a single strikethrough, with the change dated and initialed.

Samples will be hand-delivered to a laboratory representative or shipped according to the procedures described above. Coolers with their respective COC form(s) will be checked into the laboratory by a laboratory representative, and the COC will be signed and dated appropriately. The project team staff member will retain one copy of the signed COC form for the project files. The laboratory representative will verify cooler temperature, sample designation, and other relevant sample conditions. The original COC or a photocopy will be returned to the Chemist with the analytical results to go into the project files.

F4.2 Calibration Records

All instruments used in the field, for sampling or health and safety purposes, will have records of standard preparation and instrument calibration data maintained. The Field Equipment Calibration logbook shall include at a minimum, the date and time of calibration, the initials of the personnel performing the calibrations, and concentration of solutions used for the calibration. Problems encountered with the equipment during sampling in the field will be noted in the field logbook along with recalibration information. If changes are made to the instrument in the field during the day or prior to calibration for the day (i.e., changing the DO membrane), these will be documented in the field log book. SOPs describing the use of the field equipment are included in the SOPs in Appendix B.

Information on the equipment, factory calibration, and repairs performed on the equipment will be kept on file at the site. If rental equipment is used, then records of the equipment, calibration and dates of use will also be kept on file at the site.

F5.0 WASTE GENERATION AND MANAGEMENT PROCEDURES

The following is a summary of how the investigation-derived wastes (IDW) and the remediation wastes will be managed at the site. Details of waste handling procedures can be found in the Waste Management Plan.

F5.1 Investigation-Derived Wastes

All soil cuttings generated during installation of monitoring wells, extraction wells, MPE wells and electrodes in NAPL Area 1 will be stockpiled in the designated portion of NAPL Area 2 in accordance with Specification 02215 (Subsurface Drilling and Well Installation) and as detailed in the Waste Management Plan. Water generated through purging, decontamination, or well development will be contained and passed through the remediation system at the site for introduction into the infiltration gallery. Miscellaneous waste, such as paper towels, gloves, disposable tubing, rope, etc. will be disposed of as solid waste using a municipal waste disposal container.

The on-site laboratory is expected to generate the following waste streams:

- Solid waste generated from analytical activity (personal protective equipment [PPE] and reagent and sample containers); and
- Liquid waste of acetone, methanol, and acetic acid used for analytical procedures.

The solid waste stream of PPE (tyvek, gloves, boot covers, etc.), laboratory reagent containers, sample containers, Tedlar bags, and other disposable sampling equipment generated during on-site activities will be placed in plastic garbage bags with other non-hazardous waste and disposed into the on-site dumpster for removal by Waste Management, the non-regulated solid waste contractor.

In the event that liquid waste of acetone, methanol, and/or acetic acid (used for analytical procedures) is generated, the waste will be disposed in an on-site laboratory pack. Alternatively, the TRS site manager may elect to dispose of some laboratory waste chemicals by slowly feeding them into the vapor-liquid separator inlet.

F5.2 Remediation Wastes

Wastes generated during remediation include NAPL from the oil water separator and sludge from various tanks throughout the system. The NAPL will be temporarily stored in a double-walled steel tank (approximately 18,000-gallon storage capacity) until the liquids are characterized, manifested, and transported off-site for disposal. PES will transport the liquid wastes off-site for final disposal.

No on-site treatment of NAPL will be conducted. NAPL accumulation and storage in the tank will be continuous during ERH/MPE operation. The NAPL storage tank will be emptied no less frequently than every 90 days. The actual frequency will depend on the capacity of the tank and the NAPL generation rate.

F6.0 PROCEDURES FOR SAMPLE ANALYSES

Sample analysis procedures are presented in the QAPP portion of this SAP. A summary of the sample analyses, sample containers, preservatives, holding times, and QA/QC volumes are included in Table 3 for use in the field. Specific laboratory procedures are presented in the QAPP.

F7.0 SAMPLE LOCATION SURVEYING

Remediation system component coordinates will be established following installation through professional surveying.

QUALITY ASSURANCE PROJECT PLAN

Q1.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The RAMP provides and organization chart outlining the ERH project responsibilities.

Q2.0 QA OBJECTIVES FOR MEASUREMENT OF DATA

This QAPP provides a comprehensive framework for obtaining analytical data of known quality during the ERH project. The objective of this QAPP is to insure collection of appropriate and economic analytical data. The QAPP is required reading for all staff participating in ERH field activities at the Ft. Lewis EGDY and is referenced in all plans written in support of this activity.

Q2.1 Data Quality Objectives

DQOs are qualitative and quantitative statements that clarify technical and quality objectives, describe the intended use of the data, define the appropriate type of data needed to support the decision, identify the conditions under which the data should be collected, and specify the tolerable levels of decision errors due to uncertainty in the data.

This QAPP primarily addresses only the DQOs associated with the QA/QC procedures for sample collection and analytical laboratory analyses. The DQOs for the ERH project at Ft. Lewis EDGY are provided in the RAMP.

Q2.2 Laboratory Data

The measurement data from this project will be a collaborative effort of the project team, and will involve use of data from an on-site (FPA) and an off-site (fixed) laboratory (CAS). The measurement data must be of a type that can comply with the project-specific tolerances for precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS). These data quality indicators (DQIs) are discussed in Section Q2.5 below.

Both on-site and off-site data will be produced using rigorous preparatory and analytical methods such as U.S. Environmental Protection Agency (USEPA) reference methods. Analyte presence and quantitation are confirmed through extensive QC procedures performed at the laboratory. To generate data of sufficient quality for monitoring and quality control uses, the following approach for analytical data will be followed.

- Quality control samples and procedures will be utilized by the subcontracting laboratories for analysis as required by the QAPP and the respective methods.
- The subcontract laboratories will be USACE-validated and validation documentation will be on file with TRS or USACE will approve the laboratory with interim validation.
- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) (USEPA 1997)* will be used for aqueous and solid analyses when available. If SW-846 methods are not available, other standard methods will be used.
- *Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS) (USEPA 1999)* will be used for perimeter air analyses.

Contract Laboratory Program (CLP) equivalent data packages (i.e., Level IV) will be generated for all samples collected (i.e., air, water, NAPL, waste water, and HCL). As such, complete raw data packages and documentation sufficient to perform a complete data quality review will be submitted. Data quality review will be performed on the analytical data. Evaluation and subsequent validation of the analytical data will be completed as described in Section Q8.0.

Q2.2.1 Field Portable Analytical, Inc. On-Site Analysis

Data will be collected in the field using an Inficon Hapsite GC/MS. The acquisition of project chemical data in the field allows the data user to collect a greater number of analytical samples, resulting in a more detailed representation of contaminant locations and concentrations, at lower cost, and with faster turnaround times (TATs) than can be obtained from an off-site (fixed) laboratory.

Analyses of air, water, and NAPL samples will be performed using Modified USEPA Method 8260B, measuring the COC VOCs: PCE, TCE, TCA, DCE, and VC. Samples may undergo a simultaneous TPH screening during the VOC analysis.

Q2.2.2 Columbia Analytical Services, Inc. Off-Site (Fixed) Laboratory

CAS will analyze split samples selected by the project team to specifically address questions regarding uncertainty with the data set, perform analysis of perimeter air monitoring samples using USEPA Compendium Method TO-15, perform all non-VOC analyses (if required), and perform waste designation analyses.

Q2.2.3 Am Test-Air Quality, LLC

Am Test will collect a single oxidizer scrubber stack gas emission sample from each area, within 30 days of start-up, which will be analyzed for HCl content.

Q2.3 Intended Uses of Acquired Data

FPA will analyze air samples to measure the composition and mass of VOCs removed from the subsurface during remediation in order to determine the point of diminishing returns at the condenser effluent line. Discharge stack effluent will be analyzed to test for regulatory compliance of the air emissions abatement equipment.

CAS will analyze air samples to measure surface emissions of VOCs around the perimeter of the treatment area in order to meet ambient source impact level (ASIL) or other regulatory requirements.

FPA will analyze water and NAPL samples to measure the composition and mass of VOCs removed to determine the point of diminishing returns at the groundwater wellheads, MPE wells, and of the combined system influent. Treatment system effluent will be analyzed to determine contaminant removal efficiency and to support mass balance calculations. FPA will also perform analysis on IDW wastewater for waste disposal characterization purposes.

Approximately 10 percent of the air and water samples will be analyzed both by FPA and CAS. The data from CAS will be used to provide a QC check on the FPA data and to specifically address questions regarding uncertainty with the data set.

CAS will analyze NAPL samples for waste disposal characterization purposes.

CAS will analyze a stack gas emission sample, collected by Am Test, to ensure that emissions do not exceed the PSCAA guideline of less than or equal to 66 parts per million by volume (ppmv) or 9 lb/day for HCl. Additional tests will be conducted monthly as long as the HCl emissions exceed 50 ppmv.

In addition to analysis of COC VOCs, FPA will examine chromatograms for unexpected or large peaks. If such peaks are encountered, FPA will perform a library search, report compound identifications, and estimate concentrations as a tentatively identified compound (TIC).

Q2.4 Intended Users of Data

Data collected for this ERH project will be posted to an electronic repository, either a USACE project website, or external website. Both the ERH project team and the USACE will have access to this electronic repository for posting and review of data. Data will be posted on a daily, weekly, and monthly frequency, as described in the USACE specifications (01785). Additional details on the management and users of the data collected for this project can be found in the data management plan presented with the RAMP.

Q2.5 Data Quality Indicators

The DQIs of PARCCS, and the additional indicator of selectivity can be applied to all laboratory analytical measurements to ensure that data of known and appropriate quality are obtained to support specific decisions or regulatory actions. Project-specific measurement quality objectives (MQOs) for these DQIs are presented in Appendix D. The project-specific MQOs are not intended as absolute standards used to accept or reject analytical data, but rather to establish a standard for complete and unqualified usability, and to allow identification of data that must be qualified to identify limitations in usability.

Q2.5.1 Precision

Precision is a measurement of random error expressed in terms of analytical variability, and may be used to assess both analytical and sampling contributions to overall error. Precision is also affected by natural matrix variation and the distribution of a constituent within the sample matrix. For chemical analyses that do not allow for sample homogenization prior to analytical subsampling (e.g., volatile organic analysis), precision values must be interpreted with an understanding that the result is representative of a single point in space and time, and may not be reflective of the true average concentration. In order to assess the effect of matrix heterogeneity or sample handling procedures, both field and laboratory replicate samples should be collected. Alternately, collection of a larger number of primary field samples may help to reduce error in the estimated mean. Specific routine procedures to assess data precision may be found in Section Q12.1.

Q2.5.2 Accuracy

Accuracy is used as a synonym for bias, or systematic error, and is the amount of agreement between a measured value and the true value. Accuracy includes a combination of random error and systemic error components that result from sampling

and analytical operations. Accuracy can be improved by following good sampling and measurement practices. Specific routine procedures to assess data accuracy may be found in Section Q12.2.

Q2.5.3 Representativeness

Representativeness is the degree to which data accurately and precisely represents a parameter variation at a sampling point or an environmental condition. Samples that are not properly collected or preserved or are analyzed beyond acceptable holding times may not provide representative data. Representativeness is a parameter that is primarily concerned with the proper design of the sampling program and an assessment of representativeness would include an evaluation of precision in the field and laboratory duplicate samples. Representativeness can also be improved by collection of a larger number of samples.

The representativeness criterion is best satisfied in the laboratory by making certain that all subsamples taken from a given sample are representative of the sample as a whole. This would include sample premixing/homogenization prior to and during aliquotting procedures. Since samples requiring volatile analyses should not undergo premixing or homogenization, noting sample characteristics in a case narrative may assist in data evaluation.

Q2.5.4 Comparability

Comparability is the degree to which data from one study can be compared with data from other similar studies, reference values (such as background), reference materials, and screening values. Comparability of laboratory results will be achieved by using standard techniques to collect and analyze representative samples, by reporting analytical results in appropriate units, using traceable reference materials, using Class A volumetric glassware or correctly calibrated pipettors for volumetric procedures, using correctly calibrated balances for gravimetric procedures, and following good laboratory practices.

There will be strict adherence to method quality control and procedural requirements or proper documentation of any deviations from the analytical methods. If undocumented method deviations are discovered during data quality review, the quality control officer (laboratory) will evaluate the potential effect on data usability and comparability and will contact the laboratory for corrective action. Notification of corrective action will also be made to the appropriate project managers.

When performance-based methods such as field analytical techniques are employed, comparability becomes a critical data quality indicator. If comparability between standard methods and performance-based methods has not been demonstrated, a project-specific percentage of duplicate (split) samples for analysis by the standard reference method should be included. This allows an assessment of comparability between data sets by calculating the relative percent difference (RPD) and determining the usability of the performance-based method in supporting project decision-making.

For this project, 10 percent of the samples analyzed by FPA will be submitted as split samples to CAS for analysis. RPDs between the concentrations obtained from FPA and CAS should be less than or equal to 30 percent. Corrective actions for RPDs greater than 30 percent include thorough review of data from both FPA and CAS to determine if errors were made in sample calculations or reporting and a reassessment of the comparability criteria.

Q2.5.5 Completeness

Completeness is defined as the percentage of usable data out of the total amount of data generated. Analytical completeness is a measure of the number of overall accepted analytical results (valid results), including estimated values, compared to the total number of analytical results requested on samples submitted for analysis after review of the analytical data. Less than 100 percent completeness could result if sufficient chemical concentrations exist to require sample dilutions, resulting in an increase in project-required detection/quantitation limits for some parameters. Highly contaminated environments can also be sufficiently heterogeneous to prevent the achievement of specified precision and accuracy criteria. The nominal DQI goal for completeness is 95 percent overall, which means that 5 percent of data can be rejected.

Rejection of data due to severe matrix interference is sometimes unavoidable. The project contract laboratories and the quality control officer (laboratory) will make every effort to minimize matrix interference problems by selection of additional cleanup procedures or alternate analytical procedures if possible.

Rejection of data due to laboratory performance issues is unacceptable. Laboratory performance will be monitored during project execution in order to minimize the potential for discovery of severe data quality issues after the data are reported. Project laboratories are expected to pay careful attention to analytical procedures and method requirements, and to implement corrective actions to avoid rejection of results.

Specific routine procedures to assess completeness may be found in Section Q12.3.

Q2.5.6 Sensitivity

As used in this context, sensitivity refers to the ability of project analytical procedures to identify and quantify target analytes at concentrations low enough to meet project data needs. Specific indicators of sensitivity in analytical measurements include the method detection limit (MDL), method reporting limit (MRL), and the sample-reporting limit (SRL).

The MDL is a purely statistical value, which is defined by USEPA as the concentration at which an analytical system has a 99 percent probability of avoiding false positive results, and is determined by preparation and analysis of a minimum of seven replicate portions of a low level standard. The MDL lies in a region of high quantitative uncertainty, and results near the MDL must be considered as estimates.

The MRL is normally set at a factor of 5 - 10 times the MDL. The exact number depends on the amount of error the data user is willing to accept for the data generated and the lowest concentration that a laboratory can successfully use as a low calibration standard. The MRL is considered the lowest concentration that a laboratory can report with reasonable quantitative accuracy, although results less than 5 times the MRL can still be highly variable. Target analyte concentrations detected and reported below the MRL must be J qualified as estimated values.

The SRL represents the lowest concentration of an analyte that can be reported with reasonable quantitative accuracy in a particular sample. The SRL is typically represented as the MRL multiplied by the dilution factor that was required to successfully analyze the sample.

Q2.5.7 Selectivity

Selectivity is the ability of an analytical procedure to accurately identify an analyte and to distinguish that analyte from interferences. In order to ensure that project data needs are met, the subcontract laboratories will use a gas chromatograph with mass selective detector (GC/MSD), which eliminates the need for second column confirmational analysis, to analyze the air and water samples for organic compounds. The project laboratories must also maintain their analytical systems in proper working procedure by following the preventative maintenance schedules outlined in their individual Quality Systems Manuals, and that method requirements for confirmation are strictly followed. Proper compound identification will be monitored during data validation and the project laboratories will be required to provide additional explanation for any questionable compound identification. It is expected and required that laboratories will

appropriately flag the data generated from a response that does not meet the required identification criteria as being only presumptively identified.

Q3.0 SAMPLING PROCEDURES

Sample locations, sample collection procedures, and sample preservation are specified in the FSP, which is in the previous section of this SAP.

Q4.0 SAMPLE CUSTODY AND HOLDING TIMES

Sample custody procedures are necessary to prove that the sample data correspond to the sample collected, if data are intended to be legally defensible in court as evidence. The COC is a crucial piece of evidence in demonstrating an unbroken connection between the location of the sample and the analytical results. The fields on the field data collection forms are to be completed by the appropriate, qualified personnel, including the sampling personnel, any intermediaries in transfer of the samples to the laboratory, and the recipient. The data on the COC form are provided as part of the electronic data deliverables (EDD).

Sample COC forms are provided in triplicate; originals of the forms will be retained by field personnel, transferred to project files, and retained by the Contractor for the duration of the project. Copies of the custody forms are provided with the hard-copy deliverables.

A new field custody form must be started each day that field analyses are required. As each sample is relinquished to FPA, both the person relinquishing the sample and the person receiving the sample must sign and date the appropriate line corresponding with the sample I.D. The field custody form will be kept with FPA and copies will be submitted to the sampler and to the contracting officer along with the DCDQCR.

CAS must provide confirmation of sample receipt by e-mail or facsimile within 24 hours of sample receipt. Confirmation shall include copies of signed COCs and the laboratory work order or service request. This allows the project chemist to check the work order or service request and inform the laboratory of any discrepancies before analysis begins.

All analyses must take place within the method-specified holding times.

Q5.0 CALIBRATION PROCEDURES AND FREQUENCY

Analytical instrument calibration and maintenance will be conducted in accordance with the QC requirements identified in each laboratory SOP and quality assurance plan

(QAP)/quality assurance manuals (QAMs), provided in Appendices E and F, USEPA guidance, and the instrument manufacturers' instructions. General requirements are discussed below.

Q5.1 Standard Solutions

A critical element in the generation of quality data is the purity/quality and traceability of the standard solutions and reagents used in the analytical operations. To ensure the highest purity possible, the primary reference standards and standard solutions will be obtained from the National Institute of Standards and Technology (NIST), the USEPA repository, or a reliable commercial source, and will be traceable to NIST Primary Reference Standards. The laboratories will maintain written records of the supplier, lot number, concentration, receipt date, preparation date, preparer's name, method of preparation, expiration date, and all other pertinent information for all standards, standard solutions, and individual standard preparation logs.

Standard solutions will be validated prior to use. Validation procedures can range from a check for chromatographic purity to verification of the concentration of the standard solution using another standard solution prepared at a different time or obtained from a different source. Stock and working standard solutions will be checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change of concentration. Care will be exercised in the proper storage and handling of standard solutions. All containers will be labeled as to compound, concentration, solvent, expiration date, and preparation data (initials of preparer/date of preparation). Reagents will be examined for purity by subjecting an aliquot or subsample to the corresponding analytical method.

Q5.2 Balances

Analytical balances will be calibrated annually according to manufacturer's instructions and have a daily calibration check against NIST Class I weights before use by laboratory personnel. Balance calibration shall be documented in appropriate bound logbooks with pre-numbered pages.

Q5.3 Refrigerators

The refrigerators will be monitored for proper temperature by measuring and recording internal temperatures on a daily basis. At a minimum, thermometers used for these measurements will be calibrated annually, against a thermometer traceable to NIST.

Q5.4 Water Supply System

The subcontract laboratories will maintain an appropriate water supply system that is capable of furnishing American Society for Testing and Materials (ASTM) Type II polished water to the various analytical areas. This laboratory pure water shall not contain detectable concentrations of target analytes or interfering substances.

Q5.5 Laboratory and Field Instruments

Calibration of analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the sensitivity required to meet project-specific DQOs. Each instrument will be calibrated with standard solutions appropriate to the instrument and analytical method, in accordance with the methodology specified and at the QC frequency specified in the subcontract laboratory SOPs.

The calibration and maintenance history of the subcontract laboratory instrumentation is an important aspect of the project's overall QA/QC program. As such, the initial calibration (ICAL), initial calibration verification (ICV) and continuing calibration verification (CCV) procedures will be implemented by trained personnel following the manufacturer's instructions and in accordance with applicable USEPA protocols to ensure the equipment is functioning within the tolerances established by the manufacturer and the method-specific analytical requirements.

ICAL of instruments used for the analysis of organic analytes must be performed using a minimum of five standards for all single-component target analytes and surrogates. Once verified, an organic ICAL is valid until a CCV fails or significant instrument maintenance is performed. The target VOCs must meet method-specific ICAL acceptance criteria. SVOCs must meet method-specific ICAL acceptance criteria for system performance check compounds (SPCCs) and calibration check compounds (CCCs) while other SVOC compounds may use alternative ICAL acceptance criteria as long as they do not exceed the criteria established for poor performers.

ICAL of instruments used for inorganic analytes must be performed using the method-specified number of standards at the method-specified frequency.

Immediately after calibration, the analysis of an ICV standard containing the same analytes as the calibration standards, at a concentration close to the middle of the calibration range, and made from a different source, manufacturer, or lot number than the calibration standards will be required. ICV standards serve to verify the preparation and concentration of the instrument calibration standards. A single ICV is required each time the instrument is calibrated.

CCV standards containing the target analytes at concentrations close to the middle of the calibration range or at concentrations expected in the field samples must be analyzed per method requirements to verify the calibration of the analytical system over time.

ICAL, ICV, and CCV acceptance limits may be found in Appendix D.

Q6.0 ANALYTICAL PROCEDURES

In general, analytical data will be generated using appropriate USEPA SW-846 methods. However, the following analytes will be determined using methods that are not found in SW-486.

- FPA will analyze air samples for VOCs using Modified Method 8260B.
- Air samples will be analyzed for VOCs using USEPA Method TO-15 at CAS.

Analytical procedures to be used on project samples may be found in Table D-3 and in Appendix B, Standard Operating Procedures.

Q7.0 LABORATORY OPERATIONS DOCUMENTATION

The laboratory QAP/QAMs and SOPs may be found in Appendix E for FPA and in Appendix F for CAS. These SOPs and the QAP/QAMs are included to serve as the main documentation for laboratory operations.

Q7.1 Sample Management Records

Sample management records include the documentation accompanying the samples (i.e., original COC record, shipping documents, laboratory notification sheets), records generated by the laboratory that detail the condition of samples upon receipt at the laboratory (i.e., sample cooler receipt forms, telephone conversation records, etc.), and the records generated to document sample custody, transfer, analysis, and disposal.

Q7.2 Data Reporting Procedures

The chemistry data packages should contain enough information to demonstrate that the project's DQOs have been fulfilled. In general, one should be able to demonstrate the precision, accuracy, representativeness, comparability, and sensitivity of the data from the information contained in the data package.

Q7.2.1 Data Package Format and Contents

Electronic deliverables should, at a minimum, contain the elements listed below.

Electronic Data Packages

The electronic data packages, which apply to the field-based air and water analyses, will include the following:

- Sample ID number
- Preparation method
- Analysis method
- Detection limits
- Identity and quantity of analyte(s) present
- Date and time of sample collection
- Date of sample analysis
- Duplicate sample results
- Blank sample results
- Spiked sample results

Hard Copy Data Packages

The hard copy data package should be a Level IV-equivalent CLP data package that includes a cover sheet, table of contents, case narrative, the analytical results, sample documentation information, internal QA/QC information, and the pages should be sequentially numbered. Use of CLP forms for data reporting is neither required nor preferred.

1. Cover sheet: The cover sheet should specify the following information:
    - Name and location of laboratory
    - Contract number
    - Project name and site location
    - Statement of data authenticity and official signature of release

2. Table of contents: Laboratory data packages should be organized in a format that allows for easy data identification and retrieval. An index or table of contents should be included for this purpose.
3. Case narrative: A case narrative outlining any analytical problems should be included with each report. The case narrative should include:
    - A list of the methods used and which analytical tests were performed by which laboratories
    - A table corresponding field sample numbers with laboratory sample numbers and which samples were received but not analyzed
    - Extractions or analyses performed outside of the recommended holding time
    - Definitions of the data flags and qualifiers
    - QC sample deviations outside of laboratory acceptance limits and corrective actions taken by the laboratory to address the deviations
    - Any other factors that could affect sample results such as air bubbles in VOC sample vials, inappropriate sample temperature, pH, container, etc.
4. Analytical results: The results for each sample should contain the following information at a minimum:
    - Project name and unique ID number
    - Field sample ID as written on the custody form
    - Laboratory sample ID
    - Preparation and analytical batch numbers
    - Collection date
    - Date sample received at the laboratory
    - Extraction or preparation date
    - Date sample analyzed
    - Analysis time when holding time is less than 48 hours
    - Method numbers for the preparation and cleanup procedures
    - Analytical procedures and method numbers
    - Analyte or parameter
    - Detection limits

- Quantitation limits
- Analytical results with correct numbers of significant figures (Results for solid matrices should be reported on a dry weight basis)
- Concentration units
- Dilution factor: The reported data must reflect any dilutions and/or concentrations. The dilution factor, if applicable, should be noted in the analytical report. If dilution is required for organic analytes, data from both runs should be recorded and reported.
- Matrix
- Percent moisture or percent solids, as needed
- Chromatograms, as needed
- Sample aliquot analyzed
- Final extract volume
- Sample preservation

5. Lower limit reporting: The laboratory may use a reporting limit expressed in terms of detection limit, quantitation limit, regulatory action level, or project-specific threshold limit, however; the laboratory's use of these terms must be well defined. In addition, if the non-detect "ND", "U", "<", or other lower limit reporting convention is used, then these terms must also be defined.
6. Sample documentation: Original COC record, shipping documents, and sample cooler receipt forms should be attached to each data package.
7. QA/QC information: The minimum data package must include internal laboratory QA/QC and calibration data with their respective acceptance criteria. The data package should also include the laboratory's MDLs for project-specific parameters. The data package should correlate the method QC data with the corresponding environmental samples on a per batch basis. Method QC data include all spike recoveries, including surrogate spike recoveries; all measures of precision, including RPD; and all control limits for accuracy and precision. This would include laboratory performance information such as results for method blanks, laboratory control sample and laboratory control sample duplicate recoveries and precision, and recoveries for QC sample surrogates; and matrix-specific information such as sample duplicate RPDs, matrix spike and matrix spike duplicate recoveries and precision, and field sample surrogate recoveries, serial dilutions, and post-digestion spikes. At a minimum, internal QC samples should be analyzed and

reported at rates specified in the specific method or as specified in the contract (ref. The USACE Shell), whichever is greater. Any deviation from the control limits should be noted.

Q7.2.2 Electronic Deliverables

EDDs from FPA will be in the form of Excel spreadsheets containing the required electronic data packet parameters.

EDDs from CAS will be in the form of GIS/KEY© Electronic data management system (EDMS). The files will be of a DBF III or compatible file format. The EDD file (labdata.dbf) will have the structure described in the Structure Notes Table, Appendix H.

The EDD will include laboratory data specific to the project. Information in the EDD will be sufficient to reduce the amount of pre-processing by personnel prior to input. The following specific issues have been identified as requiring particular attention to prevent potential data management difficulty:

- Results of record. Multiple runs of samples (i.e., in the case of dilutions) result in multiple primary results. The primary results must be included with the results of record (the final run) clearly identified and associated with the appropriate QC data.
- Sample dates or depths. Water samples must be distinctly identified by sample date and time, while soil samples require specific depths or depth intervals. Discrepancies within samples must be identified and corrected by the laboratory (with consultant approval) prior to EDD submittal.
- Travel blank identifiers. Travel blanks are supplied by the laboratory and accompany samples intended for volatile organics analyses. Within a batch or sample delivery group, multiple travel blanks are often submitted. Travel blanks must have unique identifiers (assigned by the laboratory) and be associated with specific COC in order to identify potential cross-contamination within primary samples.

The laboratory will review the potential warning and exception codes described in the GIS/KEY©Structure Notes and make every attempt to prevent the occurrence of these codes during processing and import.

EDDs that contain significant errors or problems will be returned to the laboratory for reprocessing.

Q7.3 Data Management Procedures

The contractor and subcontract laboratories are responsible for generating, controlling, and archiving project laboratory and field reports. This information should be maintained with a system that is effective for retrieval of any documentation that affected the reported results. The technical managers determine whether supporting data should be transferred from the prime contractor to the USACE upon contract completion, or if it remains the prime contractor's responsibility for archiving the data. This includes record generation and control, security, and maintenance for the project related documents.

Field Document Control and Records Management

Project-specific records that relate to field work performed will be retained for 5 years. These records may include correspondence, COC records, field notes, and reports issued as a result of the work. In addition, records that document the field operations will be retained. This may include equipment performance records, maintenance logs, personnel files, general field procedures, and corrective action reports. Electronic or hard copy records of field operations are acceptable.

Laboratory Document Control and Records Management

The laboratory prepares and retains full analytical and QC documentation that can be tracked from initiation to disposal for each sample. The following minimum records should be stored for each project:

- Original work order, COC, and other pertinent documents received with the samples
- Communications between the laboratory, field, and the customer
- Any associated corrective actions
- Laboratory data packages
- GC/MS mass spectra for samples verified with analyst's initials
- Finalized data reports
- Laboratory log books
- GS/MS tune data, as applicable
- Electronic data

The laboratory should also maintain its QAP and related SOPs for the methods performed.

Q7.3.1 Laboratory Turnaround Time

The required TAT air and water analytical results from FPA will be 24 hours from sample collection with complete data packages submitted within 20 calendar days of sample collection. The data packages will be posted and maintained on the project website.

The requited TAT for results from CAS will be 72 hours from the verified time of sample receipt (VTSR) at the laboratory. Final data packages must be submitted within 20 calendar days of the VTSR.

Q8.0 DATA REVIEW AND REPORTING

The QA Officer, Project Chemist, and Database Manager will work together to perform the final review and approval of the data prior to its entry into the database system. This will include examining the results for field duplicates, matrix spike/matrix spike duplicates (MS/MSDs), laboratory blanks, and laboratory duplicates to ensure they are acceptable. This will also include comparing the sample descriptions with the field sheets for consistency and ensuring that any anomalies in the data are appropriately documented.

For all analyses, USEPA CLP-equivalent deliverable requirements will be employed for documentation and reporting of the data. CLP report forms will not be required.

Q8.1 FPA Data Reduction, Review, and Reporting

The Site Manager will debrief field personnel during sampling events and identify anomalous data or observations. The Site Manager will evaluate if any action needs to be taken and make recommendations to the Project Manager.

Laboratory analytical data are first generated in raw form at the instrument. These data may be in either graphic form or printed in tabular form. Specific data reduction, generation procedures, and calculations are found in each of the methods, as well as within the laboratory QAP and SOPs.

Q8.1.1 FPA Data Reduction

Data reduction procedures, whether performed by the instrument or manually, shall follow methodologies outlined within the laboratory SOP or analytical method.

Project-specific variations of general procedures, statistical approach, or formulas may be identified, depending on project-specific requirements.

Q8.1.2 FPA Data Review

This review process involves evaluation of both the results of the QC data and the professional judgment of the person(s) conducting the review. This application of technical knowledge and experience to the evaluation of data is essential in ensuring that high quality data are generated. Each subcontract laboratory has documented procedures, which are to be followed and must be accessible to the laboratory personnel. FPA generally conducts data review in a two-step process at the laboratory level prior to submittal.

- Primary Data Review- Since most field projects are conducted by a single person, primary review by a second person is very difficult. The analyst running the samples will perform most of the primary data review. The analyst will verify the following parameters:
  - 4-Bromofluorobenzene (BFB) tune check
  - Continuing calibration recovery
  - End calibration check recovery
  - Blank sample check
  - Duplicate comparison check
  - Sample name
  - Sample collection date and time
  - Amount analyzed
  - Dilution factor
  - Analyte concentrations are within the instrument's linear calibration range
  - Internal standard recoveries
  - Surrogate recoveries
  - Analyte retention times
  - Analyte spectra
  - Results over the calibration range or resulting in GC/MSD saturation or results not meeting sensitivity requirements due to dilutions
  - Unidentified peaks

- Electronic calculations must be verified once daily and all manual calculations should be checked

- Secondary Review- The data will be reported as preliminary until the data can undergo a secondary review and be released with the weekly final report. The secondary data review will be performed by the QA officer. The QA officer will check 100 percent of the data for the same parameters as the primary review to ensure that the data quality is acceptable for the intended use. The data review format and data qualifier criteria and definitions are provided in the Data Review SOP in the Appendix B. The data review will include evaluation of QC parameters over time and PE samples submitted through the course of the project.

Q8.1.3 On-Site Laboratory Data Reporting

Upon review of the data by the analyst, deliverables will be generated by FPA and submitted to the Project Manager or designee. The contract laboratory will maintain detailed procedures for laboratory record keeping in order to support the validity of the analytical work. Each data report package submitted to the Consultant Project Manager will contain the laboratories' written certification that the requested analytical method was run and that the laboratory QC checks were performed. The laboratory program administrator will provide the Consultant Project Manager with QC reports of their external audits, if appropriate, which will become part of the project files.

The subcontract laboratory will be required to report analytical results consistently. Data for liquids will be reported in micrograms per liter (µg/L) or milligrams per liter (mg/L) and data for air samples will be reported in micrograms per cubic meter ($\mu g/m^3$).

Q8.2 Off-Site Laboratory Data Reduction, Review and Reporting

Data generated by the CAS will undergo data reduction and review procedures described in the laboratory QAMs and SOPs. Data generated, reduced, and reviewed by the laboratories will undergo a comprehensive data review by a QA reviewer or designee.

Laboratory analytical data are first generated in raw form at the instrument. These data may be in either graphic form or printed in tabular form. Specific data reduction, generation procedures, and calculations are found in each of the methods, as well as within the laboratory QAMs.

Q8.2.1 CAS Data Reduction

CAS will perform in-house analytical data reduction under the direction of the laboratory QA Manager. Laboratory data reduction procedures will be those adopted, where appropriate, from SW-846 (USEPA 1997) and those described in the QAMs. The data reduction steps will be documented, signed, and dated by the analyst or designee. Data reduction will be conducted as follows:

- Raw data produced by the analyst will be processed and reviewed for attainment of QC criteria as outlined in this document and/or established USEPA methods, for overall reasonableness, and for transcription or calculation errors.
- The analyst will decide whether any sample reanalysis is required and notify the laboratory QA Manager, then proceed with reanalysis if not already done (e.g., instrument did not automatically dilute sample during analysis).
- Data will then be entered into the Laboratory Information Management System (LIMS) and a computerized report will be generated and sent to the laboratory QA Manager or designee for review.

Laboratory data reduction procedures will be those adopted, where appropriate, from Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods, SW-846 (USEPA, 1994 and updates), and those described in the laboratory QAMs provided in Appendix F. The data reduction steps will be documented, signed, and dated by the analyst.

Laboratory qualifiers as described and defined in the laboratory QAMs will include, but are not limited to:

- Concentrations below required reporting limits;
- Estimated concentrations due to poor spike recovery;
- Concentrations of the chemical also found in laboratory blank; and
- Other sample-specific qualifiers necessary to describe QC conditions.

The laboratories will maintain detailed procedures for laboratory record keeping in order to support the validity of the analytical work. Each data report package submitted to the Project Manager will contain the laboratories' written certification that the requested analytical method was run and that the QA/QC checks were performed. The laboratory program administrator will provide the Project Manager with QC reports of their external audits, if appropriate, which will become part of the project files.

Q8.2.2 Off-Site Laboratory Data Review

This review process involves evaluation of both the results of the QC data and the professional judgment of the person(s) conducting the review. This application of technical knowledge and experience to the evaluation of data is essential in ensuring that high quality data are generated. Each subcontract laboratory has documented procedures, which are to be followed and must be accessible to all laboratory personnel. The data review is generally conducted in a three-step process at the laboratory level prior to submittal:

- Level 1 Analyst/Peer Data Review - The analysts review the quality of their work based on an established set of guidelines. The review will ensure at a minimum that: appropriate preparation, analysis, and SOPs have been followed; analytical results are correct and complete; QC samples are within established control limits; and that documentation is complete (e.g., the anomalies have been documented).
- Level 2 Supervisory Data Review - a supervisor or data review specialist whose function is to provide an independent review of the data package will perform this level of review. This review will also be conducted according to an established set of guidelines (i.e., method requirements and laboratory SOP). The Level 2 review includes a review of qualitative and quantitative data and review of documented anomalies.
- Level 3 Administrative Data Review - The final review of the data, prior to submittal, is performed by a QA/QC officer or program administrator at the laboratory. This level of review provides a total overview of the data package to ensure its consistency and compliance with project requirements.

The subcontract laboratory QA officer or designee will evaluate the quality of the work based on this document and an established set of laboratory guidelines to ensure the following:

- Sample preparation information is correct and complete;
- Analysis information is correct and complete;
- Appropriate procedures have been followed;
- Analytical results are correct and complete;
- Laboratory QC check results are within appropriate QC limits;
- Special sample preparation and analytical requirements have been met;

- Documentation is complete (all anomalies in the preparation and analysis have been documented; holding times are documented); and
- Laboratory qualifiers have been assigned to the samples with data usability limitations.

These limitations and qualifiers will include, but are not limited to those discussed in Section Q8.3 of this document.

Q8.2.3 Off-Site Laboratory Data Reporting

Upon acceptance of the data by the CAS laboratory QA officer, or designee, deliverables will be generated and submitted to the Project Manager. The contract laboratory will maintain detailed procedures for laboratory record keeping in order to support the validity of the analytical work. Each data report package submitted to the Project Manager will contain the laboratories' written certification that the requested analytical method was run and that all laboratory QC checks were performed. The laboratory program administrator will provide the Project Manager with QC reports of their external audits, if appropriate, which will become part of the project files.

CAS will be required to report analytical results consistently. Data for solids will be reported in concentrations of micrograms per kilogram (µg/kg) or milligrams per kilogram (mg/kg). Data for liquids will be reported in µg/L or mg/L. Exceptions include NAPL samples, which may be reported as either solids or liquids, depending upon the laboratory procedures for preparation and extraction.

Q8.2.4 Ongoing Review of FPA Data Quality

The Environmental Consultant will review 100% of the preliminary analytical results from FPA as the data is generated through the course of the day, and will ensure that daily calibrations, blanks, spikes, and surrogate recoveries are consistent with Project DQIs. The Environmental Consultant will then report the analytical results to the Project Team, and will assist team members to interpret the significance of the data so that Project decisions may be made in a timely manner.

This data review will be performed consistent with requirements of Section Q8.3.2, and a written summary of findings and any required corrective actions will be submitted to the Project Chemist and Project Manager on a daily basis.

Q8.3 Data Verification, Validation, and Assessment

Data verification will be accomplished by a combination of computer-based data verification and review by an experienced analytical chemist. The computer-based verification is a quick and cost-effective means of ensuring that project DQOs are met. However, computer-based verification is not a substitute for manual review of the data by an experienced analytical chemist with knowledge of potential interferences and analytical difficulties, which may be encountered during sample analysis.

Q8.3.1 Computer-Based Data Verification

Data from the project is managed using the GIS/Key© EDMS. This system allows automated review of laboratory data against project DQOs and laboratory acceptance limits. Electronic review is faster and more accurate for the data verification step. It avoids transcription errors and eliminates the potential for human reviewers to inadvertently overlook QC exceedances. As an added check on data quality, 100 percent of the data will be subjected to electronic verification.

Once the EDD from the laboratory is loaded into GIS/Key©, a series of queries are executed which compare QC data to defined acceptance criteria in the database. GIS/Key© can then produce an exception report, which details QC exceedances, and add CLP qualifiers to the database. Specific QC data reports currently implemented are:

- Laboratory blank concentrations;
- Surrogate spike, blank spike, and matrix spike recoveries;
- Laboratory duplicates;
- Holding times;
- Field duplicates;
- Split samples;
- Control samples (PE samples);
- Sample labeling; and
- Automatic comparison of sample results to historical ranges.

When the GIS/Key© reports indicate unacceptable QC results for the project data, the QA Officer will work with the Project Chemist and the laboratory QA Manager to determine the cause of the unacceptable QC, and its effect on project results. Serious QC exceedances may trigger additional data validation efforts, especially if those

exceedances were not discovered by the laboratory and discussed in the laboratory data narrative.

Q8.3.2 Manual Data Quality Review

As required in the project specification 01450, 100% of chemical data from FPA and CAS will be reviewed in accordance with the USEPA Region 9 Resource Conservation and Recovery Act (RCRA) Corrective Action Program Data Review Guidance Manual, which is included as Appendix I. Data review will be performed by an experienced Environmental Analytical Chemist who is familiar with proper laboratory techniques and QA/QC procedures, understands the effects of sample matrix on analytical results, and can differentiate between problems related to sample matrix and those related to analytical or maintenance problems. Full review and validation of raw data by the TRS team is not required for this project, but team Chemists will review raw data on an as needed basis to evaluate QC problems or questionable data.

Q8.3.3 Verification of EDD Accuracy

Since EDDs are typically transmitted by the laboratory prior to finalized hardcopy deliverables, there is a possibility that the EDD and hardcopy deliverable will not match for all parameters. These discrepancies typically occur due to errors identified by the laboratory during final QC review. In order to assure accuracy of the database, 100 percent of the data in the database will be verified against the hardcopy deliverable.

Q8.3.4 Qualification of Data in the GIS/Key© Database

Data in the GIS/Key database will be qualified based on the findings of the data verification and validation process. Data qualifications will be performed to the best professional judgment of the validator. The data qualifiers used for this project will be taken from the USEPA Function Guidelines for Data Review, and will include:

U The analyte was not detected above the MDL or quantitation limit.

J The analyte was positively identified, but the associated concentration is an estimate.

UJ The analyte was not detected above the stated quantitation limit, but the quantitation limit is an estimate, and may or may not represent the actual limit of quantitation needed to accurately measure the analyte in the sample.

N Presumptive evidence of analyte presence was detected, but not all identification criteria were met. The presence of the analyte and the associated numerical concentration are both uncertain.

R Results for the analyte are unusable due to serious deficiencies in the sample analysis. The presence or absence of the analyte cannot be verified.

Data qualifications will be added to the data when contamination is found in blanks. For common contaminants, including the contaminants of concern, if blank concentrations are greater than or equal to 10% of the sample concentrations, the data will be U qualified. If blank are less than or equal to 10% of sample concentrations, the data will be J qualified.

For other contaminants, if blank concentrations are greater than or equal to 5% of sample concentrations, the data will be U qualified. If blank concentrations are less than or equal to 5% of sample concentrations, the data will be J qualified.

For diluted samples, comparison will be made to the blank concentration times the dilution factor of sample.

Q9.0 INTERNAL QUALITY CONTROL CHECKS

Evaluation of field sampling procedures requires the collection and evaluation of field QC samples. Equipment rinsate blanks, trip blanks, field replicates/duplicates, and MS/MSD will be collected and submitted to the contracted laboratories, where applicable, to provide a means of assessing the quality of data resulting from the field sampling program. The frequency of field QC samples is provided in Appendix D. Field samples will be collected from locations specified in the FSP. Single blind PE samples and interlaboratory split samples will also be integrated into the sampling and analysis program.

Q9.1.1 Equipment Rinsate Blanks

Equipment rinsate blanks, known hereafter as rinsate blanks, are collected to evaluate the potential for cross-contamination of samples during collection. Rinsate blanks will be collected at a rate of one per day per matrix when non-dedicated sampling equipment is used in the field. Equipment rinsate blanks will be obtained by passing high performance liquid chromatography (HPLC) organic-free water (for organics) or deionized water (for inorganics) through or over the decontaminated sampling equipment.

The rinsate blanks will be submitted blind to the laboratory, with unique sample numbers. Rinsate blanks will be analyzed for the same parameters as the associated field samples. It shall be required that no analyte be detected in the blank(s) above the MRL. If an analyte is detected, samples collected on the same day as the rinsate blank will be considered suspect and flagged accordingly following the data quality review.

Q9.1.2 Trip Blanks

Trip blanks will be used to evaluate whether the shipping and handling procedures are introducing contaminants into the VOC samples, and if cross-contamination in the form of VOC migration has occurred between the collected samples. A minimum of one trip blank will be submitted to the laboratory for analysis with every shipment of VOC analysis aqueous samples. Trip blanks are 40-mL vials that have been filled with HPLC grade water by the laboratory and shipped with the empty sample containers to the site prior to sampling. At no time after their preparation are the trip blanks to be opened until they are returned to the laboratory.

The trip blanks will be prepared using sample containers and labels identical to those used for the primary samples. It shall be required that no contamination be detected in the blank(s) above the MRL. If an analyte (contaminant) is detected, samples shipped in the same cooler as the trip blank will be considered suspect and flagged accordingly following the data quality review.

Q9.1.3 Field Replicate/Duplicate Samples

Field replicate/duplicate samples are collected simultaneously with a sample from the same source under identical conditions and in separate containers. A field replicate/duplicate sample is treated independently of its counterpart in order to assess the laboratory performance through comparison of the results; however, the replicate (secondary) sample must be directly associated with the original (primary) sample to evaluate laboratory performance. The association will be determined by field personnel and maintained during the data import process.

The generally accepted limit for field replicate/duplicate precision is less than or equal to 25 percent RPD. Action will not be taken on precision values alone. However, using informed professional judgment, the data reviewer may use the precision results in conjunction with other QC criteria and determine the need for some qualification of the data. If the control limit is exceeded, possible causes will be investigated and the results of the investigation and any effect on data usability will be discussed in the data quality evaluation report.

Q9.1.4 Matrix Spike/Matrix Spike Duplicates

MS and MSDs are used to evaluate analytical (preparation and analysis) precision and accuracy (Section Q2.5). The MS/MSDs will be collected and analyzed at a rate of five percent of the primary samples for each analytical method and matrix or at least one for each analytical batch, whichever is greater.

Because MS/MSD samples measure the matrix interference of a specific matrix, only MS/MSD samples from this investigation will be analyzed, and not samples from other projects. The MS/MSD samples will be analyzed for the same parameters as the associated primary samples in the same QC analytical batch. Results will be expressed as a percent recovery of the known spiked amount and as RPD for the MS/MSD pairs. The laboratory acceptance criteria are presented in Appendix D.

Q9.1.5 Interlaboratory Split Samples

Interlaboratory split samples are field duplicates that are submitted to both the primary laboratory and a secondary or QC laboratory. Interlaboratory split samples are collected simultaneously with a sample from the same source under identical conditions into separate containers. Results from the split samples are used to assess laboratory performance by comparison of qualitative and quantitative results from the two laboratories, including indications of matrix interferences such as elevated MRLs. In order to provide useful information, however, the split sample must be directly associated with the original (primary) sample to evaluate laboratory performance. The association will be determined by field personnel and maintained during the data import process.

The generally accepted limit for interlaboratory split sample precision is less than or equal to 25 percent RPD. Action will not be taken on precision values alone. However, using informed professional judgment, the data reviewer may use the precision results in conjunction with other QC criteria and determine the need for some qualification of the data. If the control limit is exceeded, possible causes will be investigated and the results of the investigation and any effect on data usability will be discussed in the data quality evaluation report.

Q9.1.6 Single Blind Performance Evaluation Samples

Single blind PE samples are certified reference materials (CRMs) that are purchased from a CRM vendor, labeled the same way as project field samples, and submitted to the laboratory as a field sample. Reported results are compared to the acceptance

ranges provided by the CRM vendor, and can be used to assess the ability of the laboratory to perform the analysis on an interference free matrix.

Aqueous PE samples will be purchased from Analytical Products Group, Inc. (APG) in Belpre, Ohio with analyte concentrations ranging between 7 ppb and 200 ppb. The PE samples will be ordered as needed due to holding time constraints and the inherent instability of VOCs.

Air PE samples will tentatively be purchased from Scott Specialty Gases. TRS will submit specific information about analyte concentrations and how the samples will be submitted to the laboratories as a QAPP addendum in memo format.

The first PE samples will be submitted to the laboratories prior to the initial set of field samples. A total of 20 PE samples will be submitted to FPA and CAS over the course of the project.

Ability to successfully determine analyte identity and concentration in the interference-free PE matrix is considered to be critical to meet project data usability requirements. Both FPA and CAS will be required to successfully analyze PE samples before any field samples are submitted for analysis. Failure to successfully analyze a PE sample at any point during the project will require immediate corrective action, which will include determination of the cause of the failure, explanation of effects of the failure on usability of data from associated samples, and possibly reanalysis of affected sample if the project team determines that it is necessary.

Q9.2 Analytical Laboratory Quality Control Samples

Laboratory internal QC samples are used to monitor the laboratory's precision and accuracy of the analytical procedure results. Laboratory internal QC samples are analyzed as part of the standard laboratory QC protocols and are accomplished through analyzing method blanks, laboratory control samples/blank spikes (LCS/BS), and surrogate spikes. Method-specific laboratory QC samples and project-specific control limits for QC samples are summarized in Appendix D.

Q9.2.1 Method Blanks

Method blanks will be used to check the level of laboratory background contamination. Laboratory method blanks will be analyzed with each sample batch. Results will be compared to the samples within the same analytical batch.

Quality control criteria require that no contaminants be detected in the blank(s) above the MRL. If an analyte (contamination) is detected, the action taken will follow the laboratory SOPs and QAP/QAMs. Blank samples will be analyzed for the same parameters as the associated field samples. Laboratory specific MRLs are presented in Appendix D.

Q9.2.2 Laboratory Control Samples/Blank Spikes

Laboratory control samples (LCS) or Blank Spikes (BS) are used to monitor the laboratory's day-to-day performance of routine analytical methods, independent of matrix effects. The LCS/BS are prepared by spiking reagent water or silica sand with standard solutions prepared independently of those used in establishing instrument calibration. The LCS/BS are extracted and analyzed with each batch of samples. Results are compared on a per-batch basis to pre-established control limits and are used to evaluate laboratory performance for precision and accuracy. LCS/BS acceptance criteria are presented in Appendix D.

Q9.2.3 Laboratory Duplicates

Precision of the analytical system is evaluated by using laboratory duplicates for inorganic parameters only. Laboratory duplicates are two portions of a single homogeneous sample digested and analyzed for the same parameters. LCS/BS duplicates will be prepared and analyzed for the batches when MS/MSD are not available. Laboratory duplicates (primary sample split into two) will be prepared and analyzed for the batches requiring duplicates as specified per method in the laboratory QAP/QAMs. The RPD calculations (precision) are described in Section Q12.1. Control limits for laboratory duplicate precision are presented in Appendix D. Not all methods require laboratory duplicates, and MSDs are preferred for many organic methods.

Q9.2.4 Surrogate Spikes

Surrogate spikes are used to evaluate accuracy, method performance, and extraction efficiency. Surrogate compounds are compounds not normally found in the environmental samples; however, they are similar to the target analytes in chemical composition and behavior in the analytical process. Samples for organics analysis will be spiked with surrogate compounds consistent with the requirements described in the laboratory SOPs and QAP/QAMs.

Since sample characteristics will affect the percent recovery (R), percent R is a measurement of accuracy of the overall analytical method on each individual sample.

The percent R of surrogates is calculated concurrently with the analytes of interest, using the equation in Section Q12.2. The surrogate spike acceptance criteria are presented in Appendix D.

Q10.0 AUDITS AND SURVEILLANCES

- The contractor will provide continuing oversight of FPA.
- CAS may be audited following any identified anomalies.
- Both FPA and CAS are expected to self-audit per their QAP/QAMs.

Q11.0 PREVENTATIVE MAINTENANCE

Preventative maintenance of analytical and data systems will proceed per SOP or laboratory QAP/QAM requirements.

Q12.0 SPECIFIC ROUTINES PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Q12.1 Precision

For this project, analytical precision will be measured as the RPD or coefficient of variation between analytical replicates/duplicates (i.e., field or laboratory) when analyte concentration is greater than five times the MRL or sample quantitation limit (SQL). Precision will also be measured in terms of an absolute concentration based on the MRL or SQL when analyte concentration is less than five times the MRL or SQL. Short-term precision will be measured since the duplicates will be analyzed at the same time the primary samples are analyzed.

Precision will be calculated as the RPD as follows:

$$\mathrm{RPD} = \left[\frac{\left|O_i - D_i\right|}{\left(O_i + D_i\right)/2} \right] \times 100\%$$

Where:

RPD_i = *Relative percent difference for compound i*

O_i = *Value of compound i in original sample or MS*

D_i = *Value of compound i in duplicate sample or MSD*

The precision performance goals for primary and definitive analyses of groundwater and air samples will be:

- RPD between duplicate blank spikes less than or equal to 20 percent.
- RPD between duplicate samples less than or equal to 30 percent for analyte concentrations greater than five times the MRL or SQL, and the absolute concentration difference less than or equal to the MRL or SQL for analyte concentrations less than or equal to the MRL or SQL.
- RPD between duplicate matrix spikes less than or equal to 30 percent.

If these goals are not met, the laboratory or laboratories will investigate the cause of the DQI exceedance and include a discussion of the exceedance and the impact on data usability in the case narrative. If the cause of the DQI exceedance is determined to be laboratory error, the laboratory will re-prepare and/or reanalyze the sample as appropriate.

Precision related to sample collection in the field will be monitored as the difference between field duplicates. The RPD between field duplicates for samples with analyte concentrations greater than five times the MRL or SQL will be less than or equal to 30 percent for aqueous samples and less than or equal to 20 percent for air samples. The absolute concentration difference between duplicate samples when concentrations are less than five times the MRL or SQL will be less than the corresponding MRL or SQL. If this DQI goal is exceeded, possible causes will be identified and the results of the investigation and the effect on data usability will be discussed in the data quality evaluation report.

Q12.2 Accuracy

Accuracy will be measured as the percent R of the MS/MSD, laboratory control samples, surrogate spike compounds, and PE samples or CRMs. It will also be measured using the analytical results of instrument calibration and other laboratory internal standards.

Accuracy will be calculated as the percent R of analytes as follows:

$$\%R_i = \left(\frac{Y_i}{X_i}\right) \times 100$$

Where:

$\%R_i$ = percent recovery for compound i

Y_i = *measured analyte concentration in sample i (measured – original sample concentration)*

X_i = *known analyte concentration in sample I*

Q12.2.1 Blank Spike (Laboratory Control Sample) Recoveries

The DQI goal for analyte recoveries in blank spikes or laboratory control samples related to aqueous samples is 70 percent to 130 percent of the known values. Recovery in this range should be routinely achievable as the blank spike is added to an interference-free matrix. For multianalyte procedures, up to 5 percent of the analytes may fail to meet this DQI without requiring reextraction as long as the recoveries for project preliminary constituents of potential concern (PCOPCs) are greater than 50 percent and as long as the laboratory can demonstrate that the low recovery does not indicate a systemic recovery problem, but is sporadic in nature. The laboratory case narrative must include a discussion of the effect of any blank spike recovery lower than 70 percent or greater than 130 percent on data usability.

The DQI goal for analyte recoveries in blank spikes or laboratory control samples related to air samples and surrogate recoveries related to laboratory control samples in aqueous or air samples is 80 percent to 120 percent of the known values. Recovery in this range should be routinely achievable as the blank spike is added to an interference-free matrix. The laboratory case narrative must include a discussion of the effect of any blank spike or surrogate recovery lower than 80 percent or greater than 120 percent on data usability.

Q12.2.2 Certified Reference Material (CRM) or Performance Evaluation (PE) Samples

The DQI goal for analyte recovery in CRMs and PE samples associated with groundwater and air samples is that the recovery of the project PCOPCs must be within the 95 percent confidence level specified by the PE or CRM manufacturer. If a recovery falls outside the limit for a CRM, the laboratory will investigate the cause of the DQI exceedance, re-prepare and/or reanalyze the associated samples if needed, and document the results of the investigation and the effects on data usability in the case narrative. If recovery of a project PCOPC in a PE sample falls outside acceptable limits, AMEC will contact the project laboratory and request that the cause of the failure be investigated. Results of the investigation will be used to determine the effect on usability of other project data. Corrective actions associated with PE samples will be reported to the USACE QA representative within 24 hours of initiation.

Q12.2.3 Surrogate and Matrix Spike Recoveries

The DQI goal for recovery of analytes and surrogate compounds spiked into the sample matrix is that recoveries less than 70 percent or greater than 130 percent must be reflective of the sample matrix rather than laboratory procedural bias, and that all matrix-related recovery problems are adequately documented in the laboratory report and raw data. Compliance with this DQI goal will be assessed by comparison of analyte and surrogate recovery in the sample matrix to laboratory performance on method blanks and blank spikes, and by results of the data validation and verification process.

Q12.2.4 Internal Standard Recoveries

The DQI goal for recovery of internal standards in GC/MS analytical methods is that internal standard areas or heights for all blanks, samples, and spikes must be 50 percent to 200 percent of the internal standard areas or heights from the last passing continuing calibration (CCAL). The laboratory must re-prepare and/or reanalyze any blank, sample, or spike that does not meet this DQI goal. If the internal standard area or height does not meet the DQI goal upon reanalysis, the laboratory must include a discussion of the possible cause and effect on data usability in the case narrative.

Q12.3 Completeness

The target goal for completeness as a whole is 98 percent for both field and laboratory analytical methods. Completeness for project-specific data needs shall be 95 percent for each individual method.

Completeness will be calculated as follows:

$$\%C = \frac{A}{I} \times 100$$

Where:

%C = Percent completeness (analytical)

A = Actual number of samples collected/valid analyses obtained

I = Intended number of samples/analyses requested

Rejection of data due to severe matrix interference is sometimes unavoidable. The project contract laboratories and the QA officer will make every effort to minimize

matrix interference problems by selection of additional cleanup procedures or alternate analytical procedures if possible.

Rejection of data due to laboratory performance issues is unacceptable. The Contractor will closely monitor laboratory performance during project execution in order to minimize the potential for discovery of severe data quality issues after the data are reported. Project laboratories are expected to pay careful attention to analytical procedures and method requirements and to implement corrective actions to avoid rejection of results. Particular attention will be focused on CCAL verification and compound identification, as these data quality elements have previously lead to systematic rejection of data from certain compound classes.

Q13.0 NONCONFORMANCE AND CORRECTIVE ACTION PROCEDURES

Proper communication between field personnel, project management personnel, and laboratory personnel will help ensure that the proper methods and techniques are used throughout the ERH remediation.

The QA Officer will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation.

The project environmental consultant will be responsible for supervising and checking that samples are collected and handled in accordance with this QAPP and that documentation of work is adequate and complete.

The subcontract laboratory QA Managers will have the responsibility of ensuring that their analytical laboratory is following in-house performance and performing system audits under their in-house QA/QC guidelines. Any irregularities found in the laboratory's performance and the laboratory will deal with system audits immediately. The laboratory QA Manager, or their designee, will also regularly conduct the following internal audits:

- Technical audit including reviews of calibration and equipment monitoring records, laboratory logbooks, maintenance records, and instrument control charts;
- Data quality audit reviews, including all aspects of data collection, reporting, and review; and
- Management system audits verifying that management and supervisory staff are effectively implementing and monitoring the QC activities necessary to support the laboratory QA program.

The Project Manager is responsible for overseeing that the project performance satisfies the QA objectives as set forth in this document. Reports and technical correspondence will be peer reviewed by qualified individuals before being finalized. The QA Data Validation Reports (see Section Q8.3) will be submitted to Ecology and maintained in the Consultant's project file.

Q14.0 QA REPORTS TO MANAGEMENT

Q14.1 Daily Chemical Data Quality Control Report (DCDQCR)

An electronic DCDQCR will be provided to the contracting officer every working day. The DCDQCR will be posted on the project website by 17:00 the following day. An example is provided at the end of this document.

Q14.2 Weekly Chemistry Data Package

The weekly chemistry data package will be provided to the contracting officer as an attachment to the Weekly Operations report. The chemical data packages will be submitted as paper hard copies and in an electronic format. Chemistry data will be posted to an electronic repository in near real time on a daily basis as data becomes available.

Q14.3 Monthly Chemistry Data Package

The monthly chemistry data package will be provided with an Independent Data Quality Review and will be included in the Monthly Operations Report submitted to the contracting officer. Data will be placed in a spreadsheet and attached electronically to the Data Quality Review. The monthly chemistry data package will include a summary of the analytical results provided to the Consultant by the contracting laboratories during the previous month, results and comparison of Primary and Definitive analytical data, a comparison of PE analyses, and a data quality assessment report for the data collected during the period.

The Data Quality Review included with the monthly Chemical Data Package will be performed according to USEPA Region 9 *Corrective Action Program Data Review Manual* (USEPA 1996) on 100 percent of the data. Data Quality Review is a process to determine if the data meets project-specific DQOs and includes verification of the following:

- Compliance with the QAPP
- Proper sample collection and handling procedures

- Holding times
- Field QC results
- Instrument Calibration verification
- Laboratory blank analysis
- Detection limits
- Laboratory duplicates
- MS/MSD percent recoveries and RPDs
- Surrogate recoveries
- Data completeness and format
- Data qualifiers assigned by the laboratories

Q14.4 Chemical Data Final Report (CDFR)

The CDFR will be provided within 30 calendar days of completing work at the site in both electronic and paper hard copy to the contracting officer. The CDFR will be included as an attachment to the NAPL Treatment Area Completion Report and, at a minimum, will include the following:

- Summary of project scope and description.
- Summary of deviations from the design chemical parameter measurement specifications.
- Summary of chemical parameter measurements.
- Analytical results, including a key to sample location, provided in a Microsoft Excel spreadsheet. Reporting limits for detected compounds will be listed as well as detection and reporting limits for non-detected compounds.
- Summary discussion of resulting data including achieving data reporting requirements.
- Summary of achieving project-specific DQOs.
- Presentation and evaluation of the data including an overall assessment of data quality for each method and matrix.
- Internal QC generated during the project, including tabular summaries correlating sample identifiers with the blanks, matrix spikes, surrogates, duplicates, laboratory samples, and batch identifiers.

- A list of the affected sample results for each analyte (indexed by method and matrix) including the appropriate data qualifier flag (U, J, N, R, etc.), where sample results are negatively impacted by adverse quality control criteria.
- Summary of field and laboratory oversight activities, providing a discussion of the reliability of the data, QC problems encountered, and a summary of the data quality evaluation for each analysis and matrix as indicated by the laboratory QC data and any other relevant findings.
- Conclusions and recommendations.
- Appendices containing the CQC Summary Reports and data summary tables for the data provided along with the data summary reports. The Contractor Summary Reports will include review of the QC parameters such as holding times, detection limits, method blanks, surrogate recoveries, matrix spikes and duplicates, and inter-laboratory and intra-laboratory data comparisons.

The CDFR does not need to include final data packages required with the monthly reports.

Q15.0 QUALIFICATIONS OF PERSONNEL

The following project personnel have specific responsibilities to the implementation of the QAPP. Additional project team members may be assigned to assist these personnel throughout the projects.

Tom Powell, Contractor Quality Control Manager

Mr. Thomas Powell, TRS Field Project Manager, is the CQC System Manager for this project. Mr. Powell will be responsible for the overall management of CQC and he has the authority to act in all CQC matters affecting this project. Mr. Powell works out of the TRS Vancouver, WA office and will be available on-site at all times during remedial action activities. The CQC manager maybe assigned other duties upon approval of the Contracting Officer (CO).

Mr. Powell has over 10 years of experience in the design, installation, operations and maintenance of *in-situ* thermal remediation systems including electrical resistance soil heating (ERSH) and vitrification. While with Battelle Northwest Laboratories, he led the initial field demonstrations of ERSH at Niagara Falls, NY, Dover AFB, DE, Chicago, IL, and Anchorage and Fairbanks, AK. Mr. Powell's areas of expertise include all aspects of electrical distribution and control, instrumentation, quality control and system configuration management. Mr. Powell has extensive experience

characterizing off-gas effluent resulting from thermal treatment applications. Mr. Powell also has extensive experience handling both hazardous wastes and radioactive wastes and the procedures associated with Federal government sites. As the field project manager, Mr. Powell was directly responsible for the successful application of ERSH for the greater than 99% reduction of TCE DNAPL at the remediation project located in Portland OR. This project presented numerous technical difficulties requiring innovative field modifications.

Sean Gormley, EAC, CHMM Project Chemist/Chemical Data Quality Manager

Mr. Gormley has over 17 years experience in environmental chemistry, including 14 years of experience supervising and managing laboratory operations and chemical data QA programs. His experience also includes forensic examination of environmental chemistry data, data validation, assessment and interpretation, preparation of project and program level QA documentation, laboratory audits, coordination and management of contract laboratories, management of field programs for combined sewer overflow and receiving water surveys.

Michael Webb, Environmental Consultant

Mr. Webb has over 20 years of experience in analytical chemistry, contaminant fate and transport, environmental compliance, and soil and water remediation technology. He has created cost-effective compliance strategies that integrate both state and federal environmental regulations. He has provided document review and regulatory policy development assistance in the areas of marine sediment analytical methods, wastewater permitting, and radioactive and hazardous waste. He has written numerous QAPs for environmental and laboratory operations, integrating regulatory requirements and analytical methods. He has facilitated the development of DQOs to meet project-specific needs and obtained regulatory approval of field screening and special analytical services. He is an experienced laboratory and field operations auditor and has worked successfully with technical managers in developing corrective action and quality improvement strategies.

He has been providing chemical data management services to the USACE Seattle District for a variety of projects: hazardous waste, polychlorinated biphenyl (PCB) transformer oil, petroleum-contaminated soil and groundwater, air sparging and soil vapor extraction remediation systems for groundwater underlying a landfill, solvent-contaminated groundwater. His responsibilities included quality control review of closure documents, data analysis and plan preparation (field sampling and QA) to meet regulatory requirements.

Q16.0 FIELD CHANGES

The contract specifications set forth by USACE provide a basis for the operation monitoring and sampling to be conducted by the Contractor during the ERH application. Analytical changes may be made by USACE during the course of the project in order to evaluate information obtained during operations. USACE will convey those change requests to the Project Manager and the Site Manager. If analytical requests are within the capacity of the on-site laboratory, the analytical change will be documented on the DCDQCR and implemented. If a requested analytical change exceeds the capacity of the on-site laboratory and is not within the original contract specifications, the Contractor will verify the validity of the request with USACE, who will in turn enact a modification to the contract specifications in order to implement the requested field change.

Q17.0 DOCUMENT CONTROL AND RECORDS MANAGEMENT

The Contractor is responsible for maintaining the database for the electronic repository. The contractor will backup the database on a daily and weekly basis to ensure that any potential system malfunction does not jeopardize the ongoing collection of all analytical parameters and that any archived information is not irretrievably lost. The Contractor will provide USACE with electronic files and hard copies of all collected and analyzed data. The Data Management Plan provides information regarding the posting frequency, format and summary information. The Contractor will maintain the database and any hard copy files as necessary for the duration of the project and for a length of time determined by USACE after the project has been completed.

Q18.0 SIGNATURES

Chemical Data QC Manager: _____

FPA Laboratory Manager: _____

CAS Laboratory Manager: _____

Q19.0 REFERENCES

ASTM Annual Updates. Annual Book of ASTM Standards. American Society for Testing and Materials.

SM Annual Updates. Standard Methods for the Examination of Water and Waste Water. Compiled by APHA, AWWA, and WPCF.

U.S. Environmental Protection Agency, 1997. Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods, Integrated Manual. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., SW-846 Final Update III, June 1997.

U.S. Environmental Protection Agency, 1999. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Center for Environmental Research Information, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio, Compendium Method TO-15, January 1999.

U.S. Environmental Protection Agency, 1994a. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA/540/R-94/013

U.S. Environmental Protection Agency, 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA/540/R-99/008

U.S. Environmental Protection Agency, 1998. USEPA Guidance for Quality Assurance Project Plans. USEPA QA/G-5. EPA/600/R-98/

U.S. Army Corps of Engineers, July 1994, Validation of Analytical Chemistry Laboratories. EM 200-1-1

U.S. Army Corps of Engineers, August 1998, Technical Project Planning (TPP) Process. EM 200-1-2

U.S. Army Corps of Engineers, February 2001, Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3

U.S. Army Corps of Engineers, October 1997, Chemical Quality Assurance for Hazardous, Toxic, and Radioactive Waste (HTRW) Projects. EM 200-1-6

APPENDIX A

Data Quality Objectives for Water, Air, Solid Waste, Electricity & Heat Monitoring, and General System Operation

Table 1: Physical Monitoring Parameters for Area 1

#	Monitoring Parameter[4]	Media Monitored	Monitoring Location (Plot Plan, Process Flow Diagram, or LWMS P&ID)	Monitoring Location ID	Monitoring Location As Described in the Specifications (Specification/Page)	Number of Locations	Equipment Type/Style	Recording Frequency[1]	Data Acquisition[2]	Units of Reporting	Minimum Sensitivity	Reason or Approval for Difference	Data To be Used to Help Answer the Following Questions[3]
1	Temperature	**Soil (unsaturated or saturated)**	Sensors are located inside TMPs and MWs (Plot Plan)	T "Grid ID" A1-XX MW "Grid ID" A1-XX Where: T = Temp. Monitoring Pt. (TMP) MW = Monitoring Well Grid ID = Plot Plan Grid (XX = 2-digit depth)	Temperature Monitoring Points (01840/12) One sensor every five vertical feet; and at least one sensor at the bottom and one at the top (1 foot below surface) of the treatment region.	246	Type T Thermocouples	Every 8 Hours	Auto	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	Type T thermocouples are more accurate than Type K thermocouples for the temperature range of interest. There are no other changes from the specifications.	1-Temp Perf? 2-Heat Contained? 7-Decrease/Expand? 8-Suspend/Treat? 10-H&S? 11-Maint?
2		**Groundwater**	Hydraulic Control Well (HCW) Lines (Process Flow Diagram)	HCW01A1 HCW02A1 HCW03A1	Groundwater Extraction Well Heads (01840/12)	3	Temp gauge	weekly	Manual	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	A temperature gauge has been selected rather than a thermocouple because monitoring will occur on the lines transporting water to the treatment compound, and not down each wellhead. There are no other changes from the specifications.	2-Heat Contained? 10-H&S? 11-Maint?
3		**Water/Liquid**	Vapor-Liquid Separator (VLS) Discharge (Process Flow Diagram)	VLSDWA1	Not Specified	1	Temp gauge	Daily	Auto	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	This monitoring is not required by the specifications, but performed to evaluate system operation.	10-H&S? 11-Maint?
4			Condenser (CD) Discharge (Process Flow Diagram)	CDDWA1	Condenser Effluent (01840-16)	1	Temp gauge	Daily	Manual	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	No change from the specifications.	10-H&S? 11-Maint?
5			Coalescing Plate Oil/Water Separator (OWS) Inlet (LWMS P&ID Temp. Indicator 101)	OWSINA1	Not Specified	1	Temp gauge	Daily	Manual	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
6			NAPL Sparge Tank (NST) Inlet (LWMS P&ID Temp. Indicator 102)	OWSDWA1	Not Specified	1	Temp gauge	Daily	Manual	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
7			Water Discharged to Infiltration Gallery (LWMS P&ID Temp. Indicator 202)	INJ01A1	Combined System Effluent (01840/17) GW Injection Well Network or Gallery (01840/17)	1	Temp gauge	daily	Manual	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	No change from the specifications.	4-Grad Control? 10-H&S? 11-Maint?
8		**Air/Vapor**	All Multi-Phase Extraction (MPE) Well Heads (Plot Plan) MPEs are co-located with the electrodes	E "Grid ID" A1 Where: E = Electrode Grid ID = Plot Plan Grid	Temperature Monitoring Sensors in Vapor Extraction Wells and Electrodes (01840/12)	106	Type T Thermocouples	Daily	Auto	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	Type T thermocouples are more accurate than Type K thermocouples for the temperature range of interest. There are no other changes from the specifications.	3-Vap Migration? 7-Decrease/Expand? 8-Suspend/Treat? 10-H&S? 11-Maint?
9			Condenser (CD) Inlet (Process Flow Diagram)	CDINA1	Condenser Influent (01840/15)	1	Type T Thermocouples	Daily	Auto	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	Influent air and water temperature both measured at this location. Type T thermocouples are more accurate than Type K thermocouples for the temperature range of interest. There are no other changes from the specifications.	10-H&S? 11-Maint?
10			Condenser (CD) Outlet (Process Flow Diagram)	CDDAA1	Condenser Outlet Line (01840/15)	1	Type T Thermocouples	Daily	Auto	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	Type T thermocouples are more accurate than Type K thermocouples for the temperature range of interest. There are no other changes from the specifications.	5-Mass Removal? 10-H&S? 11-Maint?
11			VOC Oxidizer (OX) Inlet (Process Flow Diagram)	OXIN01A1	Not Specified	1	Type T Thermocouples	Daily	Auto	degree C	Resolution +/- 2 ^{0}C Range 0 to 150 ^{0}C	This monitoring is not required by the specifications, but is performed to evaluate system operation.	5-Mass Removal? 10-H&S? 11-Maint?
12			VOC Oxidizer (OX) Reactor Temperature (Process Flow Diagram)	OXTEMPA1	Not Specified	1	Thermocouple	Daily	Auto	degree C	Resolution +/- 2 ^{0}C Range 0 to 1000 ^{0}C	This monitoring is not required by the specifications, but is performed to evaluate system operation and as required by PSCAA.	10-H&S? 11-Maint?

Table 1: Physical Monitoring Parameters for Area 1

#	Monitoring Parameter[4]	Media Monitored	Monitoring Location (Plot Plan, Process Flow Diagram, or LWMS P&ID)	Monitoring Location ID	Monitoring Location As Described in the Specifications (Specification/Page)	Number of Locations	Equipment Type/Style	Recording Frequency[1]	Data Acquisition[2]	Units of Reporting	Minimum Sensitivity	Reason or Approval for Difference	Data To be Used to Help Answer the Following Questions[3]
13	**Pressure**	**Groundwater (elevation)**	Hydraulic Control Wells (HCW) (Process Flow Diagram)	HCW01A1 HCW02A1 HCW03A1	GW Extraction Well and/or Gallery Network (01840/16) NAPL Thickness in Ground Water Wells (01840/17)	3	Electronic Oil/Water Interface Probe	Weekly	Manual	Feet above MSL	Resolution +/- 0.01 foot Oil/ Water Range: 0 to 20 ft Water Level Range: 0 to 100 ft	No change from the specifications. Interface probe also allows NAPL thickness, if present, to be measured (1840-17, wellheads)	4-Grad Control? 10-H&S? 11-Maint?
14			Infiltration gallery standpipe (Plot Plan)	None	GW Injection Well and/or Gallery Network (01840/17)	4	Electronic Oil/Water Interface Probe	Weekly	Manual	Feet above MSL	Resolution +/- 0.01 foot Oil/ Water Range: 0 to 20 ft Water Level Range: 0 to 100 ft	This monitoring is not necessary as the infiltration gallery is installed within the vadose zone. The project team proposes to eliminate monitoring of the infiltration gallery.	Not Used
15			20 Monitoring Wells (MWs) (Plot Plan) Transducers near bottom of wells	MW "Grid ID" A1 Where: MW = Monitoring Well Grid ID = Plot Plan Grid	GW Extraction Well and/or Gallery Network (01840/16)	20	Pressure Transducers	Daily	Auto	Feet above MSL	Resolution +/- 0.01 foot	Transducers located only in MWs not TMPs. However monitoring is occurring more frequently than required (12 points minimum). There are no other changes from the specifications.	4-Grad Control? 10-H&S? 11-Maint?
16		**Water/Liquid**	Hydraulic Control Well (HCW) Lines (Process Flow Diagram and LWMS P&ID PI 201, 202, 203)	HCW01A1 HCW02A1 HCW03A1	GW Extraction Wellheads (01840/16)	3	analog gauge	daily	Manual	psig	Resolution +/- 1 psig Range 0 to 60 psig Accuracy +/- 1%	No change from the specifications.	10-H&S? 11-Maint?
17			Downstream of the Vapor Liquid Separator (VLS) transfer pump (Process Flow Diagram)	VLSDWA1	Not Specified	1	analog gauge	weekly	Manual	psig	Resolution +/- 1 psig Range 0 to 60 psig Accuracy +/- 1%	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
18			Downstream of the Condenser (CD) transfer pump (Process Flow Diagram)	CDDWA1	Not Specified	1	analog gauge	weekly	Manual	psig	Resolution +/- 1 psig Range 0 to 60 psig Accuracy +/- 1%	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
19			Makeup Water (MUW) Supply (LWMS P&ID PI-207)	MUWA1	Not Specified	1	analog gauge	weekly	Manual	psig	Resolution +/- 1 psig Range 0 to 60 psig Accuracy +/- 1%	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
20			Downstream of the LNAPL transfer pump (LWMS P&ID Pump 002, PI-102)	LNAPLA1	Not Specified	1	analog gauge	weekly	Manual	psig	Resolution +/- 1 psig Range 0 to 60 psig Accuracy +/- 1%	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
21			Downstream of the DNAPL transfer pump (LWMS P&ID Pump 003, PI-103)	DNAPLA1	Not Specified	1	analog gauge	weekly	Manual	psig	Resolution +/- 1 psig Range 0 to 60 psig Accuracy +/- 1%	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
22			Final Main Sparge Tank Level (MSTs) (LWMS P&ID Level Indicator LI-203)	INJ01A1	GW Injection Well Network or Gallery (01840/17)	1	Sight Glass	daily	Manual	inches above tank bottom	Resolution +/- 0.1 Foot	Water level in the final MST will be monitored using an attached sight glass. Water level measurements could be converted to pressures if desired by USACE. Monitoring is occurring more frequently than required. There are no other changes from the specifications.	10-H&S? 11-Maint?
23		**Water/Liquid**	First of 3 Main Sparge Tank (MST) Level (LWMS P&ID Level Indicator LI-201)	MSTINW	Combined System Influent (01840/16)	1	Sight Glass	Daily	Manual	inches above tank bottom	Resolution +/- 0.1 Foot	Water level in the final MST will be monitored using an attached sight glass. Water level measurements could be converted to pressures if desired by USACE. Monitoring is occurring more frequently than required. There are no other changes from the specifications.	10-H&S? 11-Maint?

Table 1: Physical Monitoring Parameters for Area 1

#	Monitoring Parameter[4]	Media Monitored	Monitoring Location (Plot Plan, Process Flow Diagram, or LWMS P&ID)	Monitoring Location ID	Monitoring Location As Described in the Specifications (Specification/Page)	Number of Locations	Equipment Type/Style	Recording Frequency[1]	Data Acquisition[2]	Units of Reporting	Minimum Sensitivity	Reason or Approval for Difference	Data To be Used to Help Answer the Following Questions[3]
24	**Pressure**	**Air/Vapor**	Multi-Phase Extraction (MPE) Wells Six regions, one reading per region (vacuum) (Plot Plan)	MPE "Region" A1 Where: MPE = Multi-Phase Extraction Wells Regions = NW, NC, NE, SW, SC, SE	Vapor Extraction Wellheads (01840/15 and 01840/8)	6	digital manometer	weekly	Manual	In Hg	Resolution +/- 1 in Hg Range 0 to 30 in Hg Accuracy +/- 1%	No change from the specifications.	3-Vap Migration? 10-H&S? 11-Maint?
25			Vapor-Liquid Separator (VLS) Inlet (vacuum) (Process Flow Diagram)	VLSINA1	Not Specified	1	analog gauge	Daily	Manual	In Hg	Resolution +/- 1 in Hg Range 0 to 30 in Hg Accuracy +/- 1%	This monitoring is not required by the specifications, but is performed to evaluate system operation.	3-Vap Migration? 10-H&S? 11-Maint?
26			Condenser (CD) Inlet (vacuum) (Process Flow Diagram)	CDINA1	Not Specified	1	analog gauge	Daily	Manual	In Hg	Resolution +/- 1 in Hg Range 0 to 30 in Hg Accuracy +/- 1%	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
27			Condenser (CD) Outlet (Vacuum) (Process Flow Diagram)	CDDAA1	Condenser Effluent Line (01840/15)	1	analog gauge	Daily	Manual	In Hg	Resolution +/- 1 in Hg Range 0 to 30 in Hg Accuracy +/- 1%	No change from the specifications.	10-H&S? 11-Maint?
28			VOC Oxidizer (OX) Inlet (Vacuum) (Process Flow Diagram)	OXIN01A1	Not Specified	1	digital manometer	Daily	Manual	In H2O	Resolution +/- 0.5 in H2O Range 0 to 30 in H2O	This monitoring is not required by the specifications, but is performed to evaluate system operation.	5-Mass Removal? 10-H&S? 11-Maint?
29			Main Sparge Tank (MST) Air Inlet LWMS P&ID: Pressure Indicators 204, 205, and 206	MSTINA01A1 MSTINA02A1 MSTINA03A1	Not Specified	3	analog gauge	weekly	Manual	In H2O	Resolution +/- 0.5 in H2O Range 0 to 30 in H2O	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
30			NAPL Sparge Tank (NST) Inlet LWMS P&ID: Pressure Indicator 105	NSTINA01A1	Not Specified	1	analog gauge	weekly	Manual	In H2O	Resolution +/- 0.5 in H2O Range 0 to 30 in H2O	This monitoring is not required by the specifications, but is performed to evaluate system operation.	10-H&S? 11-Maint?
31			Barometric Pressure (Data from the Ft. Lewis Weather Station will be used for this and other required meteorological information collection)	PBAR	Not Specified	1	barometer	Daily	Manual	bars	n/a	Meteorological Data Collection will be performed as described in Specification 01840 (Page 9, Section 3.3).	5-Mass Removal?
32			20 Monitoring Wells (MWs) (Plot Plan) Each MW contains a vacuum piezometer in the shallow vadose zone soil	MW "Grid ID" A1 Where: MW = Monitoring Well Grid ID = Plot Plan Grid	Each Groundwater Monitoring Wellhead (01840/13)	20	digital manometer	weekly	Manual	In H2O	Resolution +/- 0.5 in H2O Range 0 to 30 in H2O	No change from the specifications.	3-Vap Migration? 10-H&S? 11-Maint?
33			10 Temperature Monitoring Points (TMPs) inside treatment area (Plot Plan)	T "Grid ID" A1 Where: T = Temp. Monitoring Point Grid ID = Plot Plan Grid	Each Groundwater Monitoring Wellhead (01840/13)	10	digital manometer	weekly	Manual	In H2O	Resolution +/- 0.5 in H2O Range 0 to 30 in H2O	No change from the specifications.	3-Vap Migration? 10-H&S? 11-Maint?
34	**Totalized Flow**	**Water**	Hydraulic Control Well (HCW) Lines (Process Flow Diagram and LWMS P&ID FQ-201, 202, 203)	HCW01A1 HCW02A1 HCW03A1	GW Extraction Wellheads (01840/16)	3	totalizer	daily	Manual	Gallons	Resolution +/- 1 gallon	No change from the specifications.	4-Grad Control? 11-Maint?
35			Water Discharged to Injection Gallery (calculated)	INJ01A1	Combined System Effluent (01840/17) GW Injection Well Network or Gallery (01840/17)	1	calculated	daily	Manual	Gallons	Resolution +/- 1 gallon	Calculated by adding measured flow from HCW01A1 through HCW03A1 to VLSDW & CDDW and subtracting MU01A1. There are no other changes from the specifications.	4-Grad Control? 10-H&S? 11-Maint?
36			Condenser (CD) Discharge (Process Flow Diagram)	CDDWA1	Condenser Effluent (01840-16)	1	totalizer	daily	Manual	Gallons	Resolution +/- 1 gallon	No change from the specifications.	11-Maint?

Table 1: Physical Monitoring Parameters for Area 1

#	Monitoring Parameter[4]	Media Monitored	Monitoring Location (Plot Plan, Process Flow Diagram, or LWMS P&ID)	Monitoring Location ID	Monitoring Location As Described in the Specifications (Specification/Page)	Number of Locations	Equipment Type/Style	Recording Frequency[1]	Data Acquisition[2]	Units of Reporting	Minimum Sensitivity	Reason or Approval for Difference	Data To be Used to Help Answer the Following Questions[3]
37			NAPL Sparge Tank (NST) Discharge LWMS PID: Totalizing Water Flow Meter 101	NSTDW01A1	Combined System Influent (01840/16)	1	totalizer	Daily	Manual	Gallons	Resolution +/- 1 gallon	No change from the specifications.	5-Mass Removal? 11-Maint?

Table 1: Physical Monitoring Parameters for Area 1

#	Monitoring Parameter[4]	Media Monitored	Monitoring Location (Plot Plan, Process Flow Diagram, or LWMS P&ID)	Monitoring Location ID	Monitoring Location As Described in the Specifications (Specification/Page)	Number of Locations	Equipment Type/Style	Recording Frequency[1]	Data Acquisition[2]	Units of Reporting	Minimum Sensitivity	Reason or Approval for Difference	Data To be Used to Help Answer the Following Questions[3]
38	**Flow Rate**	**Water**	Hydraulic Control Well (HCW) Lines (Process Flow Diagram)	HCW01A1 HCW02A1 HCW03A1	GW Extraction Wellheads (01840/16)	3	totalizer	daily	Manual	GPM	Resolution +/- 0.1 GPM	Flow rate will be calculated using totalizer and operation time.[5] There are no other changes from the specifications.	4-Grad Control? 11-Maint?
39			NAPL Sparge Tank (NST) Discharge	NSTDW01A1	Combined System Influent (01840/16)	1	calculated	Daily	Manual	Gallons	Resolution +/- 1 gallon	Calculated by adding measured flow from condenser discharge and vapor liquid separator discharge	5-Mass Removal? 11-Maint?
40			Condenser (CD) Discharge (Process Flow Diagram)	CDDWA1	Condenser Effluent (01840-16)	1	calculated	daily	Manual	Gallons	Resolution +/- 1 gallon	Flow rate will be calculated using totalizer and operation time. [5] There are no other changes from the specifications.	11-Maint?
			Vapor Liquid Separator (VLS) Discharge	VLSDW	Combined System Influent (01840/16)	1	totalizer	daily	Manual	Gallons	Resolution +/- 1 gallon	Flow rate will be calculated using totalizer and operation time.[5] There are no other changes from the specifications.	4-Grad Control? 10-H&S? 11-Maint?
41			Water Discharged to Injection Gallery (calculated)	INJ01A1	Combined System Effluent (01840/17) GW Injection Well Network or Gallery (01840/17)	1	calculated	daily	Manual	GPM	Resolution +/- 0.1 GPM	Flow rate will be calculated based on the total flow calculated from the equation presented on Line 35 above, and the operation time over which these total flow occurred. 5 There are no other changes from the specifications.	4-Grad Control? 10-H&S? 11-Maint?
42		**Air/Vapor**	Main Sparge Tank Air Flow (MST) (LWMS P&ID: Flow Measuring Points 201, 202, 203)	MSTINA01A1 MSTINA02A1 MSTINA03A1	Not Specified	3	anemometer	weekly	Manual	SCFM	TBD	This monitoring is not required by the specifications, but is performed to evaluate system operation.	11-Maint?
43			NAPL Sparge Tank (NST) Blower Outlet LWMS P&ID: Blower 001: Flow Measuring Point 101	NSTINA01A1	Not Specified	1	anemometer	weekly	Manual	SCFM	TBD	This monitoring is not required by the specifications, but is performed to evaluate system operation.	11-Maint?
44			VOC Oxidizer (OX) Inlet (Process Flow Diagram)	OXIN01A1	Condenser Effluent Line (01840/15)	1	anemometer or digital manometer	Daily	Manual	SCFM	TBD	No change from the specifications.	5-Mass Removal? 11-Maint?
45			VOC Oxidizer/Scrubber Stack (OXSS)	OXSS01A1	Discharge Stack: Abatement Equipment Effluent (01840/15) Condenser Effluent Line: (01840/15)	1	Av. pitot tube	weekly	Manual	SCFM	TBD	A digital manometer does not operate in a wet stream, and therefore averaging pitot tubes were selected. The frequency of monitoring has been reduced to weekly to match the sampling frequency proposed for PSCAA.	5-Mass Removal? 9-Reg? 10-H&S? 11-Maint?
46			Main Sparge Tank (MST) Stack (LWMS P&ID Flow Measuring Point 205)	MSTS01A1	Discharge Stack Abatement Equipment Effluent (01840/15)	1	hot wire anem.	Daily	Manual	SCFM	TBD	No change from the specifications.	5-Mass Removal? 9-Reg? 10-H&S? 11-Maint?
47		**NAPL**	NAPL Storage Tank(s) (LWMS P&ID LI-105)	LI105	NAPL Storage Tank Influent Line (01840/17)	1	calculated	Daily or Weekly	Manual	Gallons/Day	n/a	The flow rate to the NAPL tank will be calculated using the measurements collected for volume determination.	5-Mass Removal? 9-Reg? 11-Maint?
48	**Volume**	**NAPL**	NAPL Storage Tank(s) (LWMS P&ID LI-105)	LI105	NAPL Storage Tank (01840/17)	1	Pressure/Level transmitter	Daily or Weekly	Manual	Gallons	Resolution +/- 0.01 foot and +/- 50 gallons	No change from the specifications. Volume to be calculated based on liquid level and volume of tank. Frequency of measurements dependent upon liquid level in tank.	5-Mass Removal? 11-Maint?
49	**Volume**	**Water**	NAPL Storage Tank(s) (LWMS P&ID Tank 002)	LI105	NAPL Storage Tank (01840/17)	1	Interface Probe	Daily or Weekly	Manual	Gallons	n/a	No change from the specifications. Volume to be calculated based on liquid level (measured using an interface probe) and volume of tank.	5-Mass Removal? 11-Maint?

Table 1: Physical Monitoring Parameters for Area 1

#	Monitoring Parameter[4]	Media Monitored	Monitoring Location (Plot Plan, Process Flow Diagram, or LWMS P&ID)	Monitoring Location ID	Monitoring Location As Described in the Specifications (Specification/Page)	Number of Locations	Equipment Type/Style	Recording Frequency[1]	Data Acquisition[2]	Units of Reporting	Minimum Sensitivity	Reason or Approval for Difference	Data To be Used to Help Answer the Following Questions[3]
50	**Thickness**	**NAPL**	At each MW Outside the Treatment Area (Plot Plan)	MW "Grid ID" A1 Where: MW = Monitoring Well Grid ID = Plot Plan Grid	NAPL Thickness (01840/17)	8	Interface Probe	Monthly	Manual	Feet	Resolution +/- 0.01 foot	Monitoring will occur only for wells located entirely outside the treatment area. There are no other changes from the specifications.	5-Mass Removal? 11-Maint?

Table 1: Physical Monitoring Parameters for Area 1

#	Monitoring Parameter[4]	Media Monitored	Monitoring Location (Plot Plan, Process Flow Diagram, or LWMS P&ID)	Monitoring Location ID	Monitoring Location As Described in the Specifications (Specification/Page)	Number of Locations	Equipment Type/Style	Recording Frequency[1]	Data Acquisition[2]	Units of Reporting	Minimum Sensitivity	Reason or Approval for Difference	Data To be Used to Help Answer the Following Questions[3]
51	**Electrical**	**Voltage**	Overall System (Process Flow Diagram)	PCU01A1 PCU02A1 PCU03A1	PCU (01840/22)	1	Meter	weekly	Auto	Volts	Resolution +/- 1 Volt	Project Team recommends this electrical parameter be measured weekly because it changes in proportion to power input, which is measured daily.	**1-Operations?** 10-H&S? 11-Maint?
52		**Voltage**	Each Electrode - same as overall system voltage (Plot Plan)	E "Grid ID" A1 Where: E = Electrode Grid = Plot Plan Grid	PCU (01840/22)	1	Same as Overall System Voltage	weekly	Auto	Volts	Resolution +/- 1 Volt	Project Team recommends this electrical parameter be measured weekly because it changes in proportion to power input, which is measured daily.	**1-Operations?** 10-H&S? 11-Maint?
53		**Amperage**	Overall System (Process Flow Diagram)	PCU01A1 PCU02A1 PCU03A1	Electrical Meter (01840/18)	1	Meter	weekly	Auto	Amps	Resolution +/- 1 Amp	Project Team recommends this electrical parameter be measured weekly because it changes in proportion to power input, which is measured daily.	**1-Operations?** 10-H&S? 11-Maint?
54		**Amperage**	Each Electrode (Plot Plan)	E "Grid ID" A1 Where: E = Electrode Grid = Plot Plan Grid	PCU (01840/22)	106	Handheld Meter	weekly	Manual	Amps	Resolution +/- 1 Amp	Project Team recommends this electrical parameter be measured weekly because it changes in proportion to power input, which is measured daily.	**1-Operations?** 10-H&S? 11-Maint?
55		**Power**	Overall System (Process Flow Diagram)	PCU01A1 PCU02A1 PCU03A1	Electrical Meter (01840/18)	1	Meter	Daily	Auto	KW	Resolution +/- 1 KW	No change from the specifications.	**1-Operations?** 10-H&S? 11-Maint?
56		**Power**	Each Electrode (Plot Plan)	E "Grid ID" A1 Where: E = Electrode Grid = Plot Plan Grid	PCU (01840/22)	106	= Volts x Amps	weekly	Manual	KW	Resolution +/- 1 KW	Project Team recommends this electrical parameter be measured weekly because it changes in proportion to power input, which is measured daily.	**1-Operations?** 10-H&S? 11-Maint?
57		**Energy**	Overall System (Process Flow Diagram)	PCU00A1	PCU (01840/22)	1	Meter	Daily	Auto	KW-hr	Resolution +/- 1 KW-hr	No change from the specifications.	**1-Operations?** 10-H&S? 11-Maint?
58	**Sound/Noise**	**Air**	At Compound (Plot Plan)	COMP01A1	Noise/Sound (01840/15)	1	Handheld Meter	weekly	Manual	dBA	Accuracy +/- 1 dBA Range 30 to 100 dBA	No change from the specifications.	9-Reg? 10-H&S? 11-Maint?
59	**Sound/Noise**	**Air**	At Fence Line - 200 Yards From Compound (Plot Plan)	FENCEA1	Noise/Sound (01840/15)	1	Handheld Meter	weekly	Manual	dBA	Accuracy +/- 1 dBA Range 30 to 100 dBA	No change from the specifications.	9-Reg? 10-H&S? 11-Maint?

Notes:

[1] Frequency column refers to the frequency with which data is recorded. The frequencies listed for this table are minimums - the sampling frequency may be adjusted as data results warrant.

[2] Data Acquisition: Manual refers to human entry of data; Auto refers to electronic logging.

[3] Data Use: The data would be used to help answer the following data quality objective questions:

		Code
1. Have the T**emp**erature **Perf**ormance requirements of the contract been met?	=	Temp Perf?
2. Is **heat**ing sufficiently **contained** within the NAPL treatment area?	=	Heat Contained?
3. Does the MPE system control **vap**or **migration**?	=	Vap Migration?
4. Is **grad**ient **control** across the NAPL treatment area demonstrated?	=	Grad Control?
5. What is the **mass** and composition of VOCs in the recovereed vapor, water,and NAPL streams? Also, wha	=	Mass Removal?
the mass and composition of TPH in the NAPL stream?		
6. Are NAPL and dissolved phase VOC **conc**entrations in the subsurface **declining**?	=	Conc Declining?
7. Should the treatment area or depth be **decreased or expanded**?	=	Decrease/Expand?
8. Should treatment be **suspended or continued?**	=	Suspend/Treat?
9. Are system operations within the **regulatory** requirements?	=	Reg?
10. Are system operations within **health & safety** requirements?	=	H&S?
11. Do system components required **maintenance**?	=	Maint?

[4] The following monitoring parameters are not being recorded as described below:

Moisture Content of the Condenser Effluent Line (01840/15) -	This is assumed to be 100% at all times.
Flow Rate and Total Flow at Each MPE (01840/15) -	This deviation approved by the USACE in January 2003 as part of the Systematic Planning Process.
Flow Rate and Total Flow for the Condenser Influent (01840/15) -	This monitoring is not technical feasible, and the deviation approved by the USACE in January 2003 as part of the Systematic Planning Process.
Temperature of the Combined System Influent (01840/16) -	This monitoring is not necessary, and the deviation approved by the USACE in January 2003 as part of the Systematic Planning Process.
Flow Rate and Total Flow after the OWS (01840/16) -	This monitoring is not necessary because the same data is being collected post-NST.
Water Levels at Each TMP (01840/16) -	This monitoring is not possible because TMPs have no access for water level monitoring.

[5] Operation time will be recorded on a daily field log or QC form.

[6] Selected locations near the end of piping header to check for scale build-up/clogging.

Table 2: Chemical Monitoring Parameters for Area 1

#	Media	Monitoring Location (Plot Plan, Process Flow Diagram, or LWMS P&ID)	Monitoring Location ID (Duplicate IDs)	Monitoring Location As Described in the Specifications (Specification/Page)	Analyte or Parameter	Monitoring Type/Method	Frequency[1]	Number of On-site Lab Analyses Per Month	Number of Off-site Lab Analyses Per Month	Reason or Approval for Difference	Data To be Used to Help Answer the Following Questions[2]
1	Air/Vapors	Multi-Phase Extraction (MPE) Wells Six regions, one reading per region (Plot Plan)	MPE "Region" A1 Where: MPE = Multi-Phase Extraction Wells Regions = NW, NC, NE, SW, SC, SE	"Vapor Extraction Wellheads (01840/15 and 01840/8)"	COC VOCs	on-site lab	Weekly	24	0	This monitoring is not required by the specifications. The purpose of this monitoring is tracking VOC extraction rates in the various portions of the treatment area.	5-Mass Removal? 7-Decrease/Expand? 8-Suspend/Treat? 10-H&S? 11-Maint?
2	Air/Vapors	VOC Oxidizer (OX) Influent (Process Flow Diagram)	OXIN01A1 (OXIN02A1)	Condenser Effluent Line (1840-15)	COC VOCs	on-site lab	Daily	20	0	No change from the specifications.	5-Mass Removal? 7-Decrease/Expand? 8-Suspend/Treat? 9-Reg? 10-H&S? 11-Maint?
3	Air/Vapors	VOC Oxidizer (OX) Influent (Process Flow Diagram)	OXIN01A1	Condenser Effluent Line (1840-15)	Total VOCs	field instrument	Daily	0	0	No change from the specifications.	5-Mass Removal? 7-Decrease/Expand? 8-Suspend/Treat? 9-Reg? 10-H&S? 11-Maint?
4	Air/Vapors	VOC Oxidizer/Scrubber Stack (OXSS) (Process Flow Diagram)	OXSS01A1 (OXSS02A1)	Discharge Stack (1840-15)	COC VOCs	on-site lab	Weekly	20	0	No change from the specifications.	9-Reg? 10-H&S? 11-Maint?
5	Air/Vapors	VOC Oxidizer/Scrubber Stack (OXSS) (Process Flow Diagram)	OXSS01A1	Discharge Stack (1840-15)	Total VOCs	field instrument	Daily	0	0	No change from the specifications.	9-Reg? 10-H&S? 11-Maint?
6	Air/Vapors	VOC Oxidizer/Scrubber Stack (OXSS) (Process Flow Diagram)	OXSS01A1	Discharge Stack (1840-15, 19[d])	HCl	off-site lab	Once per area	0	NA	No change from the specifications.	9-Reg? 10-H&S?
7	Air/Vapors	Main Sparge Tank Stack (MSTS) (LWMS P&ID Valve 224)	MSTS01A1 (MSTS02A1)	Discharge Stack (1840-15)	COC VOCs	on-site lab	Weekly	4	0	No change from the specifications.	5-Mass Removal? 9-Reg? 10-H&S? 11-Maint?
8	Air/Vapors	Main Sparge Tank Stack (MSTS) (LWMS P&ID Valve 224)	MSTS01A1	Discharge Stack (1840-15)	Total VOCs	field instrument	Weekly	0	0	Specifications originally indicate daily monitoring (1840-15). Weekly monitoring is proposed based on the experience of the TRS project team.	5-Mass Removal? 9-Reg? 10-H&S? 11-Maint?
9	Air/Vapors	Compound (Plot Plan)	COMP01A1	Not Specified	Total VOCs	field instrument	Weekly	0	0	This monitoring is not required by the specifications. The purpose of this monitoring is for health & safety of workers within the compound.	3-Vap Migration? 9-Reg? 10-H&S? 11-Maint?
10	Air/Vapors	Compound (Plot Plan)	COMP01A1 (COMP02A1)	Not Specified	COC VOCs	on-site lab	Weekly - Only if field instrument reading is >1ppm	TBD	0	This monitoring is not required by the specifications. The purpose of this monitoring is for health & safety of workers within the compound.	3-Vap Migration? 9-Reg? 10-H&S? 11-Maint?
11	Air/Vapors	Perimeter Air Monitoring	PAM01A1 through PAM06A1 (PAM07A1)	Perimeter Monitoring (1840-15)	COC VOCs	off-site lab	see below[3]	0	1	No change from the specifications.	3-Vap Migration? 10-H&S? 11-Maint?
12	Air/Vapors	Perimeter Air Monitoring	PAM01A1 through PAM06A1	Perimeter Monitoring (1840-15)	Total VOCs	field instrument	Weekly	0	0	No change from the specifications.	3-Vap Migration? 10-H&S? 11-Maint?
13	Groundwater	20 Monitoring Wells (Plot Plan)	MW "Grid ID" A1 (MW "GhostGrid ID" A1)	Not Specified	COC VOCs	on-site lab	Baseline (pre-application), then twice per month after heat-up	40	0	This monitoring is not required by the specifications. The purpose of this monitoring is to document changes in groundwater concentration (i.e., treatment progress) during remediation.	2-Heat Contained? 6-Conc Declining? 7-Decrease/Expand? 8-Suspend/Treat? 10-H&S? 11-Maint?
14	Groundwater	All Multi-Phase Extraction (MPE) Well Heads (Plot Plan)	E "Grid ID" A1 Where: E = Electrode Grid ID = Plot Plan Grid	Not Specified	Visual observations of NAPL/Water mix	field observations	Schedule to be determined	TBD	0	This monitoring is not required by the specifications. The purpose of this monitoring is to document changes in groundwater concentration (i.e., treatment progress) during remediation.	6-Conc Declining? 7-Decrease/Expand? 8-Suspend/Treat? 10-H&S? 11-Maint?
15	Groundwater	Multi-Phase Extraction (MPE) Wells Six regions, one reading per region (Plot Plan)	MPE "Region" A1 Where: MPE = Multi-Phase Extraction Wells Regions = NW, NC, NE, SW, SC, SE	"Vapor Extraction Wellheads (01840/15 and 01840/8)"	Visual observations of NAPL/Water mix	field observations	Weekly	TBD	0	This monitoring is not required by the specifications. The purpose of this monitoring is to document changes in groundwater concentration (i.e., treatment progress) during remediation.	6-Conc Declining? 7-Decrease/Expand? 8-Suspend/Treat? 10-H&S? 11-Maint?
16	Groundwater	Hydraulic Control Well (HCW) Lines (Process Flow Diagram)	HCW01A1 through HCW03A1 (HCW04A1)	GW Extraction Wellheads (1840-16)	COC VOCs	on-site lab	Twice each month	6	0	No change from the specifications.	2-Heat Contained? 5-Mass Removal? 6-Conc Declining? 7-Decrease/Expand? 8-Suspend/Treat? 10-H&S? 11-Maint?
17	Groundwater	Hydraulic Control Well (HCW) Lines (Process Flow Diagram)	HCW01A1 through HCW03A1 (HCW04A1)	GW Extraction Wellheads (1840-16)	pH, DO, Conductivity, TDS, Turbidity	field instrument	weekly	0	0	No change from the specifications.	11-Maint?
18	Water	Water Discharged to Injection Gallery (LWMS P&ID Valve 212)	INJ01A1 (INJ02A1)	Combined System Effluent (1840-17)	COC VOCs	on-site lab	Weekly	4	0	No change from the specifications.	9-Reg? 11-Maint?

Table 2: Chemical Monitoring Parameters for Area 1

#	Media	Monitoring Location (Plot Plan, Process Flow Diagram, or LWMS P&ID)	Monitoring Location ID (Duplicate IDs)	Monitoring Location As Described in the Specifications (Specification/Page)	Analyte or Parameter	Monitoring Type/Method	Frequency[1]	Number of On-site Lab Analyses Per Month	Number of Off-site Lab Analyses Per Month	Reason or Approval for Difference	Data To be Used to Help Answer the Following Questions[2]
19	Water	Water Discharged to Injection Gallery (LWMS P&ID Valve 212)	INJ01A1	Combined System Effluent (1840-17)	pH, DO, Conductivity, TDS, Turbidity	field instrument	Weekly	0	0	No change from the specifications.	9-Reg? 11-Maint?
20	Water	Coalescing Plate Oil/Water Separator (OWS) Discharge (LWMS P&ID Valve 105)	OWSDW01A1 (OWSDW02A1)	Not Specified	COC VOCs	on-site lab	Weekly	4	0	This monitoring is not required by the specifications. The purpose of this monitoring is to document the VOC concentrations in the water stream after removal of NAPL.	5-Mass Removal? 11-Maint?
21	Water	NAPL Stream Sparge Tank (NST) Discharge (LWMS P&ID Valve 109)	NSTDW01A1 (NSTDW02A1)	Combined System Influent (1840-16)	COC VOCs	on-site lab	Weekly	4	0	No change from the specifications.	9-Reg? 11-Maint?
22	Water	NAPL Stream Sparge Tank (NST) Discharge (LWMS P&ID Valve 109)	NSTDW01A1	Combined System Influent (1840-16)	pH, DO, Conductivity, TDS, Turbidity	field instrument	Weekly	0	0	Specifications originally indicate daily monitoring (1840-16). Weekly monitoring is proposed based on the experience of the TRS project team.	11-Maint?
23	Vapor-water-NAPL Mixture	Each of 6 MPE Well Headers (Process Flow Diagram)	MPE "Region" "X"A1 (Regions = NW, NC, NE, SW, SC, SE) (X = Media; A for air/W for water)	Vapor Extraction Wellheads (1840-15)	COC VOCs[4]	on-site lab	Weekly	24	0	No change from the specifications.	
24	NAPL	At NAPL storage tank (LWMS P&ID Valve 122)	NAPL01A1 (NAPL02A1)	NAPL Storage Tank (1840-17)	COC VOCs and RCRA Requirements[5]	off-site lab	Once Per Area, Prior to disposal, and Mass Removal Sampling	NA	TBD	Specifications indicate this would be a one-time event (1840-17). Monitoring is proposed prior to disposal, as appropriate, based on the experience of the Project Team. Sampling will also be performed, as appropriate to determine mass of COC VOCs and TPH removed as NAPL.	5-Mass Removal? 9-Reg?
25	IDW Waste Water (include water generated during well installation)	(send to treatment system)	NA	Storage Containers (1840-16)	NA	NA	NA	NA	NA	Specifications indicate COC VOCs would be analyzed in real-time by the on-site lab as a one-time event (1450-20,1840-16). USACE approved management of this waste water through the existing waste water treatment system in January 2003 as part of the systematic planning process. Sampling of this water stream is covered by other waste water treatment system sampling locations.	
					TOTAL SAMPLES FOR ANALYSIS PER MONTH			**150**	**1**	These numbers EXCLUDE duplicates and other quality control samples.	

Notes

[1] Frequency column refers to the frequency with which data is recorded. The frequencies listed for this table are minimums - the sampling frequency may be adjusted as data results warrant.

[2] The data would be used to help answer the following data quality objective questions:	Code
1. Have the T**emp**erature **Perf**ormance requirements of the contract been met?	= 1-Temp Perf?
2. Is **heat**ing sufficiently **contained** within the NAPL treatment area?	= 2-Heat Contained?
3. Does the MPE system control **vap**or **migration**?	= 3-Vap Migration?
4. Is **grad**ient **control** across the NAPL treatment area demonstrated?	= 4-Grad Control?
5. What is the **mass** and composition of VOCs in the recovered vapor, water,and NAPL streams? Also, what is the mass and composition of TPH in the recovered NAPL stream?	= 5-Mass Removal?
6. Are NAPL and dissolved phase VOC **conc**entrations in the subsurface **declining**?	= 6-Conc Declining?
7. Should the treatment area or depth be **decreased or expanded**?	= 7-Decrease/Expand?
8. Should treatment be **suspended or continued?**	= 8-Suspend/Treat?
9. Are system operations within the **regulatory** requirements per medium?	= 9-Reg?
10. Are system operations within **health & safety** requirements?	= 10-H&S?
11. Do system components required **maintenance**?	= 11-Maint?

[3] Per Table 01840-2, Samples will be collected for the first three consecutive days of operation, then monthly thereafter for COC VOCs.

[4] Both air/vapor and water samples may be collected, depend on the stream flowing through the MPE header at the time of sampling. Separate sampling containers and analysis would be used for water and air/vapor samples.

[5] NAPL analysis for waste characterization would include the required RCRA parameters per table 1840-2 (page 19).

Media	Analytes	Method	Containers	Preservation	Holding Time
Air samples	VOCs*	EPA TO-15 or 8260B Mod	On-site: Tedlar Bags Off-site: Summa Canisters	None	3 days 30 days
	HCl in stack emissions	EPA 26A or EPA 0050/ EPA 300.0	250 or 500 ml HDPE	None	28 days
Water samples	VOCs*	EPA 8260B	4- 40 ml glass vials	HCl	14 days
NAPL	VOCs*	EPA 8260B	40 ml glass vial	None	14/40 days[1]
	SVOCs	EPA 8270C	2 - 8 oz. glass jars	None	14/40 days[1]
	Metals by ICP-AES	EPA 6010B	covered by the above	None	6 months
	Metals by ICP/MS	EPA 6020		None	6 months
	Total Halogens	EPA 9076		None	None
	Flash Point	EPA 1010		None	7 days
	pH	EPA 9045		None	None
	Mercury	EPA 7471A		None	28 days

HCl: hydrochloric acid
HDPE: high-density polyethylene
ICP-AES: inductively coupled plasma - atomic emission spectrometry
ICP-MS: inductively coupled plasma - mass spectrometry
SVOCs: semivolatile organic compounds
VOCs: volatile organic compounds

*COC VOCs: Trichloroethene (TCE)
Dichloroethene (DCE)
1,1,1-Trichloroethane (TCA)
Tetrachloroethene (PCE)
Vinyl Chloride (VC)

[1] Number of days from time of collection until extraction/ number of days from extraction until analysis.

WATER MONITORING, SAMPLING AND ANALYSES DATA QUALITY OBJECTIVES

1.0 Project Data Quality Objective Questions

The following eleven DQO questions have been identified for the EGDY NAPL Treatment Area 1 ERH project:

1. Have the temperature performance requirements of the contract been met?
2. Is heating contained within the NAPL treatment area?
3. Does the MPE system control vapor migration?
4. Is gradient control across the NAPL treatment area demonstrated?
5. What is the mass and composition of volatile organic compounds (VOCs) and the recovered vapor, water and NAPL streams? Also what is the mass and composition of total petroleum hydrocarbons (TPH) in the recovered NAPL stream?
6. Are NAPL and dissolved phase VOC concentrations in the subsurface declining?
7. Should the treatment area or depth be decreased or expanded?
8. Should treatment be suspended or continued?
9. Are system operations within the regulatory requirements for water treatment?
10. Are system operations within health & safety requirements?
11. Do system components require maintenance?

2.0 The conceptual site model is still being refined and will be presented in the RAMP.

3.0 DQO questions specific to water monitoring, sampling, and analyses

Of the eleven DQO questions developed for the remediation project, questions No. 2, No. 4, No. 5, No. 6, No. 7, No. 8 and No. 9 involve the monitoring, sampling, and analyses of water.

DQO #2: Is heating contained within the NAPL treatment area?

Water temperatures will be monitored weekly using thermocouples to document water temperatures in the 10 monitoring wells located outside the treatment area (see the DQOs for Electricity and Heat Monitoring). An increase of 10 degrees C or more (a significant change in temperature will indicate relevance rather than an anomalous

occurrence) would indicate that heat is not being contained within the NAPL treatment area. Some spreading of heated water is expected.

DQO #4: Is gradient control across the NAPL treatment area demonstrated?

- **What are the groundwater elevations across the NAPL treatment areas?**

For Area 1, Groundwater elevations will be measured daily using transducers at the bottom of 20 monitoring wells located adjacent to and across the NAPL treatment area. Additionally, groundwater elevations in the extraction and injection wells will be measured weekly using water level indicators.

This data will be used to measure the groundwater gradient across the NAPL treatment area in accordance to Specifications Section 021812-2.3.1.3 and to verify that groundwater elevations are either static or lower inside the area then immediately outside the area. The data will also be used to compare pumping and reintroduction rates at the extraction and injection wells to the induced gradient across the NAPL treatment area. The submission of daily/weekly reports will include data plots and contours.

Based on the information obtained during treatment of NAPL Area 1, the monitoring well locations and quantity for the Areas 2 and 3 may be adjusted.

- **What are the groundwater pumping and reintroduction rates at the extraction and injection wells?**

The volume of groundwater extracted at the extraction wells and the combined stream reintroduced into the injection wells will be totalized and groundwater extraction/injection rates determined daily. This data will be compared against the groundwater elevation data to determine the optimum extraction/injection rates necessary to establish gradient control across the NAPL treatment area.

- **What are the NAPL concentrations in the deep groundwater monitoring wells?**

Consistent increases in contaminant concentrations in deeper wells installed within the treatment area and below the till layer may be an indication that adequate capture or containment of dissolved phase and/or NAPL may not be occurring. The successful operation of the hydraulic control system should create an upward gradient from below the treatment area. In addition, dissolved phase VOC concentrations below the heated volume should remain constant or decline. If data results indicate a consistent increase in concentrations combined with the lack of an upward gradient, then the hydraulic control system is not meeting the performance specifications.

DQO #5. What is the mass and composition of volatile organic compounds (VOCs) and the mass of total petroleum hydrocarbons (TPH) in the recovered vapor, water, and NAPL streams?

- **What is the mass and composition of NAPL being extracted in liquid form from the subsurface?**

It is expected that the only source of NAPL removal from the subsurface will be from the MPE system. Sampling for NAPL at the MPE well heads is impractical because at these sampling locations the NAPL is under vacuum, at an elevated temperature, and is mixed with steam, groundwater, and air. The MPE system will route NAPL, groundwater, and condensate through the condenser to the LMS system where NAPL will be separated from the liquid phase by the OWS. The volume of NAPL discharged from the OWS will be totalized and a discrete sample collected weekly for determination of COC VOCs and their concentrations. Chemical analyses will be performed at the on-site laboratory.

The data from the totalizer will be used to determine the mass of NAPL recovered by the remediation system and the rate at which it is being recovered. However, this data will not be representative of the mass of NAPL removed from the subsurface. During remediation, NAPL mass will be lost to volatilization in the subsurface and throughout the recovery system until it is discharged from the condenser.

The data from the laboratory analyses will be used to determine the chemical composition of the NAPL at the sampling point, but will not be representative of the NAPL removed from the subsurface due to the volatilization of the various NAPL components during the recovery process.

- **What is the composition and mass of the dissolved phase VOCs extracted from the subsurface?**

Dissolved phase VOCs will be removed from the subsurface at the gradient control extraction wells and the MPE wells. It will be possible to gather discrete groundwater samples at the extraction well heads for chemical analyses at the on-site laboratory. It is impractical to sample for dissolved phase VOCs at the MPE will heads because the liquid stream at these locations is under vacuum, at temperature, and mixed with NAPL, steam, and air.

The MPE system will route dissolved phase VOCs through the condenser and to the LMS were they will be separated from NAPL in the OWS. The volume of liquids discharged from the condenser will be totalized and a discrete sample collected weekly

for determination of COC VOCs and their concentrations. Chemical analyses will be performed at the on-site laboratory.

The data from the totalizer will be used to determine the volume of groundwater and steam recovered by the remediation system and the rate at which they are being recovered. The data from the laboratory analyses will be used to determine the concentrations of COC VOCs in the recovered aqueous liquids at the sampling point.

DQO #6: Are NAPL and dissolved phase VOC concentrations in the subsurface declining?

- **What are concentrations of VOCs in the 20 MWs (10 inside and 10 outside the NAPL Area 1)?**

Prior to thermal treatment of any of the NAPL Areas, a round of groundwater samples will be collect to establish a pre-application baseline. Groundwater at each monitoring well would be sampled twice per month to document VOC concentrations both inside and outside the treatment area. Sampling will be performed using a procedure that allows hot groundwater to be safely removed from the subsurface and cooled without loss of volatile components before being placed into appropriate sample containers. Chemical analyses will be performed at the on-site laboratory with the possibility of some confirmation analyses conducted at an off-site laboratory.

Dissolved phase VOC concentrations inside the treatment area will demonstrate the progress of groundwater remediation. Because groundwater concentrations can fluctuate during thermal treatment, data from multiple sampling events will be used to evaluate trends in groundwater quality at each sampling location. Data from multiple sampling points will be used to evaluate trends in groundwater quality across the treatment area. When anomalous concentrations are observed during consecutive sampling events, additional data collection may be required.

The discovery of increasing dissolved phase VOC concentrations outside the treatment area could indicate that VOCs are migrating as a result of the remediation efforts. Additional data collection may be necessary to verify that VOC are actually migrating outside the treatment area and to evaluate potential system modifications to address the situation. Confirmation of potential dissolved phase VOC migration from the treatment area will be based upon groundwater quality data from wells outside the treatment area as well as subsurface temperatures and pressures data.

- **What is NAPL thickness in the 20 MWs (NAPL Area 1)?**

NAPL thickness will be measured in the wells outside the treatment area using a down-hole probe capable of measuring both water and NAPL, such as an interface probe. Measurements will be collected on a bi-monthly basis, in conjunction with groundwater sampling. Measurement of NAPL thickness at wells inside the treatment area will be performed before the heat-up period. After the heat-up period, measurement of NAPL thickness at the wells inside the treatment area will not be possible due to the high temperatures.

- **If NAPL is encountered, what is the composition?**

As stated in DQO Question #5, the only NAPL expected to be recovered from the system is through the MPE points, and sampling at these points is impractical. Some NAPL may be recovered from the groundwater monitoring wells during sampling activities. NAPL that has been recovered by the remediation system will be collected at the effluent to the OWS, after the NAPL has cooled. At a minimum, NAPL samples will be analyzed the for COC VOCs at the onsite laboratory. Additional NAPL analyses may be necessary for NAPL disposal purposes.

DQO#7: Should treatment area or depth be decreased or expanded?

If groundwater data collected inside the treatment area suggests that water quality in portions of the treatment area have reached acceptable levels, then consideration will be given to terminating treatment in that portion of the area. However, as stated above, groundwater concentrations can fluctuate during treatment. Consequently, ERH in a given portion of the treatment area will not terminated until a thorough evaluation of groundwater quality trends has been completed. In addition, if ERH operations are terminated in a given portion of the treatment area, monitoring will still be conducted within that area to ensure that groundwater quality does not degrade due to dissolved phase VOC migration.

If evidence of lateral migration is observed, and groundwater concentrations outside the treatment area exceed action limits to be established for the remediation system, a system evaluation will be performed. The purpose of the evaluation will be to determine if any adjustments can be made to increase system efficiency, its ability to prevent future migration, and its ability to re-capture VOCs outside the treatment area. If the system cannot be optimized to capture VOCs that have migrated outside the treatment area, system expansion will be considered.

Two of the groundwater monitoring wells will be installed deeper than the treatment volume and the other monitoring wells in an effort to document potential downward migration of NAPL during remediation system operations. If NAPL concentrations observed in the deep monitoring wells indicate that downward migration of NAPL is occurring, then operations of the hydraulic control system will need to be evaluated or the ERH system extended to a greater depth.

DQO#8: Should treatment be suspended or continued?

If groundwater data collected inside the treatment area suggests the entire treatment area has reached acceptable groundwater quality levels, then consideration will be given to terminating treatment. The decision to terminate treatment will not be based solely on groundwater data, but rather will reference multiple lines of evidence, including temperature, operating time, volume of NAPL recovered, mass removed, and the rate of mass removal with respect to costs of continued operations.

Decisions for continuation or suspension of the treatment system are instigated by USACE Seattle District. The Contractor will supply information during the construction and operations of the ERH system, as well conclusions or hypotheses based on experience at other sites. The Contractor shall not make the decision to continue or suspend operations at the Ft. Lewis EGDY. The Contractor can make the decision to suspend or discontinue operations on a short-term basis based on health and safety concerns. Those decisions are unrelated to the suspension or continuation of treatment at the site.

DQO #9: Are system operations within the regulatory requirements for water treatment?

Treated groundwater will be sampled at the header to the infiltration wells weekly and analyzed at the onsite laboratory for the chlorinated COC VOCs. If regulatory limits are exceeded, the operations of the LMS system will be adjusted. Maximum contaminant levels (MCLs) will be based on the UIC permit requirements: pH 6.5-8.5; TCE and PCE 5 µg/L; cis 1,2 DCE 70 µg/L; vinyl chloride 2 µg/L; and 1,1,1 TCA 200 µg/L.

AIR MONITORING, SAMPLING AND ANALYSES DATA QUALITY OBJECTIVES

1.0 Project Data Quality Objective Questions

The following eleven DQO questions have been identified for the EGDY NAPL Treatment Area 1 ERH project:

1. Have the temperature performance requirements of the contract been met?
2. Is heating contained within the NAPL treatment area?
3. Does the MPE system control vapor migration?
4. Is gradient control across the NAPL treatment area demonstrated?
5. What is the mass and composition of volatile organic compounds (VOCs) and the recovered vapor, water and NAPL streams? Also what is the mass and composition of total petroleum hydrocarbons (TPH) in the recovered NAPL stream?
6. Are NAPL and dissolved phase VOC concentrations in the subsurface declining?
7. Should the treatment area or depth be decreased or expanded?
8. Should treatment be suspended or continued?
9. Are system operations within the regulatory requirements for air monitoring?
10. Are system operations within health & safety requirements?
11. Do system components require maintenance?

2.0 The conceptual site model is still being refined and will be presented in the RAMP.

3.0 DQO questions specific to air monitoring, sampling, and analyses

Of the eleven DQO questions developed for the remediation project, questions No. 3, No. 5, No. 9, and No. 10 involve air monitoring, sampling, and analyses.

DQO #3. Does the MPE system control vapor migration?

- **What is the subsurface vacuum across and surrounding the NAPL treatment area?**

Vacuum piezometers will be placed within each of the 20 groundwater monitoring wells and the 10 Temperature Monitoring Points (TMPs). All of the TMPs and 10 of the monitoring wells will be inside the treatment area. The other 10 monitoring wells will be outside the treatment area. Vacuum will be measured at each monitoring well

weekly using a gauge. If subsurface vacuum is present at a monitoring location, VOC vapors and steam are being contained at that location.

DQO #5. What is the composition and mass of VOCs in the vapor stream?

- What is the composition and mass of VOCs being extracted in vapor form from the subsurface?

It is expected that the only significant source of vapor phase VOC removal from the subsurface will be from the MPE system. Sampling for vapor phase VOCs at the MPE well heads is possible, but data accuracy will be limited because at these sampling locations the vapor stream is under vacuum, at elevated temperature, and is mixed with recovered steam and entrained liquids. However, sampling VOC vapor concentrations at the MPE well heads is the only way to determine the type and mass of COC VOCs being recovered from discrete portions of the NAPL treatment area.

The MPE system will route VOC vapors, air, steam, NAPL, and groundwater through the condenser, where air and vapors will be separated from steam and liquids. Thus, the most accurate data on the type and total mass of COC VOCs recovered from the subsurface in the vapor phase can be made at the effluent to the vacuum blower located immediately after the condenser. At this point, vapors have been cooled, separated from steam and liquids, and are near atmospheric pressure.

To calculate the mass of VOCs recovered from the subsurface in the vapor phase, the following physical data must accompany each analytical sample collected: temperature, pressure, and flow rate at the sampling point. The accurate measurement of flowrate is easily accomplished at the blower effluent, but impossible at the MPE well heads.

Temperature will be recorded at the MPE well heads and the blower effluent daily using thermocouples. Pressure will be recorded at the MPE well heads at least monthly and again at each vapor sampling event. Pressure will be measured at the blower effluent at least daily and again at each vapor sampling event. Flow will be measured at the blower effluent daily and again at each vapor sampling event. Pressure will be measured using gauges, while flow will be measured using anemometers or pitot tubes.

Physical measurements taken at the blower effluent will be used to calculate the total flow of air and VOC vapors at the time of the measurements and to extrapolate the total mass of COC VOCs recovered from the subsurface over the course of the remediation.

Analytical samples will be recovered monthly from the MPE well heads using tedlar bags, while analytical samples will be recovered daily from the blower effluent using

tedlar bags. A field check, using a handheld PID, will also be performed daily at the blower effluent. Analytical samples will be analyzed at the on-site laboratory for the identification and quantification of the COC VOCs.

The physical data collected at each sampling location downstream of the condenser will be used in conjunction with the analytical data to calculate the mass of each COC VOC, the recovery rate of each COC VOC, and total COC VOCs present in the vapor state at each sampling event. The physical and analytical data collected at the effluent of the blower will be used, with system run time, to extrapolate the rate at which the system is extracting vapor phase COC VOCs and the total mass of vapor phase COC VOCs removed from the subsurface.

DQO #9. Are system operations within the regulatory requirements?

- Regulatory requirements for vapor will include adhering to the substantive standards of PSCAA and the project specific requirements for site-wide air monitoring. Emissions will be monitored at the oxidizer discharges. Annual emissions of TCE cannot exceed 1391 lb/yr. Measurements will be plotted on a graph to compare emission results with the annual criteria. Additionally, the specifications and regulations of OSHA with respect for personnel exposure through inhalation will be adhered to.
- **Are activity specific breathing zones in compliance with OSHA specifications and regulations?**

The activity specific breathing zones requiring monitoring will be identified in the SSHSP and accompanying Activity Hazards Analyses. It is anticipated that breathing zone monitoring will be limited to invasive subsurface activities such as drilling and that monitoring will be performed using handheld field instruments such as a PID. The data will be used to determine compliance with OSHA specifications and regulations and to alert the project team of a need to stop activities and evaluate upgrading PPE, engineering, and administrative controls to ensure personnel safety.

- **Is the oxidizer operating efficiently and within the substantive regulatory requirements?**

The discharge from the oxidizer will be required to meet the substantive standards of PSCAA. Sampling and monitoring will be required to determine if the oxidizer system is operating efficiently enough to meet regulatory standards. Annual emissions of TCE cannot exceed 1391 lb/yr. Measurements will be plotted on a graph to compare emission results with the annual criteria.

The destruction efficiency of the oxidizer will be determined by sampling the vapor stream at the inlet and discharge of the unit. Each sampling event will include the measurement of the physical parameters of temperature, pressure, and flow and sampling for the identification and quantification of COC VOCs.

The physical and analytical data collected at the blower effluent will be used to evaluate the oxidizer inlet vapor stream (see DQO Question #5 for air monitoring). The discharge from the oxidizer will be monitored daily for temperature and flow. Temperature will be measured using a thermocouple and flow using a anemometer or pitot tube. Air samples will be collected from the oxidizer discharge daily using tedlar bags and daily field verification readings will be performed using a PID. Air samples will be analyzed at the on-site laboratory for the identification and concentrations of COC VOCs.

From the physical and analytical data the following parameters will be calculated or extrapolated:

- The identification and concentrations of COC VOCs entering and leaving the oxidizer.
- The COC VOC destruction efficiency of the oxidizer.
- If the oxidizer destruction efficiency meets the substantive regulatory requirements.
- The total mass of COC VOCs treated by the oxidizer over the course of the project.
- The total mass of COC VOCs discharged by the oxidizer over the course of the project.

Flow will be monitored at each of these three monitoring points daily. Temperature will be measured with either thermocouples or gauge, pressure will be measured using gauges, while flow will be measured using anemometers or pitot tubes.

Air samples will be collected from all three sampling points daily using tedlar bags and daily field verification readings will be performed using a PID. Air samples will be analyzed at the on-site laboratory for the identification and concentrations of COC VOCs.

DQO #10. Are system Operations within Health & Safety Requirements?

The monitoring and sampling objectives presented for DQO #9, will be sufficient to ensure that sufficient data is collected for the purposes of meeting the site specific

Health and Safety requirements associated with air and vapors, except for area-wide air quality.

- How is system operations effecting area-wide air quality?

The criteria and action levels for sampling area-wide air quality have not been established at this time. Currently, it is proposed that area-wide air quality will be measured at selected discrete location(s) up and downwind of the NAPL treatment area. Air quality samples will be taken using a method that allows composite sampling over a 24-48 hour period. Sampling for COC VOCs will be conducted daily for the first three consecutive days of operations and monthly thereafter. These samples will be submitted to an offsite laboratory per contract specifications (Table 01840-2). Sampling for total VOCs will be conducted weekly with field instruments along the perimeter of the site (fence line) using handheld instruments. At each sampling event, the following physical measurements will be taken: ambient temperature using a thermometer, relative wind direction using a wind sock, barometric pressure using a barometer, and noise/sound using a decibel meter.

SOLID WASTE SAMPLING AND ANALYSES
DATA QUALITY OBJECTIVES

1.0 Project Data Quality Objective Questions

The following eleven DQO questions have been identified for the EGDY NAPL Treatment Area 1 ERH project:

1. Have the temperature performance requirements of the contract been met?
2. Is heating contained within the NAPL treatment area?
3. Does the MPE system control vapor migration?
4. Is gradient control across the NAPL treatment area demonstrated?
5. What is the mass and composition of volatile organic compounds (VOCs) and the recovered vapor, water and NAPL streams? Also what is the mass and composition of total petroleum hydrocarbons (TPH) in the recovered NAPL stream?
6. Are NAPL and dissolved phase VOC concentrations in the subsurface declining?
7. Should the treatment area or depth be decreased or expanded?
8. Should treatment be suspended or continued?
9. Are system operations within the regulatory requirements for waste management and disposal?
10. Are system operations within health & safety requirements?
11. Do system components require maintenance?

2.0 The conceptual site model is presented in Section 1.0 of the RAMP.

3.0 DQO questions specific to solid waste

Of the eleven DQO questions developed for the remediation project, DQO question No. 9 involves the sampling and analyses of solid waste.

1. Principal sampling objectives for each relevant DQO question:

DQO Question No. 9. Are system operations within the regulatory requirements?

The regulatory requirements for solid waste generated during the project involve proper profiling of the waste forms. It is expected that a one-time waste profile will be developed for NAPL at each site (Area 1, Area 2 and Area 3).

What is the composition of NAPL being extracted from the subsurface?

The chemical composition of the NAPL will be required for profiling the NAPL and for determining the type of NAPL holding vessels required for the project. The DQOs for Water Monitoring, Sampling, and Analyses provide for a full chemical characterization of the NAPL. Other RCRA analytical requirements may have to be performed upon the request of the DRMO. The complete list of NAPL analytical requirements has not been developed at this time.

- **At what rate are NAPL being extracted from the subsurface?**

The volume of NAPL recovered by the remediation system will determine the size of the NAPL holding tanks and the schedule for tank pumping by the NAPL disposal contractor. The DQOs for Water Monitoring, Sampling, and Analyses provide for continuous measurement of NAPL volumes during system operations.

ELECTRICITY AND HEAT MONITORING
DATA QUALITY OBJECTIVES

1.0 Project Data Quality Objective Questions

The following eleven DQO questions have been identified for the EGDY NAPL Treatment Area 1 ERH project:

1. Have the temperature performance requirements of the contract been met?
2. Is heating contained within the NAPL treatment area?
3. Does the MPE system control vapor migration?
4. Is gradient control across the NAPL treatment area demonstrated?
5. What is the mass and composition of volatile organic compounds (VOCs) and the recovered vapor, water and NAPL streams? Also what is the mass and composition of total petroleum hydrocarbons (TPH) in the recovered NAPL stream?
6. Are NAPL and dissolved phase VOC concentrations in the subsurface declining?
7. Should the treatment area or depth be decreased or expanded?
8. Should treatment be suspended or continued?
9. Are system operations within the regulatory requirements for operation of electrical power supply systems?
10. Are system operations within health & safety requirements?
11. Do system components require maintenance?

2.0 The conceptual site model is presented in Section 1.0 of the RAMP.

3.0 DQO questions specific to electricity and heat monitoring

Eleven DQO questions have been developed for the remediation project, questions No. 1, No. 2, and No. 10 involve electricity and heat monitoring.

DQO #1: Have the temperature performance requirements of the contract been met?

- **What are the temperatures in the subsurface?**

Subsurface temperature throughout the NAPL treatment area will be monitored continuously by using an automatic data acquisition system reading approximately 320 Type T thermocouples. Output from the Thermocouples will be recorded daily.

Thermocouples will be located within Temperature Monitoring Points (TMPs), MPE wells, electrodes, and groundwater monitoring wells. Thermocouple placements within the subsurface will ensure that one thermocouple will be located within each 100 cubic yards of treatment volume. Thermocouples will typically be placed in vertical "strings" with 1 thermocouple located every 5 vertical feet and at least 1 thermocouple located at the bottom and 1 at the top of the treatment region.

A disadvantage of the subsurface monitoring program is that monitoring points have to be placed before the start of heating and adding additional monitoring points within the treatment area after heating has commenced is difficult to accomplish. However, experience with subsurface heating remediation has shown that discrete subsurface thermocouples provide the most accurate determination of subsurface temperatures.

Data from these thermocouples will provide actual subsurface temperatures at the discrete thermocouple locations and, because of the large number of thermocouples deployed, allow a relatively accurate profile of subsurface temperature throughout the treatment volume to be developed. This subsurface heating profile will be used to determine subsurface heat-up rates at various subsurface locations and to verify that final design temperatures have been reached throughout the NAPL treatment area and held for the contracted time frame.

- **What is the rate that power is being input to the subsurface?**

The rate at which power can be input into the subsurface is be directly related to the rate at which the subsurface can be heated. Power input into the NAPL treatment area is tracked system-wide at the Power Control Unit (PCU). Power input into specific sections of the treatment area is tracked at the electrode well heads. The voltage and amperage applied to the entire electrode field is monitored continuously using an automatic data acquisition system at the PCU and recorded daily. The voltage and amperage at each electrode are measured weekly using a handheld meter. From this data, the power input to the electrode field and at each electrode may be calculated. Given the operating hours of the system, the total power input to the NAPL treatment area can be calculated.

DQO #2. Is heating contained within the NAPL treatment area?

- **Is there evidence that heat is spreading laterally or vertically from the NAPL treatment volume?**

Subsurface temperatures outside of the NAPL treatment volume will be monitored at approximately 80 locations using Type T thermocouples. Each thermocouple will be

monitored continuously and recorded daily. Ten groundwater monitoring wells and ten TMPs will be located outside the NAPL treatment area and each well will contain a vertical thermal couple string containing thermocouples at 5 vertical foot intervals with 1 thermocouple placed above and 1 thermocouple placed below the treatment interval.

The temperature of groundwater being removed from the groundwater extraction wells utilized for gradient control is measured weekly with a handheld meter.

Data from these groundwater extraction wells and the thermocouples located out side the NAPL treatment area will be combined with the data from the thermocouples placed inside and below the treatment area to provide direct evidence of changing subsurface temperatures in lateral and vertical directions away from the treatment area.

The temperature at the groundwater extraction used for hydraulic control will be monitored for weekly using handheld instruments. These readings will provide indication of hot water being drawn from the treatment area towards the extraction wells.

Any flow out of the treatment region (whether steam or hot water) will carry heat and will thus leave obvious evidence in the form of temperature rise in the effected monitoring well. This temperature data can be combined with level data and chemical data at the monitoring well to provide a matrix of likely causes:

Groundwater Flow	MW Temperature	MW VOC Conc.	Likely Cause or Corrective Action
gradient in	low	low	preferred condition
gradient out	low	low	modify gradient, monitor temp and VOCs closely
gradient in	**high**	low	probably due to thermal conduction, monitor VOCs closely
gradient out	**high**	low	hot water is probably leaving region, monitor VOCs closely
gradient in	low	**high**	probably routine fluctuation unrelated to remediation
gradient out	low	**high**	modify gradient, monitor temp and VOCs closely*
gradient in	**high**	**high**	possible steam migration from region, monitor VOCs closely*
gradient out	**high**	**high**	modify gradient, hot water is probably leaving region*

*Severe problem requiring strong corrective action.

DQO #10. Are system operations within health and safety requirements?

The primary health and safety issues concerning electricity and heat during system operations are induced voltages at the surface and heat on the conveyance piping of the MPE system.

- **Are induced voltages at the surface above TRS set guidelines?**

TRS sets limits for applied voltages at the surface that are significantly lower than OSHA guidelines. During startup and operations of the ERH system, TRS will perform a series of surveys to measure step-touch and touch-touch voltages at the surface of the treatment area. Monitoring points are selected based upon site specific statistical analyses and the locations of any objects touching or protruding from the subsurface. Measurements during voltage surveys are performed using handheld meters.

Following start-up testing, a voltage survey will be conducted whenever the voltage is increased to a new, higher level and following any electrical reconfiguration of the electrodes. In the event that neither of these operational triggers is activated, a voltage survey will be conducted at least every two weeks.

- **Are temperatures on the MPE conveyance lines a health and safety hazard?**

The construction materials used in the MPE conveyance lines are selected to maintain exterior temperatures below health and safety limits for contact by humans without protective clothing when the interiors of the lines are at normal ERH operating temperatures. The temperatures within these lines are monitored by thermocouples in the MPE well heads and the inlet to the condenser. These thermocouples are monitored continuously by an automatic data acquisition system and recorded daily.

GENERAL SYSTEM OPERATIONS
DATA QUALITY OBJECTIVES

1.0 Project Data Quality Objective Questions

The following eleven DQO questions have been identified for the EGDY NAPL Treatment Area 1 ERH project:

1. Have the temperature performance requirements of the contract been met?
2. Is heating contained within the NAPL treatment area?
3. Does the MPE system control vapor migration?
4. Is gradient control across the NAPL treatment area demonstrated?
5. What is the mass and composition of volatile organic compounds (VOCs) and the recovered vapor, water and NAPL streams? Also what is the mass and composition of total petroleum hydrocarbons (TPH) in the recovered NAPL stream?
6. Are NAPL and dissolved phase VOC concentrations in the subsurface declining?
7. Should the treatment area or depth be decreased or expanded?
8. Should treatment be suspended or continued?
9. Are system operations within the regulatory requirements for OSHA governing health and safety protocols?
10. Are system operations within health & safety requirements?
11. Do system components require maintenance?

2.0 The conceptual site model is presented in Section 1.0 of the RAMP.

3.0 DQO questions specific to system operations

Of the eleven DQO questions developed for the remediation project, questions No. 7 and No. 8 involve general system operations.

DQO #7: Should the treatment area or depth be decreased or expanded?

- **Is there evidence that contaminant levels within parts of the NAPL treatment area are decreasing?**

Field observable evidence of gross contamination may be found at the perimeter of the electrode field during construction, indicating the potential for lateral expansion of the treatment area. The DQOs for groundwater sampling within the NAPL treatment area

will provide data to determine the contaminant levels in the treatment area. Monitoring wells are located to allow for comparisons of contaminant levels in various sections of the treatment area. The DQOs for sampling vapor phase VOCs from individual MPE wells will provide qualitative data that can supplement groundwater data to determine the relative impacts across the treatment area. This data can be used to determine if heating should be suspended in parts of the treatment area.

It is also possible that site data could show heating and VOC recovery are robust along some portions of the treatment area boundary, but groundwater contaminant concentration levels in those areas do not show signs of decreasing. A possible explanation could be that contamination is migrating into the area; indicating that the system should be expanded along portions of the treatment area boundary.

DQO #8: Should the treatment be suspended or continued?

The suspension, continuation, or termination of treatment can be based on a number of the factors listed below. The status of continued operations will be based on the contract requirements set forth by the USACE. Thermal operations may be suspended or discontinued if the contract requirements are not being met by the original design and additional installation/system modification are required to satisfy the contract. The success of thermal operations at the site may also indicate to the USACE that, due to the effectiveness of the system, continued operations is not cost effective and that contract options for further treatment should not be exercised. Based on operations at Area 1, the USACE may determine that thermal treatment is ineffective and terminate possible activities at Areas 2 and 3 after review of costs for operations versus results.

The following parameters will also be reviewed by all concerned parties to evaluate operations at the site.

- **Have the subsurface heating goals been reached?**

The DQOs for subsurface heating will provide ample evidence of the heating results obtained through the treatment volume. If the subsurface heating goals have been reached, the decision to suspend or continue heating should be based upon the current rate of NAPL and VOC recovery from the subsurface. If the subsurface heating goals have not been met, then the rate of power input to the subsurface should be examined to determine if, and when, it is predicted that the heating goals could be reached.

- **Is power input to the subsurface decreasing?**

The DQOs for power input to the subsurface will provide the real time data and historical trends for the project to enable predictions of future subsurface heating

results. If these predictions show continued operations will result in reaching the contracted heating goals within an acceptable time frame, system operations should continue; if not, then discontinuing system operations should be considered.

- **Are NAPL and dissolved phase VOC concentrations in the treatment area decreasing?**

The DQOs for NAPL and dissolved phase VOC concentrations in the subsurface will provide sufficient data to determine the progress made by the system in removing contaminants from the treatment area. If the concentrations of NAPL and dissolved phase VOC are being reduced, then the continuation of system operations should be considered. If system operations are having only a limited effect on NAPL and dissolved phase VOC concentrations, then discontinuing operations should be considered.

- **What is the rate of NAPL and dissolved phase VOC recovery?**

The DQOs for NAPL and dissolve phase VOC recovery will provide near real-time data on the rate contaminants are being removed from the subsurface. If recovery rates indicate that the system is effectively cleaning the treatment volume, then, regardless of the rate of heating or actual subsurface temperatures, continuing operations should be an option. Conversely, if recovery rates are low, discontinuing operations should be an option regardless of actual subsurface temperatures.

- **Is heat migrating from the treatment volume?**

The DQOs for heat should provide indications of heat migration from the treatment volume. Unless there is data indicating that NAPL is also migrating from the treatment area, the movement of heat outside of the treatment area should not be used as a sole basis for discontinuing operations. Past experience on other ERH applications has shown that enhancing the steam recovery system can mitigate heat migration. The external monitoring wells are located about 20 feet from the treatment region - a distance that will prevent significant temperature rise unless fluids are leaving the treatment zone.

- **Is NAPL migrating from the treatment volume?**

Locating NAPL in the subsurface is a difficult site investigation or monitoring goal to achieve. The DQOs for groundwater quality do not provide sufficient data collection provisions to ensure that if NAPL were to migrate from the treatment volume it would be observed outside the treatment area. If new indications of NAPL were to be found in

the ten new monitoring wells immediately adjacent to the treatment area during ERH operation, the NAPL appearance could derive from one of three mechanisms:

1. Random movement or re-equilibration with the newly installed well.
2. Migration associated with the effects of the hydraulic control system.
3. Migration out of the treatment zone due to a thermal process.

Mechanisms 1 and 2 above are fairly benign. Mechanism 3 is more significant; however, its effects can be readily determined since any migration out of the treatment region will carry an unmistakable heat signature: if the NAPL comes from the treatment region, the monitoring well temperature will increase by at least several degrees.

If NAPL is migrating, the MPE extraction rates can be modified to increase drawdown in the affected region. In addition, an evaluation should be made as to whether the ERH system is operating as a net benefit in consideration of the NAPL movement.

APPENDIX B

Standard Operating Procedures for Field Operations

TRS PROJECT TEAM
STANDARD OPERATING PROCEDURES (SOPs)
FOR FIELD SAMPLING PLAN

SOP No.	SOP Title
SOP-1	Standard Monitoring Well Installation and Development
SOP-2	Field Volatile (Headspace) Screening
SOP-3	Field NAPL Screening Methods
SOP-4	Sonic Drilling and Soil Logging
SOP-5	Water Level Measurement
SOP-6	Groundwater Sampling, Standard Monitoring Well
SOP-7	MPE Well Air and Liquid Sampling
SOP-8	Field Measurement of Groundwater Parameters
SOP-9	Collection of Quality Control Samples
SOP-10	Sample Handling
SOP-11	Decontamination
SOP-12	Field Documentation
SOP-13	Tedlar Bag - Air Sampling
SOP-14	Summa Canister - Air Sampling
SOP-15	LWMS Wastewater, NAPL, and Solids Sampling
SOP-16	Drilling and Soil Logging

SOP–1 STANDARD MONITORING WELL INSTALLATION AND DEVELOPMENT

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Monitoring wells are installed to function as piezometers and to allow collection of groundwater samples multiple times at a constant location and depth. Monitoring wells are constructed in a manner to minimize infiltration of silt or other particles from entering the well, and to minimize the creation of subsurface conduits to groundwater. Monitoring well construction must comply with State regulations for monitoring well design. Monitoring wells are developed following installation to flush out particles that may remain after installation and to ensure that the well is in communication with the surrounding formation.

2.0 EQUIPMENT LIST

1. Photoionization detector (PID)
2. Blank Boring Log Form and field logbook with indelible pens (see SOP Field Documentation)
3. Electronic water level probe
4. Proposed well design details
5. Surge block
6. Submersible pump, controller, and power source (e.g., generator)
7. Portable turbidity meter and power source (e.g., charged batteries)
8. Buckets for containing purged well development water
9. Decontamination equipment (see SOP Decontamination, and sampling plan for additional Site-specific requirements)
10. Site map and Site health and safety plan (SSHP), if applicable
11. PPE appropriate for Site (see SSHP if applicable)

3.0 PROCEDURE

This SOP includes procedures for monitoring well installation and development, as described in the sections below. All newly installed monitoring wells will be developed prior to use.

3.1 Monitoring Well Installation

Monitoring well installation should begin after specified soil sampling has been completed and the total depth of the boring has been reached. State regulations will determine the diameter of the borehole relative to the diameter of the well. For instance, in Washington, the diameter of the borehole should be four inches larger than the diameter of the well. A 2-inch-diameter well requires a 6-inch-diameter borehole. No casing should be removed from the boring prior to the commencement of well installation.

Monitoring well construction materials are specified in the field sampling plan or in the specifications for the remediation system. Any changes to the well materials due to site conditions or availability of materials must be cleared with the project manager.

The steps necessary to install a monitoring well are described below.

1. Prior to the placement of well screen or prepackaged well screen and filter pack, confirm that a bottom plug is in place at the end of the well screen/casing string. If the depth of the well is 15 feet or less, the well screen and casing can be assembled prior to placement. The well screen/casing string should be slowly lowered into the boring through the center of the rotosonic or air rotary casing. The bottom plug should contact the base of the boring. The well screen/casing should be centered inside the boring, with one or more centralizers attached as appropriate, depending on the length of the well pipe.
2. After placement of the well screen/casing, installation of annulus materials will commence. Filter pack sand should be poured into the well annulus from the surface. The top of the sand will be sounded continuously as the sand is pored, to make sure there is no bridging and that sand stops at the appropriate elevation. A temporary cap should be placed on the top of the well screen/casing to prevent sand from entering the well interior. As filter pack material is poured into the annulus, casing will be extracted from the boring, simultaneously. In situations where there are heaving sands, clean potable water may be added to the boring to keep the native materials out of the casing during well installation. Monitoring wells with a prepack screen will also require additional sand to be poured into the boring, although the size might be coarser than the sand used in the prepack assembly. The level of sand in the boring should remain 1 to 2 feet above the bottom of the lead casing. Well construction materials (e.g., filter pack sand or neat silica cement grout) should always be up inside the lead casing during well installation and casing removal. Auger or casing should continuously be pulled

while filter pack material is added, until the top of the filter pack reaches an elevation of approximately 2 to 3 feet above the top of the casing.

3. After filter pack installation is complete, and prior to placement of an annular seal, the filter pack should be surged with a surge block. Surging should be continued until the filter pack ceases to settle. If necessary, additional filter pack material may be added and the well surged until the design elevation for the filter pack is reached.

4. Following filter pack development, the annular seal should be installed. Follow State requirements for a minimum annular seal length of 2 feet. The annular seal should be installed by pouring bentonite chips directly into the annulus, or using a pipe to tremie neat silica cement grout seal materials onto the top of the filter pack materials. Conditions of the formation and depth of the well will determine the method and materials used in seal placement. The elevation of the annular seal should be brought to within 6 inches below ground surface.

5. After the annular seal has been installed and hydrated, the remaining casing should be removed from the boring.

6. Depending on the location of the well, either a flush or aboveground monument should be installed to secure, protect, and allow access to the well. An aboveground well monument may be installed in areas where surface runoff may occasionally pool or where the monument can be protected and it does not interfere with Site operations. A flush surface monument should be installed in areas where surface runoff is not anticipated to pool and where an aboveground monument would affect pedestrian or vehicular traffic. The well casing is cut off just below grade for a flush surface monument, or extended above grade for an aboveground completion.

   The flush monument should be rated for vehicular traffic and set using concrete pre-mix, with the top of the monument a minimum of 1 inch above the surrounding surface to prevent small amounts of surface water from ponding on top of the monument. The flush monument includes a flush lid secured by bolts.

   The aboveground monument includes a steel outer casing set in concrete with a lid that can be secured with a padlock. Three steel posts are also set in concrete around the aboveground monument to protect it from damage.

7. Before the field crew leaves the Site and following the completion of monitoring well installation, the temporary well cap should be removed from the top of the well and replaced with a locking cap and padlock.

8. Well installation details should be accurately recorded on the Boring Log or other appropriate form according to procedures in the field Documentation SOP.

3.2 Monitoring Well Development

Well development should accomplish the following objectives: 1) removal of fine materials from the well (both the filter pack and the casing); 2) removal of smeared formation drill cuttings on the sides of the bore hole from drilling casing; 3) removal of drilling fluids or surface contamination that may have been introduced during drilling; and 4) removal of water introduced into the boring to aid in drilling, cuttings removal, or monitoring well installation. There should be a minimum of 48 hours between the monitoring well completion and development, to allow the well seal to set up.

1. Surge the well vigorously with a surge block over the entire length of the well screen. The purpose of the surging is to: 1) break up accumulations of fine materials in the bottom of well casing, 2) force water back and forth to remove any potential screen blockage or build-up, and 3) to increase porosity and permeability of the filter pack materials surrounding the screen of the well.

2. Place a submersible pump or other appropriate pump in the well, near the bottom of the well. The well should be pumped aggressively until it is pumped dry or until discharge is clear. The drawdown of the groundwater and an approximate average pumping rate are noted during and at the completion of the development.

   A minimum of five well volumes of water should be removed from the well. If water was added to the well during installation, that amount of water should be removed from the well in addition to the five well volumes.

   A well volume is calculated by adding the volume of water in the casing to the volume of water in the filter pack. Filter pack volume is calculated by multiplying the volume of the annulus between the casing and the borehole by (0.3). This value (0.3) allows for the space occupied by the sand (8-12 and 10-20 grain sizes) in the annulus.

3. Repeat steps 1 and 2 approximately 3 times or until no further improvement in water clarity is visible.

   The most obvious indication of well development is the clarity of the discharge water. Ideally, the groundwater turbidity should be reduced to 5 nephelometric turbidity units (NTUs) upon completion of development. If turbidity has not decreased to 5 NTUs, lowering the pumping rate can sometimes reduce the turbidity, depending on the aquifer unit. A maximum of 10 well volumes will be removed during development, regardless of the turbidity.

4. Monitoring well development activities should be recorded on the Boring Log, appropriate field form, or the field logbook, according to procedures in Field Documentation. Information recorded should include methods used, volume of water removed, and turbidity readings.

5. Decontaminate any down-hole, non-disposable equipment (e.g., surge block, pump, cable) according to procedures in SOP Decontamination.

6. Water removed during development and decontamination water should be contained and handled according to Site-specific procedures.

SOP–2 FIELD VOLATILE (HEADSPACE) SCREENING

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Field volatile (headspace) readings are taken on soil samples as an indication of the amount of volatile organic compounds (VOCs) in a soil sample. Although the results cannot be directly translated into the concentration of VOCs in soil, headspace readings provide an indication of relative concentrations in soil samples. This information is useful for selection of soil samples for laboratory analysis or as a screening tool to identify locations of relatively elevated VOC concentrations in soil.

2.0 EQUIPMENT LIST

1. Photo-ionization detector (PID)
2. Resealable plastic bags (e.g., Ziploc®)
3. Boring Log Form and field logbook with indelible pens (see Field Documentation SOP)
4. Site map and Site health and safety plan (SSHP), if applicable
5. PPE appropriate for Site (see SSHP if applicable)

3.0 PROCEDURE

Obtain a headspace reading of a discrete soil sample as follows:

1. Calibrate the PID on a daily basis to the appropriate calibration gas according to manufacturer's instructions.
2. Place a representative portion of the sample into an airtight, resealable plastic bag (e.g., Ziploc®) and seal it.
3. Agitate the sample, breaking up any large pieces of soil in the closed bag while being careful not to break the seal or pierce the bag. Allow the sample to equilibrate for as long as possible, or for a minimum of 15 minutes. If possible, place the bag in a warm area to encourage volatilization.
4. Insert the probe of the PID through the wall of the bag to minimize the possibility of outside air entering the bag. Record the maximum reading on the PID in the field logbook and/or the Boring Log Form, according to procedures in SOP, Field

Documentation. Take care not to contaminate the instrument from overexposure to high volatile concentrations.

5. The PID should be allowed to return to background conditions prior to use for the next headspace reading.

SOP–3 FIELD NAPL SCREENING METHODS

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

During monitoring well installation, at locations outside the treatment area, soil samples will be screened for both dense and light NAPL. This screening will be performed using a stepped approach. Visual observation will be noted first. If visual identification of the NAPL can be made, field-testing methods will not be done. If there is no visual evidence of NAPL, then a reading will be taken with a photoionization detector (PID), followed by UV light screening, sheen testing, and then the "Oil-in-Soil ™" kits with which tests for both DNAPL and LNAPL.

The "Oil-in-Soil ™" Test kit will be used to do the NAPL screening with Sudan IV. One restriction of this kit is that the petroleum, LNAPL, or DNAPL be sufficiently light in color to ensure the red dye (Sudan IV) can be seen. This product is also suitable for screening trichloroethene (TCE), 1,1,1-trichloroethane (TCA), and tetrachloroethene (PCE) materials. The soil test kit will detect oil to 500 parts per million (ppm) of TPH.

2.0 EQUIPMENT LIST

1. "Oil-in-Soil ™" Test Kits
2. Deionized water
3. Photoionization detector (e.g. MiniRAE 2000)
4. UV light and box
5. Small disposable jars (for sheen testing)
6. Documentation of the results on the boring log or field notebook

3.0 PROCEDURE

1. Soils will be visually inspected for evidence of DNAPL. If there is evidence of blebs or layers of the DNAPL, no further testing will be necessary. The observation will be noted in the boring log. If there is no evidence, the following steps will be followed using field methods to identify for the presence of DNAPL.

2. A PID will be used to screen the soil samples collected during drilling. A portion of each sample will be collected in a sealed plastic bag and placed in the sun or other

warm location, allowing volatilization to occur. The tip of the PID will be inserted into the bag and the measurement recorded on the boring log.

3. The soil sample will be placed in a UV field box that is specially darkened and examined for evidence of DNAPL. If there is anything that fluoresces, the depth and description of the fluorescence will be noted in the boring log.

4. Suspected petroleum or DNAPL contaminated soil is added to a small jar with DI water and the mixture is shaken. The result is examined for sheen on the water and made note of in the boring log.

5. Suspected petroleum or DNAPL contaminated soil is added to the sample bottle, to which potable water is also added. The contents of the bottle are shaken vigorously to expose the hydrophobic dye to the soil. A rapidly dissolving cube is attached to the cap. The cube has a Sudan IV-based red oil soluble dye and a fluorescing green water-soluble dye disbursed throughout its surface.

6. The red dye highlights petroleum products or DNAPL by turning them red. The green dye turns the water a green shade, providing a very useful visual contrast between the two colors. When free petroleum floats to the surface, it attaches to the white bead that is supplied with the kit and/or attaches to the walls of the container. When exposed to concentrations between 400 ppm (the lower limit of detection) and 2500 ppm (the upper limit of detection), the white bead will turn pink.

7. The range of detection is approximate because a soils affinity for oil will vary.

8. Since DNAPL is heavier than water it is found at the bottom of the jar. The DNAPL will also turn red and will be seen attached to the walls of the container near the bottom.

9. Results of the Soil-in-Oil NAPL field screening are to be recorded on the field log at the appropriate depth for the soil sample and in the field notebook.

SOP–4 SONIC DRILLING AND SOIL LOGGING

Sonic drilling methods will be used to install monitoring wells, especially where the placement of the well screen is dependant on the depths of particular soil types that will be identified during drilling. The drilling method will be dry, with no drilling fluids introduced. Sonic drilling methods result in a continuous six-inch diameter core to be retrieved while drilling. The core is brought up in 5- foot lengths in metal barrels. The core is laid out and a detailed description can be made.

All observations will be recorded on a boring log as described below. In addition, each core will be photographed, with a label indicating the project name and boring number, depth interval of the core, and date. After the core is described, and photographed, it will be disposed of with the other soil cuttings in the manner described in the Waste Management Plan.

1.0 BORING LOGS

In a drilling investigation, the Site geologist should complete a Boring Log. The information that should be included on the Boring Log is as follows:

- the boring number and/or monitoring well number
- drilling method and borehole diameter
- dates of start and completion of boring/well
- weather conditions
- sampling methods (if applicable)
- depths to water while drilling
- total depth of boring
- drilling characteristics (e.g., penetration rates, voids encountered)
- drilling contractor and names of drillers and helpers
- geologist name and affiliation
- lithologic description of collected samples and cuttings, as discussed below, such as density, moisture, color, modifier, soil classification including percentages of granular constituents, other macroscopic characteristics including structures, organic materials, oxidation mottling, etc.
- sample recovery, identification, and time

- odors, obvious contamination, or anything that could influence sample results
- field volatile (headspace) readings obtained from closed-bag samples (see Field Volatile [Headspace] Screening SOP), as well as borehole readings
- DNAPL or LNAPL identification
- monitoring well "as-built" information (construction details)
- start card number if applicable

The system of lithologic description to be used at the Site is the Unified Soil Classification System (USCS). Generally soils are described based on the following parameters:

- major soil constituents will be capitalized with granular soils given relative size descriptions,
- soil classification (USCS Soil Group Symbol, e.g., SP),
- density (based on split-spoon blow counts or manual determination),
- moisture,
- color (including mottling, stringers, color changes),
- percent varying grain sizes,
- other macroscopic characteristics such as sorting,
- stratification,
- sphericity and roundness of grains, and
- soil modifier.

Each sample is described on the standardized field Boring Log Form.

SOP–5 WATER LEVEL MEASUREMENT

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Depth to water measurements are used to compute groundwater elevations. Water levels may be collected manually with an electronic water level probe or automatically with a pressure transducer and associated datalogger. This SOP is specific to manual water level determination. Manual water level readings are the most common type of water level determination. Generally, this method is used if continuous water level data are not required, and at wells where there is a potential presence of dense or light non-aqueous phase liquid (DNAPL or LNAPL).

2.0 EQUIPMENT LIST

1. Well lock keys
2. Dedicated water level field logbook for with indelible pens (Field Documentation)
3. Electronic water level probe
4. Weighted tape for total depth measurement, if appropriate (see sampling plan for task-specific requirements)
5. If DNAPL or LNAPL is potentially present, interface probe and check-valve Teflon® bailer with new cord
6. Knife or scissors
7. Decontamination equipment (see Decontamination SOP, and field sampling plan for additional Site-specific requirements)
8. Site map and Site health and safety plan (SSHP)
9. PPE appropriate for Site (see SSHP)

3.0 PROCEDURE

Depth to groundwater and total well depth measurements will be made with an electronic well sounding (water level) probe. This probe is capable of measuring the depth from the top of the well casing to the nearest 0.01 foot.

1. Take measurements from cleanest to most heavily impacted wells, based on historic data, where available.

2. Check well for security damage or evidence of tampering and record pertinent observations. Note any maintenance tasks that should be completed, such as well cap or monument repairs.

3. Unlock and remove the cap from the well casing, allowing the pressure to equalize in well.

4. For wells where there is no potential presence of LNAPL or DNAPL, lower the water level probe sensor head into the well opening until an auditory or visual signal is obtained. Slightly raise and lower the sensor to determine the strongest signal, which indicates the top of the water level surface in the well casing. For wells where LNAPL or DNAPL is potentially present, use an interface probe and follow probe instructions to determine the type of signal for water versus product.

5. Read the measurement off the tape at the point that corresponds to the survey mark on top of the well casing and record it in the field logbook to the nearest 0.01 foot. Measure the depth to fluid from an established point on the well casing; this measurement will be subtracted from the elevation of that mark to calculate groundwater (or product) elevation at the well location. Record both depth to LNAPL or DNAPL (if any) and depth to water, where applicable. Also record the time the water level is taken in the field logbook.

6. If specified in the sampling or work plan, lower the water level probe or a weighted tape to the bottom of the well and record the total depth of the well relative to the same survey mark used for the water level. Record this measurement to the nearest 0.1 foot.

7. Decontaminate the exposed tape and water level or interface probe sensor head prior to rolling it onto the equipment reel.

8. For wells where LNAPL or DNAPL is potentially present or where evidence of LNAPL or DNAPL, if any, is observed on the water level probe, a disposable, weighted bailer will be used to determine whether the LNAPL or DNAPL is present. If present, visually examine the DNAPL for color, background odor, evidence of DNAPL product sheen or droplets, globules, etc. Record these observations and an LNAPL or DNAPL thickness corresponding to the thickness observed in the bailer in the field logbook.

9. Contain and dispose of PPE, bailer and cord (if used), and decontamination water according to Site-specific requirements.

SOP–6 GROUNDWATER SAMPLING, STANDARD MONITORING WELL

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Groundwater samples are collected from monitoring wells for analysis of physical and chemical parameters, either using field observations and portable equipment or using laboratory analytical methods. Monitoring wells are purged prior to sample collection to ensure that water sampled is representative of the formation. The procedures in this SOP are specific to standard monitoring wells with a single slotted interval. This method can be used for both cold and hot ambient water when using dedicated pumps or portable pumps.

2.0 EQUIPMENT LIST

1. Well lock keys
2. Groundwater Sampling Field Form, other appropriate Site-specific form(s), and field logbook with indelible pens (see Field Documentation)
3. Electronic water level probe
4. If dense non-aqueous phase liquid (DNAPL) is potentially present, interface probe and check-valve Teflon® bailer with new cord
5. Knife or scissors
6. Decontamination equipment (see Decontamination SOP and field sampling plan for additional Site-specific requirements)
7. Site map and Site health and safety plan (SSHP), if applicable
8. PPE appropriate for Site (see SSHP if applicable)
9. Submersible or peristaltic pump (for monitoring wells without dedicated pumps), and associated pump equipment (controller, connectors, power cord, etc.)
10. Compressed gas source or generator, air compressor, and fuel (if dual valve pump is used)
11. Disposable discharge tubing, if necessary
12. Stainless steel coil, small “six-pack” cooler, and ice water
13. Field water quality monitoring equipment (see Field Measurement of Groundwater Parameters SOP) and flow-through cell, if appropriate

14. Buckets or other containers for purged water

15. Sample containers, labels, packaging material (Sample Handling SOP)

3.0 PROCEDURE

Groundwater samples can be collected using low-flow purging and sampling methods. Depending on monitoring well conditions, either a dual valve pump or a peristaltic pump will be used to purge and sample the well.

If sampling in an area where the groundwater is heated, the groundwater sampling procedures are slightly modified. Electrical power from the transformer to the electrodes will be turned off prior to sampling. Monitoring and sampling will take place under conditions where water and well components are likely at temperatures above 60°C. However, the monitoring wellhead construction eliminates personnel exposure to high temperatures.

A water cooling apparatus similar to a wort chiller will be used to bring water to safe handling temperatures (< 20°C and preferably 4°C) prior to sampling. Water shall feed through the cooling coil at the site surface prior to entering a flow-through cell or handling by staff.

3.1 Low-Flow Purging and Sampling

This SOP emphasizes the need to minimize stress by inducing low water level drawdowns and low pumping rates in order to collect samples with minimal alterations to water chemistry. While purging, accurate measurement of physical groundwater quality parameters in the field requires a closed system in which groundwater does not contact open air. Dissolved oxygen (DO), oxidation-reduction potential (ORP), and pH measurements in groundwater are sensitive to reactions with the atmosphere. The flow-through cell (flow cell) is used to measure field parameters prior to collecting groundwater samples from a submersible or peristaltic pump. Stabilization of selected parameters indicates that conditions are suitable for sampling to begin. A drawdown of less than 0.3 feet in the well is desirable.

Complete the following sequential steps during low-flow purging and groundwater sampling from monitoring wells:

1. Note general condition of the well. Check well for security damage or evidence of tampering and record pertinent observations. Note any maintenance tasks that should be completed, such as well cap or padlock replacement.

2. Open the well and wait a sufficient period of time for the atmospheric pressure to equalize, allowing the water levels to approach an equilibrium state before continuing, if necessary.

3. Measure the depth to water, potential DNAPL (if any), and total well depth (if specified in sampling or work plan) according to the procedures in the Water Level Measurement SOP. All measurements should be referenced to a marked point on the well casing.

4a. If a dedicated pump is not in the well, using a nylon rope, slowly lower the pump (or intake of the disposable tubing if using a peristaltic pump) into the well to the midpoint of the zone to be sampled. Keep the pump at least two feet from the bottom of the well to minimize the mobilization of silt that may be present in the sump at the bottom of the well. Secure the pump and/or tubing to prevent the tubing or pump from moving. Proceed to step 5, below.

4b. For dedicated dual-valve pumps, connect the nitrogen tank, with regulator, to a control box, which is connected to the manifold on top of the well casing. Direct the discharge tubing to a bucket. Set the pressure, discharge time and recharge time on the control box. Start the pump and measure the flow rate from the discharge tubing using a graduated container. The pumping rate should be between 0.1 and 0.5 liters per minute (L/min), with no more than 0.3 feet of water level drawdown. Make the necessary adjustments to get the desired flow rate, recording the rate and control box settings on the Groundwater Sampling Field Form.

Purge the stagnant water from the tubing so that the groundwater from the well screen is reaching the surface. The inside diameter of the tubing and length of water column is used to calculate this purge amount, using the corresponding conversion factors on the Groundwater Sampling Field Form.

Inside Diameter (inches)	Gallons per Linear Foot
0.25	0.003
0.5	0.010
0.75	0.023

5. If sampling heated groundwater, connect the discharge tubing to the cooling coil, inserted in the six-pack cooler with ice water. If sampling cool groundwater, proceed to step 6.

5a. DO NOT connect the discharge tubing directly to a flow cell. High temperature water will damage the water parameter instrument and therefore should not be used when water temperatures are above 60° C. After connecting the discharge tubing to the cooling coil, verify the water temperature is below 60° C, then continue with step 6.

6. Connect the discharge tubing to a flow cell. Collect the purge water in a bucket from the flow cell. Monitor the water level during purging.

7. During well purging, monitor the field parameters every three to five minutes according to procedures in the SOP, Field Measurement of Groundwater Parameters. Since the majority of the monitoring wells at NAPL Area 1 are within the treatment area, they are subject to heating and, consequently, the groundwater within the wells will eventually boil. As such, achieving stabilization of water quality parameters in such a dynamic environment is difficult and the ability to do so unlikely. The monitoring wells will be purged and the water quality parameters; pH, specific conductance, temperature, DO, ORP and turbidity will be monitored and recorded every three to five minutes. If parameters do not stabilize within a 30-minute period, the final reading will be recorded and the well sampled. Temperature readings collected during sampling will be reflective of the cooling process, not the temperature within the well. As a matter of consistency, this process will also apply to monitoring wells located outside the treatment area.

   Typical stabilization readings are provided below.

Temperature:	+/-3%
Conductance:	+/-3%
pH:	+/- 0.2 pH units
DO:	+/-10% (or measurement <1 mg/L)
ORP:	+/- 10 millivolts
Turbidity	+/-10%

   If indicator parameters have not stabilized within five to eight readings over a 30-minute time period, discontinue purging, and proceed with sample collection.

8. The water sample must be collected before the water passes through the flow cell. Disconnect the influent tubing from the flow cell and directly fill the sample containers.

   If multiple analytical tests are to be performed, collect samples in order of decreasing sensitivity to handling-introduced bias (i.e., VOCs, semivolatiles, and

metals). Water should be directed down the inside walls of the bottles to minimize aeration.

Groundwater samples for dissolved metals analysis will be field-filtered with a 0.45-micron filter by placing the filter directly on the end of the discharge hose from the submersible or peristaltic pump.

9. Samples will be handled according to procedures in SOP, Sample Handling. All the sample bottles will be properly labeled, protected from breakage, placed in storage bags, and placed in a cooler on ice and packed for transport to the laboratory. Samples will be transported to the laboratory within 48 hours of collection.
10. If used, discard the dedicated tubing and nylon rope after sampling.
11. Before securing the well, measure and record the water level.
12. Decontaminate sampling equipment as described in the applicable SOP.
13. Complete field documentation according to procedures in SOP, Field Documentation. All field observations made and data generated in conjunction with the sample collection will be entered on a well-specific Groundwater Sampling Field Form, dated, and signed by the field personnel. Complete the chain-of-custody documentation after samples are collected, and before moving to the next well.

SOP–7 MPE WELL AIR AND LIQUID SAMPLING

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Air and liquid samples will be collected from individual sectors within the MPE well array. As MPE wells in each sector will be piped together, samples will be collected from the central discharge pipe for each sector. A sample port will be incorporated into the pipe, with a valve at the top of the pipe for air sampling and a valve at the base of the pipe for liquid sampling. This is to be a qualitative sampling procedure, to evaluate the progress of in-situ remediation efforts. Depending on the analytical results for any sector, individual MPE wells within that region may be completed with a similar valve set-up and sampled as needed. The procedure to do either one well or an MPE sector sample will be the same.

2.0 EQUIPMENT LIST

1. Air and/or system effluent Sampling Field Form, other appropriate Site-specific form(s), and field logbook with indelible pens (see Field Documentation)
2. Knife or scissors
3. Decontamination equipment (see Decontamination SOP and field sampling plan for additional Site-specific requirements)
4. Site map and Site health and safety plan (SSHP), if applicable
5. PPE appropriate for Site (see SSHP if applicable)
6. Disposable discharge tubing, if necessary
7. Cooling coil, cooler and ice water.
8. Liquid Sampling Apparatus
9. Sample containers, labels, packaging material (Sample Handling SOP)

3.0 PROCEDURE

The following sequential steps will be followed during air sampling:

1. Connect a piece of tubing to the air valve and to a cooling coil placed in the cooler of ice water. Attach a second piece of tubing to the other end of the cooling coil.

2. Open the valve and purge the tubing and cooling coil with air for approximately 30 seconds.

3. Attach a tedlar bag to the end of the tubing attached to the end of the cooling coil.

4. Fill the tedlar bag to just short of full and then disconnect and seal the tedlar bag.

5. Discard any non-dedicated tubing after sampling.

6. Complete field documentation according to procedures in SOP, Field Documentation. All field observations made and data generated in conjunction with the sample collection will be entered on a well-specific Air Sampling Field Form, dated, and signed by the field personnel. Complete the chain-of-custody documentation after samples are collected, and before moving to the next sample.

Liquid Sampling

1. Fit a piece of Teflon tubing over the bottom valve.

2. Run the tubing into the hole at the top of a sealed clean container, such as a Mason jar. After the jar and pipe come to equilibrium, liquid will start to fill the container.

3. Fill the container and disconnect the tubing.

4. Transfer the liquid into the appropriate sample containers.

5. Samples will be handled according to procedures in SOP Sample Handling. All the sample bottles will be properly labeled, protected from breakage, placed in storage bags, and placed in a cooler on ice and packed for transport to the laboratory.

6. Discard any non-dedicated tubing after sampling.

7. Complete field documentation according to procedures in SOP Field Documentation. All field observations made and data generated in conjunction with the sample collection will be entered on a well-specific Groundwater Sampling Field Form, dated, and signed by the field personnel. Complete the chain-of-custody documentation after samples are collected, and before moving to the next well.

SOP–8 FIELD MEASUREMENT OF GROUNDWATER PARAMETERS

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Groundwater parameters are often measured prior to sampling, and stable readings are used as an indication of formation water. The parameters measured also can provide data regarding groundwater quality or indication of natural attenuation of contaminants in groundwater. Accurate measurement of groundwater parameters is critical in documenting representativeness of samples collected and in evaluation of groundwater quality and chemical or biological processes.

2.0 PROCEDURES

2.1 Measurements for Temperature, pH, Specific Conductance, DO, TDS and ORP

Temperature, pH, specific conductance, DO, TDS and ORP will be measured in the field with portable, battery-powered instruments (e.g., YSI 556 multiprobe) with a fitted flow-through cell. Procedures for calibration and measurements are outlined in the user manuals included with these instruments. At a minimum, these instruments will be calibrated once each day before sampling activities begin. The flow-through cell should fit tightly around the probe to provide an airtight environment to collect accurate DO, ORP, and conductivity measurements.

Field measurements WILL NOT be collected at locations where water temperatures exceed 60º C.

2.2 Measurements for Turbidity

If required, measure turbidity once per well immediately prior to filling sample bottles, and upon obvious visual changes in turbidity during sample collection. Measure turbidity using appropriate portable, battery-powered field equipment, and record results in nephelometric turbidity units (NTU).

2.3 Ferrous Iron (Fe2+)

If required, field measurement of ferrous iron (Fe2+) will be conducted using a colorimetric technique, and will be completed during post-development groundwater sample collection.

Summary of procedures for Fe2+ measurement:

1. Wash all lab ware between tests with a non-abrasive detergent or solvent. Do not use paper towels on the plastic tubes, as this may scratch them.
2. Rinse all tubes thoroughly with the sample water prior to testing.
3. Fill a viewing tube with deionized water to the first 5-mL line to be used as a blank.
4. Place the blank tube in the top left opening of the color comparator.
5. Fill the measuring vial to the 25-mL mark with the sample water.
6. Use the supplied clippers to open the powder pillow.
7. Add the contents of the powder pillow to the measuring vial.
8. Swirl to mix and allow 3 minutes for full color development. An orange color will develop if Fe2+ is present.
9. Fill a second viewing tube with the prepared sample from the measuring vial to the first 5-mL mark.
10. Place the second tube in the top right opening of the color comparator.
11. Hold the comparator up to a light source and rotate the color disk until the color matches in the two openings.
12. Read the mg/L Fe2+ result in the scale window.
13. Place the tested water into the waste water container and rinse the viewing tubes and the measuring vial with clean (deionized) water.

SOP–9 COLLECTION OF QUALITY CONTROL SAMPLES

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

A variety of quality control (QC) samples are required in order to assess performance of the project team in collection of soil and groundwater samples and the performance of the analytical laboratory in analysis of these samples. The analytical results of QC samples are used in data validation to determine the quality of investigation sample results, and are therefore critical to the investigation process. The analytical results of QC samples may also prompt changes in field or laboratory analytical procedures.

2.0 PROCEDURE

In general, each type of quality control sample will be collected at a rate of approximately 10% of the total number of samples collected during a sampling episode. Each QC sample should be documented in the same manner and on the same form(s) as the primary sample, along with any activities or observations that may compromise the objective of the QC sample (see Field Documentation SOP). QC samples should be handled according to applicable procedures in the Sample Handling SOP.

The laboratory must provide water for the equipment, trip, and field blanks. The water for the blanks is processed in the laboratory by a mixed bed deionizer, boiled, and purged with an inert gas.

QC samples required for this groundwater sampling and analysis program are described below.

2.1 QC Sample Types

QC samples to be collected or handled include field duplicate samples, rinsate (or equipment) blanks, trip blanks, and laboratory QC samples.

2.1.1 Field Duplicate Samples

Field duplicates are replicate samples collected at the same location simultaneously in separate containers and submitted to the contract laboratory. Field duplicates provide an indication of the reproducibility of the sampling and analysis procedures for a given sample matrix, including heterogeneity of the sample itself. Field duplicate samples for groundwater will be collected by alternating between the sample and the replicate as

each bottle is filled. Field duplicate samples for soil will be collected from soil immediately adjacent to (above) the primary sample (e.g., the second ring in a split-spoon sample). The field duplicates will be collected in the same container types and handled and analyzed in the same manner as their associated primary samples. Field duplicate (or replicate) samples should be collected from 10% of the samples collected from the Site for each quantitative test to be performed (see Section 2.2 below).

2.1.2 Rinsate (Equipment) Blanks

Rinsate blanks are collected to evaluate the potential for cross-contamination of samples during collection, which may result from inadequate decontamination of sampling equipment. Equipment rinsate blanks will be obtained by passing organic-free water through or over the decontaminated sampling equipment, and collecting the water in VOA vials. The rinsate blank will be analyzed for the same parameters as the associated field samples and collected at a rate of 10% or one equipment blank per day (see Section 2.2 below).

2.1.3 Trip Blanks

Trip blanks are volatile organic analysis (VOA) vials filled with laboratory-provided water that are transported to the field and then returned to the lab without being opened. The laboratory provides a trip blank for each sampling event.

Trip blanks will be used to evaluate whether the shipping and handling procedures are introducing contaminants into the samples, and if cross-contamination in the form of VOC migration has occurred between the collected samples.

Trip blanks and associated sample containers should remain in the same cooler the lab shipped them in or in the on-Site refrigerator and should not be intermingled with bottles from different batches. The trip blank will be kept with samples planned for VOC analysis and will be analyzed for VOCs only. Trip blanks are labeled as "Trip Blank" followed by the associated sample date.

2.1.4 Laboratory QC Samples

Laboratory QC samples are field samples that are designated for laboratory QC procedures such as duplicate analysis or matrix spike analysis. Extra volume must be collected for laboratory QC samples so that the laboratory has sufficient volume to perform all required analyses. QC sample volume requirements are generally equivalent to three times the primary sample volume requirements for organic analyses but QC for most inorganic analyses can be performed on the primary sample column.

Refer to the project QAPP for specific details. Extra containers for laboratory QC use should be so indicated on the chain-of-custody form and applicable field sampling form(s) (see Field Documentation SOP).

2.2 QC Sample Frequency

Field Duplicate Samples:	One duplicate per 20 requests for each analytical procedure, with a minimum of one per procedure.
Rinsate Blanks:	One rinsate blank per day per matrix when non-dedicated sampling equipment is used in the field.
Trip Blanks:	One trip blank per cooler containing vials for VOC analysis. One trip blank will be submitted to the laboratory for analysis each day that samples are collected.
Laboratory QC Samples:	One laboratory QC sample per 20 requests for each analytical procedure, with a minimum of one per procedure.

SOP–10 SAMPLE HANDLING

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Proper sample handling is critical in producing reliable analytical data during an investigation. From the time samples are collected through delivery to the analytical laboratory, they must be handled appropriately to minimize the possibility of cross-contamination and loss of constituents of interest (e.g., through volatilization), and to assure proper documentation and tracking of samples through the process.

2.0 PROCEDURE

2.1 Sample Containers

The contract laboratory will supply pre-cleaned, certified containers appropriate for the required analysis. Sample container quality protocols will be strictly enforced and assured by the laboratory. The laboratory shall retain certificates of analysis from each lot of containers for a period of at least five years. Containers supplied by the laboratory shall contain any required chemical preservative, except when field preservation is necessary. Field preservation will be conducted under specific direction from the laboratory. Sample containers will be kept closed until used. Required sample containers, preservation, and holding time requirements for this project are described in the table below:

Laboratory Container, Preservation, and Holding Times
Groundwater Sampling

Method	Analysis	Container	Preservation	Holding Time
8260B	Volatile Organic Compounds (VOC)	4 - 40 mL Glass Vials 8 - 40 ml Glass Vials for Lab QC	4°C, HCl to pH <2 (no headspace)	14 days

Once the sample is collected into the appropriate container, the outside of the bottle should be wiped with a clean paper towel to remove excess sampling material. The bottle should not be submerged in water in an effort to clean it. If necessary, a clean paper towel moistened with Alconox solution may be used.

The sample bottle should then be properly labeled, a custody seal wrapped around the lid and container and clear tape may be used to cover the label to secure it on the container. See Sample Designation and Labeling, below.

2.2 Sample Designation and Labeling

The purpose of sample designation and labeling is to enable discrete sample tracking. Each sample will be labeled with the location identification (ID). All samples will be tracked using the chain-of-custody and a manually or electronically completed groundwater sampling field form by well name, sample date and time. In the case of LWMS sampling, an LWMS sampling field form will be used instead. Each sample ID will be designated by the well or LWMS valve identification with no hyphens or spaces. Since all samples have a unique date and time, consecutive samples from the same well will be identified using all three fields. Duplicate samples from a monitoring well will be assigned a "ghost" well number, which have been reserved specifically for duplicate samples. The monitoring well being duplicated will be recorded on the groundwater sampling field forms. Duplicate samples from an LWMS valve will be assigned a "ghost" valve number, which has been reserved specifically for duplicate samples. The LWMS valve being duplicated will be recorded on the LWMS field sampling form. Sample IDs and Duplicate IDs are shown for each location on Table 1 of the Field Sampling Plan.

Split samples will have identical sample labels and times as the original sample. Trip blanks will be labeled as "Trip Blank". Equipment blanks will be designated with equipment ID and followed by "rinsate". For example, the dual-valve pump would be: DVP-Rinsate.

Laboratory QA/QC will involve collecting a double volume in the appropriate containers and marking in the note section of a groundwater sampling field form and chain-of-custody "double volume for lab QA/QC".

Sample labels may be preprinted with project name and number. Items including sample ID, date and time of collection, and sample collector will be indicated on the sample label and will be filled out in the field.

2.3 Sample Preservation and Holding Times

The use of proper chemical and thermal preservation is critical to maintain validity of project samples. Field personnel will verify that the correct laboratory-supplied containers are used for each sample and labeled with the corresponding intended analysis.

All soil and groundwater samples will be placed in a cooler with blue ice or double bagged wet ice immediately after collection. The target temperature for the cooler is 4°C or less. Samples will be transported to the contract laboratory as soon as possible after collection. This will allow rapid transfer of the samples into controlled, refrigerated storage, and allow the contract laboratory adequate time to meet required analytical holding times as described in Section 2.1. A temperature blank, when provided by the laboratory with the sample containers, will be included in each cooler so the laboratory can verify sample temperature upon receipt.

2.4 Sample Storage, Packaging, and Transport

Follow proper sample handling procedures so sample quality is not compromised after the collection of the sample and prior to submitting the sample to the laboratory.

2.4.1 Sample Storage

All samples will be in possession of a TRS project team member at all times until custody is relinquished to the laboratory (in person or through shipment), or until the samples are placed in a secure storage location. Place samples into metal or plastic picnic coolers at a target temperature of 4°C, and add ice, as discussed in Section 2.3, to maintain the target temperature.

2.4.2 Sample Packaging

Transport samples in the same coolers used for sample storage. Each cooler or daily set of coolers will be accompanied by a Chain-of-Custody Form (see Field Documentation SOP). Complete the Chain-of-Custody Form, seal it in a resealable plastic bag (e.g., Ziploc®) to prevent damage to the document, and tape it to the top of each cooler. Seal each cooler with signed, self-adhesive chain-of-custody seals prior to transport.

2.4.3 Sample Transport

Place sample coolers into the back of a field vehicle for transport to the contract laboratory or to a designated sample pick-up location.

Wrap individual glass sample containers in bubble wrap bags or place them in closed-cell Styrofoam® packaging. Place samples with numerous aliquots per sample set in resealable plastic bags (e.g., Ziploc®) to help keep sets together. Place plastic sample containers in resealable plastic bags; these do not require bubble wrap.

Samples designated to be analyzed at out-of-area laboratories will be repackaged (as necessary) for shipping. Bubble wrap and Styrofoam® may be used to help prevent

sample breakage during shipping. Pack samples into coolers with blue ice and label them appropriately for shipping. Common carriers may be used for shipping. A Chain-of-Custody Form will accompany all coolers during shipment (see Documentation SOP). Common carriers do not typically sign Chain-of-Custody Forms; retain the receipt for shipment as evidence of sample transport.

SOP–11 DECONTAMINATION

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Decontamination of non-disposable equipment is performed at sites where environmental contamination is known or suspected. This is done to minimize the potential for cross-contamination between sampling locations (potentially resulting in unrepresentative samples and/or causing the spread of contamination) and to protect human health and safety.

2.0 EQUIPMENT LIST

1. Deionized water
2. Plastic buckets
3. Spray bottles
4. Disposable rags or paper towels
5. Alconox or equivalent
6. Methanol if there is a potential presence of DNAPL
7. Potable water (can be replaced by deionized water)
8. Site map and Site health and safety plan (SSHP), if applicable
9. PPE appropriate for Site (see SSHP if applicable)

3.0 PROCEDURE

Decontaminate sampling equipment (e.g., water samplers, soil samplers, flow cells, pumps, water level probe, etc.) between each sampling location as follows:

1. Soap wash (dilute solution of Alconox or equivalent in potable water solution),
2. Potable water rinse, and
3. Distilled/deionized water rinse.

If DNAPL is encountered, wipe the probes and the water level meter with a solvent-soaked (methanol) towel during retrieval and decontaminate the equipment with a solvent rinse. Wash sampling equipment that has contacted DNAPL with methanol prior to the soap wash.

Decontamination water will be stored in an appropriately labeled tank and transported from the generation point to the disposal location.

SOP–12 FIELD DOCUMENTATION

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Proper field documentation is critical in producing reliable, reproducible investigation results. This information will be collected in a variety of formats that will all be specific to the function they perform in the sampling procedure (e.g., field logbooks, Groundwater Sampling Forms, sample labels, Chain-Of-Custody Forms). Duplication of data recording is minimized to avoid errors and to streamline field efforts. Verifiable sample custody is of primary importance during field and laboratory procedures. Accurately recorded information will allow for detailed tracking of all samples from collection through transport and laboratory analysis and will facilitate the import of field data and laboratory analyses into the database system. Information should be recorded as soon as practicable after collection or occurrence.

2.0 PROCEDURE

The following is a description of the documentation to be completed during field sampling activities. All activities require entries in a field logbook or on forms to be completed in waterproof pen.

2.1 Field Logbooks

Field logbooks will be the main source of documentation for all field activities. The books will be permanently bound, with waterproof pages, chosen for their secure binding and durability in adverse field conditions. All pages will be numbered consecutively. All pages will remain intact and no page will be removed for any reason. Notes will be taken in indelible, waterproof, blue or black ink. The front and inside of each field logbook will be marked with the project name, project number, and logbook number. The field logbooks will be stored in the project files when not in use and upon completion of each sampling event.

The first entry at the beginning of each day will include the date and time, project number, names of all field personnel on Site (including subcontractors and the company for which they work), weather conditions, and the purpose of fieldwork. Each subsequent page will be started with the project number and the date. The bottom of each page will have the date and the initials of all personnel entering information onto that page. Each entry will include a time notation. Any remaining unused lines

will be crossed through. Errors will not be erased. All errors will have a single strikethrough with an initial and date next to the strikethrough and the subsequent change made.

Information included in the field logbooks may include but not be limited to the following items:

- Reasons for collecting samples (e.g., semi-annual sampling event, source area sampling);
- Field observations relevant to the sampling event, including weather (wind direction and approximate speed, air temperature, sky cover) and any events that may have occurred previous to sampling that may influence the integrity or the representative nature of the sample;
- Any malfunctions or inconsistent behavior of field detection instruments (if used);
- Observations of Site activities not covered under regular activities, including presence of persons on-Site not related to the sampling activities (subcontractors, agency representatives, members of the press, and others) and actions by those people affecting task performance;
- Sketches of relevant information;
- Information relevant to a change in scope or change in procedure, with documentation of subsequent approval;
- Justification for decisions made in the field regarding where sample collection should take place (e.g., visual or olfactory contamination, elevated volatile readings, near area where suspect materials were stored) or any variations in the planned field activities;
- Type and/or level of health and safety equipment used; and
- References to information on other field forms, as appropriate.

All information compiled in the field logbook will be written legibly in language that is clear and concise, without allowing for interpretation.

2.2 Water Level Sheets

Field sheets will be used to record water levels and date and time of measurement. Field conditions or other information that may bring data into question (e.g., measuring point not marked on well casing) should be noted on the field sheet. The field sheet should include all information included in field logbooks (see Section 2.1), as

appropriate. The field sheet is to be returned to the project manager following each event.

2.3 Field Forms

Separate and complete field forms will be completed for each sampling location or event, as appropriate. Errors will not be erased. All errors will have a single strikethrough with an initial and date next to the strikethrough and the subsequent change made. Information collected during sampling will be marked on the field form in addition to notes taken in the field logbook.

2.3.1 Boring Logs

In a drilling investigation, a Boring Log should be completed by the Site geologist. The information that should be included on the Boring Log is as follows:

- the boring number and/or monitoring well number
- drilling method and borehole diameter
- dates of start and completion of boring/well
- weather conditions
- sampling methods
- depths to water while drilling
- total depth of boring
- drilling characteristics (e.g., penetration rates, voids encountered)
- drilling contractor and names of drillers and helpers
- geologist name and affiliation
- lithologic description of collected samples and cuttings, as discussed below, such as density, moisture, color, modifier, soil classification including percentages of granular constituents, other macroscopic characteristics including structures, organic materials, oxidation mottling, etc.
- sample recovery, identification, and time
- number of containers collected and volume of each container
- odors, obvious contamination, NAPL observations, or anything that could influence sample results

- field volatile (headspace) readings obtained from closed-bag samples (see Field Volatile [Headspace] Screening SOP), as well as borehole readings
- monitoring well "as-built" information (construction details)
- start card number if applicable

The system of lithologic description to be used at the Site is the Unified Soil Classification System (USCS). Generally soils are described based on the following parameters:

- major soil constituents will be capitalized with granular soils given relative size descriptions,
- soil classification (USCS Soil Group Symbol, e.g., SP),
- density (based on split-spoon blow counts or manual determination),
- moisture,
- color (including mottling, stringers, color changes),
- percent varying grain sizes,
- other macroscopic characteristics such as sorting,
- stratification,
- sphericity and roundness of grains, and
- soil modifier.

Each sample is described on the standardized field Boring Log Form.

2.3.2 Groundwater Sampling Field Form

A separate and complete Groundwater Sampling Field Form will be created for each well sampled. Information collected during sampling will be marked on the Groundwater Sampling Field Form in addition to notes taken in the field logbook.

Information may include but will not be limited to:

- Date and time of sampling for each sample, including time of well purging, field sample collection, and laboratory sample collection;
- Well identification;
- Sample identification or naming system, including each unique sample name/number;

- Method of sampling, including procedures and equipment, as well as any variance from the methods in the applicable work plan or sampling plan;
- Laboratory samples collected;
- Volume of sample collected per sample container, type of sample container, and number of aliquots per sample;
- Sample preservation techniques and analyses requested;
- Field sampling methods and instruments;
- Results of field measurements (e.g., groundwater parameters);
- Information relevant to quality control (e.g., sampling discrepancies or difficulties, unexpected conditions, abnormal sampling procedures);
- Factors that may affect the quality of the sample (e.g., unavoidable aeration, high traffic area);
- Visual description (color, clarity, immiscible globules or sheen);
- Weather conditions;
- Depth to water;
- Purge method, time, and volume;
- Waste disposal method; and
- Decontamination method.

The fields within the form allow pertinent information to be documented appropriately.

2.3.3 Forms for LWMS Sampling

Separate forms are available for LWMS sampling and are to be completed when collecting associated samples. Specific forms that will be used for LWMS sampling are as follows:

- Wastewater Sampling Field Form
- Solids Sampling Field Form
- NAPL Sampling Field Form
- Air Sampling Field Form

2.4 Quality Control Samples

Quality control samples (see Collection of Quality Control Samples SOP) need to be noted in the field logbook. The name of the samples, time and date of collection, the purpose of their collection (e.g., equipment blank, field duplicate, trip blank), and associated samples or sampling locations, as appropriate, should be recorded.

2.5 Documenting Sampling Points

The exact location of sampling points should be documented for purposes of future sampling and for construction of accurate maps. A benchmark is chosen at each site to act as a stationary reference point from which all sampling points can be measured, if possible. Monitoring well locations or other permanent or semi-permanent points will be professionally surveyed. The sample locations are to be noted in the field logbook or on a dated Site map to be filed with the field event notes. All locations and objects are to be labeled, a north arrow and approximate scale included, and some indication on how the measurements were collected (cloth tape, paces, rolling tape, etc.) should be recorded.

2.6 Chain-of-Custody Documentation

The chain-of-custody is an integral component of the sampling process as it stands as a permanent record of sample holding and shipment. Sample custody is documented from collection through transport, analysis, and reporting. When the form is complete it should indicate that there were no lapses in sample accountability.

Samples will remain in the custody of appropriate TRS project team members until receipt by the laboratory. The corresponding Chain-of-Custody Form is in plain view at all times, in physical possession, or in a locked location where no tampering will occur. The Chain-of-Custody Form will be cross-checked for errors and signed upon receipt and release of samples. Any errors will not be erased, but will have a single strikethrough, with the change dated and initialed. The Chain-of-Custody Form will be completed as follows:

- A Chain-of-Custody Form (or several, as needed) listing every sample that has been collected during a sampling event should be filled out for each event. The form should be filled out upon completion of sampling at each location, if at all possible, or at least at the end of each day. The sample ID, date, time, preservative, and number and volume of containers need to be filled out for each sample. The analysis(es) to be run on each sample also needs to be indicated on the Chain-of-Custody Form.

- All samples will be hand-delivered to a laboratory representative or shipped according to the procedures described Sample Handling SOP.
- Coolers with their respective Chain-of-Custody Form(s) will be checked into the laboratory by a laboratory representative, and the Chain-of-Custody Form will be signed, dated, and marked with the time when samples are turned over to the laboratory. The lab representative signs the Chain-of-Custody Form and returns one carbonless copy to the sampler.

The field representative or staff member will retain one copy of the signed Chain-of-Custody Form for the project files. The laboratory representative will verify cooler temperature, sample designation, and other relevant sample conditions. The original Chain-of-Custody Form or a photocopy will be returned to the Project chemist with the analytical results to go into the project files.

SOP–13 AIR SAMPLING—TEDLAR BAGS

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Air samples are collected from ambient air and from remediation system air streams for analysis of chemical parameters using on-Site or off-Site laboratory analytical methods. Air sample sources will be purged using a vacuum pump, if necessary. The vacuum pump will also be used to fill the tedlar bag with an air sample. Because the pump will be used at multiple locations, it is important that a sufficient amount of time is allowed for purging, to purge both the air source and the pump.

2.0 EQUIPMENT LIST

1. Air Sampling Field Form, other appropriate Site-specific form(s), and field logbook with indelible pens
2. Vacuum pump and Teflon tubing
3. Photoionization detector
4. Site map and Site health and safety plan (SSHP), if applicable
5. PPE appropriate for Site (see SSHP if applicable)

3.0 PROCEDURES

A Tedlar bag is used to collected for grab samples that will be analyzed at the on-site laboratory. This sample container is meant to be used for the analysis of compounds in the parts per million by volume (ppmv) range. The holding time for a bag is 3 days for chlorinated solvents.

Grab Sampling Procedures

1. Purge the sample port using a vacuum pump and Teflon tubing.
2. Fill out Tedlar bag sample tag.
3. Attach additional Teflon tubing from the pump outlet to the Tedlar bag valve and open valve. Carefully collect the air sample, filling the bag no more that 2/3 full.

4. Close the Tedlar bag valve by hand tightening the valve clockwise.

5. Return bag to the boxes provided. DO NOT CHILL THE SAMPLE.

6. Record the date, time, location and Tedlar bag number on the field data sheet. Make any notes regarding sample location that will potentially influence the VOC sample collection.

7. Measure and record temperature, barometric pressure, and humidity. Record the general weather conditions such as percent cloud cover and precipitation. Note if there has been precipitation during the last 12 hours.

8. Place a duplicate Tedlar bag, if necessary, at the same time and follow the same procedure.

9. Record the sample information on the chain of custody.

SOP–14 AIR SAMPLING—SUMMA CANISTERS

The following standard operating procedures (SOPs) will be used by staff conducting sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Air samples are collected from ambient air and from remediation system air streams for analysis of chemical parameters using on-Site or off-Site laboratory analytical methods. Air sample sources will be purged using a vacuum pump when necessary. When using a Summa canister, a vacuum pump is not necessary for sample collection since the canisters are under pressure. When the valve on the canister is opened, air is sucked in through the valve until pressure has equalized inside and outside the canister. Depending on the sample, this equalization can take place over several seconds or be regulated over a specified period of time. Both types of samples are explained below.

2.0 EQUIPMENT LIST

1. Air Sampling Field Form, other appropriate Site-specific form(s), and field logbook with indelible pens
2. Vacuum gauge reading 0 to 30 inches of Hg.
3. 9/16 inch crescent wrench
4. Particulate filter (7 Micron)
5. Summa canister
6. Flow regulator (if needed)
7. Photoionization detector
8. Site map and Site health and safety plan (SSHP), if applicable
9. PPE appropriate for Site (see SSHP if applicable)

3.0 PROCEDURES

Grab Sampling Procedures

1. Properly site the canister. If sampling ambient air, the canister should be placed in the breathing space, approximately 4 to 5 feet above the ground surface. If

sampling a remediation system air stream, connect the canister using clean tubing. Prior to collecting a sample, verify and record the vacuum of the canister with a vacuum gauge. Canisters should have a vacuum of at least 25" of Hg when deployed. Any vacuum less than that (e.g. -20") indicates a possible leak, and the canister should not be used. The canister should be kept out of direct sunlight. Place a duplicate sample canister, if necessary, at the same time and follow the procedures for both.

2. Using a 9/16” wrench, remove the brass cap above the valve on top of the Summa Canister.

3. Attach the 7 micron filter to the canister valve.

4. Open valve ½ turn and wait approximately 30 seconds. A 6L canister normally takes 16 seconds to fill.

5. Verify and record the final vacuum of the canister. At the end of the designated sample collection period, return to the sample location and close the valve by turning clockwise. Be sure to measure and record the canister pressure to verify that a sample has been collected in the canister. At the end of sampling, canisters should have a vacuum no greater than -5". If the vacuum exceeds -9" (e.g. -15"), inform the Environmental Consultant before submitting the sample. Replace brass cap and tighten gently with 9/16” wrench.

6. Record the date, time, location, serial number of the canister, serial number of the flow controller, and final canister pressure on the field data sheet. Make any notes regarding sample location that will potentially influence the VOC sample collection.

7. Measure and record temperature, barometric pressure, wind speed, wind direction, and humidity. Record the general weather conditions such as percent cloud cover and precipitation. Note if there has been precipitation during the last 12 hours.

8. Replace the brass cap.

9. Attach the completed sample label to the canister and record the sample information on the chain of custody. (The sample label should be a hang tag and NOT a self adhesive label glued onto the canister.)

Time-Integrated Sampling Procedures

The following procedures are followed during air sampling using a 24-hour flow controller on a summa canister that has been properly evacuated and pressurized by the laboratory.

1. Properly site the canister and verify the vacuum with a vacuum gauge. Canisters should have a vacuum of at least 25" of Hg when deployed. Any vacuum less than that (e.g. -20") indicates a possible leak, and the canister should not be used. The canister should be kept out of direct sunlight. Place a duplicate sample canister, if necessary, at the same time and follow the procedures for both.

2. Using a 9/16” wrench, remove the brass cap above the valve on top of the Summa Canister.

3. Attach the 7 micron filter to the canister valve.

4. Attach the flow controller device to the top of the canister. The analytical laboratory presets the flow controller. The black knob at the top of the controller should not be touched! Tighten down with your fingers first, then tighten gently **(1/16 turn)** with a 9/16” wrench. It is essential that all connections between the canister and the flow controller be tight enough so that the pieces cannot be rotated by hand.

5. When ready, open the canister valve(s). Turn the green knob approximately 1/2 turns counterclockwise.

6. Document the date, time, location, serial number of the canister, serial number of the flow controller, and canister pressure on the field data sheet. Make any notes regarding sample location that will potentially influence the VOC sample collection.

7. Measure and record temperature, barometric pressure, wind speed, wind direction, and humidity. Record the general weather conditions such as percent cloud cover and precipitation. Note if there has been precipitation during the last 12 hours.

8. At the end of the designated sample collection period, return to the sample location and close the valve by turning clockwise. Be sure to measure and record the canister pressure to verify that a sample has been collected in the canister. At the end of sampling, canisters should have a vacuum no greater than -5". If the vacuum

exceeds -9" (e.g. -15"), inform the Environmental Consultant before submitting the sample. Replace brass cap and tighten gently with 9/16” wrench.

9. Note and record the time the valve was turned off on the canister along with the same information regarding both the canister and the location conditions as above and record on the field data sheet.

10. Attach the completed sample label to the canister and record the sample on the chain of custody. Attach the completed sample label to the canister and record the sample information on the chain of custody. (The sample label should be a hang tag and NOT a self adhesive label glued onto the canister.)

SOP–15 LWMS WASTEWATER, NAPL, AND SOLIDS SAMPLING

The following standard operating procedures (SOPs) will be used by staff conducting LWMS sampling procedures at the East Gate Disposal Yard in Fort Lewis, Washington.

1.0 PURPOSE

Wastewater and NAPL samples are collected from the LWMS for analysis of physical and chemical parameters to evaluate and optimized LWMS operation. Samples are analyzed using field-portable equipment, on-Site laboratory analytical methods, or off-Site laboratory analytical methods. Sample ports are purged prior to sample collection to ensure that samples are representative of the process stream or tank. Solids may be generated during maintenance of the LWMS. These solids will require sampling and analysis prior to disposal.

2.0 EQUIPMENT LIST

1. LWMS Sampling Field Form, other appropriate Site-specific form(s), and field logbook with indelible pens (see Field Documentation)
2. LWMS piping and instrumentation diagram (P&ID) and Site safety and health plan (SSHP), if applicable
3. Decontamination equipment (see Decontamination SOP and field sampling plan for additional Site-specific requirements)
4. PPE appropriate for Site (see SSHP if applicable)
5. Field water quality monitoring equipment (see Field Measurement of Groundwater Parameters SOP)
6. Buckets or other containers for purged water and NAPL
7. Sample containers, labels, packaging material (Sample Handling SOP)

3.0 PROCEDURE FOR WATER OR NAPL SAMPLING

1. Assemble all equipment and a list of required sampling points
2. Open sample valve and allow water or NAPL to drain into a waste bucket for at least 5 seconds

3. Close the sample valve

4. Fill appropriate sample containers with sample from the sample valve

5. Samples will be handled according to procedures in SOP Sample Handling. All the sample bottles will be properly labeled, protected from breakage, and hand delivered to the on-Site laboratory within 1 hour of sample collection. In the case of off-Site laboratory analysis, samples will be stored on ice and shipped to the off-Site laboratory within 48 hours of collection.

6. Field parameters will be measured using field probes (e.g., pH) or colorimetric test kits (e.g., Chemetrics dissolved oxygen test kit). To conduct each measurement, fill a clean sample container with sample and immediately analyze the sample for the desired field parameter. In the case of dissolved oxygen, it is especially critical to collect the sample while minimizing contact with air and then to immediately conduct the analysis.

7. Pour waste water into surge tank T-001

8. Pour waste NAPL into NAPL storage tank T-002

9. Decontaminate sampling equipment as described in the Decontamination SOP.

10. Complete field documentation according to procedures in SOP Field Documentation. All field observations made and data generated in conjunction with the sample collection will be entered on the LWMS Sampling Field Form, dated, and signed by the field personnel. Complete the chain-of-custody documentation after samples are collected.

4.0 PROCEDURE FOR SOLIDS SAMPLING

1. Assemble all equipment

2. Scrape or otherwise transfer solids to an appropriate sample container with sample

3. Samples will be handled according to procedures in SOP Sample Handling. All the sample jars will be properly labeled, protected from breakage, and hand delivered to the on-Site laboratory within 1 hour of sample collection. In the case of off-Site laboratory analysis, samples will be stored on ice and shipped to the off-Site laboratory within 48 hours of collection.

4. Decontaminate sampling equipment as described in the Decontamination SOP.

5. Complete field documentation according to procedures in SOP Field Documentation. All field observations made and data generated in conjunction with the sample collection will be entered on the LWMS Sampling Field Form, dated, and signed by the field personnel. Complete the chain-of-custody documentation after samples are collected.

SOP–16 DRILLING AND SOIL LOGGING

Air rotary drilling will be used to install the in-situ remediation components. No samples will be collected during drilling so all lithologic logging will be done through examination of the drill cuttings, noting the drilling characteristics (slow and hard versus fast and easy) and recording the elevation at which these observations are made. In examining the cuttings, it will be possible to identify the soil type, although not the bedding characteristics, such as thin bedding planes or thin layers of different material interbedded. It is important to note drilling rates for a relative density and note any problems during drilling (such as heaving sands or large boulders). Communication with the driller is important to record any observations made during drilling that aren't evident by observation.

All of the above observations are made on a boring log, following the procedures below. While logging, it should be made clear at the top of each log that no undisturbed soil samples are being collected and that the log is completed by observing cuttings and through drilling characteristics.

1.1 Boring Logs

In a drilling investigation, a Boring Log should be completed by the Site geologist. The information that should be included on the Boring Log is as follows:

- the boring number and/or monitoring well number
- drilling method and borehole diameter
- dates of start and completion of boring/well
- weather conditions
- sampling methods (if applicable)
- depths to water while drilling
- total depth of boring
- drilling characteristics (e.g., penetration rates, voids encountered)
- drilling contractor and names of drillers and helpers
- geologist name and affiliation
- lithologic description of collected samples and cuttings, as discussed below, such as density, moisture, color, modifier, soil classification including percentages of granular constituents, other macroscopic characteristics including structures, organic materials, oxidation mottling, etc.

- sample recovery, identification, and time
- number of containers collected and volume of each container
- odors, obvious contamination, or anything that could influence sample results
- field volatile (headspace) readings obtained from closed-bag samples (see Field Volatile [Headspace] Screening SOP), as well as borehole readings
- monitoring well "as-built" information (construction details)
- start card number if applicable

The system of lithologic description to be used at the Site is the Unified Soil Classification System (USCS). Generally soils are described based on the following parameters:

- major soil constituents will be capitalized with granular soils given relative size descriptions,
- soil classification (USCS Soil Group Symbol, e.g., SP),
- density (based on split-spoon blow counts or manual determination),
- moisture,
- color (including mottling, stringers, color changes),
- percent varying grain sizes,
- other macroscopic characteristics such as sorting,
- stratification,
- sphericity and roundness of grains, and
- soil modifier.

Each sample is described on the standardized field Boring Log Form.

APPENDIX C

Example Field Forms

GROUNDWATER SAMPLING FIELD FORM

TAC02 – EGDY *In-Situ* Thermal Remediation

SAMPLING DATE _____
MONITORING LOCATION ID _____

START TIME _____
FIELD PERSONNEL _____
WEATHER CONDITIONS _____

INITIAL SAMPLING DATA
Depth to Water Level _____ feet Measured at Transducer Monitoring Station

LOCATION CONDITION (Circle Condition)

Oversleeve Condition	OK	NA	Needs Repairs	Repaired
Cooling Coil Condition	OK	Crimped	Needs Repairs	Repaired

Recommended Well Repairs: _____

PURGE PARAMETERS
Instrument: _____ **Instrument Calibration Date and Time:** _____

Volume Purged (Liters or gallons)	Time (0000 – 2359)	Temperature (°C)	pH	Specific Conductivity (mS or μS)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTUs)

Total Volume Purged: _____ **gallons/liters**

SAMPLING AND ANALYSIS INFORMATION

Sample ID	Date & Time	Bottles Size	Bottles Total Number	Preservative	Destination Laboratory	Sample Transporter	Analytical Parameters and/or EPA Methods

Chain-of-Custody Number(s): _____
Deviations/Observations: _____

CERTIFICATION STATEMENT
By signing below, the listed sampler states that the information provided on these pages is accurate.

Sampler (Print) _____

Sampler Signature_____

Date Signed_____

WASTE WATER SAMPLING FIELD FORM
PAGE 1 OF 1

PROJECT NAME _____
PROJECT NUMBER _____
SAMPLING DATE _____
MONITORING LOCATION ID _____

START TIME _____
FIELD PERSONNEL _____
WEATHER CONDITIONS _____

Sampling Location	Sample ID	Sampling Date & Time	Temp (°C)	pH	Specific Conductivity (mS or μS)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTUs)

SAMPLING AND ANALYSIS INFORMATION

Sample ID	Date & Time	Bottles Size	Bottles Total Number	Preservative	Destination Laboratory	Sample Transporter	Analytical Parameters and/or EPA Methods

Chain-of-Custody Number(s): _____

Deviations/Observations: _____

_____

CERTIFICATION STATEMENT
By signing below, the listed sampler states that the information provided on these pages is accurate.

Sampler (Print) _____

Sampler Signature_____

Date Signed_____

AIR SAMPLING FIELD FORM
PAGE 1 OF 1

PROJECT NAME _____
PROJECT NUMBER _____
SAMPLING DATE _____
MONITORING LOCATION ID _____

START TIME _____
FIELD PERSONNEL _____
WEATHER CONDITIONS _____

LOCATION CONDITION AND SAMPLING CONTAINER

Type of Sampling Port:	
Does Sampling Location Need Repairs?	
Recommended Repairs:	
Sampled Stream Under Vacuum	
Sampled Stream Under Pressure	
Tedlar Bag	
Suma Canister	

SAMPLING DATA

PID Calibration Standard		PID (ppm) Standard	
PID Calibration Date	PID Calibration Time	PID (ppm) Background	

Date of Measurement		Time of Measurement
Measurement	Units	Notes
Piping Diameter	inches	Piping Material:
Vacuum (Indicate Units)		Measured Using:
Differential Pressure (dp) (Indicate Units)		Measured Using:
Flow (Indicate Units)		Measured Using:
Temperature	°C	Measured Using:
VOCs in Tedlar Bag	ppm	Measured Using: PID

SAMPLING AND ANALYSIS INFORMATION

Sample ID	Date & Time	Container Type	Container Size	Preservative	Destination Laboratory	Sample Transporter	Analytical Parameters and/or EPA Methods

Chain-of-Custody Number(s): _____

Deviations/Observations: _____

_____

CERTIFICATION STATEMENT
By signing below, the listed sampler states that the information provided on these pages is accurate.

Sampler (Print) _____

Sampler Signature_____

Date Signed_____

NAPL SAMPLING FIELD FORM
PAGE 1 OF 1

PROJECT NAME _____
PROJECT NUMBER _____
SAMPLING DATE _____
MONITORING LOCATION ID _____

START TIME _____
FIELD PERSONNEL _____
WEATHER CONDITIONS _____

Sampling Location ID	Sample ID	Sampling Date & Time	Sampling Time

SAMPLING AND ANALYSIS INFORMATION

Sample ID	Bottles Size	Bottles Total Number	Preservative	Destination Laboratory	Sample Transporter	Analytical Parameters and/or EPA Methods

Chain-of-Custody Number(s): _____

Deviations/Observations: _____

_____

CERTIFICATION STATEMENT
By signing below, the listed sampler states that the information provided on these pages is accurate.

Sampler (Print) _____

Sampler Signature _____

Date _____

SOLIDS SAMPLING FIELD FORM
PAGE 1 OF 1

PROJECT NAME _____
PROJECT NUMBER _____
SAMPLING DATE _____
MONITORING LOCATION ID _____

START TIME _____
FIELD PERSONNEL _____
WEATHER CONDITIONS _____

Sampling Location ID	Sample ID	Sampling Date & Time	Sampling Time

SAMPLING AND ANALYSIS INFORMATION

Sample ID	Bottles Size	Bottles Total Number	Preservative	Destination Laboratory	Sample Transporter	Analytical Parameters and/or EPA Methods

Chain-of-Custody Number(s): _____

Deviations/Observations: _____

_____

CERTIFICATION STATEMENT
By signing below, the listed sampler states that the information provided on these pages is accurate.

Sampler (Print) _____

Sampler Signature _____

Date _____

APPENDIX D

Laboratory Data Quality Objectives and Measurement Quality Objectives

Table D-1
PSCAA ASILs and TO-15 Detection and Reporting Limits

Parameter	PSCAA ASIL ($\mu g/m^3$)	CAS MDL (SIM) ($\mu g/m^3$)	CAS MDL (TO-15) ($\mu g/m^3$)	CAS MRL (TO-15) ($\mu g/m^3$)
1,1-Dichloroethene	67	0.003	0.2	1.0
cis-1,2-Dichloroethene	2600	0.003	0.1	1.0
trans-1,2-Dichloroethene	2600	0.004	0.1	1.0
Tetrachloroethene	1.1	0.004	0.2	1.0
1,1,1-Trichloroethane	6400	0.005	0.2	1.0
Trichloroethene	0.59	0.004	0.1	1.0
Vinyl chloride	0.012	0.006	0.1	1.0

ASIL - Acceptable Source Impact Level
CAS - Columbia Analytical Services, Inc.
MDL - Method Detection Limit
MRL - Method Reporting Limit
PSCAA - Puget Sound Clean Air Agency
SIM - Selected Ion Monitoring
$\mu g/m^3$ - micrograms per cubic meter

Table D-2
Method Detection and Method Reporting Limits

Parameter	Sampling Media	Sample Location(s)	Initial Monitoring Frequency (a)	Sensitivity Required (b)	Laboratory Detection Limits (b)	Laboratory Reporting Limits (b)
Field Instrument Analysis						
Total VOCs	Air	Oxidizer Inlet (OXIN)	Daily	1 ppm	1 ppm as isobutylene	NA
		Scrubber Stack (OXSS)	Daily			
		Main Sparge Tank Stack (MSTS)	Daily			
		At the compound	Weekly			
		Perimeter Monitoring	Weekly			
Field Portable Analytical, Inc. Data, Near Real Time Laboratory, 24 hour Turnaround Time						
TCE	**Untreated Air**			24,000 µg/m^3	270 µg/m^3	270 µg/m^3
DCE		Oxidizer Inlet (OXIN)	Daily	24,000 µg/m^3	200 µg/m^3	200 µg/m^3
TCA				24,000 µg/m^3	270 µg/m^3	270 µg/m^3
PCE	Mixed Vapor/Water	MPE Regions (MPENW, etc)	Weekly	24,000 µg/m^3	340 µg/m^3	340 µg/m^3
VC				24,000 µg/m^3	130 µg/m^3	130 µg/m^3
TCE	**Treated Air**			1,000 µg/m^3	270 µg/m^3	270 µg/m^3
DCE		Main Sparge Tank Stack (MSTS)	Weekly	1,000 µg/m^3	200 µg/m^3	200 µg/m^3
TCA		Scrubber Stack (OXSS)	Weekly	1,000 µg/m^3	270 µg/m^3	270 µg/m^3
PCE				1,000 µg/m^3	340 µg/m^3	340 µg/m^3
VC				1,000 µg/m^3	130 µg/m^3	130 µg/m^3
TCE	**Untreated Groundwater**	20 Monitoring Wells	Bimonthly	5 µg/L	0.5 µg/L	5.0 µg/L
DCE		HCW Extraction	Weekly	70 µg/L	0.5 µg/L	5.0 µg/L
TCA		Discharge of O/W separator (OWSDW)	Weekly	200 µg/L	0.5 µg/L	5.0 µg/L
PCE		Discharge of NAPL sparge tank (NSTDW)	Weekly	5 µg/L	0.5 µg/L	5.0 µg/L
VC				2 µg/L	0.2 µg/L	2.0 µg/L
TCE	**Treated Groundwater**			0.5 µg/L	0.5 µg/L	5.0 µg/L
DCE		HCW extraction that bypasses treatment	Weekly	7 µg/L	0.5 µg/L	5.0 µg/L
TCA		Treated infiltration water prior to injection	Weekly	20 µg/L	0.5 µg/L	5.0 µg/L
PCE				0.5 µg/L	0.5 µg/L	5.0 µg/L
VC				0.2 µg/L	0.2 µg/L	2.0 µg/L
TCE	NAPL	Combined system influent	As Required	(c)	(c)	(c)
DCE						
TCA						
PCE						
VC						
Columbia Analytical Services, Inc. Data, Off-Site (Fixed) Laboratory, 72 hour Turnaround Time						
TCE	Air	QC splits of primary lab samples	As Required	1,000 µg/m^3	0.1 µg/m^3	1.0 µg/m^3
DCE		Oxidizer Discharge Stack	Monthly	1,000 µg/m^3	0.1 µg/m^3	0.5 µg/m^3
TCA				1,000 µg/m^3	0.2 µg/m^3	1.0 µg/m^3
PCE				1,000 µg/m^3	0.2 µg/m^3	1.0 µg/m^3
VC				1,000 µg/m^3	0.1 µg/m^3	0.5 µg/m^3
TCE	Air	Perimeter Monitoring	First 3 consecutive days of operation, then monthly	0.59 µg/m^3	0.1 µg/m^3	1.0 µg/m^3
DCE				2600 µg/m^3	0.1 µg/m^3	0.5 µg/m^3
TCA				6400 µg/m^3	0.2 µg/m^3	1.0 µg/m^3
PCE				1.1 µg/m^3	0.2 µg/m^3	1.0 µg/m^3
VC				0.012 µg/m^3	0.1 µg/m^3	0.5 µg/m^3
TCE	Groundwater	QC splits of primary lab samples	As Required	5.0 µg/L	0.2 ug/L	0.5 ug/L
DCE	Water			70 µg/L	0.2 ug/L	0.5 ug/L
TCA	Mixed Vapor/Water			200 µg/L	0.2 ug/L	0.5 ug/L
PCE				5.0 µg/L	0.2 ug/L	0.5 ug/L
VC				2.0 µg/L	0.3 ug/L	0.5 ug/L
TCE	NAPL	NAPL Storage Tank	1 time event per area for characterization	(c)	(c)	(c)
DCE						
TCA						
PCE						
VC			As needed for disposal			
SVOCs						
Total Halogens						
RCRA Metals (d)						
Flash Point			Monthly for mass removal	± 5°C	NA	NA
pH				0.5 units	NA	NA
HCl	Mixed Vapor/Water	Air Treatment System Effluent	1 time event per area	10 ppmv (e)	0.06 mg/L	0.2 mg/L
Chloride	Water	Water Treatment System Effluent	Weekly	1 mg/L	0.06 mg/L	0.2 mg/L
TDS				100 mg/L	5 mg/L	5 mg/L

(a) Monitoring Frequency may be adjusted based on analytical results, and following principles of dynamic field activities.
(b) Based on undiluted samples. Achievable values depend on concentrations of target analytes and matrix related nontarget compounds.
On-site laboratory has indicated that reporting limits and sensitivity requirements (per contract specifications) are achievable, but may need adjustment based on field conditions.
(c) Achievable values depend on concentrations of target analytes and matrix related nontarget compounds.
(d) Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver
(e) Calculated concentration is a function of analytical reporting limit and volume of air sampled. Sufficient air will be sampled to ensure that the sensitivity goal of 10 ppmV is achieved.

Abbreviations and Acronyms

VOCs - Volatile Organic Compounds
SVOCs - Semivolatile Organic Compounds
TCE - Trichloroethene
DCE - Dichloroethene
TCA - 1,1,1-Trichloroethane
PCE - Tetrachloroethene
VC - Vinyl Chloride
GW - Groundwater
NAPL - Non-Aqueous Phase Liquid
HCl - Hydrogen Chloride
TDS - Total Dissolved Solids
ppm - parts per million
µg/m^3 - micrograms per cubic meter
µg/L - micrograms per liter
mg/Kg - milligrams per kilogram
NA - Not Applicable
ppmv - parts per million by volume

Table D-3
Summary of Measurement Quality Objectives

EPA Method 8260B VOCs

QC Element	Target Analyte/Surrogate	Frequency of Implementation	Sporadic Marginal Failures
Performance Check Standard	Instrument meets BFB mass spectral ion abundance criteria per method tuning requirements.	Daily (Once for each 12-hour shift)	No allowance.
ICAL	**Instrument Evaluation:** System performance check compounds (SPCCS): minimum response factor (RF) values per method requirements.[1] Calibration check compounds (CCCs)[2]: verify % RSD ≤ 30% Target analytes: Verify %RSD ≤ 15% for average RF calibration or r ≥ 0.99 and line not forced through the origin for linear calibration.	As needed	No allowance.
ICV	80%-120% recovery	After ICAL	No allowance.
CCV	Instrument Evaluation SPCCs: minimum RF values per method requirements. Primary evaluation (CCCs and target analytes): %Drift (%D) < 20%	Beginning of analytical sequence	No allowance.
MB	Target analytes: Analytes < 1/2 MRL	1 per sample batch[3]	Common lab contaminants: Analytes < MRL.
Trip Blank	No detectable target analytes	1 per day, per sample matrix	
LCS	All target analytes must be present in the spiking mixture. %Rec = 80%-120%	Minimum of 1 per sample batch[3]	Sporadic marginal failures: %Rec = 60% - 140%
LCS/LCSD	RPD ≤ 20%		No allowance.
CRMs/PEs	Manufacturer's 95% CI	20 Total PE samples per treatment area (10 air/10 water)	No allowance.
MS	All target analytes must be present in the spiking mixture. %Rec = 70%-130%	Minimum of 1 per sample batch[3]	Sporadic marginal failures: %Rec = 60% - 140%
MS/MSD	RPD ≤ 30%		RPD ≤ 40%
Field Duplicates	RPD ≤ 30% for aqueous samples RPD ≤ 25% for air samples	5% (1 in 20) per sample matrix	
Split Sample	RPD ≤ 30%	10% (1 in 10 samples submitted to the NRT lab) per matrix	
Surrogates	Interference-free matrix: %Rec = 80%-120% Project sample matrix: %Rec = 70% - 130%	Every sample and standard	Not applicable.
Internal Standards	Area = 50%-200% of area from last passing CCV	Every sample and standard	No allowance.

[1] Chloromethane, 1,1-Dichloroethane, Bromoform = 0.10; Chlorobenzene, 1,1,2,2-Tetrachloroethane = 0.30
If SPCCs are not present in the calibration mixture, RF values for all analytes must be greater than 0.05.

[2] 1,1-Dichloroethene, Chloroform, 1,2-Dichloropropane, Toluene, Ethylbenzene, Vinyl chloride

[3] Twenty or fewer field samples analyzed within the 12-hour BFB window

Table D-3
Summary of Measurement Quality Objectives

EPA Method TO-15 VOCs

QC Element	Target Analyte/Surrogate	Frequency of Implementation	Sporadic Marginal Failures
Performance Check Standard	Instrument meets BFB mass spectral ion abundance criteria per method tuning requirements.	Daily	No allowance.
ICAL	Target analytes: %RSD < 30% for each compound present in the calibration. Internal Standards: Area response ± 40% of the mean area response over the entire calibration range. RT shift within 20 seconds of the mean RT over the entire calibration range.	As needed	No allowance.
ICV	70%-130% recovery	After ICAL	No allowance.
CCV	%Drift (%D) ± 30% for all target analytes	Beginning of analytical sequence	No allowance.
MB	Internal Standards: Area response ± 40% of the mean area response from the most recent valid calibration. RT ± 0.33 minutes from RT in the most recent valid calibration. Target analytes: Analytes < QL (3*MDL)	1 per sample batch[1]	No allowance.
Trip Blank	No detectable target analytes	1 tedlar bag per day	
LCS	All target analytes must be present in the spiking mixture. %Rec = 70%-130%	Minimum of 1 per sample batch[1]	No allowance.
LCS/LCSD	RPD ≤ 25%		No allowance.
CRMs/PEs	Manufacturer's 95% CI	10 Total air PE samples per treatment area	No allowance.
Lab Duplicate	RPD ≤ 25%	1 per sample batch[1]	No allowance.
Field Duplicate	RPD ≤ 25%	5% (1 per 20 field samples)	
Split Sample	RPD ≤ 30%	10% (1 in 10 samples submitted to the NRT lab)	
Surrogates	Interference-free matrix: %Rec = 80%-120% Project sample matrix: %Rec = 70% - 130%	Every sample and standard	Not applicable.
Internal Standards	Area response ± 40% of the area response from the most recent valid calibration standard. RT ± 20 seconds from RT in the most recent valid calibration standard.	Every sample and standard	No allowance.

[1] Twenty or fewer field samples analyzed within the 24-hour BFB window

Table D-3
Summary of Measurement Quality Objectives

EPA Method 8270 SVOCs

QC Element	Target Analyte/Surrogate	Frequency of Implementation	Sporadic Marginal Failures
Performance Check Standard	Instrument meets DFTPP mass spectral ion abundance criteria per method tuning requirements. DDT degradation < 20%. Benzidine and PCP should not show any tailing.	Daily (Once for each 12-hour shift)	No allowance.
ICAL	**Instrument Evaluation:** System performance check compounds (SPCCS): minimum response factor (RF) values per method requirements.[1] Calibration check compounds (CCCs)[2]: verify % RSD ≤ 30% Primary Evaluation (all target analytes): %RSD ≤ 15%, r ≥ 0.995, r^2≥0.990, and line not forced through the origin Alternate Evaluation: Mean %RSD for all target analytes ≤ 15%, with maximum allowable restriction noted at right for individual analytes.	As needed	No allowance. No allowance. Alternate Evaluation: Maximum allowable %RSD for each individual target analyte ≤ 40%.
ICV	70%-130% recovery	After ICAL	No allowance.
CCV	Instrument Evaluation SPCCs: minimum RF values per method requirements. Primary evaluation (CCCs and target analytes): %Drift (%D) < 20%	Daily	No allowance. No allowance.
MB	Target analytes: Analytes < 1/2 MRL	1 per sample batch	Common lab contaminants: Analytes < MRL.
LCS	Water: %Rec = 60%-120% (~15 analytes) %Rec = 45%-135% (~35 analytes) %Rec = 20%-150% (~15 analytes) Solids: %Rec = 60%-120% (~20 analytes) %Rec = 45%-135% (~25 analytes) %Rec = 30%-150% (~15 analytes)	Minimum of 1 per sample batch[3]	Sporadic marginal failures: Water: %Rec = 15%-150% Solids:%Rec = 25%-150%
MS	%Rec = 45%-135%	Minimum of 1 per sample batch[3]	Sporadic marginal failures: Water: %Rec = 15%-150% Solids:%Rec = 20%-150%
MS/MSD	Water : RPD ≤ 50% Solids: RPD ≤ 60%		Sporadic marginal failures: RPD ≤ 60%
Surrogates	Interference-free matrix: Water: %Rec = 60%-120% B/N cmpds %Rec = 45%-135% A cmpds Solids: %Rec = 60%-120% B/N cmpds %Rec = 45%-135% A cmpds Project sample matrix: %Rec = 45%-135% B/N cmpds %Rec = 35%-140% A cmpds	Every sample and standard	Sporadic marginal failures: Water: %Rec = 15%-150% Solids:%Rec = 20%-150%
Internal Standards	Area = 50%-200% of area from last passing CCV	Every sample and standard	No allowance.

[1] N-nitroso-di-n-propylamine, Hexachlorocyclopentadiene, 2,4-Dinitrophenol, 4-Nitrophenol = 0.05(

[2] Acenaphthene, 1,4-Dichlorobenzene, Hexachlorobutadiene, Diphenylamine, Di-n-octyl phthalate, Fluoranthene, Benzo(a)pyrene, 4-Chloro-3-methylphenol, 2,4-Dichlorophenol, 2-Nitrophenol, Phenol Pentachlorophenol, 2,4,6-Trichlorophenol

[3] 20 or fewer field samples extracted together.

Table D-3
Summary of Measurement Quality Objectives

EPA Method 6010/6020 ICP Metals

QC Element	Description of Element	Frequency of Implementation	Acceptance Criteria
ICAL	Option 1: 1 Std and Blk, and a low level check std at MQL Option 2: 3 Stds and a Blk	Daily	Option 1: Low level check Std ± 20% Option 2: r ≥ 0.995
Instrument Precision	%RSD 3 integrations (exposures)	Each ICV and CCV	%RSD < 5%
ICV	Midlevel (2nd source) verification	After ICAL	%Recovery ± 10%
ICB	Interference-free matrix to assess analysis contamination	After ICAL	Analytes < MDL
ICS	ICS-A: interferents only ICS-B: interferents and target analytes	Beginning of analytical sequence	%Recovery ± 20% for target analytes
CCB	Interference-free matrix to assess analysis contamination	Every 10 samples and at end of analytical sequence	Analytes < MDL
CCV	Midlevel verification	Every 10 samples and at end of analytical sequence	%Recovery ± 10%
MB	Interference-free matrix to assess overall method contamination	1 per sample batch	Analytes < one-half MRL
LCS	Interference-free matrix containing all target analytes	1 per sample batch	%Recovery = 80%-120% Sporadic marginal failures: %Recovery = 60%-140%
MS	Sample matrix spiked with all target analytes prior to digestion	1 per sample batch	%Recovery = 75%-125%
MD or MSD		1per sample batch	RPD ≤ 25%
PDS	Sample digestate spiked with all target analytes	1 per sample batch on MS sample	%Recovery = 75%-125%
SD	1:4 dilution analyzed to assess matrix effects	As needed to assess new and unusual matrices	Agreement between undiluted and diluted results ± 10%
MSA	Method of quantitation	As needed for samples with suspected or confirmed matrix effects	r ≥ 0.995

Summary of Measurement Quality Objectives
EPA Methods 7470/7471 CVAA Mercury

QC Element	Description of Element	Frequency of Implementation	Acceptance Criteria
ICAL	5 stds and blank	Daily	r ≥ 0.995
Instrument Precision	RPD of 2 injections	All standards, and ICV/CCV	RPD ± 10%
ICV	Midlevel (2nd source) verification	After ICAL	%Recovery ± 10%
ICB	Interference-free matrix to assess analysis contamination	After ICAL	Analytes < MDL
CCB	Interference-free matrix to assess analysis contamination	Every 10 samples and at end of analytical sequence	Analytes < MDL
CCV	Midlevel verification	Every 10 samples and at end of analytical sequence	%Recovery ± 20%
MB	Interference-free matrix to assess overall method contamination	1 per sample batch	Analytes < one-half MRL
LCS	Interference-free matrix containing target analytes	1 per sample batch	%Recovery = 80%-120%
MS	Sample matrix spiked with target analytes prior to digestion	1 per sample batch	%Recovery = 80%-120%
MD or MSD		1 per sample batch	RPD ± 20%
PDS	Sample digestate spiked with target analytes	Every sample	%Recovery = 85%-115%
SD	1:4 dilution analyzed to assess matrix effects	As needed to assess new and unusual matrices	Agreement between undiluted and diluted results ± 10%
MSA	Method of quantitation	As needed for samples with suspected or confirmed matrix effects	r ≥ 0.995

Table D-3
Summary of Measurement Quality Objectives

EPA Method 300.0 Inorganic Ions by Ion Chromatography

QC Element	Description of Element	Frequency of Implementation	Acceptance Criteria
ICAL	3 standards and a blank	Daily	
ICB	Interference-free matrix to assess analysis contamination	After ICAL	Analytes < MDL
ICV	Midlevel (2nd source) verification	After ICAL	%Recovery ± 10%
CCV	Midlevel verification	After each 10 or fewer samples and at the end of the sample run	%Recovery ± 10%
CCB	Interference-free matrix to assess analysis contamination	After each 10 or fewer samples and at the end of the sample run	Analytes < MDL
MB	Interference-free matrix to assess overall method contamination	1 per sample batch	Analytes < MDL
LCS	Interference-free matrix containing target analytes	1 per sample batch	%Recovery = 90%-110%
MS	Sample matrix spiked with target analytes	1 per sample batch	%Recovery = 90%-110%
MD or MSD		1 per sample batch	RPD ± 20%

Summary of Measurement Quality Objectives
EPA Method 160.1 Total Dissolved Solids

QC Element	Description of Element	Frequency of Implementation	Acceptance Criteria
Balance Calibration	Checked against NIST-certified weights	Daily	
MB	Interference-free matrix to assess overall method contamination	Daily	Concentration < MDL
LCS	Interference-free matrix containing target analytes	Daily	%Recovery = 90%-110%
MD	Sample duplicate	Daily	RPD ± 20%

Method-specific measurement quality objectives will be used for EPA Method 1010 Flash Point and EPA Method 9045 pH

A cmpds = acid compounds
B/N cmpds = base/neutral compounds
BFB = 4-bromofluorobenzene
Blk = blank
CCB = continuing calibration blank
CCC = calibration check compounds
CCV = continuing caliobration verification
CI = confidence interval
CRM = certified reference material
%D = percent drift
DFTPP = decafluorotriphenylphosphine
ICAL = initial calibration
ICB = initial calibration blank
ICP = inductively coupled plasma
ICS = interelement check standard
ICV = initial calibration verification
IS = Internal Standards
LCS/LCSD = laboratory control sample/duplicate
MB = method blank
MD = matrix duplicate
MDL = method detection limit
MQL = method quantitation limit
MRL = method reporting limit
MSA = method of standard addition
MS/MSD = matrix spike/matrix spike duplicate
NRT = near real time
PCP = pentachlorophenol
PDS = post digestion spike
PE = performance evaluation sample
QL = quantitation limit
%Rec = percent recovery
RF = response factor
RPD = relative percent difference
RSD = relative standard deviation
RT = retention time
SD = serial dilution
SPCC = system performance check compound
SPCC = system performance check compound
Std = standard

Table D-4
Laboratory Method Summary

Field Portable Analytical, Inc. Analytical Procedures

ANALYTE	METHOD REFERENCE	PREPARATORY METHOD	CLEANUP METHOD	INSTRUMENT /DETECTOR
Trichloroethene (TCE) Dichloroethene (DCE) 1,1,1-Trichloroethane (TCA) Tetrachloroethene (PCE) Vinyl Chloride (VC)	Aqueous: EPA 8260B Air: EPA 8260B Mod	Aqueous: EPA 5030 Air: EPA 8260B Mod	Aqueous:Purge and Trap Air: Adsorbent trap	Inficon Hapsite GC/MS

Columbia Analytical Services, Inc. Analytical Procedures

ANALYTE	METHOD REFERENCE	PREPARATORY METHOD	CLEANUP METHOD	INSTRUMENT /DETECTOR
Trichloroethene (TCE) Dichloroethene (DCE) 1,1,1-Trichloroethane (TCA) Tetrachloroethene (PCE) Vinyl Chloride (VC)	Aqueous: EPA 8260B NAPL: EPA 8260B Air: EPA TO-15	Aqueous: EPA 5030 NAPL: EPA 3585 Air: EPA TO-15	Aqueous and NAPL: Purge and trap Air: Adsorbent trap	GC/MS
Semivolatile Organic Compounds (SVOCs)	EPA 8270C	EPA 3580A	EPA 3640/3650/3660	GC/MS
Metals by ICP-AES	EPA 6010B	EPA 3031/3051	Not Applicable	ICP-AES
Metals by ICP/MS	EPA 6020	EPA 3031/3051	Not Applicable	ICP/MS
Flash Point	EPA 1010	Not Applicable	Not Applicable	PMCC
pH	EPA 9045	Not Applicable	Not Applicable	pH electrode
Mercury	EPA 7471A	EPA 7471A	Not Applicable	CVAFS
Hydrogen Chloride (HCl)	EPA 300.0/9057	EPA 26/26A	Not Applicable	IC
Chloride	EPA 300.0	EPA 300.0	Not Applicable	IC
Total Dissolved Solids (TDS)	EPA 160.1	EPA 160.1	Not Applicable	Gravimetric

GC/MS = Gas Chromatograph/Mass Spectrometer
HP = Hewlett Packard
ICP-AES = Inductively Coupled Plasma-Atomic Emission Spectrometer
ICP/MS = Inductively Coupled Plasma/Mass Spectrometer
CVAFS = Cold Vapor Atomic Fluorescence Spectrophotometer
PMCC = Pensky-Martens Closed-cup
IC = Ion Chromatograph

APPENDIX E

On-Site Laboratory Standard Operating Procedures
and Quality Assurance Plan

Field-Portable Analytical, Inc.
6054 Garden Towne Way, Suite G, Orangevale, CA 95662 (916) 989-6200

VOC Analysis
by
Field-Portable GC/MS
Standard Operating Procedures

SOP #1
Rev. # 3

Effective Date: September 29, 1999

Written By: _____ Technical Review By:_____

1.0 Introduction

This SOP is a project specific SOP for the analysis of VOC's by field-portable Gas Chromatograph coupled with a Mass Spectrometer (GC/MS). The compounds listed in Table 1 have been evaluated and are suitable for analysis with this method.

2.0 Summary of the Method

Critical decisions are being made from the field analytical results. It is critical these results be definitive. Therefore GC/MS is the only way the analysis can be performed. This data will be provided within 30 minutes of receipt. If multiple samples are delivered at the same time, the highest priority sample will be delivered within 30 minutes. All other samples within 30 minutes consecutively in order of priority.

Table 1: Compounds Currently Verified

Compound	CAS Number	PQL ppmv	Quant Mass
Benzene	71-43-2	0.2	78
Carbon Tetrachloride	56-23-5	0.2	117
Chlorobenzene	108-90-7	0.2	112
Chloroform	67-66-3	0.2	83
1,2-Dibromoethane	106-93-4	0.2	107
Dichlorodifluoromethane (Fr12)	75-71-8	0.2	85
1,1-Dichloroethane	75-35-3	0.2	63
1,2-Dichloroethane	107-06-2	0.2	62
1,1-Dichloroethene	75-35-4	0.2	61
cis-1,2-Dichloroethene	156-59-2	0.2	61
trans-1,2-Dichloroethene	156-60-5	0.2	61
Ethyl Benzene	100-41-4	0.2	91
Methylene Chloride	75-09-2	0.2	49
Styrene	100-42-5	0.2	104
1,1,2,2-Tetrachloroethane	79-34-5	0.2	83
Tetrachloroethene	127-18-4	0.2	166
Toluene	108-88-3	0.2	91
1,1,1-Trichloroethane	71-55-6	0.2	97
1,1,2-Trichloroethane	79-00-5	0.2	97
Trichloroethene	79-01-6	0.2	95
Trichlorofluoromethane (Fr11)	75-69-4	0.2	101
Vinyl Chloride	75-01-4	0.2	62
o-Xylene	95-47-6	0.2	91
m-Xylene	108-38-3	0.2	91
p-Xylene	106-42-3	0.2	91
Acetone	67-64-1	0.5	58
Freon 113	76-13-1	0.2	135
n-Hexane	110-54-3	0.2	57
1,3,5-Trimethylbenzene	108-67-8	0.2	105
1,2,4-Trimethylbenzene	95-63-6	0.2	105
1,3-Butadiene	106-99-0	0.5	54
Cyclohexane	110-82-7	0.5	84
2,2,4-Trimethylpentane	540-84-1	0.5	57
Methyl tert-Butyl Ether	1634-04-4	0.2	73

2.0 Interference

Compounds which are not baseline-resolved (co-elute) with the other target analytes or internal standards/surrogates listed in Table 1 may be interferents. Generally, these co-eluting compounds can be separated by their mass fragmentation patterns. However, some compounds

may have fragment ions in their mass spectra, which are identical to the quantitation ion of a target analyte. This may produce a false positive or error in the reported concentration.

The software provides both a fit and purity measurement in full scan, GC/MS mode to indicate possible co-elution. If compounds co-elute and cannot be separated by their mass spectra, two remedies are possible: (1) the compounds are so similar that they may be reported as a total number. This is the case for m&p-Xylene (i.e. m&p-Xylene co-elute and have identical spectra). (2) A modification to the GC temperature may be sufficient to resolve the individual peaks. Co-elution has not been determined to be a problem with the halogentaed compounds listed in the method. Compounds that would present a problem are the aliphatic and olefin compounds found in petroleum products.

3.0 Safety

Safety is of utmost importance during all projects. On-site safety procedures established by the client will be adhered to at all time. It is the responsibility of *FPA* personnel to ensure they are aware of all safety procedures and hazards they may encounter on-site.

Proper personal protective equipment (PPE) including safety glasses, hard hats and steel- toed shoes will be worn when working directly at the drilling rig.

In addition to site specific and general field safety procedures, *FPA* personnel must adhere to standard safe laboratory practices. This includes:

- Maintenance and availability of Material Safety Data Sheets (MSDS)
- Use of appropriate PPE during the handling and preparation of standards
- Safe high pressure cylinder handling practices

Note: All hazardous, neat materials stored on-site must have a copy of the MSDS maintained on-site as well. This does not include working standards and standard mixtures.

4.0 Equipment and Supplies

4.1 Instrumentation

Inficon Hapsite GC/MS
Supelco SPB 1, 30m x .32mmid x 1.0*u* film column
Peripherals (Computer, Printer, Consumables, etc.)

4.2 Materials

1 Liter Tedlar Bags
Neat Liquid Standards
Nitrogen Regulator

1/8” Stainless Tubing
DI Water
Syringes: - 1ml, 5ml, 10ml, 50ml Teflon Luer Lock gastight

4.3 Gases

Carrier: Nitrogen 99.999% purity (for portable mode Inficon # 930-430)
Mass Calibration: Internal Standard 1 Inficon # 930-431 (50ppmv)
Bromopentafluorobenzene, 100ppmv 1,3,5 tris (trifluoromethyl) benzene

Instrument Parameters

4.4 GC Conditions

Column Temp.	60° C
Head Pressure	104 pa
Inlet Temp.	60° C
Probe Temp.	40° C
Valve Temp.	60° C
Run Time	10 Min.

4.5 MS Conditions

Scans/Sec.	1.04 scans/sec.
Getter Pump Temp.	400 - 480° C
Scan Range	45 - 250 amu

5.0 QA/QC Procedures

Table 2: Quality Control

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
BFB	Every 12 Hours	Ion Abundance Criteria as Described in TO-14	1) Reanalyze BFB 2) Adjust Tune Until BFB Meets Criteria
5 – Point (Minimum) Calibration	Prior to start of project or as required for acceptance criteria	%RSD ≤ 25%	Re-run Levels Which Do Not Meet Criteria
Continuing Calibration Check	Beginning of Each Day	± 30% Difference of the Initial Calibration 10% of total compounds outside limits	1) Repeat Analysis 2) Prepare and Run New Standard from Stock 3) Recalibrate
End Calibration Checks	End of Each Day	± 30%D of the Initial Calibration 10% of total compounds outside limits	1) Repeat Analysis 2) If End Check is Out, Flag Data for That Day
Duplicates	10% of the Samples	Relative Percent Difference ≤ 30%	1) Analyze a third Aliquot 2) Flag Reported Data
Method Blanks	After Beginning of Day CCC	Concentrations for All Calibrated Compounds < PQL	Re-run Blanks until Criteria are Met

7.1 Initial Calibration

The initial calibration will contain a minimum of 5 levels. The low level must be no more than 5 times the reporting limit. The highest level should encompass the linear range of the instrument or the highest concentration of the samples expected. Acceptance criteria for the initial calibration are 25% relative standard deviation (%RSD).

Corrective action for the initial calibration is to investigate the outlying level and reanalyze that level. If the problem is not corrected, it may be necessary to remake the standard or correct the problem with the instrument and reanalyze all levels.

7.2 Second Source Verification

The initial calibration will be confirmed by analyzing an independent certified solution containing several of the targets of interest. Acceptance criteria are 30%D compared to the initial calibration.

Corrective action for the Second Source is to reanalyze the standard. If it still does not meet the criteria, remake the Second Source standard from the stock and reanalyze. If criteria are still not met, repeat the initial calibration.

7.3 Continuing Calibration Verification

The continuing calibration standard is analyzed after the BFB Tune Check and before the analysis of any samples.

All compounds have a $\pm$ 30% Difference from the Initial Calibration. Only 10% of the total number of compounds can exceed these limits. All compounds must be within 50 to 150% Recovery.

Corrective action for the Continuing Calibration is to reanalyze the standard. If it continues not meet criteria, remake the standard from the stock and reanalyze. If criteria are still not met, repeat the Initial Calibration.

7.4 End Check

The end check is an end of the day calibration verification to demonstrate that the response of the instrument did not drift over the course of the day. It is the last analysis of the day. Criteria are 30%D compared to the Initial Calibration. Only 10% of the total number of compounds can exceed these limits. All compounds must be within 50 to 150% Recovery. The end check brackets all analyses for the day to demonstrate that the system was in control for those analyses.

Corrective action for the end check is to reanalyze the standard. If the criteria are still not met, flag the samples analyzed since the last valid standard.

7.5 Method Blank

The method blank should be analyzed after the continuing calibration and before any samples. A blank should also be analyzed after any sample with concentrations exceeding the calibration range by 10%. The blank acceptance criteria are that no compounds are detected above the reporting limit.

Corrective action for the method blank is to reanalyze the blank. If the system is still not clean, take actions to remove the contaminants and reanalyze the blank. The blank must be clean before proceeding unless agreed upon with the client.

7.6 Duplicates

Duplicate analyses should be performed on a frequency of 10% of the total samples. The sample chosen to duplicate should contain concentrations of targets if possible. The acceptance criteria are 30% relative percent difference (% RPD).

Corrective action for the duplicate is to reanalyze the sample. If criteria are still not met, results must be flagged.

7.7 GC/MS Tune Verification

The GC/MS tune must be verified at the beginning of each day by analyzing a standard containing Bromofluorobenzene (BFB). The acceptance criteria are listed in Table 3.

Table 3

Mass Fragment	Ion Abundance Criteria
50	15-40%
75	30-60%
95	Base Peak
96	5-9%
173	<2% (of mass 174)
174	50-100%
175	5-9% (of mass 174)
176	95-101% (of mass 174)
177	5-9% (of mass 176)

Corrective action for the tune verification is to reanalyze the BFB standard. If criteria are still not met, make adjustments to the tune until criteria are met. Analyses may not proceed until criteria are met.

7.8 Internal Standards

The internal standards are injected through the septum into each sample. Acceptance criteria for internal standards are –50 to +100% Recovery from the daily continuing calibration check.

Corrective action for internal standards is to rerun the sample unless matrix effects have been previously established. If criteria are not met, the data must be flagged.

7.9 Surrogates

The surrogates are injected through the septum into each sample. Acceptance criteria for the surrogates are 70 to 130% Recovery.

Corrective action for surrogate is to reanalyze the sample unless matrix effects have been previously established. If criteria are not met, the data must be flagged.

8.0 Detection Limits

To determine the method detection limits a 40 CFR 136, 1984 method detection limit (MDL) study will be performed. Seven replicates of the low standard are analyzed in succession. The standard deviation of these replicates is multiplied by the student's t at the 99% confidence level of 3.14. The final value is considered to be the method detection limit. See Section 4.0 for the calculation of this value. An initial MDL study will be performed during the set-up of the project or yearly in the case of routine compounds.

9.0 Procedure

9.1 Samples will be received in 1.0 liter Tedlar bags and will be accompanied with a chain of custody.

9.2 For analysis, the Tedlar bag is attached to the GC/MS sampling wand using a short piece of Teflon tubing and the sample information is logged into the computer. When the start button on the sampling wand is pressed, the internal pump pulls the sample through the sample loop for 30 seconds. During this time, internal standard and surrogate is also drawn into the instrument at a 1:10 ratio to the sample.

After 30 seconds, the valve is automatically switched to the inject position which sweeps the sample, surrogate and internal standard onto the pre-column. After 100 seconds any heavier (diesel range) compounds are back-flushed off of the system canister.

10.0 Data Analysis and Calculations

10.1 Quantitative analysis is performed by integrating the area of the identified quantitation ion. The quantitation ion for each target analyte, internal standard, and surrogate has been selected to provide interference free quantitation in the presence of the analytes listed in Table 1, except as noted above.

10.2 The concentration of the analytes is calculated using internal standards and the following equation.

$$ppmv = \frac{(Ax)\,(Is)}{(Ais)\,(\overline{RF})}$$

where:

Ax = Area of the quant ion for the target compound
Is = Concentration of the internal standard injected
Ais = Area of the quant ion for the internal standard
$\overline{RF}$ = Average Response factor from Initial Calibration for compound being measured.

11.0 Equations

11.1 Relative Response Factor

$$RRF = \frac{Std_{Area} \times IS_{Conc.}}{IS_{Area} \times Std_{Conc.}}$$

11.2 Relative % Difference

$$\%RPD = \frac{Samp_1 - Samp_2}{\left(Samp_1 + Samp_2\right)/2} \times 100$$

11.3 Relative Standard Deviation

$$\%RSD = \frac{STDev}{Avg} \times 100$$

11.4 Percent Difference

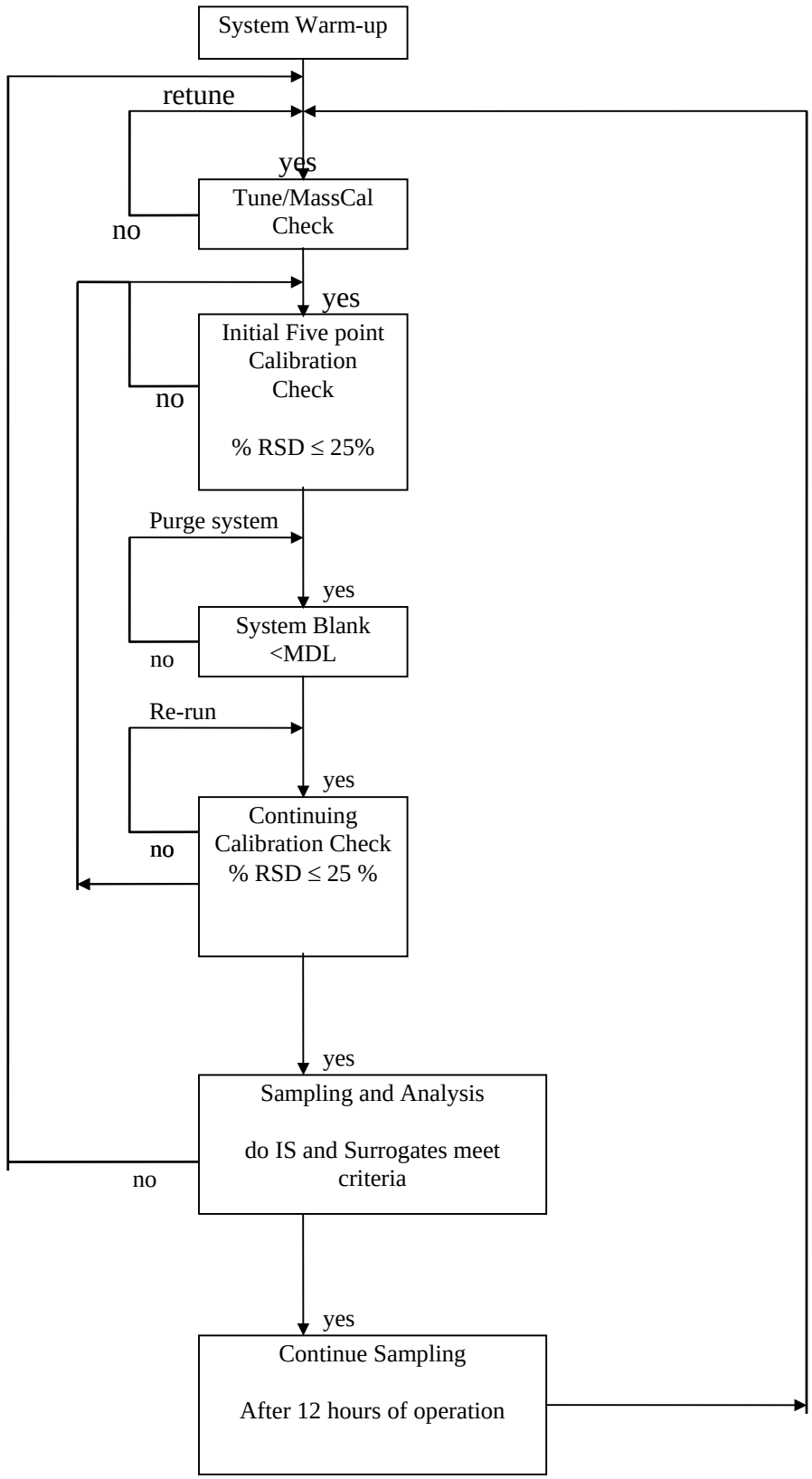
$$\%D = \frac{AvgRRF - DailyRRF}{AvgRRF} \times 100$$

11.5 Method Detection Limit

$$MDL = STDev \times 3.14$$

12.0 References

1. U.S. EPA Method 3810 Headspace
2. U.S. EPA Method 5021 Volatile Organic Compounds in Soil and other solid Matrices Using Equilibrium Headspace Analysis
3. U. S. EPA Method 8260B
4. Determination of Gaseous Organic Compounds by Direct Interface Gas Chromatography-Mass Spectrometry - May 28, 1997 Laura L. Kiner Ph.D. & James W. Peeler, Emission Monitoring Inc.
5. Quantitative Trace Analysis of VOC's in Air, Water and Soil by Equilibrium Headspace Gas Chromatography, Bruno Kolb, Perkin-Elmer Corp.


System Warm-up
retune
yes
Tune/MassCal Check
no
yes
Initial Five point Calibration Check
% RSD ≤ 25%
no
Purge system
yes
System Blank <MDL
no
Re-run
yes
Continuing Calibration Check % RSD ≤ 25 %
no
yes
Sampling and Analysis
do IS and Surrogates meet criteria
no
yes
Continue Sampling
After 12 hours of operation

Field-Portable Analytical, Inc.
3330 Cameron Park Drive, Suite 630, Cameron Park, CA 95682 (530) 676-6620

GC/MS Analysis of Water by Equilibrium Headspace

Standard Operating Procedure

SOP #3
Rev. # 1

Effective Date: **May 24th, 1999**

Written By: _____ Technical Review By:_____

1.0 Introduction

This Hapsite GC/MS method is used to determine volatile organic compounds in water. It is applicable to a wide range of organic compounds that are volatile enough to be effectively removed from the sample by use of equilibrium headspace. The compounds listed in Table 1 have been evaluated and are suitable for analysis with this method.

2.0 Summary of the Method

This method is designed for the rapid determination of VOC's in the field. It has been developed to produce definitive results in less than an hour.

Samples are collected in 40ml VOA vials. A 50ml syringe is used to take 20ml of sample into a separate 40ml screw cap VOA vial. The vial is then sealed with a PTFE coated septum. Internal standards and surrogates are added to the sample prior to equilibration. The vials are then placed in a heated chamber, maintained at 60^{o}C, and allowed to equilibrate for 20 minutes. The sample is transferred using a nitrogen carrier gas, displacing the gas phase in the vial through a heated transfer line into a gas sampling loop. The contents of the sample loop are then injected onto the GC column. Detection of the analytes is performed using mass spectrometry.

Table 1: Compounds Currently Verified

Compound	CAS Number	PQL ug/L	Quant Mass
Benzene	71-43-2	5	78
Bromodichloromethane	75-27-4	5	83
Bromoform	75-25-2	15	173
Bromomethane	74-83-9	5	94
Carbon Tetrachloride	56-23-5	5	117
Chlorobenzene	108-90-7	5	112
Chloroethane	75-00-3	10	64
Chloroform	67-66-3	5	83
Chloromethane	74-87-3	5	50
Dibromochloromethane	124-48-1	5	129
1,2-Dibromoethane	106-93-4	5	107
Dibromomethane	95-50-1	5	174
Dichlorodifluoromethane	75-71-8	10	85
1,1-Dichloroethane	75-35-3	5	63
1,2-Dichloroethane	107-06-2	5	62
1,1-Dichloroethene	75-35-4	5	61
cis-1,2-Dichloroethene	156-59-2	5	61
trans-1,2-Dichloroethene	156-60-5	5	61
1,2-Dichloropropane	78-87-5	10	63
Ethyl Benzene	100-41-4	5	91
Methylene Chloride	75-09-2	5	49
Styrene	100-42-5	5	104
1,1,1,2-Tetrachloroethane	630-20-6	20	131
1,1,2,2-Tetrachloroethane	79-34-5	20	83
Tetrachloroethene	127-18-4	5	166
Toluene	108-88-3	5	91
1,1,1-Trichloroethane	71-55-6	5	97
1,1,2-Trichloroethane	79-00-5	5	97
Trichloroethene	79-01-6	5	130
Trichlorofluoromethane	75-69-4	5	101
Vinyl Chloride	75-01-4	5	62
o-Xylene	95-47-6	5	91
m-Xylene	108-38-3	5	91
p-Xylene	106-42-3	5	91
Acetone	67-64-1	10	58
2-Butanone	78-93-3	10	57
2-Hexanone	591-78-6	10	58
Methyl tert-Butyl Ether	1634-04-4	10	73
1,2-Dichlorobenzene	95-50-1	10	146
1,3-Dichlorobenzene	541-73-1	10	146
1,4-Dichlorobenzene	106-46-7	10	146

3.0 Interference

Compounds that are not baseline-resolved may co-elute with the other target analytes or internal standards/surrogates listed in Table 1 may be interferents. Generally, these co-eluting compounds can be separated by their mass fragmentation patterns. However, some compounds may have fragment ions in their mass spectra, which are identical to the quantitation ion of a target analyte. This may produce a false positive or error in the reported concentration.

The software provides both a fit and purity measurement in full scan, GC/MS mode to indicate possible co-elution. If compounds co-elute and cannot be separated by their mass spectra, two remedies are possible: (1) the compounds are so similar that they may be reported as a total number. This is the case for m&p-Xylene (i.e. m&p-Xylene co-elute and have identical spectra). (2) A modification to the GC temperature may be sufficient to resolve the individual peaks. Co-elution has not been determined to be a problem with the halogentaed compounds listed in the method. Compounds that would present a problem are the aliphatic and olefin compounds found in petroleum products.

4.0 Safety

Safety is of utmost importance during all projects. On-site safety procedures established by the client will be adhered to at all time. It is the responsibility of *FPA* personnel to ensure they are aware of all safety procedures and hazards they may encounter on-site.

Proper personal protective equipment (PPE) including safety glasses, hard hats and steel- toed shoes will be worn when working directly at the drilling rig.

In addition to site specific and general field safety procedures, *FPA* personnel must adhere to standard safe laboratory practices. This includes:

- Maintenance and availability of Material Safety Data Sheets (MSDS)
- Use of appropriate PPE during the handling and preparation of standards
- Safe high pressure cylinder handling practices

Note: All hazardous, neat materials stored on-site must have a copy of the MSDS maintained on-site as well. This does not include working standards and standard mixtures.

5.0 Equipment and Supplies

5.1 Instrumentation

Inficon HAPSITE portable GC/MS
Supelco SPB 1, 30m x .32mmid x 1.0*u* film column
HAPSITE Headspace sampling accessory
Peripherals (Computer, Printer, Consumables, etc.)

5.2 Materials

Syringes: - 50ml, Teflon Luer Lock gastight
- 10ul, 25ul, 100ul gastight
Vials: - 40ml with PTFE septa
- 1ml micro-reaction with Mini-inert valves
- 2ml with PTFE septa

5.3 Gases

Carrier: Nitrogen 99.999% purity (for portable mode Inficon # 930-430)
Mass Calibration: Internal Standard 1 Inficon # 930-431 (50ppmv)
Bromopentafluorobenzene, (100ppmv) 1,3,5 tris (trifluoromethyl) benzene,

6.0 Reagents and Standards

6.1 Reagents - Methanol - HPLC Quality
- Organic Free Water

6.2 Standards
- Internal Standards/Surrogates (500ug/ml)
  - Pentafluorobenzene, 4-Bromofluorobenzene, 1,4-Difluorobenzene-d_4, Toluene-d_8, Bromofluorobenzene Chlorobenzene-d_5
- Target Compounds (200ug/ml, 2000ug/ml)
- Matrix Spiking solution (200ug/ml)

7.0 Instrument Parameters

7.1 GC Conditions

Column Temp.	65° C
Head Pressure	104 pa
Inlet Temp.	60° C
Probe Temp.	40° C
Valve Temp.	60° C
Run Time	15 Min.
Equib. Temp.	60° C

7.2 MS Conditions

Scans/Sec.	1.04 scans/sec.
Getter PumpTemp.	400 - 480° C
Scan Range	41 - 300 amu

8.0 QA/QC Procedures

Table 2: Quality Control

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
BFB	Every 12 Hours	Ion Abundance Criteria as Described in TO-14	1) Reanalyze BFB 2) Adjust Tune Until BFB Meets Criteria
5 – Point (Minimum) Calibration	Prior to start of project or as required for acceptance criteria	%RSD ≤ 20% Polar compounds %RSD ≤ 30	Re-run Levels Which Do Not Meet Criteria
Continuing Calibration Check	Beginning of Each Day	± 20% Difference of the Expected Concentration for the CCC Compounds	1) Repeat Analysis 2) Prepare and Run New Standard from Stock 3) Recalibrate
End Calibration Checks	End of Each Day	± 30%D of the Initial Calibration	1) Repeat Analysis 2) If End Check is Out, Flag Data for That Day
Duplicates	10% of the Samples	Relative Percent Difference ≤ 30%	1) Analyze a third Aliquot 2) Flag Reported Data
Matrix Spike/Matrix Spike Duplicate	5% of the samples	30% Recovery of spike compounds	1) Repeat Analysis 2) Prepare and Run New Spike from Stock 3) Flag Reported Data
Method Blanks	After Beginning of Day CCC	Concentrations for All Calibrated Compounds < PQL	Re-run Blanks until Criteria are Met

8.1 Initial Calibration

The initial calibration will contain a minimum of 5 levels. The low level must be no more than 5 times the reporting limit. The highest level should encompass the linear range of the instrument or the highest concentration of the samples expected. Acceptance criteria for the initial calibration are 20% relative standard deviation (%RSD) for all compounds except polar compounds, which are 30%RSD.

Corrective action for the initial calibration is to investigate the outlying level and reanalyze that level. If the problem is not corrected, it may be necessary to remake the standard or correct the problem with the instrument and reanalyze all levels.

8.2 Second Source Verification

The initial calibration will be confirmed by analyzing an independent certified solution containing several of the targets of interest. Acceptance criteria are 30%D compared to the initial calibration.

Corrective action for the Second Source is to reanalyze the standard. If it still does not meet the criteria, remake the Second Source standard from the stock and reanalyze. If criteria are still not met, repeat the initial calibration.

8.3 Continuing Calibration Verification

The continuing calibration standard is analyzed after the BFB Tune Check and before the analysis of any samples. The Continuing Calibration must contain all targets. The acceptance criteria for the Continuing Calibration are ± 20% Difference for the CCC compounds. The CCCs are:

1,1-Dichloroethene	Toluene
Chloroform	Ethylbenzene
1,2-Dichloropropane	Vinyl Chloride

No CCC compounds can exceed $\pm$ 20% Difference. All other compounds must be within $\pm$ 50% Recovery from the Initial Calibration.

Corrective action for the Continuing Calibration is to reanalyze the standard. If it continues not meet criteria, remake the standard from the stock and reanalyze. If criteria are still not met, repeat the Initial Calibration.

8.4 End Check

The end check is an end of the day calibration verification to demonstrate that the response of the instrument did not drift over the course of the day. It is the last analysis of the day. Criteria are 30% D for CCC compounds and $\pm$ 50% D for all other

compounds compared to the Initial Calibration. The end check brackets all analyses for the day to demonstrate that the system was in control for those analyses.

Corrective action for the end check is to reanalyze the standard. If the criteria are still not met, flag the samples analyzed since the last valid standard.

8.5 Method Blank

The method blank should be analyzed after the continuing calibration and before any samples. A blank should also be analyzed after any sample with concentrations exceeding the calibration range by 10%. The blank acceptance criteria are that no compounds are detected above the reporting limit.

Corrective action for the method blank is to reanalyze the blank. If the system is still not clean, take actions to remove the contaminants and reanalyze the blank. The blank must be clean before proceeding unless agreed upon with the client.

8.6 Duplicates

Duplicate analyses should be performed on a frequency of 10% of the total samples. The sample chosen to duplicate should contain concentrations of targets if possible. The acceptance criteria are 30% relative percent difference (% RPD).

Corrective action for the duplicate is to reanalyze the sample. If criteria are still not met, results must be flagged.

8.7 GC/MS Tune Verification

The GC/MS tune must be verified at the beginning of each day by analyzing a standard containing Bromofluorobenzene (BFB). The acceptance criteria are listed in Table 3.

Table 3

Mass Fragment	Ion Abundance Criteria
50	15-40%
75	30-60%
95	Base Peak
96	5-9%
173	<2% (of mass 174)
174	50-100%
175	5-9% (of mass 174)
176	95-101% (of mass 174)
177	5-9% (of mass 176)

Corrective action for the tune verification is to reanalyze the BFB standard. If criteria are still not met, make adjustments to the tune until criteria are met. Analyses may not proceed until criteria are met.

8.8 Internal Standards

The internal standards are injected through the septum into each sample. Acceptance criteria for internal standards are –50 to +100% Recovery from the daily continuing calibration check.

Corrective action for internal standards is to rerun the sample unless matrix effects have been previously established. If criteria are not met, the data must be flagged.

8.9 Surrogates

The surrogates are injected through the septum into each sample. Acceptance criteria for the surrogates are 70 to 130% Recovery.

Corrective action for surrogate is to reanalyze the sample unless matrix effects have been previously established. If criteria are not met, the data must be flagged.

8.10 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD should be performed at a frequency of 5% of the total number of samples. The matrix spike includes 1,1-Dichloroethene, Trichloroethene, Chlorobenzene, Toluene and Benzene. Acceptance criteria are 30% Recovery of the spiked compounds.

Corrective action for the MS/MSD is to reanalyze the spike. If criteria are still not met, results must be flagged.

9.0 Detection Limits

To determine the method detection limits a 40 CFR 136, 1984 method detection limit (MDL) study will be performed. Seven replicates of the low standard are analyzed in succession. The standard deviation of these replicates is multiplied by the student's t at the 99% confidence level of 3.14. The final value is considered to be the method detection limit. See Section 4.0 for the calculation of this value. An initial MDL study will be performed during the set-up of the project or yearly in the case of routine compounds.

10.0 Procedure

10.1 Sample preparation - Fill 40ml VOA vial with 20ml of sample to be

analyzed. Cap the vial with a PTFE coated septa and cap insert. Inject 2ul of 500ug/ml of internal standard/surrogate solution through the needle port in the septum cap. To minimize loss of volatiles while filling the vial, it is important to minimize sample turbulence and the length of time the sample is exposed to atmosphere.

When injecting the sample with the standard, tilt the vial so that the standard is injected into the water.

10.2 Sample Equilibration - Place the samples to be analyzed into the Headspace sampler. Allow each sample to equilibrate for a minimum of 20 minutes.

10.3 Sampling - Pierce the septum of the sample to be analyzed with the Headspace needle assembly. Press the start run button.

11.0 Data Analysis and Calculations

11.1 Quantitative analysis is performed by integrating the area of the identified quantitation ion. The quantitation ion for each target analyte, internal standard, and surrogate has been selected to provide interference free quantitation in the presence of the analytes listed in Table 1, except as noted above.

11.2 The concentration of the analytes is calculated using internal standards and the following equation.

$$ug/L = \frac{(Ax)\,(Is)}{(Ais)\,(\overline{RF})}$$

where:

Ax = Area of the quant ion for the target compound
Is = Concentration of the internal standard injected
Ais = Area of the quant ion for the internal standard
$\overline{RF}$ = Average Response factor from Initial Calibration for compound being measured

12.0 Equations

12.1 Relative Response Factor

$$RRF = \frac{Std_{Area} \times IS_{Conc.}}{IS_{Area} \times Std_{Conc.}}$$

12.2 Relative % Difference

$$\%RPD = \frac{Samp_1 - Samp_2}{\left(Samp_1 + Samp_2\right)/2} \times 100$$

12.3 Relative Standard Deviation

$$\%RSD = \frac{STDev}{Avg} \times 100$$

12.4 Percent Difference

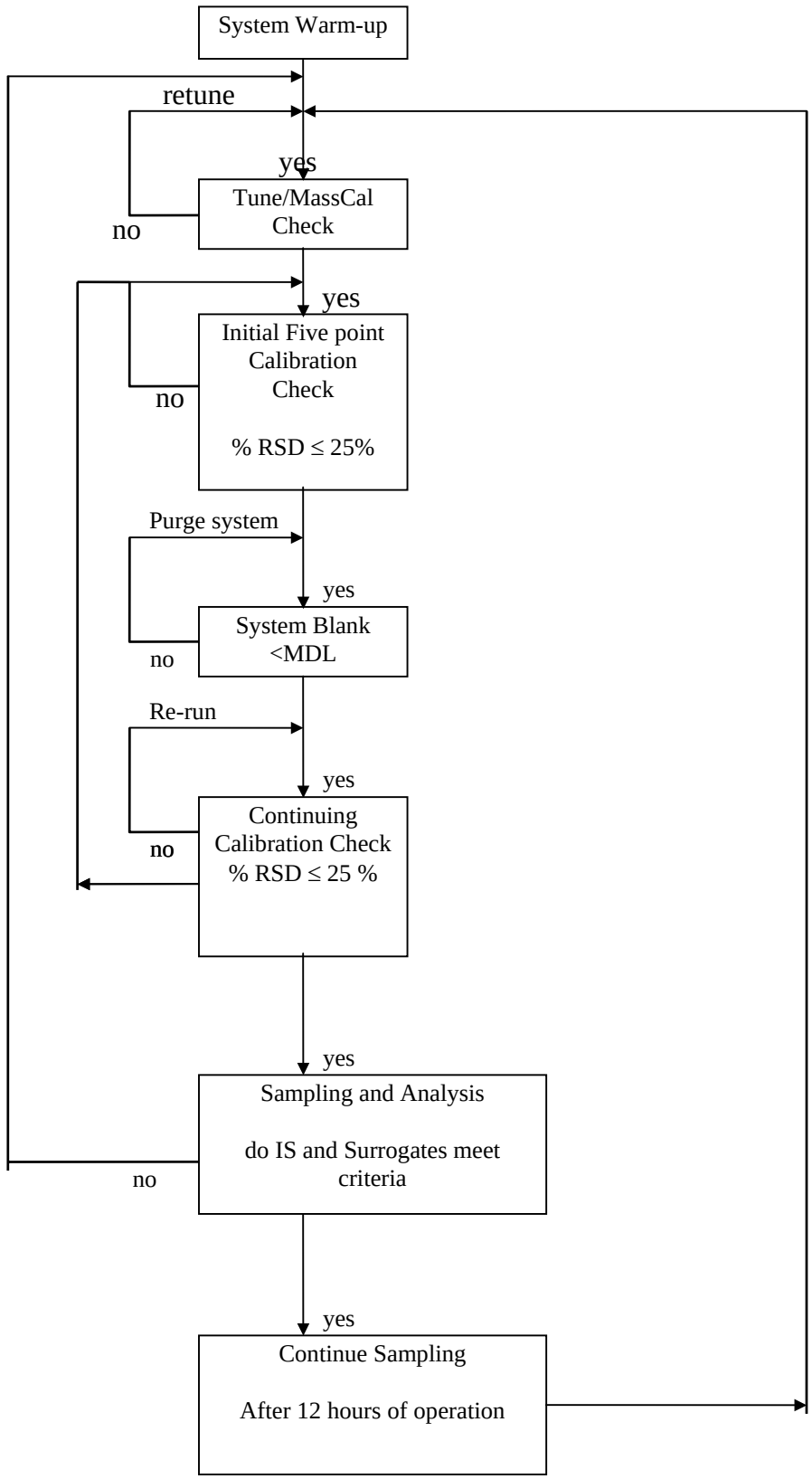
$$\%D = \frac{AvgRRF - DailyRRF}{AvgRRF} \times 100$$

12.5 Method Detection Limit

$$MDL = STDev \times 3.14$$

13.0 References

1. U.S. EPA Method 3810 Headspace
2. U.S. EPA Method 5021 Volatile Organic Compounds in Soil and other solid Matrices Using Equilibrium Headspace Analysis
3. U. S. EPA Method 8260B
4. Determination of Gaseous Organic Compounds by Direct Interface Gas Chromatography-Mass Spectrometry - May 28, 1997 Laura L. Kiner Ph.D. & James W. Peeler, Emission Monitoring Inc.
5. Quantitative Trace Analysis of VOC's in Air, Water and Soil by Equilibrium Headspace Gas Chromatography, Bruno Kolb, Perkin-Elmer Corp.


System Warm-up
retune
yes
Tune/MassCal Check
no
yes
Initial Five point Calibration Check
% RSD ≤ 25%
no
Purge system
yes
System Blank <MDL
no
Re-run
yes
Continuing Calibration Check % RSD ≤ 25 %
no
yes
Sampling and Analysis
do IS and Surrogates meet criteria
no
yes
Continue Sampling
After 12 hours of operation

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Quality Assurance Plan

Rev. # 1

Effective Date: January 11th, 2001

Revised By:_____

Table of Contents

1.0 Introduction

The purpose of this document is to outline the quality assurance procedures for on-site analysis. It is the guideline for quality assurance/quality control protocols and limits to ensure the overall usability of all data produced.

Since most field projects are unique, specific project requirements may supercede this document. In those cases, a project specific SOP will be developed to specify deviations from this document.

2.0 Safety

Safety is of utmost importance during all projects. On-site safety procedures established by the client will be adhered to at all times. It is the responsibility of *FPA* personnel to ensure they are aware of all safety procedures and hazards they may encounter on-site.

The OSHA 40 hour HAZWOPER course and subsequent 8 hour refreshers may required for all *FPA* personnel performing analyses in the field.

Proper personal protective equipment (PPE) shall be worn at all times. PPE for each project will be defined by the client and project. Often different zones or areas will dictate different levels of PPE. If personnel are unsure of the PPE required for a given area, they will follow the most stringent level until they can clarify the appropriate level.

For most projects, PPE will be based on some level of the following equipment:

- Hard Hat
- Safety Glasses
- Half Face Respirator
- Steel Toed Shoes
- Gloves
- Nomex or Tyvek Coveralls

In addition to site specific and general field safety procedures, *FPA* personnel must adhere to standard safe laboratory practices. This includes:

- Maintenance and availability of Material Safety Data Sheets (MSDS)
- Use of appropriate PPE during the handling and preparation of standards
- Safe high pressure cylinder handling practices

Note: All hazardous, neat materials stored on-site must have a copy of the MSDS maintained on-site as well. This does not include working standards and standard mixtures.

3.0 QA/QC Procedures

The QA/QC procedures listed below are the default QA/QC levels for all analyses. They are based on the following reference documents:

- Test Methods for Evaluating Solid Waste, SW-846 Third Edition, Revised November, 1986
- EPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA Document 600/4-87-006

Often specific projects have their own data quality objectives. Specific project QA/QC levels will be followed when established.

3.1 Initial Calibration

All initial calibrations will contain a minimum of 5 levels. The low level must be no more than 5 times the reporting limit. The highest level should encompass the linear range of the instrument or the highest concentration of the samples expected. See Section 5.0 for standard preparation procedures. Acceptance criteria for the initial calibration are 25% relative standard deviation (%RSD) for all compounds.

The initial calibration should be analyzed at the beginning of a project, whenever the system does not meet specifications, or when a significant change has occurred to the instrument (i.e. extensive maintenance).

Corrective action for the initial calibration is to investigate the outlier and reanalyze that level. If the problem is not corrected, it may be necessary to remake the standard or correct the problem with the instrument and reanalyze all levels.

3.2 Continuing Calibration

The continuing calibration standard is analyzed after the tune verification (GC/MS only) and before the analysis of any samples. The continuing calibration should contain all targets of interest. The concentration should represent the mid range of the calibration curve. Based on project requirements, a subset of targets may be agreed upon to verify the initial calibration. The acceptance criteria for the continuing calibration is ±30% Difference (%D) for the agreed upon compounds.

Since the Micro GC uses external standards, and the Hapsite GC/MS uses an internal standard approach, they use different techniques for quantitation. On the Micro GC, the continuing calibration is used to verify the initial calibration, and then the initial calibration is used to quantitate all analyses. For the Hapsite GC/MS, the continuing calibration is used to verify the initial calibration, and then replaces the initial calibration to quantitate all analyses.

Corrective action for the continuing calibration is to reanalyze the standard. If it still does not meet criteria, remake the continuing calibration standard from the stock and reanalyze. If criteria are still not met, repeat the initial calibration.

3.3 End Check

The end check is an end of the day calibration verification to demonstrate that the response of the instrument did not drift over the course of the day. It is the last analysis of the day. Criteria for the agreed upon compounds are 70 to 130% recovery based on that morning's continuing calibration standard. The end check brackets all analyses for the day to demonstrate that the system was in control for those analyses. It is analyzed even when it is not a project requirement.

Corrective action for the end check is to reanalyze the standard. If criteria are still not met, samples analyzed that day should be flagged. If possible, samples or a subset from the time in question should be reanalyzed.

3.4 Method Blank

The method blank should be analyzed after the continuing calibration and before any samples. A blank should also be analyzed after any sample with concentrations exceeding the calibration range by 10%. The blank acceptance criteria are that no compounds are detected above the reporting limit.

Corrective action for the method blank is to reanalyze the blank. If the system is still not clean, take actions to remove the contaminants and reanalyze the blank. The blank must be clean before proceeding unless agreed upon with the client.

3.5 Duplicates

Duplicate analyses should be performed on a frequency of 10% of the total samples on a given day, or 1 per day which ever is more frequent. The sample chosen to duplicate should contain concentrations of targets if possible. The acceptance criteria are 30% relative percent difference (% RPD).

Corrective action for the duplicate is to reanalyze the sample. If criteria are still not met, results must be flagged.

3.6 GC/MS Tune Verification

The GC/MS tune must be verified at the beginning of each day by analyzing a standard containing Bromofluorobenzene (BFB). The acceptance criteria are listed in Table 1.

Table 1

Mass Fragment	Ion Abundance Criteria
50	15-40%
75	30-60%
95	Base Peak
96	5-9%
173	<2% (of mass 174)
174	50-100%
175	5-9% (of mass 174)
176	95-101% (of mass 174)
177	5-9% (of mass 176)

Corrective action for the tune verification is to reanalyze the BFB standard. If criteria are still not met, make adjustments to the tune until criteria are met. Analyses may not proceed until criteria are met.

3.7 Internal Standards

Internal standards should be used for all GC/MS analyses. They are co-injected with each analysis. Acceptance criteria for internal standards are –50 to +100% Recovery from the daily continuing calibration check.

Corrective action for internal standards is to rerun the sample unless matrix effects have been previously established. If criteria are not met, the data must be flagged.

3.8 Surrogates

Surrogates may be used for GC/MS analysis. They are co-injected with each analysis. Acceptance criteria for surrogates are 70 to 130% Recovery.

Corrective action for surrogates is to reanalyze the sample unless matrix effects have been previously established. If criteria are not met, the data must be flagged.

4.0 Calculations

4.1 Relative Response Factor

$$RRF = \frac{Std_{Area} \times IS_{Conc.}}{IS_{Area} \times Std_{Conc.}}$$

4.2 Sample Concentrations

$$Conc. = \frac{Samp_{Area} \times IS_{Conc.}}{IS_{Area} \times RRF} \times Dil$$

4.3 Relative % Difference

$$\%RPD = \frac{Samp_1 - Samp_2}{\left(Samp_1 + Samp_2\right)/2} \times 100$$

4.4 Relative Standard Deviation

$$\%RSD = \frac{STDev}{Avg} \times 100$$

4.5 Percent Difference

$$\%D = \frac{AvgRRF - DailyRRF}{AvgRRF} \times 100$$

4.6 Method Detection Limit

$$MDL = STDev \times 3.14$$

4.7 Stock Standard Preparation

$$ppmv = \frac{uLInj.(1000)(24.055)}{Mol.wt.(FinalVol.)}$$

5.0 Standards

All standards and reagents used for calibration and analysis of samples will be the highest quality available. Neat compounds should be at least 95 % purity. If no standard is available at this purity, a lesser percentage standard may be used if the concentration is adjusted to account for the lower purity.

When available, mixes should be NIST traceable and/or certified. All documentation regarding certification must be maintained in the standard certification folder.

Stock standards will be prepared from neat compounds by static dilution. A known volume of dry air or Nitrogen is metered into a Tedlar bag. 10 to 50 microliters of HPLC grade water is then added to humidify the bag. An accurate amount of individual neat liquid standards are then added to the bag to yield the appropriate concentrations. See Section 4.7 for the calculation. The stock standard is allowed to sit for a minimum of 4 hours to allow the compounds to vaporize into the bag. Standard vaporization is facilitated by placing the bag near a heat source. The heat source must not be above 150° Celsius to avoid the potential of degrading the compounds inside or physically damaging the bag. There should be no visible droplets inside the bag after the 4 hour period.

Gaseous standards are added to the bag by adding the appropriate amount using a gas tight syringe. To keep the dilution factor correct, the bag must be filled with air to compensate for the amount of gaseous standard to be added. For instance, if 50 milliliters of standard are to be added, the bag should only be filled to 950 milliliters so that the total volume remains at 1000 milliliters.

6.0 Detection Limits

Detection limits will be determined in several ways. In most cases the typical 40 CFR 136, 1984 method detection limit (MDL) study will be performed. Seven replicates of the low standard are analyzed in succession. The standard deviation of these replicates is multiplied by the student's t at the 99% confidence level of 3.14. The final value is considered to be the method detection limit. See Section 4.0 for the calculation of this value.

An initial MDL study will be performed during the set-up of the project or yearly in the case of routine compounds. An additional MDL may be required if the power used at the site is of unknown quality. The baseline noise level can vary greatly if a noisy source of power is used. The only way to verify this is by the analysis of a standard at a concentration no more than 5 times the detection limit to be used. If the standard falls outside a 70-130% recovery acceptance criteria, a new MDL must be analyzed and used.

Due to the precise reproducibility of the Micro GC, the MDL study may yield a detection limit an order of magnitude or more below the actual reasonable detection limit. Because of this, it is critical that the detection limit for the Micro GC is set no more than 5 times less than the low standard. Because of the universal response of the detector, detection limits for most compounds will be between 0.5 and 1.0 ppmv.

7.0 Sample Receiving

Sample receiving procedures will differ from project to project due to the difference in the systems used by the contractors. The required information for receipt of each sample consists of the following:

- Receipt Date and Time
- Initials or Signature of Person Receiving the Samples
- Verification of Sample Name
- Sample Comments, If Any (i.e. Sample Condition)

This information may be contained either on the Chain of Custody (COC) form or on a Sample Receiving Log in the absence of a COC.

8.0 Data Review

Data review is critical for the production of defensible data. Since most field projects are conducted by a single person, primary review by a second person is very difficult. As a result, most primary data review will be performed by the analyst running the samples.

Data reported for projects like site characterization will be reported as preliminary until the data can undergo a secondary review and released with the final report.

8.1 Primary Data Review

The primary review will include the following verifications:

Standards and QC Samples

- BFB Tune Check (GC/MS)
- Continuing Calibration Check Recovery
- End Calibration Check Recovery
- Blank Sample Check
- Duplicate Comparison Check

Samples

- Sample Name
- Sample Collection Date and Time
- Amount Analyzed
- Dilution Factor
- No Compounds Exceed Top of Calibration Curve
- Internal Standard Recoveries (GC/MS)
- Surrogate Recoveries (GC/MS)
- Compound Retention Time
- Compound Spectra (GC/MS)
- Unidentified Peaks
- Calculations

The electronic calculations must be verified at least once daily. All manual calculations should be checked. Each sample, standard and QC sample will be clearly marked for the file name, sample information and dilution factor, and then initialed and dated by the analyst writing up the data. All pages that have been marked must be initialed and dated.

8.2 Secondary Review

The secondary review will be performed on 10% of the data and will include all of the same checks as the primary.

The secondary reviewer will initial and date the front page of each sample, standard and QC sample reviewed. All items checked by the secondary reviewer should be marked with a red check mark.

9.0 Training

Proper training is critical to a successful field project. The analyst in the field must be self-reliant and capable of making well formed decisions without a manager looking over their shoulder.

The principals of *FPA* conduct external training courses for clients on both the Agilent Micro GC and the Hapsite GC/MS. They are well versed in all aspects of calibration, analysis and data write up. They work closely with the vendors to maintain currency on the latest improvements and updates. It is important that employees are brought up to this same level of ability. The following steps should be taken to ensure adequate preparation for field projects:

- Step 1: Initial Training

The first step is to explain the theory of the instrumentation being used; review of method/SOP/Project Plan; familiarization with the hardware and software; and training on specific procedures including method development, calibration, analysis, and reporting.

- Step 2: Hands On Training

The next step is for the analyst to perform all aspects of development, calibration, analysis and reporting with constant review and guidance.

- Step 3: Final Verification

The last step is for the analyst to be completely responsible for all aspects of the instrumentation without oversight. The finished work is reviewed to verify the analyst is ready to perform the analysis on their own. Documentation of successful training (i.e. Calibration Curve, audit sample, etc.) will be maintained in the analyst's training file.

- Step 4: Continued Training

It is critical that the analyst always strives towards improvement in all methods performed. Method enhancements and improvements are a significant part of ongoing training. The analyst will document method improvements for inclusion in their training file.

10.0 **Performance Evaluation Samples / Audits**

Performance evaluation samples may be provided by the client as an independent check of the analytical performance. They are to be treated like any other sample. No special treatment must be given to this sample.

In addition to the performance evaluation samples, projects are performed in front of the Client and often the Regulator. They commonly review practices against the QAPP and make recommendations for process improvements. Procedural recommendations should be documented along with the implementation efforts. System changes beyond the QAPP will be incorporated into this QA Document and the analysis specific SOP.

11.0 Data Storage

Data shall be stored for a minimum of seven years in both hardcopy and electronic forms. Hardcopy printouts of any reports will be maintained in the project file, and electronic data will be archived to a removable hard disc cartridge (Shark or Zip) and also stored with the project file.

As required older versions of analytical software will also be archived so that older data will be able to be retrieved and viewed.

12.0 Facility Requirements

Facility requirements may vary greatly from project to project. Requirements may be as simple as a completely self-contained, “backpack” mode to a portable fixed facility. In all cases, the critical requirements are that personnel are able to conduct analyses in a safe manner with an appropriate amount of consumables available to complete the project as required.

13.0 Instrument Descriptions

13.1 Inficon Hapsite GC/MS

FPA utilizes an Inficon Hapsite GC/MS. This is a truly portable GC/MS designed specifically for the analysis of volatile compounds. The Hapsite is a full featured quadrupole GC/MS capable of meeting all of the EPA's stringent SW-846 QC criteria even though it weighs only 37 pounds and can be carried over the shoulder.

The Hapsite GC/MS uses a sampling wand with an internal pump to collect the sample. The sample is pulled into a sample loop with variable injection capabilities. The column is a 30 meter OV-1 with a 3 meter backflush column. The backflush column allows the volatile organic target compounds to get onto the column, then backflushes off the non-target semivolatile compounds. This keeps the instrument free of contamination and eliminates the need to 'bake out' the contamination between analyses. The interface between the GC and MS is a methyl silicone membrane. This membrane allows organics to migrate through to the MS while sweeping most non-organics (i.e. water and carbon dioxide) out through the vent.

By minimizing what gets into the MS, this instrument is able to utilize a chemical 'getter' pump rather than a mechanical pump. The getter pump maintains adequate vacuum for weeks at a time. It is very compact and allows the GC/MS to be used in a portable mode without the need to drag heavy mechanical pumps around.

The run time on the Hapsite GC/MS is typically about 10 minutes even for a very aggressive list of compounds. Since the column is isothermal and the heavier compounds never reach the analytical column, there is no cool down time and the next analysis can be started immediately after the last for maximum throughput.

In addition to target compounds, the Hapsite GC/MS produces standard NIST searchable spectra to identify and semi-quantitate unknown compounds. The Hapsite GC/MS co-injects 2 compounds as internal standards with every analysis. These compounds are used for semi-quantitation of any unknowns and as additional QA/QC for each analysis.

In addition to full scan mode, the Hapsite can be operated in Selected Ion Mode (SIM). In this mode, a few selective compounds can be monitored at lower concentrations. It is common to obtain an order of magnitude more sensitivity in this mode.

The Hapsite GC/MS can also be operated in MS only mode. This mode is well suited towards compound specific real time 'sniffing'. The instrument can be carried over the shoulder and operated in continuous mode directly at the site of concern. This allows for a real time, target specific screening for contamination in the ppbv range.

13.2 Agilent Micro GC

FPA's GC of choice is an Agilent portable, heated GC with Thermal Conductivity Detectors (TCD). This GC is equipped with two separate analytical modules. The first analytical module contains a thin film 4 meter OV-1 column and the second contains a thick film 14 meter OV-1 column. It is designed to be able to rapidly analyze a wide range of volatile organics. This is a rapid GC which provides full speciated data in less than 3 minutes.

Sample is introduced into the analytical modules through individual injection ports. This allows the instrument to perform simultaneous analysis of two separate sample streams with no cross over contamination. This feature is well suited for determining the destruction removal efficiencies of emission control systems. With simultaneous inlet and outlet analyses in as little as one minute, accurate emissions and destruction efficiency profiles of even dynamic sources can be provided.

The Agilent Micro GC utilizes an internal sample pump which pulls the sample into separate micromachined sample valves. These are very precise inlets which provide excellent precision and accuracy.

The TCD detectors on the Micro GC are micromachined and therefore achieve maximum sensitivity. Another feature of the TCD detector is the wide linear range. This detector can provide up to 4 orders of magnitude linearity. Lastly, the TCD is a universal detector which means that all compounds give a very similar response. This universal response gives *FPA* the ability to calculate a total concentration similar to method 25A.

14.0 Maintenance

The instrumentation utilized is designed to be rugged and stand up to harsh field conditions. Experience confirms that both the GC and GC/MS systems are very dependable with little downtime. See the sections below for maintenance and preventative maintenance for both types of equipment.

14.1 Inficon Hapsite GC/MS

The Hapsite is a modular system. Most items are replaceable instead of repairable. System diagnostics are very good on this instrument and will typically point directly to the problem. Several items can be repaired at *FPA* and others require sending the instrument to Inficon for repair under the service agreement.

The following is a list of items that are field repairable and should be maintained as spare parts in inventory:

- Getter Pump
- Sampling Wand
- Membrane
- Ion Source
- Analytical Column/Oven
- Multiplier

All other problems must be sent to Inficon for repair. The service agreement with Inficon states that they will turn the instrument around the same day as received. Shipping both directions will be dictated on the need to return the instrument to active service. All field repairable items are to be performed per the manufacturer's specifications.

There are only a few preventative maintenance items for this instrument. The chemical getter pump is a consumable item that must be replaced periodically. Replacement of this item is based on the pump's ability to maintain vacuum. An acceptable range for the vacuum pump is 8×10^{-3} Pascal or less. Once the vacuum exceeds this amount, the getter pump must be replaced. Refer to the manual for this operation.

The other item is the ion source. The source should be replaced when the instrument can no longer be tuned to meet BFB specifications.

14.2 Agilent Micro GC

The Micro GC is completely modular. The injection port, column and detector are a single module. If any part of the module fails, the entire module must be replaced or sent back to the manufacturer for repair under the service agreement. Consequently, there are no routine parts to be maintained in inventory.

15.0 Waste Management

There is no waste generated as a result of sample analysis. The samples must be disposed of properly to ensure there is no exposure to the analyst or others in the vicinity. The correct way to dispose of most samples is to vent the bag into the ambient air. Dilution of a 1 liter Tedlar bag into the atmosphere results in infinite dilution. Do not vent the samples into a closed environment.

Samples with extremely high concentrations (percent levels) or containing high hazards may need to be disposed of in a more controlled environment. These samples will be addressed in the project specific SOP or workplan.

APPENDIX F

Off-Site Laboratory Standard Operating Procedures
and Quality Assurance Manuals

This appendix was provided only to USACE Seattle District (Kira Lynch) on CD-ROM.

APPENDIX G

Quality Assurance/Quality Control Procedures
from Am Test-Air Quality, LLC

QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

The purpose of a quality assurance plan is to provide guidelines for achieving quality control in air pollution measurements. The detailed procedures Am Test-Air Quality, LLC utilizes are included in the Environmental Protection Agency's (EPA's) reference manual titled Quality Assurance Handbook for Air Pollution Measurements Systems, Volume 3, EPA-600/4-77-027b. These procedures will be followed throughout equipment preparation, field sampling, sample recovery, analysis, and data reduction. Am Test-Air Quality, LLC's quality assurance procedures are discussed below.

Calibration Procedures and Frequency

Field equipment utilized for on-site measurements is calibrated at a frequency recommended by the equipment manufacturer or industry practice. Prior to field use, each instrument is calibrated and the calibration value is reported in a calibration log. If any measuring or test device requiring calibration cannot immediately be removed from service, the Project Manager may extend the calibration cycle, providing a review of the equipment's history warrants the issuance of an extension. No equipment will be extended more than twice a calibration cycle, nor will the extension exceed one-half the prescribed calibration cycle. Test equipment consistently found to be out of calibration will be repaired or replaced.

The sample nozzles used to collect isokinetic samples are calibrated on-site before sampling using digital inside calipers readable to 0.001 inch. Three (3) measurements are taken at varying points around the inside of the nozzle tip and averaged. The dry gas meters used to accurately measure the gas sample volume during each run are calibrated using a calibrated laboratory dry gas meter. A standard P-type pitot tube or a calibrated S-type pitot tube are used for velocity measurements. The coefficients for S-type pitot tubes are determined using Method 2, Section 4.1 procedures and are re-inspected in the field during each emission evaluation. The magnehelic gauges used for pressure measurements are periodically calibrated against an oil-filled manometer. The digital thermocouple indicators used for temperature measurement have a readability of 1 degree Fahrenheit and have been certified by the manufacturer for accuracy. Each thermocouple probe used to monitor stack gas temperature is checked periodically at three (3) temperature settings. The thermocouple probes are typically checked in the field at ambient temperature and in an ice bath. Calibration data for the measurement devices used will be included in the appendices of the final report.

A field blank sample train and reagent blank for each wet chemical method will be analyzed along with the samples. A matrix spike of one sample of each type and duplicates for 10% of the samples will be requested from the analytical laboratory. All reagents to be used for this project conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society, or are the best available grade. In the laboratory, reagent and filter blanks are carried throughout the gravimetric analysis procedures. The samples are weighed to constant weights of $\pm$0.5 milligrams following desiccation in a cabinet desiccator. This desiccator is an electronic dehumidifier which automatically maintains the humidity inside the desiccator. The dehumidifier automatically recharges the internal desiccant every 5.5 hours. An Airguide humidity indicator accurate to $\pm$1% is used to check the humidity inside the desiccator when obtaining tare and final weights. A small container of indicating silica gel is placed in the desiccators to maintain the desired humidity. The Mettler AE163 electronic balance used to obtain weights is set to a time integrating mode (100,000 readings per minute) with a readability of 0.01 milligrams. The balance is calibrated prior to every weighing session. The balance is audited weekly using a 0.5 gram NIST traceable Class S weight. The calibration of Am Test's Mettler balances is checked by the manufacturer on a yearly basis.

The gaseous measurement systems are capable of meeting the system performance specifications detailed in 40 CFR 60, Appendix A, Method 6C, Section 4. For meeting these specifications, the analyzer's calibration error (linearity) must be less than $\pm$2 percent of the span for the zero, mid-range, and high-range calibration gases. The sampling system bias check must be less than $\pm$5% of the span for the zero, and mid- or high-range calibration gases. The zero drift must be less than $\pm$3% of the span over the period of each run. The calibration drift must be less than $\pm$3% of the span over the period of each run. The calibration gases are analyzed following the EPA Traceability Protocol Number 1, or next best available. Purified nitrogen is utilized for the zero gas.

Support equipment is defined as all equipment, not previously discussed that is required for completing an environmental monitoring or measurement task. This equipment may include storage and transportation containers, sample recovery glassware, and communications gear. Support equipment is periodically inspected to maintain the performance standards necessary for proper and efficient execution of all tasks and responsibilities.

During the project, a systems audit will be performed, consisting of an on-site qualitative inspection and review of the total measurement system. This inspection will be conducted on a

daily basis by the Project Leader. During the systems audit, the auditor observes the procedures and techniques of the field team in the following general areas:

- Setting up and leak testing the sampling train
- Isokinetic sampling check of the sampling train (if applicable)
- Final leak check of train
- Sample recovery

Visual inspections of pitot tubes, glassware, and other equipment are also made. The main purpose of a systems audit is to ensure that the measurement system will generate valid data, if operated properly.

Sample Recovery and Field Documentation

Data relative to samples, collected during each test, are immediately inspected for completeness and placed under the custody of the Project Leader until custody is transferred when the samples are turned over to the laboratory. Sample recovery is carried out in a suitable area sheltered from wind and dust to prevent contamination of samples.

Many types of documentation are used in the field to keep track of project information. A field notebook is used to note any conditions which are not covered by the various field data sheets which Am Test uses. The field team leader records all information related to sampling or field activities.

Chain of Custody

The history of each sample is documented from collection through all transfers of custody until it is transferred to the analytical laboratory. Internal laboratory records document the custody of the samples through their final disposition. Care is taken to record precisely the sample type, sample time, and sample location and to help ensure that the sample number on the label exactly matches those numbers on the sample logsheet and the chain-of-custody record. The persons undertaking the actual sampling in the field are responsible for the care and custody of the samples collected until they are properly transferred or dispatched. Sample labels are completed for each sample bottle using water-proof ink.

Transfer of Custody and Shipment

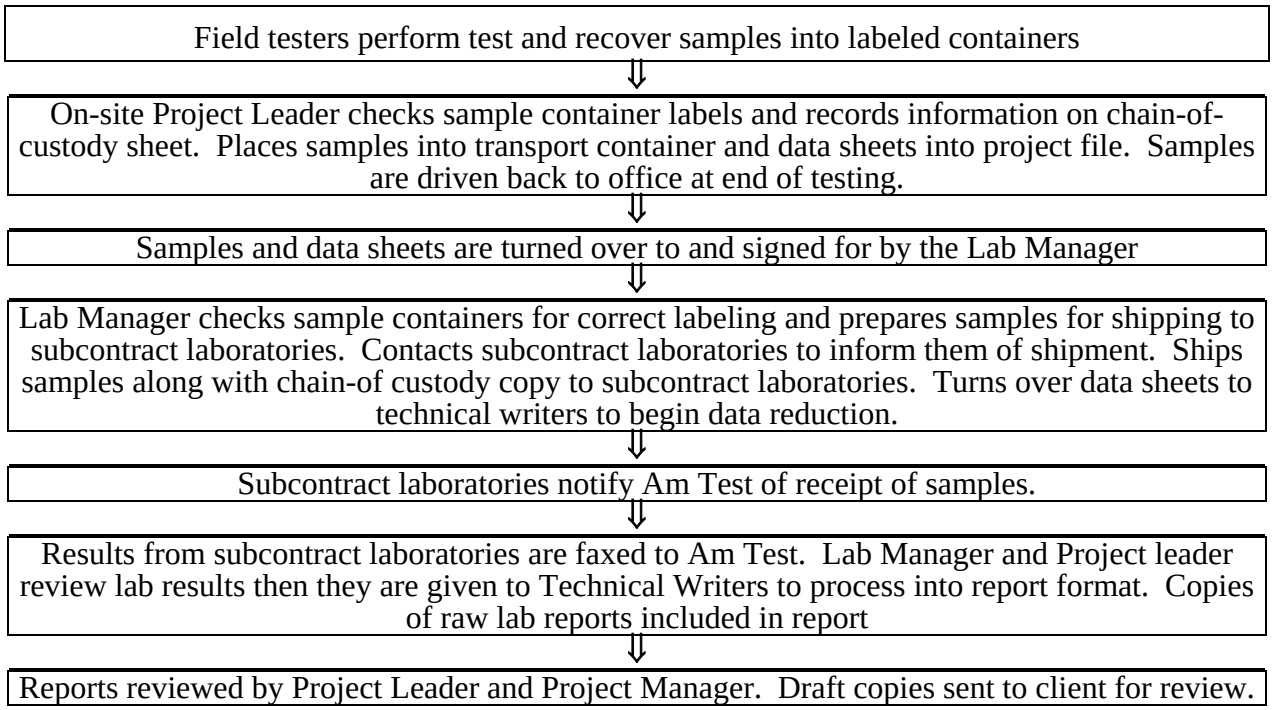
All sample shipping containers are accompanied by an analysis request or chain-of-custody record form when they leave the site. When transferring the possession of samples, the individuals relinquishing and receiving the samples sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory.

The laboratory representative who accepts the incoming sample shipment signs and dates the chain-of-custody record, completing the sample transfer process. It is the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis in accordance with the laboratory's written QA Plan.

It is important to maintain the integrity of the samples from the time of collection until the analyses are performed. The samples are preserved during transportation and storage to prevent or retard degradation or modification of chemicals in samples. If appropriate, the samples are kept cool with blue ice packets placed in the coolers the samples were shipped in. Prior to shipping, the samples are placed in boxes along with a chain-of-custody form. Empty space in the box is filled with bubble pack and styrofoam to prevent damage during shipment. The samples are shipped via overnight courier for next day delivery.

QA/QC PROJECT FLOW CHART

The following flow chart shows the progression of the samples from collection to final reporting:



APPENDIX H

GIS/Key EIMS Database Structure Notes

STRUCTURE NOTES FOR LABDATA.DBF, GIS/Key VERSION 3.1

FILE LAYOUT FOR ELECTRONIC DOWNLOAD TO GIS/Key

#	Source	Required	Justify	Field Name	Type	Len	Dec	Notes / Default parameters
1	**User**	See Notes	Left	SITE_ID	C	15		Sampling location as labeled on the GIS\Key Map. SITE_ID is required for all Primary, Duplicate and Split results. Spike results may be associated with samples from another location; SITE_ID is not required although recommended if appropriate.
2	**NA**			SP_ID	C	7		Not used in V3.1.
3	**Lab**	Yes		SAMP_TYPE	C	1		Sample type is <S>oil/Sediment/Solid or <W>ater. The import routine requires a <S> or <W> entry.
4	**Lab**	Yes	Left	RES_CODE	C	4		Preliminary code used to determine the type of chemical result. See notes at end of table for details of valid entries. RES_CODE is used by the GIS/Build routine to derive the GIS\Key RES_TYPE and RES_CLASS fields. Initially assigned by the Lab and modified as required by the User to reflect sample status not known by the Lab.
5	**GIS**	No		RES_CLASS	C	1		Assigned by GIS/Build from RES_CODE. This code refers to the type of result received from the Lab. Allowable RES_CLASS entries are <P>rimary/Duplicate/Split, <C>ontrol Sample, <B>lank, and Matrix <S>pike. A special RES_CLASS of <D> is allowed for Duplicate results of Control Samples and Matrix Spikes.
6	**GIS**	No	Left	RES_TYPE	C	3		Assigned by GIS/Build from RES_CODE. This code works in conjunction with RES_CLASS to describe the type of result. It consists of a one character code indicating the type of result, a test sequence number, and a result set sequence number.
7	**Lab**	No		RES_COLUMN	C	1		The column number of a multiple column test. Used primarily for IRPIMS reporting.
8	**Lab**	See Notes	Left	RES_ORIG	C	3		Points to the originating result of a result set of record in a multiple column or dilution test. A result set of the record may be a combination of one or more column/dilution tests. The RES_ORIG points to the result in the test run from which the result of the record came and should equal the last 3 characters of the RES_CODE for that result. Used primarily for IRPIMS reporting.
9	**Lab**	See Notes		SURROG_FLG	L	1		"T" (True) for a Surrogate result and "F" (False) otherwise.
10	**User**	No	Left	SAMP_ID	C	15		SAMP_ID is the unique identifier provided to the Lab on the sample bottle.
11	**User**	No	Left	SAMP_ID2	C	15		SAMP_ID2 is used ONLY for Field Spike Duplicates or Blind Control Sample Duplicates.
12	**User**	See Notes		SAMP_DATE	D	8		Date sample was collected (mm/dd/yy format). Required for all results except Blanks, Control Samples and Matrix Spikes.
13	**Lab / User**	See Notes		SAMP_TIME	C	5		Time sample was collected (hh:mm in 24 hour format). Required for all Primary, Duplicate, Split and Surrogate results. Not required for Blank, Control Sample, and Matrix Spike results. If not specified and SAMP_DATE is specified, default of "00:00" is automatically assigned.
14	**User**	See Notes		SAMP_DEPTH	N	8	3	Depth below ground surface in meters (metric) or feet (American) at which sample was collected. Depths above ground surface are negative. Defaults to ground surface (0.000) if not specified. Measurements in feet (American) may only be specified to two decimals (hundredths of a foot).
15	**User**	Yes		S_DEPTH	N	8	3	Depth below ground surface in meters or feet to the top of the sample interval range. Same as SAMP_DEPTH if unknown.
16	**User**	Yes		E_DEPTH	N	8	3	Depth below ground surface in meters of feet to the bottom of the sample interval range. Same as SAMP_DEPTH if unknown.
17	**User**	See Notes	Left	CASE_ID	C	5		Case and Blank IDs or Case and QA/QC IDs are used to associate Primary results with Quality Control results. CASE_ID is a required entry for QC data and should be entered for Primary results if QC data is being entered. For small projects, many GIS\Key users use sampling event (SP_ID) as CASE_ID. IRPIMS projects should enter the IRPIMS site in the CASE_ID.
18	**Lab / User**	See Notes	Left	SDG_ID	C	25		Sample Delivery Group ID. Case and SDG Ids are used to associate Rinsate Blank results with Primary results. Required for Rinsate Blanks.
19	**Lab**	See Notes	Left	QAQC_ID	C	25		QA/QC Batch Ids are normally assigned only by Labs. Used to associate Lab QC results (i.e. Lab and Method Blanks, Control Samples and Matrix Spikes) with Primary results. QAQC_ID must uniquely identify each sample batch analyzed by the Lab. Required for Method Blanks.

FILE LAYOUT FOR ELECTRONIC DOWNLOAD TO GIS/Key

#	Source	Required	Justify	Field Name	Type	Len	Dec	Notes / Default parameters
20	**Lab / User**	See Notes	Left	BLANK_ID	C	25		Field Blank ID. Case and Blank IDS are used to associate Field Blank results with Primary results. Required for Field Blanks.
21	**NA**			TCL_ID	C	10		Not used in V3.1. **Superceded by unique combination of LAB_ID and METHOD_ID.**
22	**GIS / User**	Yes		TCL_TYPE	C	1		**Replaced by LM_CODE (Lab Method code) in V3.x, but retained as TCL_TYPE for backwards compatibility.** Used to differentiate lists of chemicals having the same Lab (LAB_ID) and Test Method (METHOD_ID). Assigned the GIS/Key default value if not specified.
23	**Lab / User**	Yes	Left	METHOD_ID	C	10		Test Method ID.
24	**Lab**	No	Left	EXTRACTION	C	6		Extraction Method ID.
25	**User**	Yes	Left	LAB_ID	C	5		Lab ID.
26	**GIS**	No	Right	SEQ_NUM	C	3		Sequence Number determines the display order of constituents when editting results in GIS/Key. Assigned by GIS/Build based on the SEQ_NUM of the constituents defined in the Lab Method. If a Lab Method definition is not in the Project, SEQ_NUM is assigned sequentially for each Lab Method in LABDATA.DBF.
27	**NA**			SPLIT_ID	C	10		Not used in V3.1.
28	**NA**			SPLIT_ID2	C	10		Not used in V3.1.
29	**Lab**	No	Left	LSAMP_ID	C	15		Lab Sample ID.
30	**Lab**	No	Left	LSAMP_ID2	C	15		Lab Sample ID of QC Duplicates. Assigned by Lab for Known Control Sample duplicates and Lab Matrix Spike duplicates.
31	**Lab**	See Notes	Left	LAB_CAS_ID	C	11		CAS Registry number assigned by Lab for the constituent. Either a LAB_CAS_ID or a LAB_CHEM must be specified for each record.
32	**GIS**	No	Right	CAS_NUM	C	11		CAS Registry number from GIS\Key Compound.DBF. Assigned based on a match with LAB_CAS_ID (primarily) or LAB_CHEM (secondarily).
33	**Lab**	See Notes	Left	LAB_CHEM	C	40		Constituent name from Lab. Either LAB_CAS_ID or LAB_CHEM must be specified for each result.
34	**GIS**	No	Left	NAME	C	40		Constituent name assigned from GIS/Key Compound.DBF. If LAB_CAS_ID is used without a matching LAB_CHEM, NAME is assigned the default alias name (alias_num="0") in GIS\Key Compound.DBF.
35	**GIS**	No	Right	ALIAS_NUM	C	2		Alias number assigned by comparing LAB_CAS_ID and LAB_CHEM to GIS/Key Compound.DBF.
36	**Lab**	See Notes	Left	CONC	C	11		Constituent concentration (result) for Primarys, Duplicates, Splits, and Blanks or the concentration of a Control Sample or Matrix Spike constituent. CONC should be left blank if non-detect. Concentrations are stored as character strings to preserve significant figures. May be expressed in scientific (exponential) notation (e.g. 1.23E+03). All characters must be numeric (0-9) with the exception of "E+" or "E-" for scientific notation, "+", or a "±" (ASCII character 241). "+" after a concentration means greater than. Uncertainty may be indicated by "±" and a number following the concentration (not recommended).
37	**Lab**	See Notes	Left	LIMIT1	C	10		Detection/Report Limit 1. Generally used for the Method Detection Limit. Required for Primary, Duplicate, Split, and Blank results if CONC is not specified. Follows same format guidelines as CONC with "?" (unknown) allowed. Entered value should reflect sample dilution(s).
38	**Lab**	See Notes	Left	DL_FLAG	C	2		Detection/Report Limit Flag. Generally used for "<" to indicate the result was below LIMIT1. For IRPIMS files, DL_FLAG corresponds to the PARVQ field. DL_FLAG corresponds to the "RF" column in GIS/KEY data entry screens.
39	**Lab**	See Notes	Left	UNITS	C	5		Unit of measurement. GIS\Key can automatically convert concentrations in common units (e.g. mg/l, mg/kg, ug/l, ug/kg, ppm, ppb, and %). Other units (e.g. col for colonies of bacteria) are allowed but cannot be converted.

FILE LAYOUT FOR ELECTRONIC DOWNLOAD TO GIS/Key

#	Source	Required	Justify	Field Name	Type	Len	Dec	Notes / Default parameters
40	**Lab**	No	Left	LIMIT2	C	10		Detection/Report Limit 2. Generally used for the Practical Quantitation Limit. Follows same format and dilution guidelines as LIMIT1.
41	**Lab**	No	Left	INSTRUMENT	C	20		ID number or name of specific Lab equipment used to perform the analysis. Used primarily for Air Force reporting.
42	**Lab**	No	Left	CALIBRATE	C	20		Calibration reference number for the analysis. Used primarily for Air Force reporting.
43	**GIS**	No		SPIKE_DUP	L	1		Flag indicating a Control Sample or Matrix Spike duplicate result. GIS/Build merges with matching Control Sample or Matrix Spike primary result.
44	**Lab / User**	No	Left	TEST_ORIG	C	3		Used for Matrix Spikes to identify the RES_TYPE of the sample that was spiked.
45	**Lab**	No	Left	S_CONC	C	9		Spike concentration for Surrogates. **V3.1 copies CONC into S_CONC for Control Samples and Matrix Spikes.**
46	**Lab**	See Notes		RECOVER	N	3		Constituent Recovery Percentage (%). Required for Control Samples, Matrix Spikes and Surrogates. Specified by the Lab for Known Control Samples, Lab Matrix Spikes, and Surrogates.
47	**Lab**	See Notes		D_RECOVER	N	3		Constituent Recovery Percentage (%) of Control Sample and Matrix Spike duplicates. Required for Control Sample and Matrxi Spike duplicates. . Specified by the Lab for Known Control Sample and Lab Matrix Spike duplicates.
48	**Lab / User**	No	Left	T_CONC	C	11		Target concentration for Matrix Spikes. Should equal sample concentration (Primary CONC) plus concentration of spike added (S_CONC).
49	**Lab**	No	Left	R_CONC	C	11		Measured (result) concentration of Control Samples and Matrix Spikes.
50	**Lab**	No	Left	D_CONC	C	11		Measured (result) concentration of Control Sample and Matrix Spike duplicates.
51	**Lab**	No		RPD	N	3		Relative Percent Difference (RPD). Specified by Lab for Control Samples and Matrix Spikes that are run in duplicate and reported in a single record. For RES_CODEs DB##/DF##/DK##/DL## (duplicate runs with separate records reported), GIS/Build calculates RPD when the primary and duplicate records are combined.
52	**Lab**	No		B_RECOVER	N	3		Minimum Recovery Percentage (%) goal for Control Samples, Matrix Spikes and Surrogates.
53	**Lab**	No		E_RECOVER	N	3		Maximum Recovery Percentage (%) goal for Control Samples, Matrix Spikes and Surrogates.
54	**Lab**	No		MAX_RPD	N	3		Maximum Relative Percent Difference (RPD) goal for Control Sample and Matrix Spike duplicates.
55	**Lab / User**	Yes		PF_CODE	C	1		Preparation Fraction Code. Must match a defined PF_CODE in GIS\Key. Standard codes include <A>cide Rain Extraction, T<C>LP Extraction, <D>issolved, <E>PTOX Extraction, <T>otal, <S> California Wet Extraction, and Deionized <W>ater Extraction.
56	**Lab**	No		CR_C	C	1		CLP Review “C” Qualifier. If specified, must match a code defined in GIS\Key.
57	**Lab**	No	Left	CR_M	C	2		CLP Review “M” (Method) Qualifier. If specified, must match a code defined in GIS\Key.
58	**Lab**	No	Left	CR_Q	C	3		CLP Review “Q” Qualifier. If specified, each character must match a code defined in GIS\Key.
59	**User**	No	Left	ER_Q	C	3		Expert Review “Q” Qualifier. If specified, each character must match a code defined in GIS\Key.
60	**User**	No	Left	ER_R1	C	2		Expert Review Reason Qualifer 1. If specified, must match a code defined in GIS\Key.
61	**User**	No	Left	ER_R2	C	2		Expert Review Reason Qualifier 2. If specified, must match a code defined in GIS\Key.
62	**User**	No	Left	ER_R3	C	2		Expert Review Reason Qualifier 3. If specified, must match a code defined in GIS\Key. Suggested use of this field is to track updates.
63	**User**	No		FILTERED	C	1		Field Sample Filtration as <Y>es, <N>o or <U>nknown. Preparation Fraction codes (PF_CODE) should reflect field filtration.
64	**User**	No		PRESERVED	C	1		Field Sample Preservation code as <H>Cl, H<N>O3, H2<S>04, <O>ther, <U>nknown, or < > None.
65	**User**	No		ICED	C	1		Field Sample Iced (stored/shipped on ice) as <Y>es, <N>o or <U>nknown.

FILE LAYOUT FOR ELECTRONIC DOWNLOAD TO GIS/Key

#	Source	Required	Justify	Field Name	Type	Len	Dec	Notes / Default parameters
66	**Lab**	See Notes	Left	CUSTODY	C	25		Chain of Custody ID. Associates Travel Blanks with Primarys. Required for Travel Blanks.
67	**Lab**	See Notes		DILUTION	N	7	2	Dilution Factor. Total dilution for test relative to original sample. Required for Primarys, Duplicates, Splits, and Blanks. Must be a postive number.
68	**GIS / User**	See Notes		PROG_TYPE	C	1		Program code. Must match a code defined in GIS/Key. Program codes must be identical for all results for a test.
69	**Lab**	No		RECEIVED	D	8		Date sample was Received at Lab (mm/dd/yy format).
70	**Lab**	No		REC_TIME	C	5		Time sample was Received at Lab (hh:mm in 24 hour format).
71	**Lab**	No		PREPARED	D	8		Date sample was Prepared/Extracted at Lab (mm/dd/yy format).
72	**Lab**	No		PREP_TIME	C	5		Time sample was Prepared/Extracted by Lab (hh:mm in 24 hour format).
73	**Lab**	No		TESTED	D	8		Date sample was Tested/Analyzed by Lab (mm/dd/yy format).
74	**Lab**	No		TEST_TIME	C	5		Time sample was Tested/Analyzed by Lab (hh:mm in 24 hour format).
75	**Lab**	No		REPORTED	D	8		Date test results were Reported by Lab (mm/dd/yy format).
76	**Lab**	No		APPROVED	D	8		Date test results were Approved by Lab (mm/dd/yy format).
77	**Lab / User**	No	Left	LOT_NUMBER	C	4		IRPIMS Lot Control Number (LOTCTLNUM) used to associate primary samples with QC.
78	**Lab / User**	No	Left	SA_CODE	C	3		IRPIMS Sample Type code (SA_CODE) used to identify the type of sample collected.
79	**Lab / User**	No	Left	MATRIX	C	2		IRPIMS Sample Matrix code.
80	**Lab / User**	No		BASIS	C	1		Indicates whether results are reported on a <D>ry or <W>et basis. Required for soil results.
81	**Lab / User**	No		MOISTURE	N	4	1	Percent (%) Moisture of a soil sample.
82	**NA**			EXC_CODE	C	30		Not used in V3.1
83	**NA**			WARN_CODE	C	20		Not used in V3.1
84	**NA**			BUILD_FLAG	C	1		Not used in V3.1
85	**Lab/ User**	No	Left	NOTE	C	50		Lab and/or User notes for samples (stored in GIS/Key CSample.DBF).
86	**Lab / User**	No	Left	TEST_NOTE	C	50		Lab and/or User notes for tests (stored in GIS/Key CTest.DBF).
87	**Lab**	No	Left	UNCERT_1	C	10		Result Uncertainty 1. For Radiologic results only.
88	**Lab**	No	Left	UNCERT_2	C	10		Result Uncertainty 2. For Radiologic result only.
89	**Lab**	No	Left	RAD_LIMIT3	C	10		Detection/Report Limit 3. For Radiologic result only.
90	**Lab**	No	Left	LR_Q	C	3		Lab Review Qualifier. For Radiologic result only.
91	**Lab / User**	See Notes		RAD_FLAG	L	1		T" (True) for a Radiologic result and "F" (False) otherwise.
92	**Lab**	No		DUP_RPD	N	3		Maximum Relative Percent Difference (RPD) goal for Primary Duplicates.

FILE LAYOUT FOR ELECTRONIC DOWNLOAD TO GIS/Key

#	Source	Required	Justify	Field Name	Type	Len	Dec	Notes / Default parameters
93	**Lab**	No		SPLIT_RPD	N	3		Maximum Relative Percent Difference (RPD) goal for Primary Splits
94	**Lab / User**	See Notes	Left	PRIME_LAB	C	5		Lab ID code of Primary Lab for Splits. (LAB_ID is Lab ID Code of Split Lab)

RES_CODE	Result Description
PP0<1-9>	Primary Result
PD[1-9]<1-9>	Duplicate of Primary
PS[1-2]<1-9>	Split of Primary
BF[1-9]<1-9>	Field Blank
BL[1-9]<1-9>	Lab Blank
BM[1-9]<1-9>	Method Blank
BR[1-9]<1-9>	Rinsate Blank
BT[1-9]<1-9>	Travel Blank
CB[1-9]<1-9>	Blind Control Sample
CK[1-9]<1-9>	Known Control Sample
SL[1-9]<1-9>	Lab Matrix Spike
SF[1-9]<1-9>	Field Matrix Spike
DB[1-9]<1-9>	Duplicate Blind Control Sample
DK[1-9]<1-9>	Duplicate Known Control Sample
DL[1-9]<1-9>	Duplicate Lab Matrix Spike
DF[1-9]<1-9>	Duplicate Field Matrix Spike
Numbers in [] denote test sequence number	
Numbers in <> denote result set sequence number	

DUPLICATE RECORD KEY FOR PRIMARIES, DUPLICATES AND SPLITS (RES_CODE = PP0#, PD##, PS##):

SAMP_TYPE + SITE_ID + SAMP_DATE + SAMP_TIME + SAMP_DEPTH + LAB_ID + METH_ID + LM_CODE + PF_CODE + RES_CODE + CAS_NUM

DUPLICATE RECORD KEY FOR BLANKS (RES_CODE = BR##, BM##, BT##, BF##, BL##):

SAMP_TYPE + CASE_ID + BLANK_ID + LAB_ID + METH_ID + PF_CODE + RES_CODE + CAS_NUM

DUPLICATE RECORD KEY FOR SPIKES AND CONTROL SAMPLES (RES_CODE = SF##, SL##, CB##, CK##):

SAMP_TYPE + CASE_ID + LBATCH_ID + LAB_ID + METH_ID + PF_CODE + RES_CODE + CAS_NUM

ASSIGNING RES_CODE TEST SEQUENCE NUMBERS [1-9]:
The test sequence number refers to a sample sequence used to differentiate test results that otherwise have the same primary key. For example, a test sequence number of 2 for a duplicate sample would mean that the result set is for the second of 2 duplicate samples originating from the same primary sample. A test sequence number of 2 for a method blank would mean that 2 method blanks were run for the same batch (QAQC_ID). Note that matrix spikes and control samples and their duplicates should always have matching test sequence numbers.

ASSIGNING RES_CODE RESULT SET SEQUENCE NUMBERS <1-9>:
The result set occurrence is used to differentiate multiple column or dilution runs of the same sample and test method that otherwise have the same primary key. Occurrence = 1 is the set of record and the set used for reporting and graphics.

STRUCTURE NOTES FOR LABDATA.DBF, GIS/Key VERSION 3.1

FILE LAYOUT FOR ELECTRONIC DOWNLOAD TO GIS/Key

ASSIGNING RES_ORIG CODES:

RES_ORIG codes are equal to the last three characters of RES_CODEs for all results except when multiple column/dilution runs are being reported and the result being reported is for the combined "best estimate" result. In this case, the RES_ORIG code equals the last three characters of the RES_CODE of the originating column/dilution run.

ADDITIONAL GUIDANCE FOR FIELD/LAB MATRIX SPIKE DUPLICATES AND BLIND/KNOWN CONTROL SAMPLE DUPLICATES:

Field/lab matrix spike duplicate and blind/known control sample duplicate concentrations are always entered in the D_CONC field, with recoveries in the D_RECOVER field. Spike and control sample duplicates may be entered as individual records using RES_CODEs DL##, DF##, DB##, DK##, or can be combined with the record storing the original spike or control sample when using RES_CODEs SL##, SF##, CB##, CK##.

EXCEPTION CODES: (an exc_code indicates bad or missing data)
01= Invalid SAMP_TYPE (S or W)
02= Invalid RES_CLASS (First Charcater of RES_CODE)
03= Invalid RES_TYPE (Last three charcters of RES_CODE)
04= LAB_ID Required
05= METH_ID Required
06= PF_CODE Required
07= LBATCH_ID Required
08= Invalid TEST_ORIG
09= Invalid RES_ORIG
10= SAMP_DATE required
11= Invalid SAMP_TIME
12= SAMP_DEPTH to precise
13= Undefined PT_CODE
EXCEPTION CODES: (Continued)
14= Invalid FILTERED
15= Invalid ICED
16= Invalid PRESERVED
17= CASE_ID required.
18= BLANK_ID required
19= Undefined PRIME_LAB
20= ALIAS_NUM required
21= Embedded space in C_UNIT
22= Invalid CONC
23= Invalid LIMIT1
24= Invalid LIMIT2
25= Negative DUP_RPD
26= Negative SPLIT_ID
27= Negative DILUTION
28= Invalid BASIS
29= Negative MOISTURE
30= Invalid S_CONC

WARNING CODES:	
01=	Undefined PF_CODE (Project)
02=	Unknown SITE_ID (Project)
03=	Undefined PT_CODE (Project)
04=	Unknown CAS_NUM (Shared)
05=	Unknown COMP_NAME (Shared)
06=	Undefined / Unknown C_UNIT
07=	Undefined / Unknown R_UNIT
08=	Undefined LM_CODE (Project)
20=	SAMP_DATE Year before 1990
21=	RECEIVED Year before 1990
22=	PREPARED Year before 1990
23=	TESTED Year before 1990
24=	APPROVED Year before 1990
25=	REPORTED Year before 1990
90=	**Dataset Duplicates (These should be viewed before sending to project, otherwise only one set will be sent, leaving "duplicate" sets behind) This was an EXCEPTION in previous versions.**
99=	No Parent in current dataset or project

FILE LAYOUT FOR ELECTRONIC DOWNLOAD TO GIS/Key

EXCEPTION CODES: (Continued)
31= Invalid T_CONC
32= Invalid R_CONC
33= Negative RECOVER
34= SPIKE_DUP (data and no flag)
35= Invalid D_CONC
36= Negative D_RECOVER
37= Negative RPD
38= Negative B_RECOVER
39= Negative E_RECOVER or below B_RECOVER
40= Negative MAX_RPD
41= Unknown CR_C
42= Unknown CR_M
43= Unknown CR_Q1
44= Unknown CR_Q2
45= Unknown CR_Q3
46= Unknown ER_Q1
47= Unknown ER_Q2
48= Unknown ER_Q3
49= Unknown ER_R1
50= Unknown ER_R2
51= Unknown ER_R3
52= RECEIVED before SAMP_DATE
53= Invalid REC_TIME
54= PREPARED before RECEIVED / SAMP_DATE
55= Invalid PREP_TIME
56= TESTED before PREPARED / RECEIVED / SAMP_DATE
57= Invalid TEST_TIME
58= RMETH_ID required
59= Embedded space in R_UNIT
60= Invalid R_CONC
61= Invalid UNCERT_1
62= Invalid UNCERT_2
63= Invalid RLIMIT_1
64= Invalid RLIMIT_2
65= Invalid RLIMIT_3
66= Unknown LR_Q1
67= Unknown LR_Q2
68= Unknown LR_Q3
69= SAMP_DEPTH out of range of S_DEPTH and E_DEPTH
70= S_DEPTH greater than E_DEPTH
71= Undefined CAS_NUM
72= Invalid LM_CODE

APPENDIX I

USEPA Region 9 RCRA Corrective Action Program
Data Review Guidance Manual

RCRA Corrective Action Program

DATA REVIEW GUIDANCE MANUAL

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TABLE OF CONTENTS

0.0 INTRODUCTION

The US Environmental Protection Agency (EPA) is dedicated to providing objective, reliable, and understandable information that helps EPA protect human health and the environment while building public trust in EPA's judgement and actions. EPA's decisions are always subject to public review and may at times be subjected to rigorous scrutiny by those with a personal or financial interest in the decision. It is, therefore, the goal of EPA to ensure that **all decisions are based on data of known quality**.

This guidance manual will provide the EPA decision-maker with the ability to ensure that his/her decisions are based on data of known quality. We will start with an overview of the tools and practices available in the field of data quality assessment. Thereafter, we will concentrate on one particular data quality assessment tool: data review. There are other factors affecting environmental data which are outside the scope of this guidance, including: field screening samples vs. traditional lab methods, sample design issues, the number of samples to collect, etc.

Data quality assessment, broadly defined, is the process of evaluating the extent to which a data set satisfies the project's objectives. Not every set of data needs to be 100% perfect in order to make high quality decisions. The objectives of your project will determine the overall level of uncertainty that you as a decision-maker are willing to accept. Hence, depending on the project objectives, the type of data quality assessment you choose may be either cursory or rigorous. In the Resource Conservation and Recovery Act (RCRA) program, project objectives may require that the data reported be legally defensible for enforcement purposes; or project objectives may simply require that data be of reasonably known quality because the data gathered are part of an ongoing quarterly monitoring effort where data trends are reasonably understood from previous monitoring data. This manual provides the RCRA project managers with assistance in selecting and developing the level of data quality assessment appropriate for your project's needs.

The first section of this manual introduces the reader to various tools which can be employed to assess the quality of reported data. The second section of this manual focuses on data review as a means to assess the quality of data and introduces the reader to data review terms and definitions. Knowledge of these terms will help project managers communicate with their facilities and laboratories regarding EPA's data quality requirements. The third section of this manual details the up-front planning that is needed to gather data which is tailored to the level of data quality review to be performed. The fourth section of this manual introduces our "desk-top review" process. This newly created process provides non-chemist project managers with data review guidelines which can be used by project managers at their desk with little or no assistance. In the fifth section of this manual we discuss the procedures that project managers should follow when their project objectives require that their environmental data be fully validated. The final section presents case studies - actual data from real sites.

0.1 Consistent Use of Terms

Before we discuss the various "tools" available to assess data quality, we need to point out an inherent confusion within this field. Consistent definitions of terms like data validation, data review, and data quality assessment do not exist. Sometimes these terms are used interchangeably. Other times, the terms have different definitions to different groups. What one group includes in their data validation process

may not be included in another's. And in preparing this manual we have coined a new term, the "desk-top review".

To simplify this confusion (at least for the sake of this manual) we will consistently use the terms in accordance with the following definitions:

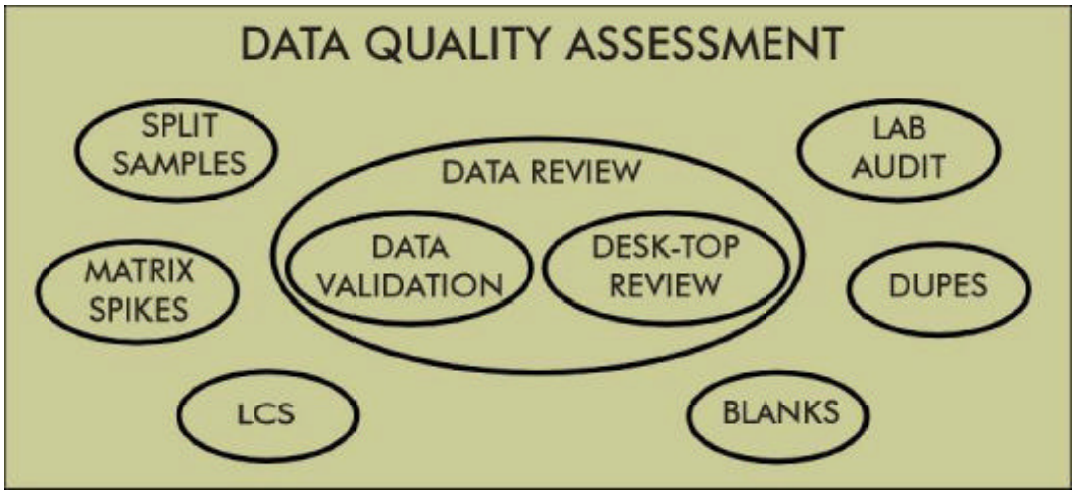
Data Quality Assessment: A broad term which encompasses data validation, "desk-top reviews", split-samples and any other process used to evaluate the quality of analytical data collection and analysis process.

Data Review: The process by which laboratory analytical data reports are examined to evaluate their quality; the process may be rigorous or cursory depending on the project's objectives.

Data Validation: The formal, rigorous process in which experienced chemists evaluate the quality of laboratory analytical data, check to see that results have been calculated correctly and that reported hits have been correctly identified, and provide data qualifier flags and comments to assist the data user in determining the usability of the data for their project.

Desk-top Review: A less-rigorous process which RCRA project managers (non-chemists) can use to evaluate the quality of laboratory analytical data reports.

Figure 1: **Data Quality Assessment Venn Diagram**



1.0 UP-FRONT PREPARATION

1.1 Data Quality Objectives

Before any environmental samples are collected, data quality objectives (DQOs) should be established. What are DQOs? Strictly defined, they are qualitative and quantitative statements derived from the outputs of each step of the DQO process that:

1) Clarify the project objective(s)

2) Define the most appropriate type of data to collect

3) Determine the most appropriate conditions from which to collect the data

4) Specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the decision.

The outcomes of these steps are your DQOs; these are then used to develop a scientific and resource-effective sampling plan.

Establishing DQOs is the most important part of any data collection activity because without clear objectives and good planning, data may be unusable no matter how good a job the sampling crew and laboratory does. For example, if one of the project objectives is to determine whether or not a waste collected during the sampling activity is a hazardous waste because of its lead content, then some of the data quality objectives would be that data must be representative of what is actually in the waste, and that lead quantitation must be reliable at or below the regulatory threshold. Appropriate sampling and analysis techniques must then be chosen. If the objectives are not properly determined ahead of time, then the wrong sampling or analytical technique may be chosen. The laboratory might do an excellent job of performing an analytical method, but if the detection limit for that method is above the regulatory limit, then the data are unusable for the purpose of determining whether or not the waste is hazardous.

The process of establishing DQOs is the responsibility of whomever is responsible for generating data and making decisions based on that data. RCRA Project Managers should review the thought process behind the DQOs presented by regulated facilities in some detail. If you are developing your own sampling plan, then the DQO process is essential. Most experienced project managers go through the steps informally when planning data collection, even if they don't call the outcome DQOs. For all but the most simple data collections, the process is likely to involve numerous people (chemists, risk assessors, project managers, etc.), and is likely to cover multiple project objectives. EPA's "Guidance for Planning for Data Collection in Support of Environmental Decision Making Using the Data Quality Objectives Process" (EPA QA/G-4), put out by the EPA headquarters, takes the reader step by step through the process, and is helpful in formalizing the process. This document can be ordered directly from EPA's Office of Research and Development (ORD) Publication Office by calling (513) 569-7562.

2.0 DATA QUALITY ASSESSMENT

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

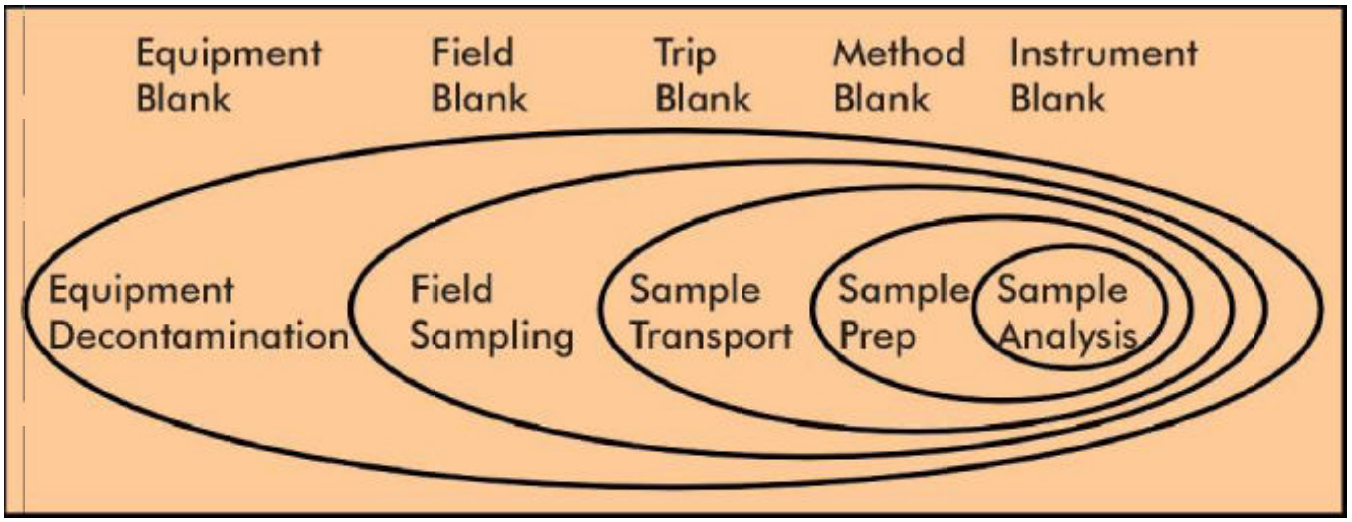
There are many Quality Assurance/Quality Control (QA/QC) samples that can be collected and analyzed; however, it is not cost-efficient to require every QA/QC sample at every sampling event. Hence, careful selection of appropriate QA/QC samples will control project costs and help ensure that you will be able to assess the quality of the reported data. The following is a brief description of some of the QA/QC samples commonly used; they will be discussed in more detail later in this document, and are included in the Glossary of Terms in Appendix A.

2.1.1 Artificially Introduced Contamination

Since contamination can be introduced into a sample at one or several different points during the collection and handling process, identifying the source of contamination can be crucial. Several types of blanks can be analyzed in an effort to identify and possibly isolate these sources. An example of the use of different blank samples functioning together to isolate the source of introduced contamination is as follows:

- A trip blank measures combined field and laboratory sources of artificially introduced contamination.
- A method blank measures only laboratory sources of artificially introduced contamination.
- Sources of contamination artificially introduced in the field or the laboratory can then be deduced through comparison of these blanks.

Figure 2: Blank Samples and Artificially Introduced Contamination



The Venn diagram shown in Figure 2 indicates some of the blanks which may be used in the sampling/analytical process. An equipment blank, for example, which is intended to measure cleanliness of the sampling equipment, could potentially be contaminated in the field, during transport to the lab, or in the laboratory itself. A method blank, on the other hand, could only be contaminated during sample preparation and analysis, as it never leaves the laboratory.

2.2 Field Audits

Field audits are a check of sample collection and sample handling procedures, and are conducted by experienced field personnel. Field sampling is the "front-end" of the environmental measurement process. Although field methods will not be covered in this manual, correct sampling technique is critical to the overall success (or failure) of environmental monitoring. Field audits typically include:

- Preliminary research (document review) into the facility's field sampling plan, standard operating procedures, and Quality Assurance Project Plan.
- An on-site visit, which will include observation of field personnel as they perform all aspects of the sampling program: field instrument calibration, equipment decontamination, well purging, sample collection, sample packaging, and documentation. The on-site visit will also include a review of field logs, chain-of-custody forms, field calculations, etc. The auditor will also talk individually with field personnel to determine consistency of sampling procedures and adherence to the approved field sampling plan.
- A field audit report, detailing significant findings, and possibly, suggestions to correct deficiencies.

2.3 Laboratory Audits

Laboratory audits are similar to field audits, and are usually conducted by a senior chemist with auditing experience. Laboratory audits may be initiated by regulated facilities, by the States (California's ELAP program conducts audits for certification of labs for hazardous waste analysis), or by EPA. Regulated facilities have a financial stake in assuring that they are receiving good quality data. Data which is rejected by the regulatory agencies is very expensive to regenerate. Lab audits include:

- Preliminary research (document review) into the lab's operating plan, standard operating procedures, Quality Assurance Project Plan, past performance on Performance Evaluation (PE) samples, etc.
- A site visit, where the auditor will examine documents at the lab (instrument run logs, calibration logs, maintenance logs, etc), talk with the analysts performing the work, and observe their performance in the laboratory.
- A lab audit report, detailing significant findings, and possibly, suggestions to correct deficiencies.

2.4 Split-samples

Split-samples are duplicate samples which are analyzed by two (or more) different labs. Although split-samples are primarily used as a check of inter-laboratory performance, they can also serve as duplicate samples to indicate sample heterogeneity. Split-samples are somewhat problematic, since there is no "correct" laboratory (just like there was no "right" answer on that final exam in Philosophy 101). This tends to be especially problematic for heterogeneous samples such as soils or oily wastes, which may have significant matrix interference and are difficult to analyze. Moreover, samples which contain very low levels of contaminants, which is often the case with groundwater, may show a "non-detect" result from one lab and a small, but measurable, value from the other lab, even though both labs are using the same method. If the analytical results are significantly different, it may be necessary to do further evaluation to investigate the causes of the discrepancy. Nevertheless, appropriately applied split sampling data can provide valuable information.

2.5 Performance Evaluation Samples

Performance evaluation (PE) samples are samples with known concentrations of certain target analytes, and which are submitted "blind" to a lab as a check of laboratory performance. They may be "single blind", in which the laboratory knows that the sample is a PE sample but doesn't know what is in it; or "double blind", in which the laboratory does not even know that the sample is a PE sample. Many labs participate (and are often required to participate by regulatory agencies) in performance evaluation studies. In these studies, the labs are sent single blind PE samples. Laboratory results from PE samples are compared to the "true" concentrations. Usually, PE sample suppliers will collect data from numerous analyses of the PE samples and provide statistically derived "acceptance windows" for the results. The results from single blind performance evaluation samples are useful to some extent, but may not be indicative of the lab's day-to-day performance.

A single-blinded PE sample consists of a sample (often a small (1 ml) glass ampule or other container that does not look like a typical environmental sample container) containing a specific amount of a given analyte or analytes. The laboratory receives the sample along with instructions on how to prepare and analyze the sample. Obviously, the laboratory knows that the sample is a PE sample which will be used to assess their performance. However, the laboratory does not know the "true" concentration of the sample. (Note: Some people feel that single-blinded PE samples are not particularly useful because a lab knows it is being tested and will tend to perform its highest quality work.)

A double-blind PE sample is prepared in a sample container identical to the ones used for the actual environmental samples. The PE sample is then inserted into a batch of samples, and submitted to the laboratory. Hopefully, the receiving lab is unaware that one of the sample containers is a PE sample and will therefore treat all samples the same way. Consequently, the analytical results of the PE sample can be compared to the certified concentration as a means of assessing laboratory performance. (Note: It can be very difficult to obtain double-blind PE samples and the logistics of having it included with a batch of samples can be complex since they generally are not as stable as single blind PE samples.)

Project managers can request from a laboratory a list of the performance evaluation studies that they participate in and the results of the relevant PE samples they have analyzed. A project manager may also decide that his or her project is important or sensitive enough to send PE samples to the laboratory doing the analyses for the project themselves. PE samples may be purchased from commercial vendors or arranged through EPA's Environmental Services Branch. Project specific PE samples should ideally include the analytes of concern for the project at approximately the concentrations present at the site. This is not always easy to arrange, but the effort is often well worth it in terms of valuable information about the lab's ability to provide reliable results for a particular project.

2.6 Data Quality vs. Data Usability

All data from environmental laboratories are estimates; some are just rougher estimates than others. Some data of poor quality may still be usable. If a decision can still be made based on the data, then re-sampling and re-analysis may not be necessary. Conversely, some data of relatively good quality may be unusable. Enough uncertainty in the quality of the data may exist to prevent a decision from being made without an unacceptable risk that the decision will be wrong. The same piece of data may be usable for some decisions, but not for others. Hence, data quality and data usability are interrelated but independent.

2.7 Laboratory Data Deliverables

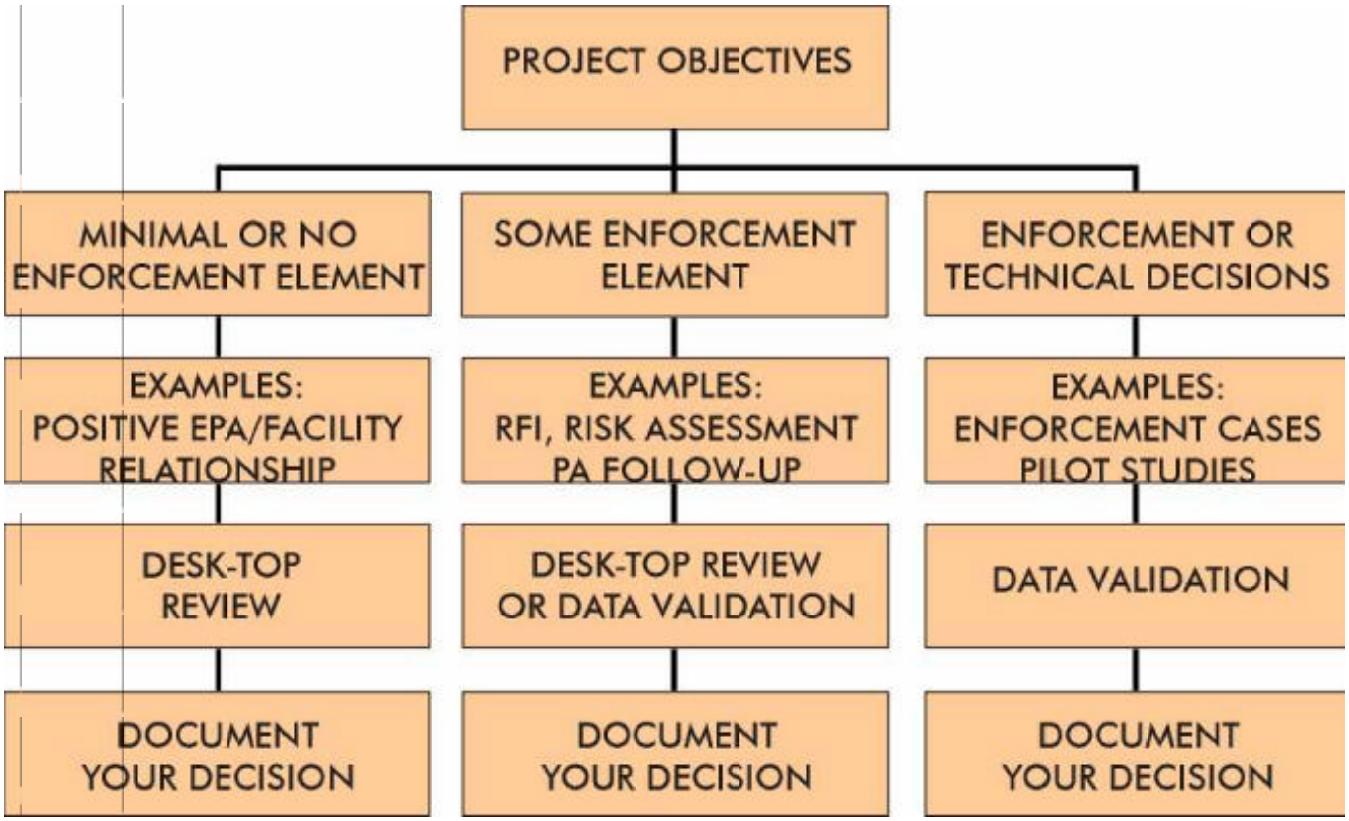
Commercial analytical laboratories present data in a multitude of formats, and often offer their clients several choices of format and of the amount of information provided in the report. The amount of information provided, or "data deliverables" are generally offered at three levels (or variations thereof).

A basic report contains sample results only. It may include information such as detection limits and dates analyzed, but not much more than that. Generally speaking, the RCRA corrective action program should not accept this minimum level of information. A second level of data deliverable includes a summary report of applicable lab QC measurement results (method blank, laboratory control standards, lab duplicates, matrix spike and matrix spike duplicates, etc.). This level would be appropriate for a desk-top review. The most expensive level of data deliverables would include not only the lab QC summaries, but all of the raw data, including calibration data. The Superfund Contract Laboratory Program (CLP) data package requirements are a popular, though far from universal, standard for assembling this level of data deliverable. This level would be necessary for performance of complete data validation.

When requesting facilities to submit analytical data to EPA, RCRA staff should consider whether they expect to review the quality of the data themselves, by means of a desk-top review, or to send the complete data package to an experienced chemist for data validation. If data will be sent to a chemist for validation, the data package requires considerably more information than we would need for a desk-top review. Also, the level of information that corrective action facilities typically provide is more appropriate for a desk-top review than for data validation (e.g., quarterly groundwater monitoring data). Therefore, the request for additional analytical reporting requirements must be stated up front (before the sample collection takes place); in the permit, order, or letter which requests the facility to collect environmental samples. Keep in mind that a complete data package adds to the cost of analysis (10-50% extra), so the facility may resist providing all this information. The complete list of documentation requirements for data validation is in Appendix B. This list can be copied and attached to the appropriate permit/order/letter.

The following flow chart has been prepared to assist project managers with the thought process behind decisions concerning the appropriate level of data quality review.

Figure 3: **Data Quality Review Decision Flowchart**



3.0 ELEMENTS OF DATA REVIEW

Now we will begin our focus on one particular type of data quality assessment tool - data review. Before one can understand the applications and limitations of data review, one must be able to understand the terminology used in the data review process. The following section defines and illustrates some of the key terms. This section covers the types of QA/QC samples commonly used in data review and includes a discussion of laboratory detection and quantitation limits. A more complete glossary is included in Appendix A: GLOSSARY OF TERMS.

3.1 QA/QC Samples Used in Data Review

3.1.1 BLANK SAMPLE: A generic term for a sample of analyte-free media (usually specially prepared clean water) which is used to check for possible contamination during a specific point in the sample collection and analysis procedure. For example, a trip blank is a sample of analyte-free media (water or air) transported from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organic samples. Blank samples are usually collected for water and air, but not for soil. It is difficult to match a laboratory soil blank with a field soil sample, due to variations in grain size, color, and texture. See also, EQUIPMENT BLANK, METHOD BLANK, FIELD BLANK, STORAGE BLANK, and TRIP BLANK for specific applications of blank QA/QC samples.

3.1.2 DUPLICATE: A generic term for a sample which is identical (i.e., collected at the same location, at the same time and by the same procedure) to another sample. A duplicate is used to measure the precision of a specific aspect of the sample collection and analysis procedure. Duplicate field samples should be submitted “blind” to the laboratory, although variability in duplicate results may not always be an indication of poor laboratory performance, but sometimes of matrix variability. See also, FIELD DUPLICATE, MATRIX SPIKE DUPLICATE, and LAB DUPLICATE for specific applications of duplicate QA/QC samples.

3.1.3 LABORATORY CONTROL SAMPLE (LCS): A known matrix which contains compounds representative of the target analytes. A laboratory control sample is used to document laboratory performance. A LCS usually consists of interference-free water spiked with known concentrations of the target analytes. The spiking occurs at the lab prior to preparation and analysis. The theory behind a LCS is that the laboratory should be able to reliably measure the concentration of a target analyte when that analyte is spiked into interference-free water.

3.1.4 MATRIX SPIKE: A known volume of an environmental sample spiked with a known concentration of target analyte(s). The spiking occurs prior to sample preparation and analysis. The measured value is compared with the known (spiked) value. A matrix spike is used to determine the bias of a method in a given sample matrix.

3.1.5 MATRIX SPIKE DUPLICATE: Intra-laboratory (within the same laboratory) split-samples spiked with identical concentrations of target analyte(s). The spiking occurs prior to sample preparation and analysis. Matrix Spike Duplicates are used to assess the precision and bias of a method for a given sample in a given sample matrix.

3.1.6 SURROGATE: (Also called System Monitoring Compounds) An organic compound which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, and which is spiked into every sample and blank in the analytical batch. An example would be the use of fluorinated organic compounds in an analysis which looks for chlorinated and brominated organic compounds because they are all halogenated organics.

3.2 Detection and Quantitation Limits

This section contains basic information on detection and quantitation limits.

3.2.1 DETECTION LIMITS: A generic term which identifies the lower limit at which you can differentiate a measurement from background ("background" in this case is instrument noise, and limitations due to dilution, etc.). The lowest level at which a "yes, the compound is present at or above a given level" or a "no, the compound is not present at or above a given level" determination can be made. The application of this term is commonly the METHOD DETECTION LIMIT (MDL); defined as the minimum concentration of an analyte that can be determined with 99% confidence that the true value is greater than zero. However, it is important to recognize that other types of detection limits exist, such as the INSTRUMENT DETECTION LIMIT (IDL), LIMIT OF DETECTION (LOD) and the CONTRACT REQUIRED DETECTION LIMIT (CRDL), and the REPORTING DETECTION LIMIT (RDL). Lab reports often state "DL" without reference to the type of detection limit.

3.2.2 QUANTITATION LIMITS: A generic term which identifies the lower limit at which a measurement can be quantified with a certain degree of confidence. The application of this term is commonly the METHOD QUANTITATION LIMIT (MQL); defined as the minimum concentration of a substance which can be measured and reported. Other types of quantitation limits exist, such as the PRACTICAL QUANTITATION LIMIT (PQL), LIMIT OF QUANTITATION (LOQ) and the CONTRACT REQUIRED QUANTITATION LIMIT (CRQL).

3.2.3 REPORTING LIMIT: The lower limit at which a laboratory reports data. This limit may have no relationship to the detection limit, and is often project and/or site-specific. For example, a facility may say to the laboratory, "My action level at this site is x. Don't report anything below x." Data reviewers should carefully evaluate lab reports with "reporting limits" rather than detection limits.

4.0 DESK-TOP REVIEW

Varying degrees of data review can be performed. This section presents tips for the non-chemist on reviewing environmental laboratory data and QC summary reports and determining data usability. Appendix C: Desk-top Data Review Checklist contains a checklist which will help organize and document your desk-top review.

4.1 Things To Keep in Mind When Reviewing Data

The following items should be kept in mind while evaluating data:

- Project Objectives
- Data Quality Objectives
- Action Limits
- Sensitivity of the Project and of Project Decisions
- Potential for Enforcement Actions/Decisions
- Environmental Impacts and Dollar Values of Decision Choices
- Existing Data
- Data Quality vs. Data Usability
- Can you identify problems which, if corrected, could improve data collected in the future?

Ideally, if data quality objectives are well thought out ahead of time, all of the other factors will have already been factored into your DQOs. Still, as a reality check, it is best to be thinking about what you are trying to accomplish by gathering environmental data as you are reviewing it.

4.2 Reviewing the Data

Error in analytical data can originate from many sources. It is best to take a holistic approach when reviewing data. Be sure to look at the whole data gathering and reporting process, and not just at one or two steps. If possible, review sampling procedures and samplers' notes along with the laboratory report. The tips presented below assume that the reviewer has access to sampling information and a lab report with QC summary results. Be aware that without having a chemist review the raw data, check calculations, etc., you are taking it on faith that the results (both sample and QC) have been reported correctly.

4.2.1 Overall Measurement System - From Sample Acquisition Through Reporting

Check sample collection procedures and samplers' notes. Were correct procedures followed? Were split-samples, performance evaluation samples, field blanks, and/or field duplicates submitted? Can sample numbers reported on lab report be matched with site locations?

Compare lab analysis with project objectives and with the Sample Plan. Was the correct method run? Do the reported detection limits meet project requirements? Were the correct analytes reported (all of them)?

Compare **split-sample** results (if any). Split-samples are samples which are split in the field and then sent to two different laboratories to be analyzed for the same analytes. Significant differences indicate error somewhere in the overall measurement system. A good rule of thumb is that, for a pair of results more than five to ten times the detection limit, the relative percent difference (RPD) between the two results should not be greater than 50% or further investigation is needed to determine the sources of error. Precision near the detection limit is often inherently poor due to instrument limitations, and higher RPDs are not unexpected. In case it is not apparent, RPDs cannot be calculated if one or both values is/are reported as "below detection limits" or "non-detect (ND)."

Figure 4: **Use of Split Samples - Example Data**

DATA-R-US LABORATORY

	UNITS	DL	MW-38	MW-39	MW-40
Pb	ug/l	1	<1	24	<1

BESTDATA LABS, INC

	UNITS	DL	MW-38	MW-39	MW-40
Pb	ug/l	1	<1	31	<1

In the example shown above, split samples were analyzed at Data-R-Us and BestData labs. The Relative Percent Difference (RPD) for well MW-39 is:

$$RPD = \frac{\text{Difference between split results}}{\text{Mean of split results}} \times 100$$

$$RPD = \frac{31-24}{27.5} \times 100 = \frac{7}{27.5} \times 100 = 25.45\%$$

The same formula is used to determine the RPD for duplicate samples (samples analyzed by the same lab).

Check **field, trip, and equipment blanks** (if any). These give indications of possible contamination somewhere in the sample collection or analysis process. If contamination is discovered refer to Section 2.1.1 on Artificially Introduced Contamination to see if the blanks can help isolate the source of the contamination. Also, refer to Section 3.3 on Data Quality vs. Data Usability to see if some or all of the data can still be used for decision making purposes.

Figure 5: **Use of Equipment Blank - Example Data**

SBB ANALYTICAL SERVICES

	UNITS	MW-1	MW-2	MW-3	EB	FB	TB
Hexane	ug/l	<1	3	<1	12	<1	<1
Chloroform	ug/l	16	<1	<1	<1	4	<1

In the example shown above, the equipment blank (EB) contains hexane, probably due to inadequate rinsing during the decontamination procedure. Sample MW-2, which contains 3 mg/l hexane, is probably an artifact of the poor decontamination procedure. The example shown for chloroform, however, is less intuitively obvious. In this case, both the field blank (FB) and well MW-1 should be considered non-detect for chloroform, even though the concentration in well MW-1 is higher than the field blank. Both results (4 and 16 ug/l) are likely due to contamination in the blank water. Chloroform is a common disinfection by-product (breakdown product of chlorine), and low levels in blanks and environmental samples are frequently encountered.

A comparison of blank samples can be useful in determining the source of contamination. Common field contaminants include decontamination solvents such as hexane, acetone, and methanol. Common laboratory contaminants include acetone and methylene chloride in the volatile fraction, and some types of phthalates, especially bis(2-ethylhexyl)phthalate, in the semi-volatile fraction. In the absence of any other significant detected analytes, low levels of these contaminants can usually be ignored.

Some contaminants, such as acetone, are common laboratory contaminants, but are also organic breakdown products and typically present at hazardous waste facilities. In these cases, determining whether a detected analyte is “real” or is an artifact of the sampling/analytical process can be a difficult task. Comparisons of historical site data and known contaminants at the facility can be useful in determining the source of contamination.

Check **field duplicates** (if any). Field duplicates are separate samples collected as close together in space and time as possible, and sent to the lab “blind” (i.e., the lab doesn’t know that the two samples are duplicates). Field duplicates differ from split-samples in that the duplicate samples are sent to the same lab. Poor precision (RPD greater than 35% for water, 50% for soils, sediments, etc., though acceptable precision is also method dependent) may indicate poor sampling technique, improper handling, a heterogeneous sample matrix, or poor lab performance.

Figure 6: **Use of Duplicate Samples - Example Data**

DATA-R-US LABORATORY

	UNITS	DL	MW-38	MW-39	MW-100
Pb	ug/1	1	<1	24	27

In the example shown above, duplicate samples were analyzed at Data-R-Us Laboratory. The Relative Percent Difference (RPD) for well MW-39 and the duplicate (MW-100) is:

$$RPD = \frac{\text{Difference between duplicate results}}{\text{Mean of duplicate results}} \times 100$$

$$RPD = \frac{27-24}{25.5} \times 100 = \frac{3}{25.5} \times 100 = 11.76\%$$

The same formula is used to determine the RPD for split samples (samples analyzed by different labs). Note that the duplicate sample, MW-100 was sent "blind" to the lab, using a bogus well number, rather than MW-39D, which would have identified it as a "D"uplicate sample.

44.2.2 Laboratory Performance

4.2.2.1 A Note About QC Control Limits and Analytical Method Performance

Not all analytical methods are created equal. Some methods are inherently more precise or more accurate than others. Some methods are used to analyze for a long list of target analytes. The method may work very well for most of the analytes, but, since the method is designed to perform optimally for the majority of the analytes, there may be a few "bad actors" that don't "behave well" analytically. The net result is that it is difficult to apply hard and fast rules as to what constitutes "good" performance.

"Control limits" are ranges of acceptable results for each type of QC measurement. Hopefully, the control limits for your project were well thought out and set up in advance when a Quality Assurance Project Plan was written. More likely, you will receive a sheet of paper with a bunch of QC results, and will have to figure it out after the fact. Most laboratories have their own internal set of control limits that they will use unless it is agreed upon beforehand to use project specific limits. If QC measurements do not fall within the control limits, the laboratory should perform some appropriate corrective action, or, if the problem is related to the sample matrix, note the problem in the analytical report. This is not always done.

Where do control limits come from? Often the laboratory will derive their own internal control limits statistically from QC data generated at the lab. If applied correctly, this is a sensible approach since different labs have different equipment and personnel, and what may be a "bad actor" in one lab may perform better in another lab. Unfortunately, statistically derived control limits are not always applied correctly, and a lab may end up with internal control limits that are so wide that even sloppy work is "within limits".

Control limits are method and analyte specific. For example, a 55% recovery for a chromium LCS run on an ICP instrument would be considered pretty poor, and would probably be outside control limits, but for phenol in a method 8270 GC/MS LCS 55% might be as good as you're going to get. Try to find out before you begin your review what the appropriate control limits would be. The list below is intended to give you a rough idea ONLY of how most analytical methods should be capable of performing. If you

notice a QC result outside of the ranges described below, you should consult with someone knowledgeable about the method to see if the result is acceptable.

Lab QC Measurement	**Approx. Control Limits**
Laboratory Control Sample Recovery	75% - 125%
Matrix Spike Recovery	65% - 135%
Surrogate Spike Recovery	75% - 125%
Laboratory Duplicate	<20% (water) 30% (soil)
Matrix Spike/Matrix Spike Duplicate RPD	<20% (water) 30% (soil)

4.2.2.2 Checking Laboratory Performance

Check laboratory case narrative (if provided). The case narrative should describe any problems that the laboratory encountered, either due to laboratory error or sample matrix problems.

Check holding times. Missed holding times can have a drastic effect on results in some cases, and a lesser effect in other cases. For example, missing the holding time for PCB analysis by one day probably doesn't have a very great effect on data quality since PCBs are extremely stable in the environment. Missing the holding time for volatile organics may have a much greater effect on data quality since, as the name implies, the compounds are volatile. However, in either case, the data may not hold up in a court of law since the holding times were missed.

Check performance evaluation (PE) sample results (if any). Results should be within acceptable range as established by the vendor of the PE sample.

Check Laboratory Control Sample (LCS) results. These are usually expressed as percent recovery of amount of analyte spiked into an interference free matrix (distilled/de-ionized water). Poor performance indicates that the lab is having problems running the method properly. Performance is method specific. For example, a 55% recovery for a chromium LCS run on an ICP instrument would be considered pretty poor, but for phenol in a method 8270 GC/MS LCS it might be as good as you're going to get. If you see recoveries outside the 75 -125% window you should consult with someone knowledgeable about the method to see if the recovery is acceptable. Occasionally a lab will run duplicate LCSs, and present precision data in the form of a relative percent difference (RPD). This is very useful information. A lab must be able to demonstrate good precision between duplicate LCSs or you can have no confidence in their ability to generate reproducible data. If RPDs for duplicate LCSs exceed 20% for analytes of concern there may be a problem. Consult with someone familiar with the method.

Check method blank results. Contamination in the method blank indicates that laboratory contamination may also exist in your samples. Note however, that your data may still be usable, depending on the level of analyte in your samples, degree of contamination, action levels, etc. Refer to Section 2.1.1 on Artificially Introduced Contamination to see if the blanks can help isolate the source of the

contamination. Also, refer to Section 2.6 on Data Quality vs. Data Usability to see if some or all of the data can still be used for decision making purposes.

Check surrogate recoveries (if applicable) in method blank and LCS. As with the LCS, the laboratory should be able to achieve surrogate recoveries within control limits, since the surrogate is spiked into an interference-free matrix. Poor surrogate performance (i.e., outside the control limits) in blanks or LCS indicates that the laboratory may be having trouble performing the method correctly.

4.2.3 Method Performance

Check matrix spike and matrix spike duplicate recoveries (if applicable). Poor recoveries could indicate that either the analytical method does not perform well on that particular sample matrix (due to interfering substances present in the sample), or that the laboratory is performing the method poorly.

Check laboratory duplicate or matrix spike/matrix spike duplicate precision. These are usually expressed as a relative percent difference (RPD). If RPD is not within control limits, it could indicate a non-homogeneous matrix, poor lab technique, or that the method does not perform well on the matrix. In any case, poor precision casts doubt on all of the analyses because you can not be certain that the data are reproducible.

Check surrogate recoveries (if applicable) in samples. Surrogate recoveries outside of control limits indicate that the method is not performing properly for that specific sample. Poor surrogate recoveries could indicate that the method is not well suited to the sample matrix, or that the laboratory is not performing the method properly.

5.0 DATA VALIDATION

If the decisions that are to be made using your environmental data are sensitive, you might consider having data validation performed by a trained chemist. Data validation differs from the desk-top data review described above in that the reviewer will also look at raw data submitted by the laboratory and check that analytes have been correctly identified, quantified, and reported. The reviewer will check instrument calibration and performance data, recalculate results from the raw data, check that standards used are correctly documented, traceable, and not expired, check that chain-of-custody documents are in order, and make sure that all documentation is present so that the entire analytical event can be reconstructed for any sample analysis from the data provided in the data package. The data validation report will usually include data qualifier flags that alert the data user that certain results may be "estimated" or "rejected". Comments in the report will explain the reasons behind the qualification and indicate, where possible, whether a high or low bias can be expected in the data.

The "*USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*" (EPA-540/R94-013) and "*USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*" (EPA-540/R94-012) provide guidance for performing validation of Contract Laboratory Program data. Other data validation guidance may exist, however we were not able to find any data validation guidance specific to RCRA Corrective Action.

6.0 CASE STUDIES

The following two pages contain a case study which can help reinforce the information which has been presented earlier in this document. The first page is a mock-up of the data as it was received from the lab, consultant, facility, etc. Try examining the first page to see if you can identify any concerns with the data. On the second page are shaded boxes which explain the particular concerns with the data. Of course, if you are in a hurry you could simply look at the back of each of these pages, but like most learning exercises - the more effort you put into it, the more knowledge you get out of it.

GAS CHROMATOGRAPHY / MASS SPECTROSCOPY RESULTS

TEST: EPA 8260 (GC/MS CAPILLARY COLUMN FOR VOLATILE ORGANICS)
CLIENT: KNOCKEMDEAD, INC.
MATRIX: GROUNDWATER
PROJECT ID: 44108

LAB ID	CLIENT ID	DATE SAMPLED	DATE ANALYZED	DILUTION FACTOR
1	MW-18B	03-MAR-96	09-MAR-96	1.0
2	MW-26R	03-MAR-96	09-MAR-96	1.0
3	MW-9	03-MAR-96	09-MAR-96	1.0
4	MW-9DUP	03-MAR-96	09-MAR-96	1.0
5	FB	03-MAR-96	09-MAR-96	1.0
6	EB	03-MAR-96	19-MAR-96	1.0

PARAMETER	UNITS	DL	1	2	3	4	5	6
CHLOROMETHANE	ug/l	1	<1	<1	<1	<1	<1	<1
VINYL CHLORIDE	ug/l	1	33	<1	42	47	<1	<1
ACETONE	ug/l	5	<5	14	<5	<5	<5	<5
1,1-DICHLOROETHENE	ug/l	1	12	<1	<1	<1	<1	<1
METHYLENE CHLORIDE	ug/l	1	<1	<1	<1	<1	<1	<1
CARBON DISULFIDE	ug/l	1	<1	<1	<1	<1	<1	<1
1,1-DICHLOROETHANE	ug/l	1	8	<1	<1	<1	<1	<1
TRANS-1,2-DICHLOROETHENE	ug/l	5	79	<5	<5	<5	<5	<5
CHLOROFORM	ug/l	5	<5	11	<5	<5	7	5
1,1,1-TRICHLORETHANE	ug/l	1	24	<1	<1	<1	<1	<1
2-BUTANONE (MEK)	ug/l	5	<5	<5	<5	<5	<5	<5
1,2-DICHLOROETHANE	ug/l	1	18	<1	<1	<1	<1	<1
1,1,2-TRICHLORETHANE	ug/l	1	<1	<1	<1	<1	<1	<1
TETRACHLOROETHENE	ug/l	1	5	<1	14	11	<1	<1

MATRIX SPIKE / MATRIX SPIKE DUPLICATE — Laboratory

CONSTITUENT	Spike (ug/l)	MS Conc.	% Rec	MSD Conc.	% Rec.	QC Limits RPD	RPD	% Rec.
VINYL CHLORIDE	100	84	84	87	87	4	35	28-110
ACETONE	100	32	32	73	73	78	50	26-128
1,1-DICHLOROETHENE	180	166	92	140	78	17	22	35-105
1,1,1-TRICHLOROETHANE	150	136	91	128	128	35	24	60-110
TETRACHLOROETHENE	200	208	104	176	88	17	30	56-120
2-BUTANONE	150	112	__	134	__	__	28	40-120

Directions:
Circle any errors or information that might indicate problems with the analysis.
Calculate the % recoveries for the MS and MSD for 2-butanone _____
What is the RPD between the MS and MSD for 2-butanone? _____
Were the lab QC limits met for 2-butanone? _____
What is the RPD of Vinyl Chloride in Samples 3 and 4?_____
What is the RPD of PCE in Samples 3 and 4?_____

APPENDIX A: GLOSSARY OF TERMS

ACCURACY: The closeness of agreement between an observed value and the true value. PRECISION is a measure of the reproducibility of a value, without knowledge of the true value. The classic example used to illustrate these terms is a dartboard example: The placement of four darts thrown at a dartboard is considered accurate if the darts are each close to the bullseye (regardless of their proximity to one another). The placement is considered precise if the darts are all grouped closely together, regardless of their distance from the bullseye. Hence, to be both accurate and precise the four darts would need to be grouped closely together and be close to the bullseye.

ANALYTE: That which is analyzed for. This can be chemical (chromium, benzene), biological (fecal coliform bacteria), mineral (asbestos fibers), or radiological (alpha and beta emissions).

BATCH: A group of samples which are processed together by the laboratory. Ideally, all the samples in a batch will be similar enough that matrix QC measurements performed with the batch will be representative of all of the samples in the batch.

BIAS: The difference between the reported result and the true result. Bias may be introduced through field or laboratory variability and error or due to substances in the sample which interfere with the analytical system's ability to provide an accurate measurement. Since the true concentration of an analyte in an environmental sample is generally never known, bias is estimated by using surrogates, matrix spikes, laboratory control standards, and other indicators of analytical accuracy.

BLANK: See EQUIPMENT BLANK, FIELD BLANK, METHOD BLANK, STORAGE BLANK, or TRIP BLANK. [See also § 3.1.1 and § 4.2.1]

BLANK SPIKE: See LABORATORY CONTROL STANDARD

BLIND: A term used to denote various types of QA/QC samples which are submitted to a laboratory for analysis without the laboratory knowing that they are QA/QC samples. Sometimes the terms "single blind" and "double blind" are used. See PERFORMANCE EVALUATION (PE) SAMPLE for a definition of these two terms. [See also § 2.5]

CALIBRATION: The process of correlating instrument signal response with analyte concentration. An instrument must be properly calibrated in order to produce accurate results.

CONTRACT REQUIRED DETECTION LIMIT (CRDL): The minimum level of detection acceptable under the Superfund Contract Laboratory Program (CLP) statement of work for inorganic analysis. [See also § 3.2]

CONTRACT REQUIRED QUANTITATION LIMIT (CRQL): Minimum level of quantitation acceptable under the CLP statement of work for organic analysis. [See also § 3.2]

CONTROL LIMITS: Ranges of acceptable results for each type of QC measurement. They may be set up on a project specific basis, or they may be derived internally at a laboratory from historic QC performance data. [See also § 4.2.2.1]

CONTROL SAMPLE: A quality control sample introduced into a process to monitor the performance of the system. See also, LABORATORY CONTROL SAMPLE. [See also § 3.1.3 and § 4.2.2.2]

DATA QUALITY ASSESSMENT: A broad term which encompasses data validation, “desk-top reviews”, split-samples and any other process used to evaluate the quality of analytical data collection and analysis process. [See also § 0.1]

DATA QUALITY OBJECTIVES (DQOs): A statement of the overall level of uncertainty that a decision-maker is willing to accept in results derived from environmental data. This is qualitatively distinct from quality measurements such as precision, bias, and detection limit. [See also § 1.1]

DATA REVIEW: The process by which laboratory analytical data reports are examined to evaluate their quality; the process may be rigorous or cursory depending on the project’s objectives. [See also § 0.1]

DATA VALIDATION: The formal, rigorous process by which trained chemists evaluate the quality of laboratory analytical data reports, check for calculation errors and analyte identification errors, and provide data qualifier flags and comments to help the data user determine the usability of the data for their intended use. [See also § 0.1]

DESK-TOP REVIEW: A less-rigorous process which RCRA project managers (non-chemists) can use to evaluate the quality of laboratory analytical data reports. [See also § 0.1]

DUPLICATE: See FIELD DUPLICATE, MATRIX SPIKE DUPLICATE, and LAB DUPLICATE. [See also § 3.1.2 and § 4.2.1]

ENVIRONMENTAL SAMPLE: A sample taken un-altered (as much as possible) from the environment (as opposed to a blank, PE sample, matrix spike sample, etc.).

EQUIPMENT BLANK: A sample of analyte-free media (e.g., clean water poured over a bailer), which has been used to rinse the sampling equipment. The equipment blank is collected after completion of decontamination and prior to collection of environmental samples. This blank is useful in documenting adequate decontamination of sampling equipment. An Equipment Blank may also be referred to as a Rinsate Blank. [See also § 2.1.1, § 3.1.1, and § 4.2.1]

FIELD BLANK: A sample containing an analyte-free matrix which is collected and processed in exactly the same manner as an equivalent environmental sample (e.g., clean water is poured into a sample container in the same physical location where the environmental sample is collected, and is subsequently handled, processed and analyzed exactly as an equivalent environmental sample). The field blank is used to identify contamination resulting from field sample collection techniques. [See also § 2.1.1, § 3.1.1, and § 4.2.1]

FIELD DUPLICATES: Separate and independent samples collected as close together in space and time as possible. These duplicates are analyzed separately, and are useful in documenting the precision of the sampling and analysis process. Field duplicates differ from split-samples in that field duplicates are sent to the same lab. [See also § 3.1.2 and § 4.2.1]

INSTRUMENT DETECTION LIMIT (IDL): Smallest signal above background noise that an instrument can detect reliably. [See also § 3.2]

LAB DUPLICATE (may also be called SAMPLE DUPLICATE): Two portions of the same sample that are prepared and analyzed separately by the laboratory. Used to evaluate laboratory precision. [See also § 3.1.2 and § 4.2.1]

LABORATORY CONTROL SAMPLE (LCS): A known matrix which contains compounds representative of the target analytes. A laboratory control sample is used to document laboratory performance. A LCS usually consists of interference-free water spiked with known concentrations of the target analytes (if the list of target analytes for a particular analysis is long, the LCS may contain a subset of the target analytes). The spiking occurs at the lab prior to preparation and analysis. The theory behind a LCS is that the laboratory should be able to reliably measure the concentration of a target analyte when that analyte is spiked into interference-free water. Sometimes referred to as a BLANK SPIKE. [See also § 3.1.3 and § 4.2.2.2]

LIMIT OF DETECTION (LOD): The lowest concentration that can be determined to be statistically different from a blank. [See also § 3.2]

LIMIT OF QUANTITATION (LOQ): The concentration above which quantitative results can be obtained with a specified degree of confidence. [See also § 3.2]

MATRIX: The component which contains the analyte of interest (e.g., surface water, drinking water, air, soil, tissue, etc.).

MATRIX INTERFERENCE: Bias introduced because something in the sample interferes with the analytical system's ability to provide an accurate measurement. The interference may be physical (turbidity in storm water run-off may block light transmission in an analysis based on U.V. absorbance), or chemical (a chemical similar to the analyte of interest may increase the response of the instrument, resulting in a positive bias).

MATRIX SPIKE: A measured amount of sample spiked with a known concentration of target analyte(s). The spiking occurs prior to sample preparation and analysis. A matrix spike is used to assess the bias of a method in a given sample matrix. [See also § 3.1.4 and § 4.2.3]

MATRIX SPIKE DUPLICATES: Intra-laboratory (within the same laboratory) split-samples spiked with identical concentrations of target analyte(s). The spiking occurs prior to sample preparation and analysis. Matrix Spike Duplicates are used to assess the precision and bias of a method in a given sample matrix. [See also § 3.1.2, § 3.1.5 and § 4.2.3]

METHOD BLANK: An analyte-free matrix which is prepared and processed at the lab in exactly the same manner as an equivalent environmental sample (i.e., all reagents are added in the same volumes or proportions as used in sample processing). The method blank is used to document contamination resulting from the analytical process. [See also § 2.1.1, § 3.1.1 and § 4.2.2.2]

METHOD DETECTION LIMIT (MDL): The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. [See also § 3.2]

METHOD QUANTITATION LIMIT (MQL): The minimum concentration of a substance that can be quantified with confidence. [See also § 3.2]

PERFORMANCE EVALUATION (PE) SAMPLES: Samples with known concentrations of certain target analytes, and which are submitted "blind" to a lab as a check of laboratory performance. [See also § 2.5]

PRACTICAL QUANTITATION LIMIT (PQL): The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The PQL is (by definition in SW-846) 5 to 10 times the Method Detection Limit (MDL). [See also § 3.2]

PRECISION: A measure of the reproducibility of a result. This should not be confused with ACCURACY. An analytical system may be very precise (give you the same result no matter how many times you run the analysis) but very inaccurate at the same time. See ACCURACY

QUALITY ASSURANCE: An integrated system or program of activities involving planing, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. *In other words, QA is the overall* ***strategy*** *for obtaining a quality product.*

QUALITY CONTROL: The system of routine technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users. *In other words, QC activities are the* ***tactics*** *which are used to measure and control quality.*

REAGENT BLANK: See METHOD BLANK

RELATIVE PERCENT DIFFERENCE: A measure of precision. The relative percent difference (or RPD) between duplicate analyses is calculated as follows [See also § 4.2.1, § 4.2.2.2 and § 4.2.3]:

$$RPD = \frac{|\text{Difference between duplicate results}|}{\text{Mean of duplicate results}} \times 100\%$$

REPORTING LIMIT: The lower limit at which a laboratory reports data. This limit may have no relationship to the detection limit, and is often project and/or site-specific. For example, a facility may say to the laboratory, "My action level at this site is 'x'. Don't report anything below 'x'." Data reviewers should carefully evaluate lab reports with "reporting limits" rather than detection limits. [See also § 3.2]

RINSATE BLANK: See EQUIPMENT BLANK

SPIKE: Known amount of analyte that is introduced purposely into a sample (either an environmental sample or a blank) for the purpose of determining whether or not the analytical system can accurately measure the analyte.

SPLIT SAMPLES: Samples taken from the same source and/or location at he same time and sent to two different laboratories to be analyzed independently. They are used to assess inter-laboratory precision, and the possibility of large errors at one lab or the other. [See also § 4.2.1]

STANDARD REFERENCE MATERIAL (SRM): An environmental material (soil, sediment, ore, type of waste) with a known and certified concentration of analyte(s) in it. SRMs are analyzed and used to

assess method accuracy on a particular matrix. They are sometimes used in place of Laboratory Control Standards. SRMs are very useful if the SRM is a similar matrix to the types of samples being analyzed. Unfortunately, only a limited number of types of SRMs are available.

STORAGE BLANK: Analyte free water placed in the refrigerator or other storage area at the laboratory with environmental samples. Used to evaluate whether or not samples may be cross-contaminating each other in storage, or whether a source of contamination exists in the storage area. [See also § 3.1.1]

SURROGATE: An chemical which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which is not expected to be present in the sample. Surrogates are added to the all the environmental samples, blanks, and QC samples in the analytical batch during the preparation stage of the analysis. Surrogates are use to monitor the performance of the analytical process. An example would be the use of fluorinated organic compounds in an analysis which looks for chlorinated and brominated organic compounds. Surrogates may also be called SYSTEM MONITORING COMPOUNDS. [See also § 4.2.2.2 and § 4.2.3]

TARGET ANALYTE: A chemical that is being looked for in an analysis.

TENTATIVELY IDENTIFIED COMPOUND (TIC): A compound which is outside the standard list of analytes in a GC/MS method, but which is reported based on a tentative match between the instrument response and the instrument's computer library. The identification and quantitation of these compounds is tentative.

TRIP BLANK: A sample of analyte-free media (such as distilled/de-ionized water) taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organic samples. [See also § 2.1.1, § 3.1.1, and § 4.2.1]

APPENDIX B: SUMMARY OF DOCUMENTATION REQUIREMENTS FOR DATA VALIDATION

Organic Data

1. Case Narrative

2. Chain-of-Custody Documentation

3. Summary of Results

- Form listing the Environmental samples, with quantitation limits (include dilutions and re-analyses)

4. QA/QC Results Summaries

- Initial calibration
- Continuing calibration
- Method blanks
- Surrogate recoveries
- Matrix spike (MS)
- Laboratory duplicate or matrix spike duplicate (MSD)
- Laboratory QC check sample, if applicable
- Retention time windows
- Method detection limits (MDL)

5. Raw Data - chromatogram and area/quantitation limits

- Environmental samples (include dilutions and re-analysis)
- Instrument tuning, for mass spec (GC/MS) analyses
- Initial calibration
- Continuing calibration
- Method blanks
- Surrogate recoveries
- Matrix spike (MS)
- Laboratory duplicate or matrix spike duplicate (MSD)
- Laboratory QC check sample, as applicable
- Retention time windows
- Percent moisture in soil samples
- Sample extraction and clean-up logs
- Instrument analysis run log for each instrument used

Requirements for Data Validation

Inorganic Data

1. Case Narrative
2. Chain of custody documentation
3. Summary of results

- Form listing the Environmental samples, with quantitation limits (include dilutions and re-analyses)

4. QA/QC Results Summaries

- Initial calibration
- Continuing calibration
- Method blanks, continuing calibration blanks, and prep blanks
- ICP interference check sample
- Matrix spike (MS)
- Laboratory duplicate
- Laboratory control sample
- Method of standard additions
- ICP serial dilution
- Instrument detection limits
- ICP linear range

5. Raw Data - sequential measurement readout records for ICP, graphite furnace AA, flame AA, cold vapor mercury, cyanide and/or other inorganic analyses

- Environmental samples (include dilutions and re-analyses)
- Initial calibration
- Continuing calibration
- Continuing calibration and Preparation blanks
- Matrix spike (MS)
- Post digest spikes
- Method of standard additions, when applicable
- Laboratory duplicate or matrix spike duplicate (MSD)
- ICP serial dilutions
- Laboratory control samples, when applicable
- Percent moisture in soil samples
- Sample digestion and/or sample preparation logs
- Instrument analysis run log for each instrument used
- Instrument tuning data, for ICP-MS, when applicable

APPENDIX C: DESK-TOP DATA REVIEW CHECKLIST

This checklist includes items that a knowledgeable non-chemist can review when determining data usability.

I. Overall Measurement System

- Correct sampling procedures followed?
- Correct method run?
- All analytes reported?
- Detection limits meet project requirements?
- Split-sample results (if any) not significantly different?
- Contamination in field, trip, or equipment blanks?
- Field duplicate results (if any) acceptable?

II. Laboratory Performance

- Does laboratory case narrative (if provided) note any analytical problems?
- Holding times met?
- Performance Evaluation (PE) sample results (if any) acceptable?
- Laboratory Control Sample (LCS) results within control limits?
- Contamination in method blanks?

III. Method Performance

- Matrix spike/matrix spike duplicate recoveries within control limits?
- Lab duplicate and/or matrix spike/matrix spike duplicate precision within control limits?
- Surrogate recoveries (where applicable) within control limits?

APPENDIX J

Example Daily Data Quality Monitoring Reports

GSA Data Review	May 28, 2003	Garry Struthers Associates, Inc.

These data are the analytical laboratory results for grab samples collected during a Phase II ESA field activity.

These preliminary data have been reviewed for internal consistency and not verified against the hardcopy laboratory report. These data are deemed usable for the quantitative purposes intended. No data needed to be qualified by GSA for deficiencies. J flags noting estimated values were applied by the laboratory to data reported above detection but below the laboratory Practical Quantitation Limit. A summary of the data quality indicators evaluated and explanations needed are presented below. The definitions for data flags used by the laboratory are provided with the report. Definitions of flags used by GSA as a result of this data review are defined in the comments below.

Approval: Title: Senior Chemist Date: 05/28/2003

Codes Used: A = Acceptable R = Rejected Q (*) = Qualified by GSA (Flag) NE= Cannot be evaluated with the data as submitted

Source Document(s): USEPA SW-846 @ http://www.epa.gov/epaoswer/hazwaste/test/main.htm

Laboratory: **OnSite Environmental Inc., Redmond , WA** Report Number: Report Date:

Project Number: Project Title: EGDY Thermal Remediation

Date Sampled: 05/14/2003

Intended Data Use: Site Assessment to Support Phase I ESA Recommendations

Number of Samples/Matrix: **5 Water (and 1 duplicate and 1 Trip Blank for VOCs)**

Analytes	**Volatile Organics**	**Diesel-range Hydrocarbons (Soil)**	**Diesel-range Hydrocarbons (Water)**
Analytical Method	EPA 8260B	NWTPH-Dx	NWTPH-Dx
ID of Field Samples	RV208.2-03-10S05 to -12.5-10S06, RV210-10-11S07 to -40-13S18	0303-009: 208.2-04.3-8S01& -06.3-9S03 0303-078: RV208.2-03-10S05 to -12.5-10S06,	0303-009: 208.2-04.3-8S01& -06.3-9S03 0303-078: RV208.2-03-10S05 to -12.5-10S06,
ID of Field Duplicate Samples	RV210-10-13S15D	RV210-10-13S15D	RV210-10-13S15D
Sample Handling	A	A	A
Holding Time	A	A	A
Chain of Custody	A	A	A
Analytical Sensitivity	A	A	A
Calibration	A	A	A
Lab Blank	A	A	A
Surrogates	A	A	A
Matrix Spike	A	A	A
Laboratory Control Samples	NA	NA	NA
Laboratory Precision	A	A	A
Field Duplicate QC Precision	A	A	A
Performance Evaluation Samples	A		
Field Preservation	A	A	A
Field Blanks	A	A	A
Data Completeness	A	A	A
Background Samples	NA	NA	NA
Chromatograms and/or Spectra	A	A	A
Sensibility	A	A	A
Field Sampling Issues	A	A	A

DAILY DATA QUALITY MONITORING REPORT

Line #	Sample Location	Matrix	Lab Job Number	COC [1] Complete Yes/No	Analysis	Analysis Method	Date Collected	Date Extracted/ Prepared	Date Analyzed	Holding Time In/Out	Reporting Limits [2]
1	Equipment Blank	water	P3D0265	Yes	VOCs	8260B	04/07/2003	04/10/2003	04/10/2003	In	Normal limits
2	Dup#1-H2O-040703	water	P3D0265	Yes	VOCs	8260B	04/07/2003	04/10/2003	04/10/2003	In	Normal limits
3	E15@20-H2O-040703	water	P3D0265	Yes	VOCs	8260B	04/07/2003	04/10/2003	04/10/2003	In	Normal limits
4	E45@20-H2O-040703	water	P3D0265	Yes	VOCs	8260B	04/07/2003	04/10/2003	04/10/2003	In	Normal limits
5	MP4-H2O-040703	water	P3D0268	Yes	VOCs	8260B	04/07/2003	04/09/2003	04/09/2003	In	Elevated 20 times
6	MP44-H2O-040703	water	P3D0268	Yes	VOCs	8260B	04/07/2003	04/10/2003	04/10/2003	In	Normal limits
7	MW81-H2O-040703	water	P3D0265	Yes	VOCs	8260B	04/07/2003	04/10/2003	04/10/2003	In	Normal limits
8	MW83-H2O-040703	water	P3D0265	Yes	VOCs	8260B	04/07/2003	04/10/2003	04/10/2003	In	Normal limits
9	Trip Blank	water	P3D0265	Yes	VOCs	8260B	04/07/2003	04/10/2003	04/10/2003	In	Normal limits

[1] COC = Chain of Custody

[2] Normal reporting limits are as follows: Aqueous VOCs in general - 1.0 µg/L;
Hexachlorobutadiene, Isopropylbenzene, p-Isopropyltoluene, Naphthalene, m,p-Xylene - 2.0 µg/L;
Bromomethane, n-Butylbenzene, Chloromethane, 1,2-Dibromo-3-Chloropropane, Dichlorodifluoromethane, 4-Methyl-2-Pentanone, Methylene Chloride - 5 µg/L;
2-Butanone, Carbon Disulfide, 2-Hexanone - 10 µg/L;
Acetone - 25 µg/L;
Sulfide, Sulfate - 1 mg/L

DAILY DATA QUALITY MONITORING REPORT

Line #	Blank Sample Results			Surrogate Recovery In/Out	Spike Recoveries		Duplicate Precision In/Out	Data Quality Objectives Met?
	Lab. In/Out	Equip. In/Out	Trip In/Out		MS In/Out	MSD In/Out		
1	In	In	In	In	Batch E45@20	Batch E45@20	Batch E45@20	Yes. Equipment blank.
2	In	In	In	In	Batch E45@20	Batch E45@20	Batch E45@20	Yes. Duplicate of sample MW83-H2O-040703.
3	In	In	In	In	Batch E45@20	Batch E45@20	Batch E45@20	Yes.
4	In	In	In	In	In	In	In	Yes. MS/MSD.
5	In	In	In	In	Batch E45@20	Batch E45@20	Batch E45@20	Yes for benzene, cis-1,2-dichloroethene, ethyl ether, toluene, and vinyl chloride. Flag all others "U".
6	In	In	In	In	Batch E45@20	Batch E45@20	Batch E45@20	Yes. MS/MSD. Sample was initially analyzed 4/9/2003. Sample was reanalyzed 4/10/2003 due to high surrogate recovery.
7	In	In	In	In	Batch E45@20	Batch E45@20	Batch E45@20	Yes.
8	In	In	In	In	Batch E45@20	Batch E45@20	Batch E45@20	Yes.
9	In	In	In	In	Batch E45@20	Batch E45@20	Batch E45@20	Yes. Trip blank.