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# U.S. ARMY ENVIRONMENTAL CENTER

## WOODBRIDGE RESEARCH FACILITY
## REMEDIAL INVESTIGATION/FEASIBILITY STUDY

### Sampling and Analysis Plan
### Vol II: Quality Assurance Project Plan

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Response to Comments
on the WRF RI/FS Sampling and Analysis Plan
Vol II: Quality Assurance Project Plan, Draft Final
from Nancy Rios Jafolla, USEPA

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**Comment 1., Determination of the Decontamination Water Source**

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**Comment:** The use of the on-site potable water supply for decontamination without further rinsing using appropriate solvents is questioned, since it may introduce contamination into the samples and may cause unnecessary sampling bias. Please check with the QA/QC officer for the site with regards to use of the appropriate water source for rinsing instruments, etc.

**Response:** Please review the WRF RI/FS Sampling and Analysis Plan Vol I: Field Sampling Plan, Section 4.8.4.2 for a description of the decontamination procedures which include rinsing sampling equipment with a 10% nitric acid solution and hexane as well as rinsing the equipment with the deionized organic-free water.

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**Comment 2., Reporting Limits**

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**Comment:**

(1) The reporting limits for PCBs (0.13 ppb) is greater than the RBC for this contaminant for tap water of 0.008 ppb.

(2) The reporting limits for VOCs in groundwater and surface water are high. They should be risk-based if the MCL is not protective (e.g., The MCL for vinyl chloride is 2 ppb equivalent to a 1E-04 cancer risk; RBC of 0.02 ppb).

(3) The reporting limits for PCTs are not noted in the Report.

**Response:**

(1) The method used for the analysis of PCBs in aqueous samples provides the lowest reporting limit available using standard USEPA methodologies.

(2) For future samples collected, groundwater and surface water samples will be analyzed using USEPA SW-846 Method 8260 with a 25 mL purge. This modification will be noted in the QAPP addendum for the Feasibility Studies.

(3) The reporting limits for PCTs are provided in Table 6-14.

---

Response to Comments
on the WRF RI/FS Sampling and Analysis Plan
Vol II: Quality Assurance Project Plan, Draft Final
from Jennifer Cook, USAEC

---

**Comment 1., Table 4-1**

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**Comment:** Change "criterion of detection" to "method detection limit" in the 7th block.

**Response:** The text has been changed accordingly.

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**Comment 2., Section 5.4**

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**Comment:** State that if cooler temperatures are not between 2 and 6 degrees celsius, then the project chemist and prime contractor shall be notified.

**Response:** The text has been changed accordingly.

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U.S. Army Woodbridge Research Facility (WRF) was used in the past as a major military communications center and a research and development laboratory where electromagnetic pulse energy was tested on military and other equipment. WRF is presently an inactive facility on the Base Realignment and Closure (BRAC) list. Past investigation activities indicate that PCBs are a primary chemical of concern. The WRF is presently in the process of being turned over to the USFWS to be used as a wildlife refuge and training facility. This task calls for provision of the necessary staff and equipment to provide remedial investigation/ feasibility support for the USAEC BRAC Program investigation at WRF. The scope of work includes Focused Feasibility studies, Remedial Investigations, Feasibility studies, ecological assessments, risk assessments, proposed plans, RODS and community relations support. This Sampling and Analysis Plan, Vol II: Quality Assurance Project Plan presents the data quality objectives, proposed laboratory methods for chemical and physical methods, and standard operating procedures for field operations.

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FINAL DOCUMENT

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## 1.0 INTRODUCTION

The United States Army Environmental Center (USAEC) has tasked ICF Kaiser Engineers, Inc., (ICF KE) to perform the Remedial Investigation/Feasibility Study (RI/FS) for sites at the Woodbridge Research Facility (WRF) in accordance with guidance from the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). This work will be performed under Contract No. DACA31-94-D-0064, Delivery Order 1.

This Quality Assurance Project Plan (QAPP) delineates the purpose, policies, Standard Operating Procedures (SOPs), quality assurance and quality control protocols, and organization of the QA program which will be used to establish the integrity and meet the Data Quality Objectives (DQOs) required for completion of the RI/FS at WRF. The procedures detailed in this QAPP incorporate elements of the U.S. Army Environmental Center Guidelines for the Implementation of ER 1110-1-263 for USAEC Projects, May 1993. This document is referenced throughout the QAPP and will be referred to as USAEC Guidelines. In addition, elements of U.S. Environmental Protection Agency (USEPA) Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, October 1988, will be incorporated when approved by the USAEC. In cases where the above-listed guidance documents are in conflict, the more stringent requirement was selected. Therefore, the procedures in this QA plan meet or exceed USAEC Guidelines and USEPA QA requirements.

Quality assurance goals for the WRF RI/FS will be achieved through proper planning, organization, review, communication of objectives, reporting, and corrective action. The QA Program will be carried out by personnel knowledgeable in QA theory and practice. Facilities, equipment, and services which affect data quality or integrity will be routinely inspected and maintained, as required by SOPs.

Implementation of the QAPP requires that the project staff maintain an awareness of contractual procedures and goals. It is the policy of ICF KE to provide a QA program to ensure that information produced by its employees and subcontractors is valid and of known quality. QA program requirements cover activities which generate environmental measurement data. These requirements include statements of completeness, comparability, representativeness, precision, and accuracy, where applicable.

This QAPP is divided into thirteen sections. Project description, organization, and responsibilities are delineated in Sections 2 and 3. Responsibilities for field and laboratory activities are provided as well as a list of key individuals. Section 4 defines the project data quality objectives and identifies potential applicable or relevant and appropriate requirements (ARARs) for the WRF RI/FS. Section 5 defines the sample management to include sampling protocols, preservation, sample custody, and sample shipment. Section 6 outlines the analytical program, determines appropriate parameters for the WRF RI/FS, and discusses laboratory and filed calibration procedures. Section 7 defines data reduction, validation, and reporting requirements. Section 8 defines data management, and system controls for laboratory data quality. Section 9 discusses internal quality control. This section defines QC sample acceptance criteria and corrective actions. Quality assessments for project plans and readiness reviews are delineated in Section 10. Sections 11 and 12 delineate corrective action and quality control reports format and procedures. Section 13 contains a bibliography of references which were used in the development of this document.

### 1.1 PURPOSE

Quality Assurance (QA) is defined as the overall system of activities for assuring the reliability of data produced. The system integrates the quality planning, assessment, and improvement efforts of various

groups in the organization to provide the independent QA program necessary to establish and maintain an effective system for collection and analysis of environmental samples and related activities. The program encompasses the generation of valid and complete data and its subsequent review, validation, and documentation.

## 1.2 SCOPE

This QAPP establishes function-specific responsibilities and authorities for data quality and defines procedures which will ensure that field and laboratory activities will result in the generation of quality data. Implementation of the QAPP will help to ensure the validity of data collected, and will establish a firm foundation for decisions regarding the RI/FS at WRF.

Inherent in the QA program is the implementation of Quality Control (QC) measures. These measures provide assurance that the monitoring of quality-related events has occurred, and that data gathered in support of the project is accurate, precise, representative of the sample matrix, and complete.

## 2.0 PROJECT DESCRIPTION

### 2.1 PROJECT SCOPE

The scope of this task is encompassed by the following subtasks:

- Discussion and summary of the previous studies in order to provide a detailed overview of the current contamination at WRF;
- Defining of the project and site-specific DQOs;
- Identifying of any data deficiencies such that project and site-specific data quality objectives are met; and
- Generating the Work Plan and the Sampling and Analysis Plan for completion of the WRF RI/FS.

This QAPP will address the specific DQOs, methodologies, SOPs, and the general QA Program which will be implemented during the WRF RI/FS.

### 2.2 PROJECT OBJECTIVE

The primary objective of the RI/FS is the collection of data for a baseline human health and facility wide ecological risk assessments, establishment of background levels of target compounds, completion of a feasibility study, and selection of remedial action(s). Environmental samples will be collected to characterize and define the nature and extent of contamination throughout the facility. In order to effectively assess the extent of current contamination, Areas Requiring Environmental Evaluation (AREEs) were established during the 1984 RI (USAEC 1984). Maps and specific sample locations are provided in the Sampling and Analysis Plan, VOL I: Field Sampling Plan (FSP). Tables summarizing the samples and associated analytical parameters to be collected from each AREE and analyses for each are located at the end of Section 2.0 for reference.

#### 2.2.1 Former and Potential Dump Areas

For the purpose of the investigation, the Former Dump Areas which include AREEs 1 through 4, 6a and 6b have been grouped together. In addition, due to the proximity, AREE 7 - Former Pistol Range is included in the Former and Potential Dump Areas investigation.

**2.2.1.1 Downgradient Locations**. Based on previous investigations, groundwater beneath the former dump areas is estimated to flow toward Marumsco Creek and the Occoquan Bay. The following samples will be collected to determine the impact of activities at the former dump areas to downgradient areas. A summary of sample IDs and associated analytical parameters is presented in Table 2-1.

Groundwater. Two monitoring wells will be installed downgradient of the former dumps in order to evaluate migration of contamination via groundwater. Groundwater samples will be collected during two rounds and analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), Target Analyte List (TAL) metals, total petroleum hydrocarbons (TPH), polynuclear aromatic hydrocarbons (PAHs), polychlorinated terphenyls (PCTs), and the physical parameters of temperature, pH, conductivity, redox potential, and dissolved oxygen. For this QAPP, these physical parameters will be referred to as water quality parameters.

Subsurface Soil. In order to evaluate the migration of subsurface contaminants from AREE 1, three borings will be drilled and 3 samples per boring will be collected. Subsurface soil samples will be chemically analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, TPH, and PCTs. In addition, one sample per boring will be tested for grain size, percent moisture, Atterberg limits, USCS classification, and total organic content (TOC).

**2.2.1.2 AREE 1 - Former Dump No. 1**. This AREE is defined as Former Dump No. 1. The source and extent of contamination of AREE 1 will be further characterized by sampling groundwater, surface soil and subsurface soil. Subsurface and surface soil samples will be collected to determine the surficial and vertical extent of contamination. Groundwater samples will be collected to determine the contribution of the source. A summary of sample IDs and associated analytical parameters is presented in Table 2-2.

Groundwater. Four monitoring wells will be installed and sampled and six existing monitoring wells will be sampled during two rounds within AREE 1. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and water quality parameters in order to further characterize groundwater within AREE 1.

Subsurface and Surface Soil. Four surface soil samples will be collected to evaluate surficial contamination within AREE 1. Four borings will be drilled and 3 samples per boring will be collected in order to determine vertical extent of contamination within AREE 1. Soil samples will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs. In addition, one sample per boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

Test Pits. In addition to the surface and subsurface soil investigation, two test pits will be dug. Two samples per pit will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs.

**2.2.1.3 AREEs 2 and 5 - Former Dumps 2 and 5**. These AREEs are defined as Former Dumps 2 and 5. The source and extent of contamination of AREEs 2 and 5 will be further characterized by sampling groundwater, subsurface soil, and surface soil. Surface and subsurface soil samples will be collected in order to determine the vertical extent of contamination. Groundwater samples will be collected to determine the contribution of the source. A summary of sample IDs and associated analytical parameters is presented in Table 2-3.

Groundwater. Ten monitoring wells will be installed and sampled and five existing monitoring wells will be sampled during two rounds within AREEs 2 and 5. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals, PAHs, PCTs, TPH, and water quality parameters in order to further characterize groundwater within AREEs 2 and 5.

Subsurface and Surface Soil. Five surface soil samples will be collected to characterize surficial contamination within AREEs 2 and 5. Ten soil borings will be drilled and 3 samples per boring will be collected in order to evaluate and characterize potential source areas within AREEs 2 and 5. Soil samples will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH. In addition, one sample per boring will be tested for grain size, Atterberg limits, percent moisture, USCS classification, and TOC.

Test Pits. In addition to the surface and subsurface soil investigation, two test pits will be dug. Two samples per pit will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

**2.2.1.4 AREE 3 - Former Dump No. 3**. This AREE is defined as Former Dump No. 3. The source and extent of contamination of AREE 3 will be further characterized by sampling surface soil. A summary of sample IDs and associated analytical parameters is presented in Table 2-4.

Surface Soil. Three surface soil samples will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals.

Test Pits. In addition to the surface and subsurface soil investigation, two test pits will be dug. Two samples per pit will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals.

**2.2.1.5 AREE 4 - Former Dump No. 4**. This AREE is defined as Former Dump No. 4. The source and extent of contamination of AREE 4 will be further characterized by sampling groundwater, subsurface soil, and surface soil. Subsurface and surface soil samples will be collected in order to determine the vertical extent of contamination. Groundwater samples will be collected to determine the contribution of the source. A summary of sample IDs and associated analytical parameters is presented in Table 2-5.

Groundwater. Three monitoring wells will be installed and sampled during two rounds within AREE 4. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, TPH, and water quality parameters in order to further characterize groundwater within AREE 4.

Subsurface and Surface Soil. Four surface soil samples will be collected to characterize surficial contamination within AREE 4. Three borings will be drilled and 3 samples per boring will be collected in order to evaluate and characterize potential source areas within AREE 4. Subsurface soil samples will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH (soil samples will also be analyzed for PAHs in order to meet ecological levels of concern). In addition, one sample per boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

Test Pits. In addition to the surface and subsurface soil investigation, eight test pits will be dug. Two samples per pit will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

**2.2.1.6 AREE 6A - Former Dump No. 6A**. This AREE is defined as Former Dump No. 6A. The source and extent of contamination of AREE 6A will be further characterized by sampling groundwater, subsurface soil, and surface soil. A summary of sample IDs and associated analytical parameters is presented in Table 2-6.

Groundwater. One newly-installed monitoring well will be sampled during two rounds within AREE 6a. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and water quality parameters in order to further characterize groundwater within AREE 6a.

Subsurface and Surface Soil. Seven surface soil samples will be collected and analyzed to characterize surficial contamination within AREE 6a. One boring will be drilled and 3 samples from the boring will be collected in order to evaluate and characterize potential source areas within AREE 6a. Soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals. In addition, one sample from the boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

Test Pits. In addition to the surface and subsurface soil investigation, three test pits will be dug. Two samples per pit will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals.

**2.2.1.7 AREE 6B - Potential Dump No. 6B**. This AREE is defined as Potential Dump No. 6B. The source and extent of contamination of AREE 6B will be further characterized by sampling groundwater, surface soil, and subsurface soil. Subsurface and surface soil samples will be collected in order to determine the vertical extent of contamination. Groundwater samples will be collected to determine the contribution of the source. A summary of sample IDs and associated analytical parameters is presented in Table 2-7.

Groundwater. One monitoring well will be installed and sampled during two rounds within AREE 6B. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and water quality parameters in order to further characterize groundwater within AREE 6B.

Subsurface and Surface Soil. One surface soil sample will be collected to characterize surficial contamination within AREE 6b. One boring will be drilled and 3 samples per boring will be collected in order to evaluate and characterize potential source areas within AREE 6B. Subsurface soil samples will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH and surface soil samples will be collected and analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, TAL metals, and TPH in order to further characterize contaminated soils within AREE 6B. In addition, one sample per boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

Test Pits. In addition to the surface and subsurface soil investigation, three test pits will be dug. Two samples per pit will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH.

**2.2.1.8 AREE 7 - Former Pistol Range**. This AREE is defined as the Former Pistol Range. The source and extent of contamination of AREE 7 will be further characterized by sampling groundwater and subsurface soil. Subsurface and surface soil samples will be collected in order to determine the vertical extent of contamination. Groundwater samples will be collected to determine the contribution of the source. A summary of sample IDs and associated analytical parameters is presented in Table 2-8.

Groundwater. One monitoring well will be installed and sampled during two rounds within AREE 7. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, TPH, and water quality parameters in order to further characterize groundwater within AREE 7.

Subsurface Soil. One boring will be drilled and 3 samples from the boring will be collected. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH to characterize potentially contaminated soils. In addition, one sample per boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

### 2.2.2 AREEs Associated with the Main Facility Compound

AREEs associated with the main facility compound include: 8, 11 through 15, 17, 18, 19, 20, 23, 24, and 29. The AREEs in the vicinity of Building 202 will be evaluated as one area for investigative purposes and include AREEs 11, 22, 23, and 24. No samples will be collected from AREEs 13, 15, 17 18, 19, and 20 as these AREEs have been investigated during previous studies (USAEC 1991) and results indicate that no additional work is required and/or they are being investigated as part of the State of Virginia, Department of Environmental Quality, Site Characterization program.

**2.2.2.1 Downgradient from Main Compound Area**. Based on previous investigations, groundwater beneath the Main Compound Area is estimated to flow toward Marumsco Creek and the Occoquan Bay. The following samples will be collected to determine the impact of previous activities at the Main Compound Area on downgradient areas. A summary of sample IDs and associated analytical parameters is presented in Table 2-9.

Groundwater. One monitoring well will be installed and sampled during two rounds. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, TPH, PAHs, and water quality parameters in order to further characterize groundwater downgradient of the Main Compound Area.

Subsurface Soil. One boring will be drilled and 3 samples from the boring will be collected. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH to characterize potentially contaminated soils. In addition, one sample per boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

**2.2.2.2 AREEs in Vicinity of Building 202**. The source and extent of contamination of this area will be further characterized by sampling groundwater, surface soil, and subsurface soil. Surface and subsurface soil samples will be collected in order to determine the vertical extent of contamination. Groundwater samples will be collected to determine the contribution of the source. A summary of sample IDs and associated analytical parameters is presented in Table 2-10.

Groundwater. Five monitoring wells will be installed and sampled, and one existing well will be sampled during two rounds within this area. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, TPH, PCTs, and water quality parameters in order to further characterize groundwater within this area.

Subsurface Soil. Nine borings will be drilled and 3 samples per boring will be collected in order to evaluate and characterize potential source areas within these AREEs. Subsurface soil samples will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH in order to further characterize contaminated soils within these AREEs. In addition, one sample per boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

**2.2.2.3 AREE 8**. A summary of sample IDs and associated analytical parameters is presented in Table 2-11.

Groundwater. Two existing wells will be sampled during two rounds within this AREE. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, TPH, PAHs, and water quality parameters in order to further characterize groundwater within these AREEs.

**2.2.2.4 AREE 12 - Former Drum Storage Area**. This AREE is defined as the Former Drum Storage Area. The source and extent of contamination of AREE 12 will be further characterized by sampling groundwater and subsurface soil. Groundwater samples will be collected to determine the contribution of the source. A summary of sample IDs and associated analytical parameters is presented in Table 2-12.

Groundwater. Two existing monitoring wells will be sampled during two rounds within AREE 12. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, TPH, and water quality parameters in order to further characterize groundwater within AREE 12.

**2.2.3 AREE 14 - Oil/Water Separator at Building 211.** Groundwater samples will be collected to evaluate potential contamination due to the Oil/Water Separator. A summary of sample IDs and associated analytical parameters is presented in Table 2-13.

Groundwater. One existing monitoring will be sampled during two rounds. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, TPH, PAHs, and water quality parameters in order to further characterize groundwater within AREE 14.

**2.2.4 AREE 23a - UST at Building 201.** A summary of sample IDs and associated analytical parameters is presented in Table 2-14.

Subsurface Soil. One boring will be drilled and 3 samples from the boring will be collected. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH to characterize potentially contaminated soils. In addition, one sample per boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

**2.2.5 AREE 24e and f - UST at Building 306.** A summary of sample IDs and associated analytical parameters is presented in Table 2-15.

Subsurface Soil. Two borings will be drilled and 3 samples per boring will be collected. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH to characterize potentially contaminated soils. In addition, one sample per boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

**2.2.6 Facility Wide Characterization and Includes AREEs 25, 26, 27, and 35.**

Surface Water and Sediment. Forty-five sediment and surface water samples will be collected throughout the facility in order to evaluate the potential for a creek, ditch, or other surface water body to be impacted by the AREEs; to identify the drainage patterns at WRF; to overlap locations at which clam live-boxes were deployed; and to provide adequate spatial coverage of WRF and sufficient representation of reference conditions. Surface water and sediment samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH. In addition, sediment samples will be tested for grain size, percent moisture, and TOC; surface water samples will be additionally tested for water quality parameters.

Surface Soil. Twenty-five samples will be collected and analyzed in order to evaluate and characterize potential source areas within this area. Surface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PAHs in order to further characterize contaminated soils within this area. A summary of sample IDs and associated analytical parameters is presented in Table 2-16.

**2.2.7 Background**

In order to determine background levels of ubiquitous elements and compounds, four groundwater, three subsurface soil, five surface soil, five sediment, and five surface water samples will be collected up-gradient from the WRF and analyzed for TCL VOCs, SVOCs, TAL metals, pesticides/PCBs, PAHs (except subsurface soils), PCTs, and TPH. In addition to chemical analyses, one subsurface soil sample from each boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC; sediment samples will be tested for grain size, percent moisture, and TOC; and aqueous samples will be tested for water quality parameters. A summary of sample IDs and associated analytical parameters is presented in Table 2-17.

### 2.2.8 Site Hydrogeologic Evaluation

A site hydrogeologic evaluation will be conducted to determine groundwater elevation and direction of flow. A summary of sample IDs and associated parameters is provided in Table 2-18.

Subsurface Soil. Eight borings will be drilled and 3 samples per boring will be collected. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals, to characterize potentially contaminated soils. In addition, one sample per boring will be tested for grain size, Atterberg limits, USCS classification, percent moisture, and TOC.

## TABLE 2-1
## SUMMARY OF CHEMICAL ANALYSIS PROPOSED FOR LOCATIONS DOWNGRADIENT OF DUMPSITES

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-75 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| MW-76 | ✓ | ✓ | ✓ | ✓ | | |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-75 | ✓ | | ✓ | ✓ | ✓A | ✓ |
| MW-76 | ✓ | | ✓ | ✓ | | |
| PZ-13 | ✓ | | ✓ | ✓ | | |

a In addition to duplicates and rinse blanks. trip and field blanks will be associated with every aqueous VOC fraction collected.

b Newly installed monitoring wells will be sampled twice.

c Three samples per boring will be collected for chemical analyses.

## TABLE 2-2
## SUMMARY OF CHEMICAL ANALYSIS FOR PROPOSED SAMPLES AT AREE 1

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Existing Monitoring Wells*** | | | | | | |
| MW-7 | ✓ | ✓ | ✓ | | | |
| MW-8 | ✓ | ✓ | ✓ | | | |
| MW-9 | ✓ | ✓ | ✓ | | | |
| MW-10 | ✓ | ✓ | ✓ | | | |
| MW-11 | ✓ | ✓ | ✓ | | | |
| MW-12 | ✓ | ✓ | ✓ | | | |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-77 | ✓ | ✓ | ✓ | | | |
| MW-78 | ✓ | ✓ | ✓ | | | |
| MW-79 | ✓ | ✓ | ✓ | | | ✓ |
| MW-80 | ✓ | ✓ | ✓ | | | |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-77 | ✓ | | ✓ | | ✓B | |
| MW-78 | ✓ | | ✓ | | | |
| MW-79 | ✓ | | ✓ | | | |
| MW-80 | ✓ | | ✓ | | ✓C | ✓ |
| ***Surface Soil*** | | | | | | |
| RISS-1 | ✓ | ✓ | ✓ | | ✓ | ✓ |
| RISS-2 | ✓ | ✓ | ✓ | | | |
| RISS-3 | ✓ | ✓ | ✓ | | | |
| RISS-4 | ✓ | ✓ | ✓ | | | |
| ***Test Pits*** | | | | | | |
| TP1 (a & b) | ✓ | | ✓ | | ✓ (a) | ✓ |
| TP2 (a & b) | ✓ | | ✓ | | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Newly installed monitoring wells will be sampled twice.

c Three samples per boring will be collected for chemical analyses.

## TABLE 2-3
## SUMMARY OF CHEMICAL ANALYSIS FOR PROPOSED SAMPLES AT AREES 2 AND 5

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Existing Monitoring Wells*** | | | | | | |
| MW-1 | ✓ | ✓ | ✓ | ✓ | | |
| MW-2 | ✓ | ✓ | ✓ | ✓ | | |
| MW-3 | ✓ | ✓ | ✓ | ✓ | | |
| MW-4 | ✓ | ✓ | ✓ | ✓ | | |
| MW-5 | ✓ | ✓ | ✓ | ✓ | | |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-68 | ✓ | ✓ | ✓ | ✓ | | |
| MW-69 | ✓ | ✓ | ✓ | ✓ | | |
| MW-70 | ✓ | ✓ | ✓ | ✓ | | |
| MW-71 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| MW-72 | ✓ | ✓ | ✓ | ✓ | | |
| MW-73 | ✓ | ✓ | ✓ | ✓ | | |
| MW-74 | ✓ | ✓ | ✓ | ✓ | | |
| MW-81 | ✓ | ✓ | ✓ | ✓ | | |
| MW-82 | ✓ | ✓ | ✓ | ✓ | | |
| MW-83 | ✓ | ✓ | ✓ | ✓ | | |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-68 | ✓ | | ✓ | ✓ | | |
| MW-69 | ✓ | | ✓ | ✓ | | |
| MW-70 | ✓ | | ✓ | ✓ | | |
| MW-71 | ✓ | | ✓ | ✓ | ✓A | |
| MW-72 | ✓ | | ✓ | ✓ | | |
| MW-73 | ✓ | | ✓ | ✓ | | |
| MW-74 | ✓ | | ✓ | ✓ | ✓B | ✓ |
| MW-81 | ✓ | | ✓ | ✓ | | |
| RISB-6 | ✓ | | ✓ | ✓ | | |
| PZ-12 | ✓ | | ✓ | ✓ | ✓C | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Newly installed monitoring wells will be sampled twice.

c Three samples per boring will be collected for chemical analyses.

## TABLE 2-3 (CONTINUED)
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES AT AREES 2 AND 5

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Surface Soil*** | | | | | | |
| RISS-5 | ✓ | ✓ | ✓ | ✓ | | |
| RISS-6 | ✓ | ✓ | ✓ | ✓ | | |
| RISS-7 | ✓ | ✓ | ✓ | ✓ | | |
| RISS-8 | ✓ | ✓ | ✓ | ✓ | | |
| RISS-9 | ✓ | ✓ | ✓ | ✓ | | |
| ***Test Pits*** | | | | | | |
| TP3 (a & b) | ✓ | | ✓ | ✓ | | |
| TP4 (a & b) | ✓ | | ✓ | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

## TABLE 2-4
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES AT AREE 3

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Surface Soil*** | | | | | | |
| RISS-10 | ✓ | ✓ | * | | | |
| RISS-11 | ✓ | ✓ | * | | ✓ | |
| RISS-12 | ✓ | ✓ | * | | | |
| ***Test Pits*** | | | | | | |
| TP13 (a & b) | ✓ | | * | | | |
| TP14 (a & b) | ✓ | | * | | ✓ (a) | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

* If PCBs are detected in a soil sample, the laboratory will be instructed to analyze the sample for PCTs.

## TABLE 2-5
## SUMMARY OF CHEMICAL ANALYSIS FOR PROPOSED SAMPLES AT AREE 4

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-64 | ✓ | ✓ | ✓ | ✓ | | |
| MW-66 | ✓ | ✓ | ✓ | ✓ | | |
| MW-67 | ✓ | ✓ | ✓ | ✓ | | |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-64 | ✓ | | ✓ | ✓ | | |
| MW-66 | ✓ | | ✓ | ✓ | | |
| MW-67 | ✓ | | ✓ | ✓ | | |
| ***Surface Soil*** | | | | | | |
| RISS-13 | ✓ | ✓ | ✓ | ✓ | | |
| RISS-14 | ✓ | ✓ | ✓ | ✓ | | |
| RISS-15 | ✓ | ✓ | ✓ | ✓ | | |
| RISS-16 | ✓ | ✓ | ✓ | ✓ | | |
| ***Test Pits*** | | | | | | |
| TP5 (a & b) | ✓ | | ✓ | ✓ | | |
| TP6 (a & b) | ✓ | | ✓ | ✓ | | |
| TP7 (a & b) | ✓ | | ✓ | ✓ | | |
| TP8 (a & b) | ✓ | | ✓ | ✓ | | |
| TP9 (a & b) | ✓ | | ✓ | ✓ | ✓ (a) | ✓ |
| TP10 (a & b) | ✓ | | ✓ | ✓ | | |
| TP11 (a & b) | ✓ | | ✓ | ✓ | | |
| TP12 (a & b) | ✓ | | ✓ | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Newly installed monitoring wells will be sampled twice.

c Three samples per boring will be collected for chemical analyses.

## TABLE 2-6
## SUMMARY OF CHEMICAL ANALYSIS FOR PROPOSED SAMPLES AT AREE 6A

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-65 | ✓ | ✓ | * | | ✓ | |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-65 | ✓ | | * | | ✓A | ✓ |
| ***Surface Soil*** | | | | | | |
| RISS-17 | ✓ | ✓ | * | | | |
| RISS-18 | ✓ | ✓ | * | | | |
| RISS-19 | ✓ | ✓ | * | | | |
| RISS-20 | ✓ | ✓ | * | | | |
| RISS-21 | ✓ | ✓ | * | | ✓ | ✓ |
| RISS-22 | ✓ | ✓ | * | | | |
| RISS-23 | ✓ | ✓ | * | | | |
| ***Test Pits*** | | | | | | |
| TP15 (a & b) | ✓ | | * | | | |
| TP16 (a & b) | ✓ | | * | | ✓ (a)' | |
| TP17 (a & b) | ✓ | | * | | | |

a. In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b. Newly installed monitoring wells will be sampled twice.

c. Three samples per boring will be collected for chemical analyses.

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

## TABLE 2-7
## SUMMARY OF CHEMICAL ANALYSIS FOR PROPOSED SAMPLES AT AREE 6B

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-60 | ✓ | ✓ | * | ✓ | | |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-60 | ✓ | | * | ✓ | | |
| ***Surface Soil*** | | | | | | |
| RISS-24 | ✓ | ✓ | * | ✓ | | |
| RISS-25 | ✓ | ✓ | * | ✓ | | |
| ***Test Pits*** | | | | | | |
| TP18 (a & b) | ✓ | | * | ✓ | | |
| TP19 (a & b) | ✓ | | * | ✓ | | |
| TP20 (a & b) | ✓ | | * | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Newly installed monitoring wells will be sampled twice.

c Three samples per boring will be collected for chemical analyses.

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

## TABLE 2-8
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES AT AREE 7

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs,TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-59 | ✓ | ✓ | ✓ | ✓ | | |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-59 | ✓ | | ✓ | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Newly installed monitoring wells will be sampled twice.

c Three samples per boring will be collected for chemical analyses.

## TABLE 2-9
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES DOWNGRADIENT FROM MAIN FACILITY COMPOUND

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-61 | ✓ | ✓ | * | ✓ | | |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-61 | ✓ | | * | ✓ | ✓B | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Newly installed monitoring wells will be sampled twice.

c Three samples per boring will be collected for chemical analyses.

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

## TABLE 2-10
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES IN VICINITY OF BUILDING 202

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-55 | ✓ | ✓ | ✓ | ✓ | | |
| MW-56 | ✓ | ✓ | ✓ | ✓ | | |
| MW-57 | ✓ | ✓ | ✓ | ✓ | | |
| MW-58 | ✓ | ✓ | ✓ | ✓ | | |
| MW-62 | ✓ | ✓ | ✓ | ✓ | | |
| ***Existing Monitoring Well*** | | | | | | |
| MW-39 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-55 | ✓ | | ✓ | ✓ | | |
| MW-56 | ✓ | | ✓ | ✓ | | |
| MW-57 | ✓ | | ✓ | ✓ | ✓C | ✓ |
| MW-58 | ✓ | | ✓ | ✓ | | |
| RISB-1 | ✓ | | ✓ | ✓ | | |
| RISB-2 | ✓ | | ✓ | ✓ | | |
| RISB-3 | ✓ | | ✓ | ✓ | ✓A | |
| RISB-4 | ✓ | | ✓ | ✓ | | |
| RISB-5 | ✓ | | ✓ | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Newly installed monitoring wells will be sampled twice.

c Three samples per boring will be collected for chemical analyses.

## TABLE 2-11
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES AT AREE 8

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Existing Monitoring Wells*** | | | | | | |
| MW-33 | ✓ | ✓ | * | ✓ | | |
| MW-34 | ✓ | ✓ | * | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

## TABLE 2-12
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES AT AREE 12

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Existing Monitoring Wells*** | | | | | | |
| MW-37 | ✓ | ✓ | * | ✓ | | |
| MW-38 | ✓ | ✓ | * | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

## TABLE 2-13
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES AT AREE 14

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs,TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Existing Monitoring Wells*** | | | | | | |
| MW-35 | ✓ | ✓ | * | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

## TABLE 2-14
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES AT AREE 23A

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs,TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| *Subsurface Soil*[b] | | | | | | |
| RISB-8 | ✓ | | * | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Three samples per boring will be collected for chemical analyses.

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

## TABLE 2-15
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SAMPLES AT AREE 24e & f

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Subsurface Soil[b]*** | | | | | | |
| RISB-7 | ✓ | | * | ✓ | | |
| PZ-5 | ✓ | | * | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Three samples per boring will be collected for chemical analyses.

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

## TABLE 2-16
## SUMMARY OF CHEMICAL ANALYSES FOR FACILITY WIDE CHARACTERIZATION

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| *Surface Soil* | | | | | | |
| RISS-26 | ✓ | ✓ | | | | |
| RISS-27 | ✓ | ✓ | | | | |
| RISS-28 | ✓ | ✓ | | | | |
| RISS-29 | ✓ | ✓ | | | | |
| RISS-30 | ✓ | ✓ | | | | |
| RISS-31 | ✓ | ✓ | | | ✓ | |
| RISS-32 | ✓ | ✓ | | | | |
| RISS-33 | ✓ | ✓ | | | | |
| RISS-34 | ✓ | ✓ | | | | |
| RISS-35 | ✓ | ✓ | | | | |
| RISS-36 | ✓ | ✓ | | | | |
| RISS-37 | ✓ | ✓ | | | | |
| RISS-38 | ✓ | ✓ | | | | |
| RISS-39 | ✓ | ✓ | | | | |
| RISS-40 | ✓ | ✓ | | | | |
| RISS-41 | ✓ | ✓ | | | ✓ | ✓ |
| RISS-42 | ✓ | ✓ | | | | |
| RISS-43 | ✓ | ✓ | | | | |
| RISS-44 | ✓ | ✓ | | | | |
| RISS-45 | ✓ | ✓ | | | | |
| RISS-46 | ✓ | ✓ | | | | |
| RISS-47 | ✓ | ✓ | | | | |
| RISS-48 | ✓ | ✓ | | | | |
| RISS-49 | ✓ | ✓ | | | | |
| RISS-50 | ✓ | ✓ | | | | |

[a] In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

## TABLE 2-17
## SUMMARY OF CHEMICAL ANALYSIS FOR BACKGROUND SAMPLES

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Newly Installed Monitoring Wells[b]*** | | | | | | |
| MW-52 | ✓ | ✓ | ✓ | ✓ | | |
| MW-53 | ✓ | ✓ | ✓ | ✓ | | |
| MW-54 | ✓ | ✓ | ✓ | ✓ | | |
| MW-63 | ✓ | ✓ | ✓ | ✓ | | |
| ***Subsurface Soil[c]*** | | | | | | |
| MW-52 | ✓ | | ✓ | ✓ | ✓C | |
| MW-53 | ✓ | | ✓ | ✓ | | |
| MW-54 | ✓ | | ✓ | ✓ | | |
| ***Surface Soil*** | | | | | | |
| RIBKSS-1 | ✓ | ✓ | ✓ | ✓ | ✓ | |
| RIBKSS-2 | ✓ | ✓ | ✓ | ✓ | | |
| RIBKSS-3 | ✓ | ✓ | ✓ | ✓ | | |
| RIBKSS-4 | ✓ | ✓ | ✓ | ✓ | | |
| RIBKSS-5 | ✓ | ✓ | ✓ | ✓ | | |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Newly installed monitoring wells will be sampled twice.

c Three samples per boring will be collected for chemical analyses.

## TABLE 2-18
## SUMMARY OF CHEMICAL ANALYSES FOR PROPOSED SITE HYDROGEOLOGICAL EVALUATION

| Sample ID | Parameters | | | | Field Quality Control Samples[a] | |
|---|---|---|---|---|---|---|
| | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals | PAHs | PCTs | TPHs | Duplicates | Rinse Blanks |
| ***Subsurface Soil[b]*** | | | | | | |
| PZ-3 | ✓ | | * | | | |
| PZ-4 | ✓ | | * | | ✓A | ✓ |
| PZ-6 | ✓ | | * | | | |
| PZ-7 | ✓ | | * | | | |
| PZ-8 | ✓ | | * | | ✓B | |
| PZ-9 | ✓ | | * | | | |
| PZ-10 | ✓ | | * | | | |
| PZ-11 | ✓ | | * | | ✓C | ✓ |

a In addition to duplicates and rinse blanks, trip and field blanks will be associated with every aqueous VOC fraction collected.

b Three samples per boring will be collected for chemical analyses.

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

## 3.0 PROJECT ORGANIZATION AND QA RESPONSIBILITY

This section describes the project organization and responsibilities for key WRF RI/FS personnel.

### 3.1 PROJECT ORGANIZATION

The Commander of USAEC is ultimately responsible for the quality of data collected in support of USAEC projects. The Commander delegates the applicable authority to the Project Officers. The responsibilities include:

a. Overseeing and monitoring performance of all WRF RI/FS participants;

b. Interfacing with regulatory agencies;

c. Acting as liaison between USAEC and ICF KE;

d. Requiring effective implementation of the USAEC QA Program; and

e. Requiring completion of corrective actions, when required.

Figure 3-1 denotes the line of authority and project organization for the WRF RI/FS. Principal project participants and responsibilities for the project QA program reside with personnel from ICF KE, the RI/FS contractor. Table 3-1 provides the names, titles, addresses, and phone numbers of personnel responsible for ensuring the execution of the WRF Quality Assurance Program. Statements of Qualification (SOQs) for WRF RI/FS personnel are provided in Appendix B.

### 3.2 RESPONSIBILITIES

#### 3.2.1 Project QA/QC

Responsibilities for implementation of the project QA program in accordance with QA/QC contractual obligations lies principally with the USAEC Contracting Officer's Representative and the QA Manager. The QA Manager has the responsibility to ensure the reliability and validity of project activities and deliverables in compliance with the project QA program. Specific responsibilities include the following:

a. Initiating QA activities within the program to ensure that QC measures are being implemented and maintained;

b. Ensuring records, logs, SOPs, and analytical results are documented and maintained in a retrievable manner;

c. Conducting periodic readiness reviews and field surveillance to ensure acceptable quality of project activities;

d. Preparing periodic quality reports and QA sections of final reports; and

e. Ensuring corrective action has been implemented and documented to preclude similar incidents from occurring.

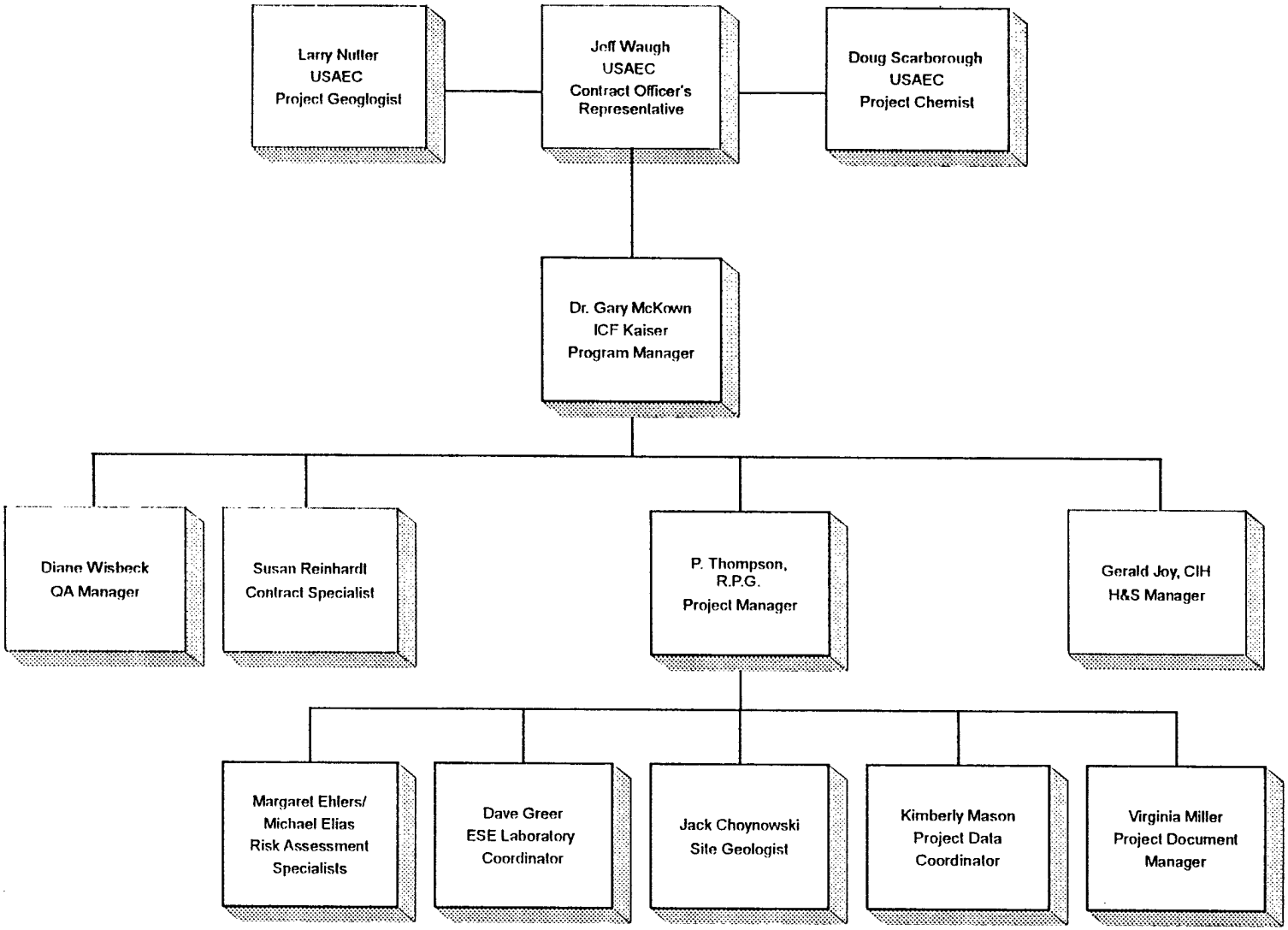


**Figure 3-1. Project Organizational Chart**

**TABLE 3-1**
**KEY INDIVIDUALS FOR THE WRF RI/FS**

| Name | Title | Address | Phone Number |
|---|---|---|---|
| Jeff Waugh | Project Officer, USAEC | U.S. Army Environmental Center<br>Aberdeen Proving Ground, MD 21010 | (410) 671-1610 |
| Doug Scarborough | Project Chemist, USAEC | U.S. Army Environmental Center<br>Aberdeen Proving Ground, MD 21010 | (410) 671-1514 |
| Larry Nutter | Project Geologist, USAEC | U.S. Army Environmental Center<br>Aberdeen Proving Ground, MD 21010 | (410) 671-1516 |
| Gary McKown, Ph.D. | Program Manager<br>ICF Kaiser Engineers | 1301 Continental Drive, Suite 101<br>Abingdon, MD 21009-2335 | (410) 612-6358 |
| Patricia Thompson, R.P.G. | Project Manager | 1301 Continental Drive, Suite 101<br>Abingdon, MD 21009-2335 | (410) 612-6371 |
| Jack Choynowski | Site Geologist and<br>Site Health and Safety Officer | 1301 Continental Drive, Suite 101<br>Abingdon, MD 21009-2335 | (410) 612-6370 |
| Diane Wisbeck | Quality Assurance Manager<br>ICF Kaiser Engineers | 1301 Continental Drive, Suite 101<br>Abingdon, MD 21009-2335 | (410) 612-6361 |
| Gerald Joy, C.I.H | Health and Safety Manager | Four Gateway Center<br>Pittsburgh, PA 15222 | (412) 497-2056 |
| Margaret Ehlers | Risk Assessment Specialist<br>(Human Health)<br>ICF Kaiser Engineers | 9300 Lee Highway<br>Fairfax, VA 22031 | (703) 934-3578 |
| Michael Elias | Risk Assessment Specialist<br>(Ecological)<br>ICF Kaiser Engineers | 9300 Lee Highway<br>Fairfax, VA 22031 | (703) 934-3838 |
| Kimberly Mason | Project Data Coordinator<br>ICF Kaiser Engineers | 1301 Continental Drive, Suite 101<br>Abingdon, MD 21009-2335 | (410) 612-6372 |
| Dave Greer | Laboratory Coordinator<br>Environmental Science and<br>Engineering (ESE) | 14220 Newberry Rd.<br>Gainesville, FL 32607 | (904) 333-1608 |
| Jim Falcione | Laboratory Coordinator<br>Akenheil Engineers, Inc. | Akenheil Engineers, Inc.<br>1000 Banksville Road<br>Pittsburgh, PA 15216 | (412) 531-7111 |

The QA Manager has the responsibility and the authority to report directly to the Program Manager, USAEC, and the laboratory, as necessary, to resolve any conflicts deemed adverse to quality achievement.

### 3.2.2 Field Activities

Responsibilities for implementation of the QA program in conjunction with field activities lies principally with the Field Operations Leader. Specific responsibilities of the Field Operations Leader include the following:

a. Ensuring that sampling activities are consistent with the approach defined in the FSP and this QAPP;

b. Ensuring that QC measures are being implemented and maintained;

c. Ensuring that records and logs are documented and maintained in a retrievable manner; and

d. Identifying conditions requiring corrective actions and implementing and documenting the appropriate corrective action.

### 3.2.3 Laboratory Activities

Environmental Science and Engineering Laboratories (ESE), located in Gainesville, Florida, has been chosen to provide chemical analytical support services for the WRF RI/FS, using USEPA SW-846 methods performance demonstrated in accordance with USAEC Guidelines. Akenheil Engineering Inc., located in Pittsburgh, Pennsylvania, was selected to conduct physical testing of sediment and soil samples. The designated Laboratory Coordinator is responsible for implementing the laboratory QA program and this QAPP for each laboratory. The specific responsibilities include:

a. Monitoring laboratory QA/QC functions to ensure that practices are in compliance with approved policies and SOPs, and that quality controls indicate acceptable data quality;

b. Evaluating QA activities within the program to ensure that QC measures are being implemented and maintained;

c. Ensuring that records, logs, SOPs, and analytical results are maintained in a retrievable manner;

d. Identifying conditions requiring corrective actions and implementing the appropriate corrective action; and

e. Conducting periodic performance and system audits to ensure acceptable analytical performance.

In addition, the primary responsibility for the review of data and subsequent validation rests with the contract laboratory. It is the Laboratory Coordinator's responsibility to ensure that each data package is generated to meet USAEC Guidelines and that each package is reviewed and validated prior to submission to the Installation Restoration Data Management Information System (IRDMIS).

## 3.3 PERSONNEL QUALIFICATION AND TRAINING

The ICF KE Project Manager is responsible for ensuring that WRF RI/FS personnel possess the appropriate qualifications. Personnel performing work shall be trained and qualified based on project-specific requirements prior to the start of the work or activity. The need to require formal qualification or certification of personnel performing certain specialized activities shall be evaluated by the ICF KE Project Manager and implemented where necessary. Appropriate technical and management training as well as certifications and registrations shall be performed and documented on the Training Record Form. An example of this form is presented in Figure 3-2. When job requirements change, the need for retraining to ensure continued satisfactory job proficiency shall be evaluated. Objective evidence of personnel job proficiency shall be documented and maintained for the duration of the project or activity affected, or longer if required by statute or organization policy. Resources for required training shall be provided.

The Project Manager is specifically responsible for the following activities:

a. Identifying project-specific personnel qualification requirements and work functions requiring special skills, including security clearance, licenses, certifications, and registrations;

b. Verifying that project staff demonstrate and maintain the required skills, clearances, certifications, and/or registrations to perform their assigned work;

c. Verifying the qualifications of suppliers and subcontractors relative to project objectives and in accordance with specified requirements;

d. Advising staff and subcontractors of their roles and responsibilities in achieving project objectives; and

e. Ensuring that staff and subcontractors are cognizant of and compliant with contractual and regulatory requirements (e.g., DOT regulations, CERCLA).

During the readiness review, the QA Manager will be responsible for assessing the adequacy of resources for personnel training and verifying that specified staff requirements are met prior to initiating affected project activities and periodically thereafter.

Methods and procedures used in measurement and monitoring efforts will conform to the Work Plan, the FSP, and this QAPP. Field team members will possess the appropriate qualifications and training prior to collecting environmental samples and performing engineering-related tasks. Program personnel will be familiar with the required conventions, formats, and schedules specified in documents pertinent to project activities. The professional registration requirements that apply to the state of Virginia will be identified and adhered to.

## TRAINING RECORD

| NAME: | YR. JOINED ICF: | DEGREE(S) AND YEAR: | EIT, PE, PG AND YEAR |
|---|---|---|---|

## AREAS OF SPECIALIZATION

| | | | | | |
|---|---|---|---|---|---|
| ☐ | DRILLING/SOIL SAMPLING | ☐ | GROUNDWATER SAMPLING | ☐ | BIOTA SAMPLING |
| ☐ | WELL INSTALLATION | ☐ | SURFACE SOIL SAMPLING | ☐ | GEOPHYSICAL SURVEYS |
| ☐ | WELL DEVELOPMENT | ☐ | SURFACE WATER SAMPLING | ☐ | SOIL GAS SURVEYS |
| ☐ | AQUIFER TESTING | ☐ | SEDIMENT SAMPLING | ☐ | FIELD GC ANALYSIS |
| ☐ | _____ | ☐ | _____ | ☐ | _____ |

| ON-THE-JOB TRAINING AND EXPERIENCE | | | | | |
|---|---|---|---|---|---|
| DATE | SITE | DUTIES AND NEW RESPONSIBILITIES | MENTOR | REV/D SOPS? | VERIFIED |
| | | | | | |
| | | | | | |
| | | | | | |

**FIGURE 3-2**
**TRAINING RECORD FORM**

# 4.0 QUALITY ASSURANCE AND DATA QUALITY OBJECTIVES

## 4.1 QUALITY ASSURANCE

The overall QA objective is to develop and implement procedures for sample and data collection, sample shipment, and reporting that will allow QA reviewers to determine whether the field and laboratory data collected during the RI/FS at WRF meet the criteria and endpoints established in the Data Quality Objectives (DQOs). The QA objective will be achieved through the implementation of specific procedures for sampling, field data collection, chain-of-custody, calibration, internal quality control, audits, preventive maintenance, and corrective actions as described in this QAPP. The purpose of this section is to define QA goals for precision, accuracy, representativeness, completeness, and comparability. These goals are summarized in Tables 4-1 (definitive), and 4-2 (field).

### 4.1.1 Accuracy

Accuracy is the degree of agreement of a measurement (or an average of measurements of the same parameter), X, with an accepted reference or true value, T, usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100 (X-T)/T, and sometimes expressed as a ratio, X/T. Accuracy is a measure of bias in a system.

For chemical data collected for use in a risk assessment, accuracy of the extraction and analysis procedures will be checked quantitatively through the use of matrix and surrogate spikes, and blanks. The accuracy is calculated based on the percent recovery of the spikes and concentrations of target analytes in the blanks. Accuracy of chemical standards is evaluated through the use of independent check standards (i.e., stock standards purchased from a different source from the working standards). These standards are discussed in detail in Section 9.0.

Field documentation and QA readiness reviews and surveillance will be used to establish that protocols for sampling and measurement follow appropriate SOPs as presented in Appendix A. Field surveillance performed by the ICF KE QA Manager will be used to identify deviations and perform corrective actions (see Section 12.0). Accuracy of field measurements will be qualitatively controlled through the use of SOPs which have been developed to standardize the collection of measurements and samples. Consistent and proper calibration of equipment throughout the field exercises, as described in this QAPP, will ensure in the accuracy of measurements.

### 4.1.2 Precision

Precision refers to the level of agreement among repeated measurements of the same parameter. It is usually stated in terms of standard deviation, relative standard deviation, relative percent difference, range, or relative range. The overall precision of data is a mixture of sampling and analytical factors. The analytical precision is easier to control and quantify because the laboratory is a controlled, and therefore, measurable environment. Sampling precision is unique to each site, making it harder to control and quantify. The goals for each factor are addressed below.

For chemical data collected for use in a risk assessment, sampling precision will be evaluated by obtaining one duplicate sample for every 10 samples collected for each type of media (10%). Precision will be evaluated by calculating the relative percent difference (RPD) as follows:

$$RPD = \frac{(XA - XB)}{XM} \times 100$$

## TABLE 4-1
## ANALYTICAL QC ELEMENTS OF QA PROGRAM

| Item | DQO | Parameter | Frequency of Association | Criteria Requirement |
|---|---|---|---|---|
| Analytical Method | C | All* | Each analysis | Approved USAEC SOP, based on USEPA standard methods as defined in Table 6-1 |
| USAEC Chemical Data Packages | A,P,C | All* | Each lot | Pass peer review and formal QA/QC check; pass USAEC QA/QC check |
| Quarterly Laboratory Internal Audit Reports | R | All* | Quarterly | No deficiencies |
| Laboratory Chain of Custody | R | All* | All sample containers | No deficiencies |
| Laboratory System Controls | R | All* | During laboratory operations | Custody of sample within laboratory fully accounted for and documented |
| Holding Time | A,P,R | All* | Each analysis | No deficiencies (Region III modifications) |
| USAEC Calibration Method Detection Limit | A,P,R | All* | Each analysis; each calibration | USAEC derived reporting limit; demonstrated with each initial calibration |
| USAEC Calibration -Upper Reporting Limit | A,P,R | All* | Each analysis; each calibration | Linear range of analysis; demonstrated with each initial calibration |
| Method blanks | A | All* | Each lot | No target analytes detected in the method blanks |
| Matrix Spikes and duplicates | A,P | All* | Each lot | Must meet USEPA criteria as defined in Table 9-1 |
| Surrogates | A | All* | Organic fractions, including QC samples | Required to meet the stricter of the USAEC and USEPA criteria. Percent recovery criteria for the WRF RI/FS are defined in Table 9-1. |
| Serial dilutions | A | Metals | Each lot | Must meet USEPA Region III criteria as defined in Table 9-1 |
| Resolution Check Mixtures | A | Pesticides/PCBs | Each lot | Must meet USEPA criteria as defined in Table 9-1 |

A = Accuracy
C = Completeness
P = Precision
R = Representativeness

* Parameters include TCL VOCs, SVOCs, PAHs, pesticides/PCBs; TAL Inorganics, PCTs, and TPHs

## TABLE 4-2
## FIELD QC ELEMENTS OF QA PROGRAM

| Item | DQO | Parameter | Frequency of Association | Criteria Requirement |
|---|---|---|---|---|
| Source Water | R | All* | per site | Less than USAEC reporting limit or if detected approved by USAEC |
| Field Duplicates | P | All* | 1 per 10 samples | RPD ≤50% |
| Trip Blank | R | Volatiles in water | 1 per cooler with volatiles | No target analytes |
| Rinse Blank | R | All* | 1 per 20 samples per matrix per equipment type | No target analytes |
| Field Blank | R | Volatiles in water | 1 per day | No target analytes |
| Chain of Custody | R | All* | every sample | Filled out correctly to include signatures; no missing or incorrect information |
| Field Parameter Forms | R | All* | every sample | Filled out correctly to include analytical parameters; map file data; and applicable IRDMIS coding information. |
| Field Instrument Calibration Logs | A | All* | every measurement | All measurements must have associated calibration reference. |

Legend:

A = Accuracy
C = Completeness
P = Precision
R = Representativeness
RPD = Relative percent difference

* Parameters include TCL VOCs, SVOCs, PAHs, pesticides/PCBs, TAL metals, PCTs, and TPHs.

XA > XB
XA and XB are duplicate analyses, and
XM is the mean value of duplicate analysis XA and XB

The RPD will be calculated for each analytical parameter. It is expected that the duplicates for aqueous matrices will have a RPD less than 50% and solid matrices will have a RPD less than 100%. If these criteria are not met, a careful examination of the sampling techniques, sample media, and analytical procedure will be conducted to identify the cause of the high RPD and the usefulness of the data. The data will be qualified and the location may be re-sampled and reanalyzed based on the decision of the USAEC Project Officer.

Analytical precision will be addressed by analysis of USAEC standard spikes and USEPA matrix spikes and duplicates. One low-level and two high-level spike standard QC samples will contain target analytes at a concentration near the lower and upper limits of the performance demonstrated linear range, respectively. Control charts will be maintained to track laboratory performance. The recovery of the standard spikes will be charted weekly and review by the USAEC Project Chemist.

USEPA matrix spikes and duplicates will be created in accordance with USEPA CLP protocol. The RPD for each matrix spike and duplicate will be calculated and compared to the USEPA Region III criteria. If these criteria are not met, an examination of the data will be conducted to determine the cause of the variability and usefulness of the data. The data will be qualified in accordance with USEPA Region III criteria (USEPA 1995).

### 4.1.3 Representativeness

Representativeness is a measure of the degree to which the measured results accurately reflect the medium being sampled. It is a qualitative parameter which is addressed through the proper design of the sampling program in terms of sample location, number of samples, and actual material collected as a "sample" of the whole.

Sampling protocols have been developed to assure that samples collected are representative of the media. Field handling protocols (e.g., storage, handling in the field, and shipping) have also been designed to protect the representativeness of the collected samples. Proper field documentation and QA audits will be used to establish that protocols have been followed and that sample identification and integrity have been maintained.

### 4.1.4 Completeness

Completeness is a measure of the amount of information that must be collected during the field investigation to allow for a successful achievement of the objectives. An adequate amount and type of data must be collected for conclusions to be valid. Missing data may reduce the precision of estimates or introduce bias, thus lowering the confidence level of the conclusions. While completeness has been historically presented as a percentage of the data that is considered valid, this does not take into account critical sample locations or critical analytical parameters.

The amount and type of data that may be lost due to sampling or analytical error cannot be predicted or evaluated in advance. The importance of any lost or suspect data will be evaluated in terms of the sample location, analytical parameter, nature of the problem, decision to be made, and the consequence of an erroneous decision. Critical locations or parameters for which data is determined to be inadequate will either be re-sampled and reanalyzed or the data will be appropriately qualified based on the decision of the Project Officer. The completeness goal percentage of valid data is set at 80-100% for the WRF RI/FS.

Completeness will be calculated using the following equation:

$$\% \text{ Completeness} = \frac{\text{Number of Successful Analyses}}{\text{Number of Requested Analyses}}$$

### 4.1.5 Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability will be controlled through the use of SOPs which have been developed to standardize the collection of measurements and samples. Consistent and proper calibration of equipment throughout the field exercises, as described in this QAPP, will assist in the comparability of measurements. Field documentation and QA audits will be used to establish that protocols for sampling and measurement follow appropriate SOPs.

## 4.2 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements which outline the decision making process and specify the data required to support the WRF RI/FS. DQOs are statements of the level of uncertainty that will be accepted in results derived from environmental data. DQOs will be defined for the WRF RI/FS by area in the associated work plan and will define the following aspects of the WRF RI/FS:

a. The purpose of collecting data from the media associated with each field activity;

b. The data types required to meet analytical, chemical and physical objectives. Included is the estimated number of samples that will be collected to meet the data objective;

c. A description of the sampling method being employed for each type of data;

d. The purpose for which data are being collected. This has been described by using general purpose categories which represent different data uses (e.g., Site Characterization, Alternatives Analysis, Risk Assessment);

e. The identification of an appropriate analytical level for the analysis (or measurement) being performed. Four such levels have been defined by USEPA for chemical analyses;

f. The analytical method that will be employed to analyze samples;

g. The typical detection limit requirements for the chosen analytical methods. Detection limits will be lower than the levels of concern, if possible (see Section 4.3);

h. Evaluation of critical samples, those for which valid data must be obtained to satisfy the objectives of the sampling and analysis task; and

i. The types and numbers of quality control samples that will be collected in association with each sampling event/media.

Site specific DQOs are defined in the following tables.

**TABLE 4-3**
**DATA QUALITY OBJECTIVES FOR**
**LOCATIONS DOWNGRADIENT OF DUMPSITES**

| DQO Element | Groundwater | Subsurface Soil |
|---|---|---|
| Objective | In order to further characterize groundwater downgradient of former and potential dump sites, two newly installed monitoring wells will be sampled for chemical analysis. | Three soil borings will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination downgradient of former and potential dump sites. |
| Chemical data | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, TPH, PAHs, and PCTs | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, TPH, and PCTs |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, conductivity, salinity | TOC, grain size, Atterberg limits, USCS, % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, field blanks, trip blanks | Duplicates, rinse blanks |

**TABLE 4-4**
**DATA QUALITY OBJECTIVES FOR AREE 1 - FORMER DUMP NO. 1**

| DQO Element | Groundwater | Subsurface Soil | Test Pits |
|---|---|---|---|
| Objective | In order to further characterize groundwater within AREE 1, four existing monitoring wells and six newly installed monitoring wells will be sampled for chemical analysis. | Four soil borings will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination within AREE 1. | In order to evaluate and characterize contamination within AREE 1, two test pits will be dug and soil samples will be collected for chemical analysis. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity | TOC, grain size, Atterberg limits, USCS, % moisture | % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks, field blanks | Duplicates, rinse blanks | Duplicates, rinse blanks |

## TABLE 4-5
## DATA QUALITY OBJECTIVES FOR AREEs 2 and 5 - FORMER DUMP NOs 2 AND 5

| DQO Element | Groundwater | Subsurface Soil | Test Pits |
|---|---|---|---|
| Objective | In order to further characterize groundwater within AREEs 2 and 5, five existing monitoring wells and ten newly installed monitoring wells will be sampled for chemical analysis. | Ten soil borings will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination within AREEs 2 and 5. | In order to evaluate and characterize contamination within AREEs 2 and 5, two test pits will be dug and soil samples will be collected for chemical analysis. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity | TOC, grain size, Atterberg limits, USCS, % moisture | % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, field blanks, trip blanks | Duplicates, rinse blanks | Duplicates, rinse blanks |

**TABLE 4-6**
**DATA QUALITY OBJECTIVES FOR AREE 3 - FORMER DUMP NO. 3**

| DQO Element | Surface Soil | Test Pits |
|---|---|---|
| Objective | In order to evaluate and characterize surficial contamination within AREE 3, three surface soil samples will be collected and analyzed. | In order to evaluate and characterize contamination within AREE 3, two test pits will be dug and surface soil samples will be collected for chemical analysis. |
| Chemical data | TCL VOCs, SVOCs, Pesticides/PCBs, and TAL Metals | TCL VOCs, SVOCs, Pesticides/PCBs, and TAL Metals |
| Physical data | % moisture | % moisture |
| Sample type | Environmental, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks | Duplicates, rinse blanks |

## TABLE 4-7
## DATA QUALITY OBJECTIVES FOR AREE 4 - FORMER DUMP NO. 4

| DQO Element | Groundwater | Subsurface Soil | Surface Soil | Test Pits |
|---|---|---|---|---|
| Objective | In order to further characterize groundwater beneath contaminated soils within AREE 4, three newly installed monitoring wells will be sampled for chemical analysis. | Three soil borings will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination within AREE 4. | In order to evaluate and characterize surficial contamination within AREE 4, four surface soil samples will be collected and analyzed. | In order to evaluate and characterize contamination within AREE 4, eight test pits will be dug and soil samples will be collected and analyzed. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity | TOC, grain size, Atterberg limits, USCS, % moisture | % moisture | % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, grab, biased | Environmental, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks, field blanks | Duplicates, rinse blanks | Duplicates, rinse blanks | Duplicates, rinse blanks |

## TABLE 4-8
## DATA QUALITY OBJECTIVES FOR AREE 6A - FORMER DUMP NO. 6A

| DQO Element | Groundwater | Subsurface Soil | Surface Soil | Test Pits |
|---|---|---|---|---|
| Objective | In order to further characterize groundwater within AREE 6a, one newly installed monitoring well will be sampled for chemical analysis. | One soil boring will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination within AREE 6a. | In order to evaluate and characterize surficial contamination within AREE 6A, seven surface soil samples will be collected and analyzed. | In order to evaluate and characterize surficial contamination within AREE 6A, three test pits will be dug and soil samples will be collected for chemical analysis. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs | TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs | TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity | % moisture | % moisture | % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, grab, biased | Environmental, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive | Intrusive | Intrusive |
| Data use | Risk assessment | Risk assessment, site characterization | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks, field blanks | Duplicates, rinse blanks | Duplicates, rinse blanks | Duplicates, rinse blanks |

## TABLE 4-9
## DATA QUALITY OBJECTIVES FOR AREE 6B - POTENTIAL DUMP 6B

| DQO Element | Groundwater | Subsurface Soil | Surface Soil | Test Pits |
|---|---|---|---|---|
| Objective | In order to further characterize groundwater beneath contaminated soils within AREE 6B, one newly installed monitoring well will be sampled for chemical analysis. | One soil boring will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination within AREE 6B. | In order to evaluate and characterize surficial contamination within AREE 6B, two surface soil samples will be collected and analyzed. | In order to evaluate and characterize contamination within AREE 6B, three test pits will be dug and soil samples will be collected for chemical analysis. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity | TOC, grain size, Atterberg limits, USCS, % moisture | % moisture | % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, grab, biased | Environmental, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks, field blanks | Duplicates, rinse blanks | Duplicates, rinse blanks | Duplicates, rinse blanks |

## TABLE 4-10
## DATA QUALITY OBJECTIVES FOR AREE 7 - FORMER PISTOL RANGE

| DQO Element | Groundwater | Subsurface Soil |
|---|---|---|
| Objective | In order to further characterize groundwater within AREE 7, one newly installed monitoring well will be sampled for chemical analysis. | One soil boring will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination within AREE 7. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity | TOC, grain size, Atterberg limits, USCS, % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks | Duplicates, rinse blanks |

## TABLE 4-11
## DATA QUALITY OBJECTIVES FOR DOWNGRADIENT FROM MAIN FACILITY COMPOUND

| DQO Element | Groundwater | Subsurface Soil |
|---|---|---|
| Objective | In order to further characterize groundwater downgradient of the main facility compound, one newly installed monitoring well will be sampled for chemical analysis. | One soil boring will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination downgradient of the main facility compound. |
| Chemical data | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, PAHs, and TPH | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, and TPH |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity | TOC, grain size, Atterberg limits, USCS, % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks | Duplicates, rinse blanks |

**TABLE 4-12**
**DATA QUALITY OBJECTIVES FOR AREES IN VICINITY OF BUILDING 202**

| DQO Element | Groundwater | Subsurface Soil |
|---|---|---|
| Objective | In order to further characterize groundwater beneath contaminated soils within these AREEs, five newly installed monitoring wells and one existing well will be sampled for chemical analysis. | Nine soil borings will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination within these AREEs. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity | TOC, grain size, Atterberg limits, USCS, % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks, field blanks | Duplicates, rinse blanks |

## TABLE 4-13
## DATA QUALITY OBJECTIVES FOR AREE 8 - SPILLS AROUND USTs AT BLDG 202

| DQO Element | Groundwater |
|---|---|
| Objective | In order to further characterize groundwater beneath contaminated soils within AREE 8, two existing monitoring wells will be sampled for chemical analysis. |
| Chemical data | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, PAHs, and TPH |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity |
| Sample type | Environmental, unfiltered, grab, biased |
| Sampling method | Intrusive |
| Data use | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks, field blanks |

## TABLE 4-14
## DATA QUALITY OBJECTIVES FOR AREE 12 - FORMER DRUM STORAGE AREA

| DQO Element | Groundwater |
|---|---|
| Objective | In order to further characterize groundwater beneath contaminated soils within AREE 12, two existing wells will be sampled for chemical analysis. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity |
| Sample type | Environmental, unfiltered, grab, biased |
| Sampling method | Intrusive |
| Data use | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks, field blanks |

## TABLE 4-15
## DATA QUALITY OBJECTIVES FOR AREE 14 - OIL/WATER SEPARATOR AT BUILDING 211

| DQO Element | Groundwater |
|---|---|
| Objective | In order to characterize groundwater beneath AREE 14, one existing well will be sampled for chemical analysis. |
| Chemical data | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, PAHs, and TPHs |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity |
| Sample type | Environmental, unfiltered (SW), grab, biased |
| Sampling method | Intrusive |
| Data use | Risk assessment |
| Data level | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM |
| Field QC samples | Duplicates, rinse blanks, field blanks, trip blanks |

## TABLE 4-16
## DATA QUALITY OBJECTIVES FOR AREE 23a - UST AT BUILDING 201

| DQO Element | Subsurface Soil |
|---|---|
| Objective | One soil boring will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination within AREE 23a. |
| Chemical data | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, PAHs, and TPH |
| Physical data | TOC, grain size, Atterberg limits, USCS, % moisture |
| Sample type | Environmental, grab, biased |
| Sampling method | Intrusive |
| Data use | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM |
| Field QC samples | Duplicates, rinse blanks |

**TABLE 4-17**
**DATA QUALITY OBJECTIVES FOR AREE 24 - USTs AT BUILDING 306**

| DQO Element | Subsurface Soil |
|---|---|
| Objective | Two soil boring will be drilled and 3 samples/boring will be collected in order to determine the vertical extent of contamination within AREE 24. |
| Chemical data | TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, PAHs, and TPH |
| Physical data | TOC, grain size, Atterberg limits, USCS, % moisture |
| Sample type | Environmental, grab, biased |
| Sampling method | Intrusive |
| Data use | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM |
| Field QC samples | Duplicates, rinse blanks |

## TABLE 4-18
## DATA QUALITY OBJECTIVES FOR FACILITY-WIDE CHARACTERIZATION

| DQO Element | Surface Soil | Surface Water and Sediment |
|---|---|---|
| Objective | In order to evaluate and characterize surficial contamination within these areas, twenty-five surface soil samples will be collected for chemical analysis. | Surface water and sediment sampling will be employed in order to evaluate migration of contamination from the WRF throughout the facility into the surrounding water bodies. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH |
| Physical data | % moisture | TOC, grain size, Atterberg limits, USCS, % moisture |
| Sample type | Environmental, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks | Duplicates, rinse blanks (SED), field blanks (SW), trip blanks (SW) |

**TABLE 4-19**
**DATA QUALITY OBJECTIVES FOR BACKGROUND SAMPLES**

| DQO Element | Groundwater | Surface Water and Sediment | Subsurface Soil | Surface Soil |
|---|---|---|---|---|
| Objective | In order to determine the background concentrations of target compounds, four newly installed monitoring wells will be sampled for chemical analysis. | In order to determine the background concentrations of target compounds, five surface water and sediment samples will be collected for chemical analysis. | In order to determine the background concentrations of target compounds, three subsurface soil samples will be collected for chemical analysis. | In order to determine the background concentrations of target compounds, five surface soil samples will be collected for chemical analysis. |
| Chemical data | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAH, TPH, and PCTs | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, TPH, and PCTs | TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, TPH, and PCTs |
| Physical data | Temperature, pH, redox potential, dissolved oxygen, and conductivity | SW: Temperature, pH, redox potential, dissolved oxygen, conductivity, salinity<br>SED: TOC, grain size, % moisture | TOC, grain size, Atterberg limits, USCS, % moisture | TOC, grain size, Atterberg limits, USCS, % moisture |
| Sample type | Environmental, unfiltered, grab, biased | Environmental, unfiltered (SW), grab, biased | Environmental, grab, biased | Environmental, grab, biased |
| Sampling method | Intrusive | Intrusive | Intrusive | Intrusive |
| Data use | Risk assessment, site characterization | Risk assessment | Risk assessment, site characterization | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM | ASTM | ASTM | ASTM |
| Field QC samples | Duplicates, rinse blanks, trip blanks, field blanks | Duplicates, field blanks (SW) rinse blanks (SED), trip blanks (SW) | Duplicates, rinse blanks | Duplicates, rinse blanks |

## TABLE 4-20
## DATA QUALITY OBJECTIVES FOR SITE-WIDE HYDROGEOLOGIC INVESTIGATION

| DQO Element | Subsurface Soil |
|---|---|
| Objective | Eight soil borings will be drilled and 3 samples/boring will be collected in order to conduct a hydrogeologic investigation of the WRF facility. Subsurface soil samples will collected for chemical and physical analyses. |
| Chemical data | TCL VOCs, SVOCs, Pesticides/PCBs, and TAL Metals |
| Physical data | TOC, grain size, Atterberg limits, USCS, % moisture |
| Sample type | Environmental, grab, biased |
| Sampling method | Intrusive |
| Data use | Risk assessment, site characterization |
| Data level | Chemical: Level IV<br>Physical: Level I |
| Chemical analytical method | USEPA SW-846 methods, performance demonstrated in accordance with USAEC guidelines |
| Physical testing method | ASTM |
| Field QC samples | Duplicates, rinse blanks |

## 4.3 APPLICABLE, RELEVANT, AND APPROPRIATE REQUIREMENTS

An integral part of the identification of Data Quality Objectives is the determination of Levels of Concern (LOC), and their comparison with ESE's USAEC performance demonstrated reporting limits. The selection of an LOC does not necessarily reflect levels relevant to the WRF RI/FS contamination assessment. LOCs are developed solely to ensure that the chosen analytical methods have detection limits which are low enough to achieve compliance with Applicable or Relevant and Appropriate Requirements (ARARs).

As part of the DQO process the ARARs and other guidance were compared with the USAEC reporting limits to ensure that the reporting limit is at or below the LOC. As appropriate to the human health and ecological risk assessments, where no ARAR existed, the USEPA Region III surface water, sediment, and soil Risk-Based Concentration under the Industrial Scenario was compared to the reporting limit (USEPA 1995). Methods were selected based on the requirement to detect analyte concentrations at or less than the associated LOC. The comparison is provided in Appendix C - Comparison of USAEC performance demonstrated reporting limits and WRF RI/FS LOCs.

### 4.3.1 Groundwater ARARs

Groundwater ARARs for the WRF RI/FS include the following: Federal Maximum Contaminant Levels, Commonwealth of Virginia Water Quality Standards, Federal Maximum Contaminant Level Goals, Drinking Water Health Advisory for Lifetime Exposure, and USEPA Secondary Maximum Contaminant Levels. The groundwater ARARs for the WRF RI/FS are presented in Table 4-21.

### 4.3.2 Surface Water ARARs

ARARs selected for WRF RI/FS surface water are based on the Federal Surface Water Quality Criteria (Freshwater) and Virginia Water Quality Standards for Protection of Aquatic Life and Human Health. The ARARs for the WRF RI/FS are presented in Table 4-22.

### 4.3.3 Soil ARARs

The ARARs for soil are based on Action Levels used in previous soil removal activities, Commonwealth of Virginia guidance documentation, and USEPA Proposed RCRA Corrective Action Level. The ARARs for soil are presented in Table 4-23.

### 4.3.4 Sediment ARARs

The ARARs in sediment are based on the Long and Morgan, 1990, Freshwater Effects Range-Low (ER-L) and the Effects Range-Moderate (ER-M) values and are presented in Table 4-24. In addition, Sediment Quality Criteria for Selected Organic Compounds are presented in Table 4-25.

### 4.3.5 Tissue ARARs

The ARARs for tissue are the Region III Risk-Based Concentrations (RBCs) for Fish Consumption (USEPA 1995). The RBCs are continually updated by the USEPA Region III and the most recent version available at this time is as referenced.

## TABLE 4-21
## GROUNDWATER ARARs AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN

| Chemical | Federal Maximum Contaminant Levels (µg/L) | Other Federal Guidance (µg/L) | | | Virginia Water Quality Standards (µg/L) (a) |
|---|---|---|---|---|---|
| | | Maximum Contaminant Level Goals | Drinking Water Health Advisory for Lifetime Exposure | Secondary Maximum Contaminant Levels | |
| Aldrin | -- | -- | -- (r,v) | -- | 0.003 |
| Aluminum | -- | -- | -- | 50-200 (d) | -- |
| Antimony | 6 (o) | 6 (o) | 3(n) | -- | -- |
| Arsenic | 50 (e) | -- | -- (v) | -- | 50 |
| Barium | 2,000 (e,f,g) | 2,000 (e,g) | 2,000 (n) | -- | 1000 |
| Benz(a)anthracene | 0.1 (b,r) | 0 (b,r) | -- | -- | -- |
| Benzene | 5 (e) | 0 (e) | -- (v) | -- | 5 (ab) |
| Benzo(b)fluoranthene | 0.2 (b,r) | 0 (b,r) | -- | -- | -- |
| Benzo(k)fluoranthene | 0.2 (b,r) | 0 (b,r) | -- | -- | -- |
| Benzo(a)pyrene | 0.2 (o) | 0 (o) | -- | -- | -- |
| Beryllium | 4 (o) | 4 (o) | -- (v,y) | -- | -- |
| Gamma-BHC (Lindane) | 0.2 (d,e) | 0.2 (d,e) | 0.2 (r) | -- | 0.01 |
| Bromacil | -- | -- | 90 (w) | -- | -- |
| Bromodichloromethane | 80 (p,q) | 60 (b,p) | 60 (r,v,y) | -- | -- |
| Bromoform | 80 (p,q) | 0 (p,q) | -- (r,v, mm) | -- | -- |
| Bromomethane | -- | -- | 10 (n) | -- | -- |
| 2-Butanone (MEK) | -- | -- | -- (h,UR) | -- | -- |
| Butyl benzyl phthalate | 100 (r) | 0 (r) | -- | -- | -- |
| Cadmium | 5 (d,e) | 5 (d,e) | 5 (n) | -- | 0.4 (ab) |
| Carbon tetrachloride | 5 (e) | 0 (e) | -- (r,v) | -- | 5 |
| Chlordane | 2 (d,e) | 0 (d,e) | -- (r,v) | -- | 0.01 |
| Chloride | -- | -- | -- | 250,000 (k) | 50000 |
| Chlorobenzene | 100 (d,e) | 100 (d,e) | 100 (r) | -- | -- |
| Chloroform | 80 (p,q) | 0 (b,p) | -- (v) | -- | -- |
| bis(2-Chloroisopropyl)ether | -- | -- | 300 (n) | -- | -- |
| Chloromethane | -- | -- | 3 (n) | -- | -- |
| 2-Chlorophenol | -- | -- | 40 (r,y) | -- | -- |
| Chromium | 100 (d,e) | 100 (d,e) | 100 (n) | -- | 50 (ab) |
| Chrysene | 0.2 (r) | 0 (r) | -- | -- | -- |
| Copper | 1,300 (i,j) | 1,300 (j) | -- | 1,000 (k) | 1,000 |
| Cyanide | 200 (o) | 200 (o) | 200 (n) | -- | 5 |
| DDT | -- | -- | -- | -- | 0.001 |
| Dibenz(a,h)anthracene | 0.3 (b,r) | 0 (b,r) | -- | -- | -- |
| Dibromochloromethane | 80 (p,q) | 60 (b,p) | 60 (r,y) | -- | -- |
| 1,2-Dichlorobenzene | 600 (d,e) | 600 (d,e) | 600 (h) | -- | -- |
| 1,3-Dichlorobenzene | 600(r) | 600(r) | 600 (h) | -- | -- |
| 1,4-Dichlorobenzene | 75 (e) | 75 (e) | 75 (h) | 5 (b,l) | 75 (ab) |
| 1,2-Dichloroethane | 5 (e) | 0 (e) | -- (r,v) | -- | 5 (ab) |
| 1,1-Dichloroethene | 7 (e) | 7 (e) | 7 (n) | -- | 7 |
| cis-1,2-Dichloroethene | 70 (d) | 70 (d) | 70 (n) | -- | -- |
| trans-1,2-Dichloroethene | 100 (d,e) | 100 (d,e) | 100 (r) | -- | -- |

## TABLE 4-21 (CONTINUED)
## GROUNDWATER ARARs AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN

| Chemical | Federal Maximum Contaminant Levels (μg/L) | Other Federal Guidance (μg/L) | | | Virginia Water Quality Standards (μg/L) (a) |
|---|---|---|---|---|---|
| | | Maximum Contaminant Level Goals | Drinking Water Health Advisory for Lifetime Exposure | Secondary Maximum Contaminant Levels | |
| 2,4-Dichlorophenol | -- | -- | 20 (r,y) | -- | -- |
| 1,2-Dichloropropane | 5 (d,e) | 0 (d,e) | -- (r,v) | -- | -- |
| 1,3-Dichloropropene | -- | 0 (r,s) | -- (r,v) | -- | -- |
| Dieldrin | -- | -- | -- (r,v) | -- | -- |
| Bis(2-ethylhexyl) phthalate | 6 (o) | 0 (o) | -- (r,v, UR) | -- | -- |
| 1,3-Dinitrobenzene | -- | -- | 1 (u) | -- | -- |
| Endrin | 2 (k,o) | 2 (o) | 2 (r) | -- | 0.004 |
| Ethylbenzene | 700 (d,e) | 700 (d,e) | 700 (n) | 30 (b,l) | -- |
| Fluoride | 4,000 (e) | 4,000 (e) | -- | 2,000 (k) | 1,400 |
| Heptachlor | 0.4 (d,e) | 0 (d,e) | -- (r,v) | -- | 0.001 |
| Heptachlor epoxide | 0.2 (d,e) | 0 (d,e) | -- (r,v) | -- | 0.001 |
| Hexachlorobenzene | 1 (o) | 0 (o) | -- (r,v) | -- | -- |
| Hexachlorobutadiene | -- | 1 (r,s) | 1 (n) | -- | -- |
| Hexachlorocyclopentadiene (HEX) | 50 (o) | 50 (o) | -- | 8 (b,c) | -- |
| Hexachloroethane | -- | -- | 1 (r) | -- | -- |
| Indeno (1,2,3-cd)pyrene | 0.4 (b,r) | 0 (b,r) | -- | -- | -- |
| Iron | -- | -- | -- | 300 (n) | 300 |
| Isophorone | -- | -- | 100 (z) | -- | -- |
| Lead | 15 (i,j) | 0 (e,j) | -- | -- | 50 |
| Manganese | -- | -- | -- | 50 (n) | 50 |
| Mercury | 2 (d,e) | 2 (d,e) | 2(n) | -- | 2 (ab) |
| Methoxychlor | 40 (d,e) | 40 (d,e) | 40 (n) | -- | 0.03 |
| Methylene chloride (dichloromethane) | 5 (o) | 0 (o) | -- (r,v) | -- | -- |
| Naphthalene | -- | -- | 20 (m) | -- | -- |
| Nickel | 100 (o) | 100 (o) | 100 (n) | -- | -- |
| Pentachlorophenol | 1 (e,g) | 0 (e,g) | -- (r,v) | -- | -- |
| Phenol | -- | -- | 4000 (z) | -- | 1 |
| Polychlorinated Biphenyls (PCBs) | 0.5 (d,e) | 0 (d,e) | -- | -- | -- |
| Polychlorinated Terphenyls (PCTs) | | | | | |
| Selenium | 50 (d,e) | 50 (d,e) | -- | -- | 10 |
| Silver | -- | -- | 100 | 100 (n) | 50 (ab) |
| Sodium | -- | -- | -- | -- | 100,000 |
| Sulfate | 500,000 | 500,000 | -- | 250,000 (k) | 50,000 |
| Styrene | 100 (d,e) | 100 (d,e) | 100 (n) | -- | -- |

## TABLE 4-21 (CONTINUED)
## GROUNDWATER ARARs AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN

| Chemical | Federal Maximum Contaminant Levels (µg/L) | Other Federal Guidance (µg/L) | | | Virginia Water Quality Standards (µg/L) (a) |
|---|---|---|---|---|---|
| | | Maximum Contaminant Level Goals | Drinking Water Health Advisory for Lifetime Exposure | Secondary Maximum Contaminant Levels | |
| 1,1,1,2-Tetrachloroethane | -- | -- | -- (n,v) | -- | -- |
| Tetrachloroethene | 5 (d,e) | 0 (d,e) | -- (r,v) | -- | -- |
| Thallium | 2 (o) | 0.5 (o) | 0.4 (n) | -- | -- |
| Toluene | 1,000 (d,e) | 1,000 (d,e) | 1,000 (n) | -- | -- |
| Total Petroleum Hydrocarbons | -- | -- | -- | -- | 1,000 |
| Toxaphene | 3 (d,e) | 0 (d,e) | -- (r,v) | -- | 5 (ab) |
| 1,2,4-Trichlorobenzene | 70 (o) | 70 (o) | 70 (n) | -- | -- |
| 1,1,1-Trichloroethane | 200 (e) | 200 (e) | 200 (n) | -- | 200 (ab) |
| 1,1,2-Trichloroethane | 5 (o) | 3 (o) | 3 (n) | -- | -- |
| Trichloroethene | 5 (e) | 0 (e) | -- (r,v) | -- | 5 (ab) |
| 2,4,6-Trinitrotoluene | -- | -- | 2 (t) | -- | -- |
| Vinyl chloride | 2 (e) | 0 (e) | -- (v) | -- | 2 (ab) |
| Xylenes (total) | 10,000 (d,e) | 10,000 (d,e) | 10,000 (r) | -- | -- |
| Zinc | -- | -- | 2,000 (r) | 5,000 (n) | 50 |

TCL VOCs, TCL SVOCs, TCL Chlorinated Pesticides/PCBs, Polychlorinated Terphenyls, TAL Metals, and total petroleum hydrocarbons listed in the QAPP were checked for applicable or relevant and appropriate regulations. If the compound is not listed in this table, no regulations exist.

-- = Standard not developed for this chemical. If no state standard is shown, then concentrations are required to be below the detection limit.
UR = Under Review.

(a) Virginia Department of Environmental Quality (VA DEQ). Water Quality Standards for Groundwater. VR 680-21-05.1
(b) Proposed.
(c) Environmental Protection Agency (EPA). 1990. National Primary and Secondary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals. Proposed Rule. Federal Register. Vol. 53, No. 143, Wed. July 25, 1990.
(d) Environmental Protection Agency (EPA). 1991. National Primary Drinking Water Regulations; Final Rule. Federal Register. Vol. 56, No. 20, Wednesday, January 30, 1991. 3526-3597.
(e) 40 CFR, Part 141-National Primary Drinking Water Regulations. 559-563, 620-621.
(f) The MCL for barium of 1,000 µg/l shall remain effective until January 1, 1993 when the MCL of 2,000 µg/l will take its place.
(g) Environmental Protection Agency (EPA). 1991. National Primary Drinking Water Regulations - Monitoring for Volatile Organic Chemicals; MCLGs and MCLs for Aldicarb, Aldicarb Sulfoxide, Aldicarb Sulfone, Pentachlorophenol, and Barium; Final Rule. Federal Register. Vol. 56, No. 126, Monday, July 1, 1991. 30266-30281.
(h) Environmental Protection Agency (EPA). 1987. Health Advisories. Office of Drinking Water. Washington, D.C. March 31, 1987.
(i) Action Level; exceeded if the level of concentration in more than 10 percent of the targeted tap samples is greater than the specified value (90th percentile).
(j) Standards effective December 7, 1992.
Environmental Protection Agency (EPA). 1991. Drinking Water Regulations; Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper; Final Rule. Federal Register. Vol. 56, No. 110, 26460-26564, Friday, June 7, 1991.
(k) 40 CFR, Part 143-National Secondary Drinking Water Regulations. 674.
(l) Environmental Protection Agency (EPA). 1989. National Primary and Secondary Drinking Water Regulations; Proposed

## TABLE 4-21 (CONTINUED)
## GROUNDWATER ARARs AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN

Rule. Federal Register. Vol. 54, No. 97, Monday, May 22, 1989. 22062-22160.

(m) Environmental Protection Agency (EPA). 1990. Health Advisory for Naphthalene. Office of Drinking Water. Washington, D.C. March, 1990.

(n) Environmental Protection Agency (EPA). 1992. Drinking Water Regulations and Health Advisories. Office of Water, Washington D.C. November, 1992.

(o) Standards effective January 17, 1994 (except endrin, standards effective August 17, 1992). Environmental Protection Agency (EPA). 1992. National Primary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals. Final Rule. Federal Register. Vol. 57, No. 188, Friday, July 17, 1992. 31776-31849.

(p) Environmental Protection Agency (EPA). 1994. National Primary Drinking Water Regulations; Disinfectants and Disinfection Byproducts; Proposed Rule. July 29, 1994.

(q) The value of 80 ug/l is for total trihalomethanes (i.e., the sum of chloroform, bromodichloromethane, bromoform, and dibromochloromethane).

(r) Environmental Protection Agency. 1993. Summary Table of Drinking Water Regulations and Health Advisories. Office of Water. May 1993.

(s) Tentative; regulation is an internal draft of the Office of Water; not an official or enforceable standard. the specified value (90th percentile).

(t) Environmental Protection Agency (EPA). 1989. Health Advisories for Diisopropyl Methylphosphonate (DIMP) and 2,4,6-Trinitrotoluene. Office of Drinking Water. Washington, D.C. January, 1989.

(u) Environmental Protection Agency (EPA). 1991. Health Advisory for 1,3-Dinitrobenzene. Office of Drinking Water. Washington, D.C. January 1991.

(v) Although there is a health advisory for this chemical, the determination of a lifetime health advisory is not recommended by EPA because this chemical is classified as a carcinogen (either probable or known).

(w) Environmental Protection Agency (EPA). 1988. Health Advisories for 50 pesticides. Office of Drinking Water. Washington, D.C. August 1988.

(x) Environmental Protection Agency (EPA). 1988. Health Advisories for Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) and Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX). Office of Drinking Water. Washington, D.C. November 1988.

(y) As of November 1992, this Health Advisory was a draft.

(z) Environmental Protection Agency (EPA). 1992. Office of Drinking Water. Washington, D.C. April 1992.

(aa) Environmental Protection Agency (EPA), Region IX. 1995. Drinking Water Standards and Health Advisories Table. California MCL for Freon 113. January 1995.

(ab) Commonwealth of Virginia State Board of Health. 1993. Waterworks Regulations. VR 355-18-000.

## TABLE 4-22
## SURFACE WATER ARARs AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN

| Analyte | Federal Surface Water Quality Criteria (µg/L) | | | | State Surface Water Quality Criteria |
|---|---|---|---|---|---|
| | Freshwater Acute Criteria | Freshwater Chronic Criteria | Water and Fish Ingestion (**) | Fish Consumption Only (**) | |
| Chloromethane | NC | NC | NC | NC | 4,700 (h) |
| Bromomethane | NC | NC | NC | NC | NC |
| Vinyl chloride | NC | NC | 2 | 525 | 5,250 (h) |
| Chloroethane | NC | NC | NC | NC | NC |
| Methylene chloride | NC | NC | 4.7 | 1600 | NC |
| Acetone | NC | NC | NC | NC | NC |
| Carbon Disulfide | NC | NC | NC | NC | NC |
| 1,1-Dichloroethene | *11,800 | NC | 0.057 | 3.2 | NC |
| 1,1-Dichloroethane | NC | NC | NC | NC | NC |
| 1,2-Dichloroethene (total) | *11,800 | NC | NC | NC | NC |
| Chloroform | *28,900 | *1,240 | 5.7 | 470 | 5,700 (h) |
| 1,2-Dichloroethane | *118,000 | *20,000 | 0.38 | 99 | 990 (h) |
| 2-Butanone | NC | NC | NC | NC | NC |
| 1,1,1-Trichloroethane | NC | NC | NC (e) | NC (e) | NC |
| Carbon tetrachloride | *35,200 | NC | 0.25 | 4.4 | 45 (h) |
| Bromodichloromethane | NC | NC | 0.27 | 22 | 220 (h) |
| 1,2-Dichloropropane | *23,000 | *5,700 | NC | NC | NC |
| cis-1,3-Dichloropropene | *6,000 | *244 | 10 | 1700 | NC |
| Trichloroethene | *46,000 | *21,800 | 2.7 | 80.7 | 807 (h) |
| Dibromochloromethane | NC | NC | 0.41 | 34 | 57,000 (h) |
| 1,1,2-Trichloroethane | NC | *9,400 | 0.6 | 42 | NC |
| Benzene | 5,300 | NC | 1.2 | 71 | 710 (h) |
| trans-1,3-Dichloropropene | *6,000 | *244 | 87 | $14.1\times10^3$ | NC |
| Bromoform | NC | NC | 4.3 | 380 | 3,600 (h) |
| 4-Methyl-2-pentanone | NC | NC | NC | NC | NC |
| 2-Hexanone | NC | NC | NC | NC | NC |
| Tetrachloroethene | *5,280 | *940 | 0.8 | 8.85 | 3,519 (h) |
| 1,1,2,2-Tetrachloroethane | NC | *2,400 | 0.17 | 11 | NC |
| Toluene | *17,500 | NC | 6800 | 200 | 6,800 (h) |
| Chlorobenzene | *250 | *50 | 680 | 21,000 (c) | 680 (h) |
| Ethylbenzene | *32,000 | NC | 3100 | 29,000 | 29,000 (h) |
| Styrene | NC | NC | NC | NC | NC |
| Xylene (total) | NC | NC | NC | NC | NC |
| Phenol | *10,200 | *2,560 | 21,000 | 4,600,000 | 4,600,000 (h) |
| Bis(2-chloroethyl)ether | NC | NC | 0.031 | 1.4 | NC |
| 2-Chlorophenol | *4,380 | *2,000 | NC | NC | NC |
| 1,3-Dichlorobenzene[a] | *1,120 | *763 | 400 | 2,600 | 2,600 (h) |
| 1,4-Dichlorobenzene[f] | *1,120 | *763 | 400 | 2,600 | 2,600 (h) |
| 1,2-Dichlorobenzene[f] | *1,120 | *763 | 2,700 | 17,000 | 17,000 (h) |
| 2-Methylphenol | NC | NC | NC | NC | NC |
| Bis(2-chloroisopropyl)ether | NC | NC | 1,400 | 170,000 | NC |
| 4-Methylphenol | NC | NC | NC | NC | NC |
| N-Nitroso-di-n-propylamine | NC | NC | NC | NC | NC |

## TABLE 4-22 (CONTINUED)
## SURFACE WATER ARARs AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN

| Analyte | Federal Surface Water Quality Criteria (µg/L) | | | | State Surface Water Quality Criteria |
|---|---|---|---|---|---|
| | Freshwater Acute Criteria | Freshwater Chronic Criteria | Water and Fish Ingestion (**) | Fish Consumption Only (**) | |
| Hexachloroethane | *980 | *540 | 1.9 | 8.9 | NC |
| Nitrobenzene | *27,000 | NC | 17 | 1900 | NC |
| Isophorone | *117,000 | NC | 8.4 | 600 | 490,000 (h) |
| 2-Nitrophenol[b] | *230 | *150 | NC | NC | NC |
| 2,4-Dimethylphenol | *2,120 | NC | NC | NC | NC |
| Bis(2-chloroethoxy)-methane | NC | NC | NC | NC | NC |
| 2,4-Dichlorophenol | *2,020 | *365 | 93 | 790 | NC |
| 1,2,4-Trichlorobenzene | NC | NC | NC | NC | NC |
| Naphthalene | *2,300 | *620 | NC | NC | NC |
| 4-Chloroaniline | NC | NC | NC | NC | NC |
| Hexachlorobutadiene | *90 | *9.3 | 0.44 | 50 | NC |
| 4-Chloro-3-methylphenol | NC | NC | NC | NC | NC |
| 2-Methylnaphthalene | NC | NC | NC | NC | NC |
| Hexachlorocyclopenta-diene | *7 | *5.2 | 240 | 17,000 | NC |
| 2,4,6-Trichlorophenol | NC | *970 | 2.1 | 6.5 | 65 (h) |
| 2,4,5-Trichlorophenol | NC | NC | 2,800 | NC | NC |
| 2-Chloronaphthalene[c] | *1,600 | NC | NC | NC | NC |
| 2-Nitroaniline | NC | NC | NC | NC | NC |
| Dimethylphthalate | *2,120 | NC | 313,000 | 2,900,000 | NC |
| Acenaphthylene | NC | NC | NC | NC | NC |
| 2,6-Dinitrotoluene | NC | NC | 70 | $14.3\times10^{3}$ | NC |
| 3-Nitroaniline | NC | NC | NC | NC | NC |
| Acenaphthene | *1,700 | *520 | NC | NC | NC |
| 2,4-Dinitrophenol[b] | *230 | *150 | 70 | 14,000 | NC |
| 4-Nitrophenol[b] | *230 | *150 | NC | NC | NC |
| Dibenzofuran | NC | NC | NC | NC | NC |
| 2,4-Dinitrotoluene | NC | NC | **0.11 | **9.1 | NC |
| Diethylphthalate | NC | NC | 23,000 | 120,000 | NC |
| 4-Chlorophenyl-phenylether | NC | NC | NC | NC | NC |
| Fluorene | NC | NC | 1,300 | 14,000 | 14,000 (h) |
| 4-Nitroaniline | NC | NC | NC | NC | NC |
| 4,6-Dinitro-2-methylphenol | NC | NC | NC | NC | NC |
| N-Nitrosodiphenylamine | NC | NC | 5.0 | 16 | NC |
| 4-Bromophenyl-phenyl ether | NC | NC | NC | NC | NC |
| Hexachlorobenzene | NC | NC | 0.00075 | 0.00077 | NC |
| Pentachlorophenol | ***20 | ***13 | 0.28 | 8.2 (c) | 7.9 (g); 82 (h) |
| Phenanthrene (Ecological) | NC | NC | $2.8\times10^{-3}$ | $31.1\times10^{-3}$ | NC |
| Anthracene | NC | NC | 9,600 | 110,000 | 110,000 (h) |
| Di-n-butylphthalate | NC | NC | 2,700 | 12,000 | NC |

## TABLE 4-22 (CONTINUED)
## SURFACE WATER ARARs AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN

| Analyte | Federal Surface Water Quality Criteria (µg/L) | | | | State Surface Water Quality Criteria |
|---|---|---|---|---|---|
| | Freshwater Acute Criteria | Freshwater Chronic Criteria | Water and Fish Ingestion (**) | Fish Consumption Only (**) | |
| Fluoranthene | *3,980 | NC | 300 | 370 | 370 (h) |
| Pyrene | NC | NC | 960 | 11,000 | 11,000 (h) |
| Butylbenzylphthalate | NC | NC | NC | NC | NC |
| 3,3'-Dichlorobenzidine | NC | NC | 0.04 | 0.077 | NC |
| Benz[a]anthracene[d] | NC | NC | .0028 | .031 | 0.311 (h) |
| Chrysene[d] | NC | NC | .0028 | .031 | NC |
| Bis(2-ethylhexyl)-phthalate | NC | NC | 1.8 | 5.9 | 59 (h) |
| Di-n-octylphthalate | NC | NC | NC | NC | NC |
| Benzo[b]fluoranthene[d] | NC | NC | .0028 | .031 | 0.311 (h) |
| Benzo[k]fluoranthene[d] | NC | NC | .0028 | .031 | 0.311 (h) |
| Benzo[a]pyrene[d] | NC | NC | .0028 | .031 | 0.311 (h) |
| Indeno(1,2,3-cd)pyrene[d] | NC | NC | .0028 | .031 | 0.311 (h) |
| Dibenz[a,h]anthracene[d] | NC | NC | .0028 | .031 | NC |
| Benzo[g,h,i]perylene[d] | NC | NC | NC | NC | NC |
| Carbazole | NC | NC | NC | NC | NC |
| alpha-BHC | *100 | NC | 0.0039 | 0.013 | NC |
| beta-BHC | NC | NC | 0.014 | 0.046 | NC |
| delta-BHC | NC | NC | NC | NC | NC |
| gamma-BHC (lindane) | NC | 2 (b) | 0.08 (b) | 0.019 | 0.08 (f); 0.01 (g); 25 (h) |
| Heptachlor | 0.52 | 0.0038 | 0.00021 | 0.00021 | 0.0038 (f); 0.0036 (g); 0.0021 (h) |
| Aldrin | 3.0 | NC | 0.00013 | 0.000014 | 0.3 (f);0.13 (g); 0.0014 (h) |
| Heptachlor epoxide | 0.52 (b) | 0.0038 (b) | 0.00010 | 0.00011 | NC |
| Endosulfan I | 0.22 (b) | 0.056 (b) | 0.93 | 2.0 | 0.056 (f);0.0087 (g); 2.0 (h) |
| Dieldrin | 2.5 (b) | 0.0019 (b) | 0.00014 | 0.00014 | 0.0019 (f); 0.0019 (g); 0.0014 (h) |
| 4,4'-DDE | *1.050 | NC | 0.00059 | 0.00059 | NC |
| Endrin | 0.18 (b) | 0.0023 (b) | 0.76 | 0.81 | 0.0023 (f); 0.0023 (g); 0.76 (h) |
| Endrin aldehyde | NC | NC | 0.76 | 0.81 | NC |
| Endosulfan II | 0.22 (b) | 0.056 (b) | 0.93 | 2.0 | 0.056 (f);0.0087 (g); 2.0 (h) |
| 4,4'-DDD | NC | NC | 0.00083 | 0.00084 | NC |
| Endosulfan sulfate | NC | NC | 0.93 | 2.0 | NC |
| 4,4-DDT | 1.1 (b) | 0.001 (b) | 0.00059 | 0.00059 | 0.001 (f); 0.001 (g); 0.0059 (h) |
| Methoxychlor | NC | 0.03 | 100 | NC | NC |
| Endrin ketone | NC | NC | NC | NC | NC |

## TABLE 4-22 (CONTINUED)
## SURFACE WATER ARARs AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN

| Analyte | Federal Surface Water Quality Criteria (µg/L) | | | | State Surface Water Quality Criteria |
|---|---|---|---|---|---|
| | Freshwater Acute Criteria | Freshwater Chronic Criteria | Water and Fish Ingestion (**) | Fish Consumption Only (**) | |
| Chlordane | 2.4 (b) | 0.0043 (b) | 0.00057 | 0.00059 | 0.0059 (h) |
| Toxaphene | 0.73 | 0.0002 | 0.00073 | 0.00075 | 0.0002 (f); 0.0002 (g); 0.0075 (h) |
| Aroclor-1016[e] | *7,240 | 0.014 (b) | 0.000044 | 0.000045 | 0.014 (f); 0.03 (g); 0.00045 (h) |
| Aroclor-1221[e] | *7,240 | 0.014 (b) | 0.000044 | 0.000045 | 0.014 (f); 0.03 (g); 0.00045 (h) |
| Aroclor-1232[e] | *7,240 | 0.014 (b) | 0.000044 | 0.000045 | 0.014 (f); 0.03 (g); 0.00045 (h) |
| Aroclor-1242[e] | *7,240 | 0.014 (b) | 0.000044 | 0.000045 | 0.014 (f); 0.03 (g); 0.00044 (h) |
| Aroclor-1248[e] | *7,240 | 0.014 (b) | 0.000044 | 0.000045 | 0.014 (f); 0.03 (g); 0.00044 (h) |
| Aroclor-1254[e] | *7,240 | 0.014 (b) | 0.000044 | 0.000045 | 0.014 (f); 0.03 (g); 0.00044 (h) |
| Aroclor-1260[e] | *7,240 | 0.014 (b) | 0.000044 | 0.000045 | 0.014 (f); 0.03 (g); 0.00044 (h) |
| 2,4-Dinitrotoluene | NC | NC | 0.11 | 9.1 | 91 (h) |
| 2,6-Dinitrotoluene | NC | NC | NC | NC | NC |
| Aluminum | NC | NC | NC | NC | NC |
| Antimony | *9,000 | *1,600 | 14 | 4,300 | NC |
| Arsenic | 360 (d) | 190 (d) | 0.018 (a) | 0.014 (a) | 50 (h) |
| Barium | NC | NC | 1,000 | NC | 2,000 (h) |
| Beryllium | *130 | *5.3 | NC (e) | NC (e) | NC |
| Cadmium | +3.9 (d) | +1.1 (d) | 43 (d) | 9.3 (d) | 170 (h) |
| Calcium | NC | NC | NC | NC | NC |
| Chromium | +1,700 (d) | +210 (d) | NC (e) | NC (e) | 11 (f); 50 (g); 3,400 (h) |
| Cobalt | NC | NC | NC | NC | NC |
| Copper | +18 (d) | +12 (d) | NC | NC | 2.9 (g); 1,300 (h) |
| Iron | NC | 1,000 | 300 | NC | 300 (h) |
| Lead | +82 (d) | +3.2 (d) | NC (e) | NC (e) | 8.5 (g); 15 (h) |
| Magnesium | NC | NC | NC | NC | NC |
| Manganese | NC | NC | 50 | 100 | 50 (h) |
| Mercury | 2.4 (d) | 0.012 (c) | 0.14 | 0.15 | NC |
| Nickel | +1,400 (d) | +160 (d) | 610 | 4600 | 8.3 (g); 4,583 (h) |
| Potassium | NC | NC | NC | NC | NC |
| Selenium | 20 | 5 | NC (e) | NC (e) | 5 (f); 71 (g); 11,200 (h) |
| Silver | +4.1 | 0.12 | NC | NC | 2.3 (g) |
| Sodium | NC | NC | NC | NC | NC |
| Thallium | *1,400 | *40 | 1.7 | 6.3 | NC |

## TABLE 4-22 (CONTINUED)
## SURFACE WATER ARARs AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN

| Analyte | Federal Surface Water Quality Criteria (µg/L) | | | | State Surface Water Quality Criteria |
|---|---|---|---|---|---|
| | Freshwater Acute Criteria | Freshwater Chronic Criteria | Water and Fish Ingestion (**) | Fish Consumption Only (**) | |
| Vanadium | NC | NC | NC | NC | NC |
| Zinc | +120 (d) | +110 (d) | NC | NC | 13 (f); 86 (g); 5,000 (h) |
| Conductivity | NC | NC | NC | NC | NC |
| Cyanide | 22 | 5.2 | 700 | 220000 | 5.2 (f); 1.0 (g); 215,000 (h) |
| Nitrate and Nitrite as Nitrogen | NC | NC | NC | NC | 10,000 (h) |

Source: Ambient Water Quality Criteria as listed in Federal Register, Vol. 57, No. 246, December 22, 1992. State Criteria obtained from Virginia Water Quality Standards for Protection of Aquatic Life and Human Health (VR 680-21-40.3)

TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, PCTs, and TPH as listed in the QAPP were checked for applicable or relevant and appropriate regulations. If the compound is not listed in this table, no regulations exist.

+ Hardness Dependent Criteria (100 mg/L used)
* Insufficient Data to Develop Criteria Value presented is the harvest Observed Effect Level (LOEL)
** Human Health Criteria for Carcinogens Reported for Three Risk Levels Value Presented is $10^{-6}$ Risk Level
*** pH Dependent Criteria (7.8 pH used)
NC No Criterion
NA Not Available
a aquatic protection based criteria
b Federal criteria are for nitrophenols.
c Federal criteria are for chlorinated naphthalenes.
d Federal criteria are for total carcinogenic PAHs.
e Federal and State criteria are for total PCBs.
f Federal criteria are for total dichlorobenzenes.
h criteria based upon human health information
a+ or h+ criteria developed after review of both human health information and aquatic protection data. The basis for the criterion adopted (human health or aquatic protection) is indicated by the letter preceding the *.
(a) The criteria refers to the inorganic form only.
(b) The acute values shown are final acute values (FAV) which by the 1980 Guidelines are instantaneous values as contrasted with a CMC which is a one-hour average.
(c) If the CCC for total mercury exceeds 0.012 µg/L more than once in a 3-year period in the ambient water, the edible portion of aquatic species of concern must be analyzed to determine whether the concentration of methyl mercury exceeds the FDA action level (1.0 mg/kg). If the FDA action level is exceeded, the State must notify the appropriate EPA Regional Administrator, initiate a revision of its mercury criterion in its water quality standards so as to protect designated uses, and take other appropriate action such as issuance of a fish consumption advisory for the affected area.
(d) Criteria for these metals are expressed as a function of the water effect ratio, WER, as defined in 40 CFR 131.36(c).
(e) EPA is not promulgating human health criteria for this contaminant. However, permit authorities should address this contaminant in NPDES permit actions using the State's existing narrative criteria for toxics.
(f) This value refers to the Virginia Water Quality Standards for Freshwater.
(g) This value refers to the Virginia Water Quality Standards for Saltwater.
(h) This value refers to the Virginia Water Quality Standards for Water and Fish Ingestion.

## TABLE 4-23
## SOIL CLEANUP CRITERIA

| Contaminant | U.S. EPA Proposed RCRA Corrective Action Levels (µg/g) (a) | U.S. EPA Recommended Soil Action Level in Soil (µg/g) (b) | Virginia UST Program Action Level in Soil (µg/g)(c) |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | 2,000 | -- | -- |
| 4,4'-DDD | 3 | -- | -- |
| 4,4'-DDE | 2 | -- | -- |
| 4,4'-DDT | 2 | -- | -- |
| alpha-Chlordane | 0.5 | -- | -- |
| Acetone | 8,000 | -- | -- |
| Antimony | 30 | -- | -- |
| Arsenic | 80 | -- | -- |
| Beryllium | 0.2 | -- | -- |
| Bis (2-ethylhexyl) phthalate | 50 | -- | -- |
| Bromodichloromethane | 0.5 | -- | -- |
| Cadmium | 40 | -- | -- |
| Chlorobenzene | 2,000 | -- | -- |
| Chloroform | 100 | -- | -- |
| Chromium, Hexavalent | 400 | -- | -- |
| Dieldrin | 0.04 | -- | -- |
| Ethylbenzene | 8,000 | -- | -- |
| Methyl Ethyl Ketone | 4,000 | -- | -- |
| Nickel | 2,000 | -- | -- |
| PCB-1242 | 0.09 | 1 | -- |
| PCB-1254 | 0.09 | 1 | -- |
| PCB-1260 | 0.09 | 1 | -- |
| Toluene | 20,000 | -- | -- |
| Total Petroleum Hydrocarbons | -- | -- | 100 |

Legend:

-- No Criterion

(a) Information obtained from USEPA Proposed RCRA Corrective Action Levels for SWMUs at Hazardous Waste Management Facilities (1990) and are to be considered as guidance.

(b) Information obtained from USEPA Guidance on Remedial Actions for Superfund Sites with PCB Contamination and is based on future residential use of the site.

(c) Information obtained from VA DEQ Underground Storage Tank (UST) Program unpublished guidance for tank removal. Above this concentration, further risk characterization is required.

## TABLE 4-24
## SCREENING LEVEL VALUES FOR INORGANICS, PESTICIDES, AND PAHs IN SEDIMENT (μg/g)

| Chemical Analyte | ER-L Concentration[a] | ER-M Concentration | Subjective Degree of Confidence in ER-L/ER-M Values |
|---|---|---|---|
| **Trace Elements (μg/g)** | | | |
| Antimony | 2 | 25 | Moderate/moderate |
| Arsenic | 33 | 85 | Low/moderate |
| Cadmium | 5 | 9.0 | High/high |
| Chromium | 80 | 145 | Moderate/moderate |
| Copper | 70 | 390 | High/high |
| Lead | 35 | 110 | Moderate/high |
| Mercury | 0.15 | 1.3 | Moderate/high |
| Nickel | 30 | 50 | Moderate/moderate |
| Silver | 1.0 | 2.2 | Moderate/moderate |
| Zinc | 120 | 270 | High/high |
| **Pesticides (μg/g)** | | | |
| DDT | 0.001 | 0.007 | Low/low |
| DDD | 0.002 | 0.020 | Moderate/low |
| DDE | 0.002 | 0.015 | Low/low |
| Chlordane | 0.0005 | 0.006 | Low/low |
| Dieldrin | 0.00002 | 0.008 | Low/low |
| Endrin | 0.00002 | 0.045 | Low/low |
| Total PCBs | 0.05 | 0.40 | Moderate/moderate |
| **Polynuclear Aromatic Hydrocarbons (μg/g)** | | | |
| Acenaphthene | 0.016 | 0.50 | Low/low |
| Anthracene | 0.085 | 1.10 | Low/moderate |
| Benzo(a)anthracene | 0.261 | 1.60 | Low/moderate |
| Benzo(a)pyrene | 0.43 | 1.60 | Moderate/moderate |
| Chrysene | 0.384 | 2.80 | Moderate/moderate |
| Dibenz(a,h)anthracene | 0.063 | 0.26 | Moderate/moderate |
| Fluoranthene | 0.60 | 3.60 | High/high |
| 2-methylnaphthalene | 0.07 | 0.67 | Low/moderate |
| Naphthalene | 0.16 | 2.10 | Moderate/high |
| Phenanthrene | 0.24 | 1.50 | Moderate/moderate |
| Pyrene | 0.665 | 2.60 | Moderate/moderate |
| Total PAH | 4.02 | 44.8 | Low/low |

[a] Long and Morgan, 1990. The ER-L and ER-M are reference numbers used to identify the presence of contamination exceeding levels potentially harmful to aquatic life. Specific cleanup objectives are to be developed on a case-by-case basis.

## TABLE 4-25
## SEDIMENT QUALITY CRITERIA FOR SELECTED ORGANIC COMPOUNDS

| Compound | Sediment Criterion (µg/g Carbon) (top # is FW criterion, bottom # SW criterion) | | |
|---|---|---|---|
| | 95% Confidence Interval | | |
| | Mean | Lower | Upper |
| Acenaphthene (a) | 130<br>230 | 62<br>110 | 280<br>500 |
| Dieldrin (b) | 11<br>20 | 5.2<br>9.5 | 24<br>44 |
| Endrin (c) | 4.2<br>0.76 | 2.0<br>0.35 | 9.1<br>1.6 |
| Fluoranthene (d) | 620<br>300 | 290<br>140 | 1300<br>640 |
| Phenanthrene (e) | 180<br>240 | 85<br>110 | 390<br>510 |

(a) Environmental Protection Agency (EPA). 1993. Sediment Quality Criteria for the Protection of Benthic Organisms: Acenaphthene. Washington, D.C. September 1993.
(b) Environmental Protection Agency (EPA). 1993. Sediment Quality Criteria for the Protection of Benthic Organisms: Dieldrin. Washington, D.C. September 1993.
(c) Environmental Protection Agency (EPA). 1993. Sediment Quality Criteria for the Protection of Benthic Organisms: Endrin. Washington, D.C. September 1993.
(d) Environmental Protection Agency (EPA). 1993. Sediment Quality Criteria for the Protection of Benthic Organisms: Fluoranthene. Washington, D.C. September 1993.
(e) Environmental Protection Agency (EPA). 1993. Sediment Quality Criteria for the Protection of Benthic Organisms: Phenanthrene. Washington, D.C. September 1993.

FW = fresh water
SW = salt water
NA = not available

The sediment quality criteria are reference numbers used to identify the presence of contamination exceeding levels potentially harmful to aquatic life. Specific cleanup objectives are to be developed on a case-by-case basis.

## 4.4 BLANK CONTAMINATION ASSESSMENT

Blank contamination assessment will occur both at the laboratory and a second review will be performed by the ICF KE QA Manager.

### 4.4.1 USEPA Blank Assessment

Field and laboratory QC blank data will be reviewed in accordance with the National Functional Guidelines (NFGs) for Organic and Inorganic Data Review (USEPA 1994a, USEPA 1994b) and USEPA Region III modifications to the NFGs (USEPA 1993, 1994c). In cases where more than one blank is associated with a given sample, qualification will be based upon a comparison with the associated blank having the highest concentration of the contaminant. The following are the USEPA criteria by which the blanks will be reviewed:

Inorganic:

- Any analyte detected in the environmental sample at less than 5 times the concentration in the associated blank will be qualified "B".

Organic:

- The sample result is qualified "B," when the compound concentration is greater than the reporting limit but less than ten times the amount in any blank for common laboratory contaminants, (i.e., methylene chloride, acetone, 2-butanone (methyl ethyl ketone (MEK)), and common phthalate esters); and,

- The sample result for other contaminants are qualified "B," when the sample concentration is greater than the reporting limit but less than five times the amount detected in the associated blank.

Following the qualification of data, the ICF KE Project Manager will evaluate the usefulness of the qualified data and will either decide to re-sample and re-analyze or will decide to use the data in the qualified state. Results of the ICF KE QA Manager blank assessment will be presented in the Final Report as an addition to the USAEC blank contamination assessment.

### 4.4.2 USAEC Blank Assessment

In addition to the USEPA review of QC blank data, data will also be reviewed by the laboratory using the USAEC Guidelines. Method blanks are used to determine the potential contamination from the laboratory environment and analytical method used to process the sample. Method blanks will be processed at the beginning of each analytical run by the laboratory to determine whether the internal laboratory environment, reagents used during analyses, analytical techniques, or the instrumentation system are sources of contamination that could affect the integrity of the sample. The criterion for the evaluation of blank contamination applies to any blank associated with the samples, and states that no contamination should be in the blank. If contamination is detected, data associated with the blank will be carefully evaluated to determine if there is an inherent variability in the data for the lot, or if the problem is an isolated occurrence not affecting all samples in the lot. The following are the USAEC guidelines for the qualification of data associated with a contaminated method blank (USAEC 1991b):

- All environmental results will be flagged "B" when the analyte is found in the method blank or QC blank (rinse, trip, or field) as well as the sample. This flagging code will be used when an analyte was detected and quantitated at "higher-than-normal background levels." For metals in soil, if the analyte is detected in the method blank, both the field and QC samples are to be flagged; however, if the analyte is detected in the QC blank, only the QC samples are to be flagged.

A blank contamination assessment will be performed to review the decontamination of sampling equipment. Rinse blanks will be reviewed to determine the integrity of decontamination events. Inorganic and organic analytes detected in both the rinse blank and associated environmental samples will be flagged in IRDMIS in accordance with the following USAEC guidelines:

- Environmental results will be flagged "G" when an analyte is found in the sample and the associated rinse blank. A blank contamination assessment will be performed to determine the impact of volatile organic contaminant contributions originating from point and non-point sources. These potential sources include field sampling procedures, sample shipment, and the laboratory environment.

Potential cross-contamination during sample collection and shipment, and in the laboratory, will be assessed through the evaluation of trip blanks. Volatile contaminants detected in a trip blank and the associated samples (associated during collection and shipping) will be flagged in accordance with the following USAEC guidelines:

- Environmental sample results will be flagged "A" when an analyte is detected in both the sample and the associated trip blank. This flagging code is to be used for volatile organic compounds only.

## 5.0 SITE SELECTION AND SAMPLING PROCEDURES

The following procedures ensure the traceability of data to the sampling and analytical procedures, performance standards, analysts, and measurement and test equipment. Sample collection, preservation, handling, storage, packaging, and shipping will be performed in a manner that minimizes damage, loss, deterioration, and artifacts.

### 5.1 SAMPLE MANAGEMENT

Sample labeling, container requirements, preservation, sample collection, sample custody, and field calibration are briefly described in this section. Procedures described are designed to eliminate external contamination and to ensure data quality through the use of SOPs. References to methods of collection and detailed SOPs are provided in Appendix A.

#### 5.1.1 Sample Containers

The integrity of containers for soil and water samples is ensured by the use of appropriate cleaning techniques as specified by the USEPA Contract Laboratory Program (CLP) and provided in Appendix C of the USAEC Guidelines. The contract laboratory will purchase pre-cleaned sample bottles for chemical analyses according to requirements set forth in USAEC Guidelines. The sample containers to be used for the various analyses for the WRF RI/FS are provided in Table 5-1 (aqueous), Table 5-2 (solid), and Table 5-3 (physical).

#### 5.1.2 Sample Preservatives

Preservatives will be included in the shipping container sent to the field. Preservatives will be required to retard hydrolysis of chemical compounds and complexes, to reduce volatility of constituents, and to retard biological action during transit and storage prior to laboratory analysis. Preservatives will be added to appropriate samples at the time of collection, except the VOC fraction container which will be pre-preserved. The types of preservation required for samples collected during this project are contained in Table 5-1 (aqueous), Table 5-2 (solid), and Table 5-3 (physical). In addition to chemical preservatives, samples for chemical analysis will be transported to the laboratory in temperature-controlled coolers. Blue ice or wet ice will be used to maintain the internal cooler temperature required for preservation.

#### 5.1.3 Holding Times

Sample holding time is the interval from sample collection to sample extraction and analysis such that a sample may be considered valid and representative of the sample matrix. The allowable holding times for samples are summarized in Table 5-1 (aqueous) and Table 5-2 (solid). The laboratory tracking system is designed to ensure that holding times are not exceeded.

#### 5.1.4 Sample Documentation

This section describes the sample documentation and sample transfer procedures which will be used during the WRF RI/FS.

## TABLE 5-1
## SAMPLE PRESERVATION, BOTTLE REQUIREMENTS, AND HOLDING TIMES FOR AQUEOUS SAMPLES

| Analyte | Bottle Requirement and Volume | Required Headspace | Preservative | Holding Time |
|---|---|---|---|---|
| TCL volatile organic compounds | 3 X 40-mL amber glass vials with Teflon-lined septum | 0% | HCl to pH ≤ 2<br>Cool to 4±2°C | 14 days to analysis |
| TCL semivolatile compounds | 2 X 1-L amber glass bottles, Teflon-lined cap | 10% | Cool to 4±2°C | 7 days to extraction (40 days after extraction) |
| Polynuclear aromatic hydrocarbons | 1 X 1-L amber glass bottles, Teflon-lined cap | 10% | Cool to 4±2°C | 7 days to extraction (40 days after extraction) |
| TCL pesticides/ PCBs | 2 X 1-L amber glass bottles, Teflon-lined cap | 10% | Cool to 4±2°C | 7 days to extraction (40 days after extraction) |
| Polychlorinated terphenyls | 2 X 1-L amber glass bottles, Teflon-lined cap | 10% | Cool to 4±2°C | 7 days to extraction (40 days after extraction)[a] |
| TAL metals | 1 X 1-L polyethylene | 10% | $HNO_3$ to pH ≤ 2,<br>Cool to 4±2°C | 6 months, except Mercury (28 days) |
| Total petroleum hydrocarbons | 2 X 250-mL amber glass, Teflon-lined cap | 0% | $H_2SO_4$ to pH ≤ 2<br>Cool to 4±2°C | 28 days |

a No requirements defined under Appendix F of ER 1110-1-263. Requirements for PCBs will be employed based on chemical similarities.

## TABLE 5-2
## SAMPLE PRESERVATION, BOTTLE REQUIREMENTS, AND HOLDING TIMES FOR SOLID SAMPLES

| Analyte | Bottle Requirement-Volume | Preservative | Holding Time |
|---|---|---|---|
| TCL volatile organic compounds | 2 X 40-mL glass Teflon septa vial | Cool to 4±2°C | 14 days |
| TCL semivolatile organic compounds | 1 X 8-oz glass, Teflon-lined cap | Cool to 4±2°C | 7 days to extraction (40 days to analysis) |
| Polynuclear aromatic hydrocarbons | 1 X 8-oz glass, Teflon-lined cap | Cool to 4±2°C | 7 days to extraction (40 days to analysis) |
| TCL pesticides/PCBs | 1 X 8-oz glass, Teflon-lined cap | Cool to 4±2°C | 7 days to extraction (40 days to analysis) |
| Polychlorinated terphenyls | 1 X 8-oz glass, Teflon-lined cap | Cool to 4±2°C | 7 days to extraction (40 days to analysis) |
| TAL metals | 1 X 8-oz glass, Teflon-lined cap | Cool to 4±2°C | 6 months, except Mercury (28 days) |
| Total petroleum hydrocarbons | 1 X 8-oz glass, Teflon-lined cap | Cool to 4±2°C | 28 days |

**TABLE 5-3**
**SAMPLE PRESERVATION, BOTTLE REQUIREMENTS, AND HOLDING TIMES FOR PHYSICAL SAMPLES**

| Analyte | Bottle Requirement* | Preservative | Holding Time |
|---|---|---|---|
| Percent moisture | 1-L mason jar | none | none |
| Atterberg limits | 1-L mason jar | none | none |
| USCS classification | 1-L mason jar | none | none |
| Grain size | 1-L mason jar | none | none |
| Total organic carbon | 1-L mason jar | none | 28 days |

* All analyses can be performed from one 1-L sample volume.

**5.1.4.1 Field Logbook**. Information pertinent to the sampling effort will be recorded in a log book or equivalent standardized form. Each page/form will be consecutively numbered. Entries will be made in indelible ink, and corrections will consist of line-out deletions that are initialed and dated. At a minimum, entries in a field logbook will include the following:

- Time and date of sample collection;
- Unique sequential field sample number;
- Identification of sampler and operation manager;
- Type of sample (e.g., groundwater, effluent, or filter cake);
- Requested analytes;
- Sampling methodology, including distinction between grab and composite sample;
- Sample preservation;
- QA/QC samples associated with this sample;
- Sample shipment (e.g., name of the laboratory and cartage agent, i.e., Federal Express, United Parcel Service, etc.);
- Any field measurements made (e.g., pH, conductivity, and temperature); and
- Signature and date by the personnel responsible for observations.

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a logbook. However, records should contain sufficient information so the sampling activity can be reconstructed without relying on the collector's memory.

**5.1.4.2 Field Parameter Form**. Information pertinent to the sampling effort will be recorded in a bound logbook and Field Parameter Form (FPF). Each page/form will be consecutively numbered. Entries will be made in indelible ink and corrections will consist of line-out deletions that are initialed and dated. Figure 5-1 is an example of a FPF. At a minimum, entries in the field logbook will include the following:

- Installation/site and area;
- Installation code;
- File name;
- Site type;
- Site ID;
- Field sample number;
- Date/Time (military format);
- Sample Program;
- Depth of sample collected/depth interval/units;
- Sample method (IRDMIS Code);
- Field measurements and calibration reference;
- Requested analytes;
- Sample container/number of containers;
- Laboratory ID; and
- Preservation information.

**5.1.4.3 Sample Labelling**. Each sample will be assigned a unique sequential number at the time of sampling, which will be permanently affixed to the sample container with polyethylene tape to prevent the loss of the label during shipment. Figure 5-2 illustrates an example of a sample label. The sample label will be filled out using indelible ink and will include the following information:

- Project name;
- Project number;
- Sample location/site ID;
- Sampling date and time;
- Analyses to be performed;
- Preservative; and
- Sampler

**FIGURE 5-1**
**FIELD PARAMETER FORM**

ICF KAISER ENGINEERS

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FIELD PARAMETER/LOGBOOK FORM
SOIL AND SEDIMENT SAMPLES

HIGH CONCENTRATION EXPECTED? _____ HIGH HAZARD? _____

INSTALLATION SITE _____ AREA _____

INST CODE _____ FILE NAME _____ SITE TYPE _____

SITE ID _____ FIELD SAMPLE NUMBER _____

DATE (MM DD YY) _____ _____ _____ TIME _____ AM PM SAMPL. PROG. _____

DEPTH (TOP) _____ DEPTH INTERVAL _____ UNITS _____

SAMPLE METHOD

SPLIT SPOON _____ AUGER _____ SHELBY TUBE _____ SCOOP _____ OTHER _____

| CHK | ANALYSIS | SAMPLE CONTAINER | NO. | REMARKS |
|---|---|---|---|---|
| | | | | |
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| | | | | |
| | | | | |

TOTAL NUMBER OF CONTAINERS FOR SAMPLE _____

WEATHER TEMPERATURE _____ SAMPLER _____

After the sample has been collected, the lid will be screwed on tightly and secured with strapping tape (except VOC vials).

PROJECT NAME _____ PROJECT NUM. _____

SAMPLE LOCATION/SITE ID _____

DATE: ___/___/___ TIME: ____:____

ANALYTES: VOC SVOC P/P METALS TPH PCTs PAHs

FILTERED: [NO] [YES]

PRESERVATIVE: [HCl] [$HNO_3$] [NaOH] [$H_2SO_4$]

SAMPLER: _____

**FIGURE 5-2**
**SAMPLE LABEL**

## 5.2 SAMPLE COLLECTION

Detailed procedures for the collection of samples are provided as SOPs in Appendix A and are summarized in the Work Plan, included with this submittal, and thus will not be discussed further in this document. Collection of samples will follow standard USEPA and USAEC protocols. This section discusses the collection of quality control samples.

### 5.2.1 Field Quality Control Samples

Field operations performed during the RI/FS at WRF will include the collection of several types of quality control samples. These samples will include duplicates, split samples, rinse blanks/equipment blanks, trip blanks, and source water samples for gross decontamination water.

**5.2.1.1 Duplicate Samples**. Duplicate samples will be collected from areas which are known or suspected to be contaminated and will consist of 10% of field samples per matrix. Fractions for the same analytical parameters will always be collected consecutively. Volatile fractions for soil will not be homogenized before collection; however, they will be collected consecutively. The field duplicate samples will be sent to the contract laboratory as separately identified.

**5.2.1.2 Rinse Blanks**. Rinse blanks will be collected when the sampling equipment is decontaminated and reused in the field or when a sample collection vessel (bailer or beaker) will be used. Rinse blanks will be collected at a frequency of 1 per 20 samples per matrix per equipment type or 1 per day per matrix per equipment type, whichever results in fewer QC samples. A consistent volume of rinse water (demonstrated analyte free) will be poured over the equipment (i.e., rinsing the equipment) and collected in a sample container. The rinse blank determines whether the decontamination procedure has been adequately performed and that there is no cross-contamination of samples occurring due to the equipment itself. Analysis of rinse blanks will be for analytes of interest.

**5.2.1.3 Field Blanks**. Field blanks are analyte-free (deionized) water which is transferred to the appropriate sample containers in the field, and submitted for analysis. These samples are used to assess the potential incidental contamination of aqueous samples due to the field operations (exposure to air) and/or contamination due to the sample container. Field blanks will be collected when surface water or groundwater volatiles fractions are collected and at a frequency of 1 per matrix per day.

**5.2.1.4 Trip Blanks**. Trip blanks will be provided by the contract laboratory and will consist of demonstrated analyte-free water in 40-mL teflon-lined septum vials. The trip blank is used to determine if any on-site atmospheric contaminants are seeping into the sample vials, or if any cross-contamination of samples is occurring during shipment or storage of sample containers. The trip blanks will accompany the aqueous samples for VOC analysis to the laboratory and one trip blank will be included for each cooler of samples for VOC analysis. At no time, prior to analysis, will the trip blank be opened.

**5.2.1.5 Source Water**. Prior to commencement of field activities, one sample will be collected from the fire hydrant at WRF and analyzed for target analytes. Results of this sample will be forwarded to the USAEC for approval for use as a gross decontamination water source. If required by the USAEC project Chemist, the source water will be treated prior to use.

## 5.3 SAMPLE CUSTODY

Evidence of sample custody shall be traceable from the time the cleaned sample containers leave the laboratory until the filled sample containers are transmitted back to the laboratory. To achieve this condition, custody seals and chain-of-custody documentation will accompany sample containers.

### 5.3.1 Chain of Custody

Chain of Custody (COC) forms will accompany sample containers in the field, during transit to the off-site laboratory, and upon receipt by the laboratory. Figure 5-3 is an example of a COC form which may be used. The COC form will be a carbonless duplicate model. The top original will be given to the laboratory sample custodian when samples are submitted to the laboratory. A copy will be retained by the sampler for a record of the sampling event. COC procedures are in accordance with procedures stipulated in USAEC Guidelines.

The COC will be filled out using indelible ink and will include the following information:

- Project name and number;
- The signatures of the sampling personnel;
- The site code and sample number;
- Sampling dates, locations, and sampling times (military format);
- List of the chemical analysis, container volume, and any preservatives used;
- Type of sample, whether "grab" or "composite", indicated by an "X" in the appropriate column;
- The total number of containers per location;
- The custody seal number;
- Sample relinquisher, date and time; and
- Courier, or carrier airbill number, and the destination of the samples (i.e., off-site analytical laboratory).

### 5.3.2 Sample Packaging and Shipment

Samples will be transferred to the contract laboratory for analysis via waterproof plastic coolers. Before samples can be put in the cooler, any drains must be sealed with tape to prevent leaking. Each cooler will be packed in the following manner:

- Ensure sample lids are tight. For bottles other than VOC vials.
- Place about 3 inches of inert cushioning material such as vermiculite in bottom of the cooler.
- Wrap environmental samples and associated QC samples in bubble wrap and place in a water-tight plastic bag.
- Fill cooler with enough packing material to prevent breakage of glass bottles.
- Place sufficient ice in cooler to maintain the internal temperature at 4±2°C during transport. The ice will be double-bagged to prevent contact of the melt water with the samples. If chemical ice is used, it should also be placed in a plastic bag;
- Place associated COCs in a water proof plastic bag, and tape it with masking tape to the inside lid of the cooler;
- Seal coolers at a minimum of two locations with signed custody seals or evidence tape before being transferred off site. Attach completed shipping label to top of the cooler. Place "This Side Up" labels

| Proj. no. | Site Name | | | | Num. of Con-tain-ers | Analytical Fractions | | | | | | | | | LAB : |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Samplers: | | | | | | | | | | | | | | | AIRBILL No: |
| | | | | | | | | | | | | | | | Courier: |
| Date | Time | Comp | Grab | Field Sample No. | | | | | | | | | | | REMARKS |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | |
| | | | | TOTAL | | | | | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Relinquished by: | Date/ time | Received by: | Relinquished by: | Date/ Time | Received by: |
| Relinquished by: | Date/ time | Received by: (for lab) | Date/Time | Remarks | |

**FIGURE 5-3**
**CHAIN OF CUSTODY FORM**

on all four sides and "Fragile" labels on at least two sides. Cover seals with wide, clear tape and continue around the cooler.

Sample coolers will be shipped to arrive at the laboratory the morning after sampling (priority overnight) or will be sent by a courier to arrive the same day. The laboratory will be notified of the sample shipment and the estimated date of arrival of the samples being delivered.

## 5.4 SAMPLE RECEIPT

Samples delivered to the lab will be accepted by the laboratory technician. Samples can be accepted Monday through Friday. Special arrangements will be required if Saturday delivery is necessary. Chain of Custody for laboratory receipt will be established in the following manner:

1. The carrier and the time of arrival is documented in the daily receipt log. The number of items on the COC is compared to the actual number received to ensure that all samples arrived.

2. Notation is made as to whether the shipping container (cooler) was sealed with custody seals.

3. The cooler is opened, the internal ambient temperature of the cooler taken, and the samples are itemized. Deviations are noted and reported to the laboratory QA Coordinator. If cooler temperature is not between 2° and 6°C, then the USAEC Project Chemist and ICF KE QA Manager must be notified immediately.

4. Lot numbers will be assigned to the samples. Reference to field numbers will be documented in the appropriate logbook. Data are entered into the computer tracking system, with analyses required by holding-time specified dates.

### 5.4.1 Laboratory Receipt

Once the sample has been transmitted to the laboratory, the following sequence of events will occur:

1. The samples are recorded on the Sample Log-In Form to summarize the information pertaining to the sample/order to instruct the laboratory on the proper analysis and reporting of samples.

2. After the samples are logged in, they are assigned to the appropriate locked storage refrigerator.

3. All transfers of samples into and out of storage are documented.

4. Samples remain in secured storage until removed for sample preparation or analysis.

5. A refrigeration log must be generated by laboratory personnel to ensure refrigerators/freezers are operating at the appropriate temperature. The log must indicate the ambient internal temperature as well as the initials of the person recording the reading and the date. Should the temperature fluctuate outside of the specified holding time temperature range, corrective action must be taken. Corrective action must include notification of the USAEC Project Chemist and the ICF KE QA Manager.

## 6.0 ANALYTICAL PROCEDURES

In this section, sample management, holding times, preparation, instrument calibration, analytical procedures, and data management procedures are discussed.

## 6.1 LABORATORY ANALYTICAL PROCEDURES

USEPA SW-846 methods performance demonstrated in accordance with USAEC Guidelines will be used for the analysis of samples to include the USEPA TCL VOCs, SVOCs, pesticides/PCBs, PAHs (as a subset of the SVOC analyte list), PCTs, and TPH as summarized in Table 6-1. Modifications of standard methods are defined in the following sections with the method description. American Society for Testing and Materials (ASTM) methods will be used for the physical analyses of soils. Listings of analytes defined by parameter are provided in Tables 6-2 through 6-8 and physical parameters are listed in Table 6-9. This section briefly describes the analytical methodologies to be used in the WRF RI/FS.

### 6.1.1 Methods for the Analysis of Abiotic Samples

**6.1.1.1 Metals Analysis**. Samples will be analyzed for total USEPA TAL metals using USEPA SW-846 Method 6010 performance demonstrated in accordance with USAEC Guidelines (USEPA 1986). The metal constituents will be analyzed using one of the following methodologies: (1) mercury: cold vapor atomic absorption (CVAA); (2) arsenic (As), antimony (Sb), cadmium (Cd), lead (Pb), thallium (Tl) in aqueous samples and beryllium (Be) in solid samples: inductively coupled argon emission plasma spectroscopy (ICP), coupled with Mass Spectroscopy (MS); (3) Sb in solid samples: Graphite Furnace Atomic Absorption (GFAA); (4) remaining metals in aqueous and solid samples: ICP (alone).

The ICP method involves the simultaneous or sequential multi-element determination of trace elements in solution. The basis of the method is the measurement of atomic emission by optical spectrometry. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer and the intensities of the line are monitored by photomultiplier tubes. The photocurrents from the photomultiplier tubes are processed and controlled by a computer system. A background correction technique is utilized to compensate for variable background contribution to the determination of trace elements. Background is measured adjacent to analyte lines on samples during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used will be free of spectral interference and will reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction will not be required in cases of line broadening where a background correction measurement would actually degrade the analytical result. Interferences will also be recognized and appropriate corrections made.

In order to achieve reporting limits lower than those provided by the ICP for As, Sb, Cd, Pb, and Tl (aqueous) and Be (solid) to meet the Levels of Concern, the ICP will be coupled with a Mass Spectrometer for analysis of aqueous samples. The ICP-MS method utilizes an ICP, water cooled interface, quadrupole mass spectrometer (QMS), channel electron multiplier (CEM) and computerized data reduction for analysis. Samples will be aspirated into in ICP ionization source. The ions entrained in the plasma are drawn into the QMS via the interface and filtered according to their mass to charge ratio (m/z). The filtered ion output from the quadrupole is detected by the CEM and measured as ion counts per second. Quantitative results are obtained by concurrent measurement of calibration standards of known concentration and isotopic ratio.

In order to obtain reporting limits lower than those provided by the ICP method, solid samples will be analyzed for Be and Sb using GFAA, USEPA SW-846 Method 7091 and 7041, respectively (USEPA 1986). GFAA involves the digestion of a representative sample using nitric acid and hydrogen peroxide. The digestate is subsequently analyzed by GFAA using the optimum instrumental conditions for the analytes

## TABLE 6-1
## SUMMARY OF CHEMICAL AND PHYSICAL ANALYTICAL METHODS

| Parameter/Analytes | | Matrix | USAEC Performance Demonstrated Method | Reference USEPA Method |
|---|---|---|---|---|
| TCL volatile organic compounds | | Soil | USAEC VMS12-S: GC/MS | USEPA SW-846 M8240 |
| | | Aqueous | USAEC VMS12-W: GC/MS | USEPA SW-846 M8240 |
| TCL semivolatile organic compounds | | Soil | USAEC SMV1-S: GC/MS | USEPA SW-846 M8270 |
| | | Aqueous | USAEC SMV1-W: GC/MS | USEPA SW-846 M8270 |
| Polynuclear aromatic hydrocarbons | | Soil | USAEC PAH1-SO: HPLC | USEPA SW-846 M8310 |
| | | Aqueous | USAEC PAH1-WA: HPLC | USEPA SW-846 M8310 |
| TCL pesticides/PCBs | | Soil | USAEC PST1-S: GC/ECD | USEPA SW-846 M8080 |
| | | Aqueous | USAEC PST1-W: GC/ECD | USEPA SW-846 M8080 |
| Polychlorinated terphenyls | | Soil | USAEC PCT1-SO: GC/ECD | Hale, *et. al.* |
| | | Aqueous | USAEC PCT1-WA: GC/ECD | Hale, *et. al.* |
| Metals | TAL Metals | Soil | USAEC ICP1-SO: ICP | USEPA SW-846 M6010 |
| | | Aqueous | USAEC ICP1-WA: ICP | USEPA SW-846 M6010 |
| | Arsenic | Soil | USAEC ICP1-SO: ICP | USEPA SW-846 M6010 |
| | | Aqueous | USAEC ICPMS-WA: ICP/MS | USEPA SW-846 M6020 |
| | Antimony | Soil | USAEC GSB1-SO: GFAA | USEPA SW-846 M7041 |
| | | Aqueous | USAEC ICPMS-WA: ICP/MS | USEPA SW-846 M6020 |
| | Beryllium | Soil | USAEC ICPMS-SO: ICP/MS | USEPA SW-846 M6020 |
| | | Aqueous | USAEC ICPMS-WA: ICP/MS | USEPA SW-846 M6020 |
| | Cadmium | Soil | USAEC ICP1-SO: ICP | USEPA SW-846 M6010 |
| | | Aqueous | USAEC ICPMS-WA: ICP/MS | USEPA SW-846 M6020 |
| | Lead | Soil | USAEC ICP1-SO: ICP | USEPA SW-846 M6010 |
| | | Aqueous | USAEC ICPMS-WA: ICP/MS | USEPA SW-846 M6020 |
| | Mercury | Soil | USAEC HGC1-SOIL: CVAA | USEPA SW-846 M7471 |
| | | Aqueous | USAEC HGC1-WATER: CVAA | USEPA SW-846 M7470 |
| | Thallium | Soil | USAEC ICP1-SO: ICP | USEPA SW-846 M6010 |
| | | Aqueous | USAEC ICPMS-WA: ICP/MS | USEPA SW-846 M6020 |
| Total petroleum hydrocarbons | | Soil | USAEC TPH1-SO: GC | USEPA SW-846 M8015 |
| | | Aqueous | USAEC TPH1-WA: GC | USEPA SW-846 M8015 |
| Total organic content | | Soil/sediment | ASTM Method D-2974-87 | NOT APPLICABLE |
| Percent moisture | | Soil/sediment | ASTM Method D-2216-80 | NOT APPLICABLE |
| Atterberg limits | | Soil | ASTM Method D4318-84 | NOT APPLICABLE |
| USCS classification | | Soil | ASTM Method D2487-85 | NOT APPLICABLE |
| Grain Size | | Soil/sediment | ASTM Method D442-63 | NOT APPLICABLE |

**TABLE 6-1 (continued)**
**SUMMARY OF CHEMICAL AND PHYSICAL ANALYTICAL METHODS**

Legend:

| | |
|---|---|
| SW-846: | *Test Methods for Evaluating Solid Waste*, USEPA SW-846, Third Edition, September 1986 with all current revisions. |
| ASTM | American Society for Testing and Materials |
| CVAA | Cold Vapor and Atomic Adsorption Spectroscopy |
| GC/ECD | Gas Chromatography and Electron Capture Detector |
| GC/FPD | Gas Chromatography with Flame Photometric Detection |
| GC/MS | Gas Chromatography/Mass Spectroscopy |
| GFAA | Graphite Furnace Atomic Adsorption Spectroscopy |
| ICP | Inductively Coupled Argon Plasma Spectroscopy |
| ICP/MS | Inductively Coupled Plasma Mass Spectrometer |
| USAEC Method | USEPA SW-846 Method performance demonstrated in accordance with USAEC Guidelines. |

## TABLE 6-2
## TCL VOLATILE ORGANIC COMPOUNDS ANALYTE LIST

| |
|---|
| Acetone |
| Benzene |
| Bromodichloromethane |
| Bromoform |
| Bromomethane |
| 2-Butanone |
| Carbon disulfide |
| Carbon tetrachloride |
| Chlorobenzene |
| Chloroethane |
| Chloroform |
| Chloromethane |
| Dibromochloromethane |
| 1,1-Dichloroethane |
| 1,2-Dichloroethane |
| 1,1-Dichloroethene |
| 1,2-Dichloroethene (total) |
| 1,2-Dichloropropane |
| cis-1,3-Dichloropropene |
| trans-1,3-Dichloropropene |
| Ethylbenzene |
| 2-Hexanone |
| 4-Methyl-2-pentanone |
| Methylene chloride |
| Styrene |
| 1,1,2,2-Tetrachloroethane |
| Tetrachloroethene |
| Toluene |
| 1,1,1-Trichloroethane |
| 1,1,2-Trichloroethane |
| Trichloroethene |
| Vinyl chloride |
| Xylenes (total) |

## TABLE 6-3
## TCL SEMIVOLATILE ORGANIC COMPOUNDS ANALYTE LIST

1,2-Dichlorobenzene
1,2,4-Trichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2-Chloronaphthalene
2-Chlorophenol
2-Methylnaphthalene
2-Methylphenol
2-Nitroaniline
2-Nitrophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,6-Dinitrotoluene
3-Nitroaniline
3,3'-Dichlorobenzidine
4-Bromophenyl-phenylether
4-Chloro-3-methylphenol
4-Chloroaniline
4-Chlorophenyl-phenylether
4-Methylphenol
4-Nitroaniline
4-Nitrophenol
4,6-Dinitro-2-methylphenol
Acenaphthylene
Acenaphthene
Anthracene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
bis(2-Chloroethoxy)methane
bis(2-Chloroethyl)ether
bis(2-Chloroisopropyl)ether
bis(2-ethylhexyl)phthalate
Butyl benzyl phthalate
Carbazole
Chrysene
Di-n-butylphthalate
Di-n-octylphthalate
Dibenz(a,h)anthracene
Dibenzofuran
Diethylphthalate
Dimethylphthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
N-Nitroso-di-n-propylamine
N-Nitrosodiphenylamine
Naphthalene
Nitrobenzene
Pentachlorophenol
Phenanthrene
Phenol
Pyrene

## TABLE 6-4
## POLYNUCLEAR AROMATIC HYDROCARBON ANALYTE LIST[1]

| |
|---|
| Acenaphthene |
| Acenaphthylene |
| Anthracene |
| Benzo(a)anthracene |
| Benzo(a)pyrene |
| Benzo(b)fluoranthene |
| Benzo(ghi)perylene |
| Benzo(k)fluoranthene |
| Chrysene |
| Dibenzo(a,h)anthracene |
| Fluoranthene |
| Fluorene |
| Indeno(1,2,3-cd)pyrene |
| Naphthalene |
| Phenanthrene |
| Pyrene |

1 This analyte list is a subset of the TCL SVOC analyte list. These analytes will be analyzed in addition to TCL SVOCs by USEPA Method 8310, performance demonstrated in accordance with USAEC guidelines, in order to meet WRF RI/FS ARARs.

**TABLE 6-5**
**TCL PESTICIDES/PCBs ANALYTE LIST**

| |
|---|
| Aldrin |
| alpha-BHC |
| beta-BHC |
| delta-BHC |
| gamma-BHC (Lindane) |
| Chlordane |
| Dieldrin |
| 4,4'-DDD |
| 4,4'-DDE |
| 4,4'-DDT |
| Endosulfan I |
| Endosulfan II |
| Endosulfan sulfate |
| Endrin |
| Endrin Ketone |
| Heptachlor |
| Heptachlor epoxide |
| Methoxychlor |
| Toxaphene |
| AROCLOR-1016 |
| AROCLOR-1221 |
| AROCLOR-1232 |
| AROCLOR-1242 |
| AROCLOR-1248 |
| AROCLOR-1254 |
| AROCLOR-1260 |

**TABLE 6-6**
**POLYCHLORINATED TERPHENYLS ANALYTE LIST**

| |
|---|
| AROCLOR-5432 |
| AROCLOR-5442 |
| AROCLOR-5460 |

**TABLE 6-7**
**TAL METALS ANALYTE LIST**

| |
|---|
| Aluminum |
| Antimony |
| Arsenic |
| Barium |
| Beryllium |
| Cadmium |
| Calcium |
| Chromium |
| Copper |
| Iron |
| Lead |
| Magnesium |
| Manganese |
| Mercury |
| Nickel |
| Potassium |
| Selenium |
| Silver |
| Sodium |
| Thallium |
| Vanadium |
| Zinc |

**TABLE 6-8**
**TOTAL PETROLEUM HYDROCARBON ANALYTE LIST**

| |
|---|
| Gas |
| Diesel (including JP-4) |

of interest. This method will be performance demonstrated in accordance with USAEC Guidelines. Until the performance demonstration is complete, reporting limits based on ESE's USEPA SW-846 Reporting Limits will be included for reference.

In order to obtain reporting limits lower than those provided by the ICP method, mercury will be analyzed using CVAA under USEPA SW-846 Methods 7471 (solid) and 7470 (aqueous) performance demonstrated in accordance with USAEC Guidelines (USEPA 1986). CVAA analysis is based on the absorption of radiation at 253.7 nm. A sample aliquot is initially digested with nitric acid to free any combined mercury. The mercury is then reduced to its elemental state and aerated from the solution into a closed system. The mercury vapor is passed through a cell positioned in the path of a mercury light source and the measured absorbance is proportional to the concentration of mercury in the sample.

**6.1.1.2 Volatile Organic Compound Analysis**. TCL VOCs will be analyzed using USEPA SW-846 Method 8260, performance demonstrated in accordance with USAEC Guidelines (USEPA 1986). In analyzing for volatile organic compounds, the extract is screened on a gas chromatograph/flame ionization detector (GC/FID) to determine the approximate concentration of organic constituents in the sample. For analysis in soil, an inert gas is bubbled through a mixture of reagent water and soil sample contained in a specifically designed purging chamber that is held at 40°C. The purgeables are efficiently transferred through a sorbent column where they are trapped. For analysis of aqueous samples, an inert gas is bubbled through a 5 mL sample contained in a specifically designed purging chamber at ambient temperature. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed for both soil and aqueous samples, the sorbent column is heated and backflushed with the inert gas to desorb the purgeables onto a gas programmed to separate the purgeables which are then detected with a mass spectrometer (MS). Tuning and calibration procedures will follow guidelines specified in USEPA CLP OLM01.8 (USEPA 1991)

**6.1.1.3 Semivolatile Organic Compound Analysis**. TCL SVOCs will be analyzed using USEPA SW-846 Method 8270, performance demonstrated in accordance with USAEC Guidelines (USEPA 1986). Solid samples are prepared for analysis by SW-846 Method 3540, Soxhlet extraction (USEPA 1986). The solid sample is mixed with anhydrous sodium sulfate, placed between two plugs of glass wool, and extracted using methylene chloride in a Soxhlet extractor. The extract is then dried through anhydrous $Na_2SO_4$ and concentrated. Waste samples arriving will be extracted as a solid sample. Non-aqueous (oil based) waste samples will be diluted and analyzed by direct injection.

Aqueous samples are prepared for analysis by SW-846 Method 3520 - Continuous liquid/liquid extraction (USEPA 1986). One liter of water is extracted for 18-24 hours with methylene chloride at an acid pH (pH < 2.0), the pH is then adjusted to pH > 11.0 and extracted for an additional 18-24 hours.

The analysis procedure follows SW-846 Method 8270 with one minor exception. In accordance with USAEC Guidelines, the tuning requirements and criteria from the USEPA CLP Statement of Work for Organic Analysis, Document Number OLM01.8 are enforced rather that USEPA SW-846 requirements (USEPA 1991).

***Polynuclear Aromatic Hydrocarbons***-In order to meet WRF RI/FS LOCs, groundwater, surface water, surface soil, and sediment samples will be analyzed for PAHs using USEPA SW-846 Method 8310 (USEPA, 1986), performance demonstrated in accordance with USAEC Guidelines. This method uses high performance liquid chromatography (HPLC) for the detection of part per billion (ppb) levels of PAHs. Method 8310 involves the extraction of 15 grams of a solid sample or 1 liter of an aqueous sample using methylene chloride. The extract from the solid or aqueous sample is dried by filtration through anhydrous sodium sulfate, concentrated by Kuderna-Danish apparatus, and solvent exchanged to acetonitrile. The extract is then brought to a final volume of 5.0-mL with acetonitrile and analyzed by HPLC with fluorescence and ultraviolet (UV) detection.

**6.1.1.4 Pesticides/PCBs Analysis**. Samples will be analyzed for pesticides and PCBs using USEPA SW-846 Method 8080 performance demonstrated in accordance with USAEC Guidelines (USEPA 1986). For solid samples, a 15 g sample is continually extracted with methylene chloride using a Soxhlet extractor. For aqueous samples, a measured volume of sample (1000 mL is continuously extracted with methylene chloride using a continuous liquid-liquid extractor). In both cases, the methylene chloride is exchanged for hexane, then concentrated to a final volume of 10 mL for soil and 5 mL for aqueous samples. The extract is then analyzed using a Gas Chromatograph equipped with Electron Capture Detector. Chromatographic conditions are described which permit the separation and measurement of the analytes in the hexane extract. Identification is performed using retention times, and quantitation is performed using external standard curves.

**6.1.1.5 Polychlorinated Terphenyls Analysis**. Samples will be analyzed for PCTs by a method based on the article "Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment", Environmental Science and Technology, Vol. 24, No. 11, 1990. This method has been modified to incorporate quantitation by Mass Spectrometry (MS) and will be performance demonstrated in accordance with USAEC Guidelines.

**6.1.1.6 Total Petroleum Hydrocarbon Analysis**. Samples will be analyzed for TPH using USEPA SW-846 Method 8015, performance demonstrated in accordance with USAEC Guidelines (USEPA 1986). For solid samples, a measured volume of sample (10g) is extracted with 10 mL of carbon disulfide by tumbling the extraction bottle for 1 hour. In aqueous samples, 100 mL of sample are extracted with 5 mL of carbon disulfide by tumbling the extraction bottle for 1 hour. The carbon disulfide extract is then analyzed by gas chromatography with flame ionization detection. Chromatographic conditions are described with flame ionization detection. Chromatographic conditions are described which permit the separation and measurement of the analytes in the carbon disulfide ($CS_2$) extract. Identification is performed using pattern recognition and retention envelopes. Quantitation is performed using external standard curves.

### 6.1.2 Methods for the Chemical Analysis of Biotic Samples

Methods used for the chemical analysis of tissue samples have been modified from standardized methods used to analyze solid matrices. Modifications include initial preparation of samples and additional cleanup steps to eliminate matrix interferences.

**6.1.2.1 Initial Laboratory Preparation of Samples**. The samples will be received by the laboratory and logged in to the sample tracking system. Biological tissue samples will be securely stored in a freezer at -20°F from the time of receipt through final analysis.

To prepare the biological organism, tissue, or organ sample for analysis of organics compounds, the sample will be unwrapped and weighed. The samples will be chopped into three-centimeter chunks using a scalpel or sharp knife and mallet. Crushed or pelleted dry ice will be ground in a micro-grinder to pre-cool the grinder. Tissue samples will then be homogenized to a uniform consistency. Samples for non-volatile analyses will be ground and thoroughly mixed two more times. The grinder will be cleaned of any remaining material, which will be added to the ground sample. The sample will be transferred to a an appropriately solvent-cleaned glass jar with aluminum or teflon lined plastic lid, and stored in a freezer at -20°F for later sub-sampling and analysis.

An aliquot of the ground biological sample, as prepared above in a micro-grinder, may be used for the analysis of inorganics. However, the stainless steel grinder may be a possible source of nickel and chromium contamination. Therefore, samples will be prepared for analysis of metals using a blender equipped with a tantalum blade or other equipment that has been proven contaminant-free. A fish that weighs between 50 g and 300 g will be chopped with a meat cleaver or knife and mallet and placed into a blender that has been pre-cooled with dry ice. The sample will be blended with dry ice until homogenous, and will be stored in a loosely sealed plastic bag (to allow carbon dioxide to escape) and frozen for at least 16 hours before digestion.

**6.1.2.2 TAL Metals Analyses**. Lead and mercury in biotic tissues will be analyzed using USEPA SW-846 method for ICP.

Lead and Mercury. Samples prepared for the analysis of lead and mercury will undergo wet digestion procedures. A 5 g aliquot of the homogenized tissue is mixed with concentrated nitric acid for 15 hours and then gently heated in increasing increments to a maximum of 250°C. The sample is digested until tissue has been solubilized. The sample is then oxidized with perchloric acid over heat until the solution is clear. Analysis for arsenic, lead, and selenium require the addition of a matrix modifier during the digestion procedure.

The ICP method will be used for lead and mercury analysis. Samples will be analyzed in accordance with USEPA SW-846 Method 6010.

**6.1.2.3 Organic Chemical Analyses**. Clean-up of biological tissues for analysis of organic chemicals includes column chromatography methods. For organisms, tissue, and organ samples, the first step in the clean-up is gel-permeation chromatography (GPC), which is used for removal of lipids. Clean-up for analysis of other organic compounds may include additional methods such as florisil, silica gel, or alumina column chromatography for removal of polar biogenic compounds.

The organic constituents will be analyzed by gas chromatography/mass spectroscopy (GC/MS), gas chromatography-electron capture detector (GC-ECD), high pressure liquid chromatography (HPLC), or ion chromatography (IC).

TCL Polynuclear Aromatic Hydrocarbon Analysis. Analysis of TCL semivolatile organic compounds in biological samples will be analyzed by GC/MS. A homogenized tissue sample undergoes Soxhlet extraction with sodium sulfate, methanol and dichloromethane for 24 hours. After Soxhlet extraction, the sample undergoes liquid-liquid aqueous extractions in order to remove water and methanol, and to enhance the partitioning of organic compounds. The extract is dried over sodium sulfate, concentrated, and loaded onto a calibrated GPC column for removal of biological macromolecules such as lipids. The collected extract is then analyzed with GC/MS operated in the electron impact mode.

TCL Pesticides/PCBs Analysis. Samples for TCL pesticides/PCBs analyses will undergo the same extraction procedures used for analysis of semivolatile compounds. In addition, the sample will undergo cleaned-up using Gel Permeation Chromatography. The collected extract is then analyzed with GC/ECD in accordance with USEPA SW-846 Method 8080.

Polychlorinated Terphenyl Analysis. Samples for PCTs analysis will undergo the same extraction procedures used for analysis of semivolatile compounds. In addition, the sample will undergo clean-up using GPC. The collected extract is then analyzed in accordance with the method developed based on Hale *et. al* 1990.

**6.1.2.4 Other Analyses**.

Lipid Content. Percent lipids in biological tissues will be analyzed by first extracting a homogenized tissue sample in a Soxhlet extractor with methanol and dichloromethane. The extract is then dried over sodium sulfate, concentrated, and loaded onto a calibrated GPC column. Biological macromolecules elute in the dump phase, or first 100 mL of eluate. This fraction is first dried under nitrogen and then later air dried on an aluminum planchet. Lipid content is determined gravimetrically.

Dry Weight Determination. A homogenized tissue sample is dried in a pre-weighed drying dish overnight. The solid residue is weighed to determine the dry weight. Dry weight is determined whenever results will be reported as dry weight concentrations.

### 6.1.3 Physical Testing Methods

**TABLE 6-9**
**LIST OF PHYSICAL TESTING PARAMETERS**

| |
|---|
| USCS Classification |
| Percent Moisture |
| Total Organic Content |
| Grain Size Distribution |
| Atterberg Limits |

Soil and sediment samples will be collected and analyzed for selected physical analysis by ASTM methods. Analyses include percent moisture/percent solids, grain size distribution, total organic carbon, and Atterberg limits, and United Soil Classification System (USCS) designation, also listed in Table 6-9.

**6.1.3.1 Percent Moisture**. Percent moisture in soil will be determined using ASTM Method D-2216 (ASTM 1991a). This method involves the determination of the percent water mass in a known mass of undried soil by weighing the soil before and after drying in an oven controlled at 110°C. The water content of a material is defined as the ratio, expressed as a percentage, of the mass of "pore" or "free" water in a given mass of material to the mass of the solid material particles. Percent solids will be determined in sediment as opposed to percent moisture.

**6.1.3.2 Atterberg Limits**. Atterberg limits will be determined using ASTM Method D-4318-84 (ASTM 1991b). This method involves the determination of the plasticity index of soils. The sample is processed to remove any material retained on a 425 $\mu$m (No. 40) sieve. The liquid limit is determined by performing trials in which a portion of the sample is spread in a brass cup, divided in tow by a grooving tool, and then allowed to flow together from the shocks caused by repeatedly dropping the cup in a standard mechanical device. The plastic limit is determined by alternately pressing together and rolling into a 3.2 mm diameter thread a small portion of plastic soil until its water content is reduced to a point at which the thread crumbles and is no longer able to be pressed together and rerolled. The water content of the soil at this stage is reported as the plastic limit. The plasticity index is calculated as the difference between the liquid limit and the plastic limit.

**6.1.3.3 Grain Size**. Grain size distribution will be determined using ASTM Method D-442 (ASTM 1991c). This method covers the quantitative determination of the distribution of particle sizes in soil. A No. 200 sieve is used to separate particles larger than 75$\mu$m from the soil, while the distribution of particles smaller than 75$\mu$m is determined by a sedimentation process, using a hydrometer to secure the necessary data.

**6.1.3.4 Total Organic Content**. Total organic content (TOC) of soils will be determined using ASTM Method D-2974 (ASTM 1991d). This method involves the ignition of an oven-dried soil sample in a muffle furnace. The weight of the sample is taken before and after ignition, and the organic mass is the difference of the two masses. The organic content (a percentage) is expressed as this difference divided by the weight of the sample before ignition.

**6.1.3.5 USCS Classification**. Classification of soils will be based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index using ASTM Method D-2487 (ASTM 1991e). The system is based on the Unified Soil Classification System (USCS).

## 6.2 REPORTING LIMITS

The lowest concentration that is reported for any analyte has been established in the USAEC program from a statistical analysis of spikes and blanks. The concentration, termed the performance demonstrated reporting limit, is the lowest value that can be reported with a 90% confidence level. The method reporting limits are derived by preparing a standard matrix sample at 1 to 5 times the estimated Method Detection Limit (MDL) (based on the Required Detection Limit (RDL) and the Instrument Detection Limit (IDL)); 7 aliquots of the sample shall be processed through the entire method; the standard deviation shall be calculated from the results for the seven aliquots; the MDL is equal to the standard deviation times the Student's t value (3.143) for that number of measurements. This procedure is based upon 40 CFR Chapter 1, and upon the CLP inorganic Statement of Work.

The upper reporting limit (URL) for the range is the highest standard analyzed during the method performance demonstration. ESE's USAEC performance demonstrated reporting limits are presented in Table 6-10 through 6-16. In cases where the USAEC performance demonstrated reporting limits are being determined, the ESE USEPA SW-846 reporting limits have been referenced in order to evaluate the data quality objectives. Reporting limits for tissue samples will be based on the reporting limits for solid

## TABLE 6-10
## USAEC REPORTING LIMITS FOR TCL VOLATILE ORGANIC COMPOUNDS

| Analyte | USAEC Acronym | USAEC Reporting Limits[a] | |
|---|---|---|---|
| | | Solid-Low conc. (μg/g)[b] | Aqueous (μg/L) |
| Methylene chloride | CH2CL2 | 0.010 | 10 |
| 1,1-Dichlororethane | 11DCLE | 0.010 | 2 |
| 1,2-Dichloroethene (total) | 12DCE | 0.010 | 2 |
| 1,1-Dichloroethylene | 11DCE | 0.010 | 2 |
| Chloroform | CHCL3 | 0.010 | 2 |
| 1,2-Dichloroethane | 12DCLE | 0.010 | 2 |
| 1,1,1-Trichloroethane | 111TCE | 0.010 | 2 |
| Carbon tetrachloride | CCL4 | 0.010 | 2 |
| Trichloroethylene | TRCLE | 0.010 | 2 |
| Benzene | C6H6 | 0.010 | 2 |
| 1,1,2-Trichloroethane | 112TCE | 0.010 | 2 |
| Tetrachloroethylene | TCLEE | 0.010 | 2 |
| Toluene | MEC6H5 | 0.010 | 2 |
| Chlorobenzene | CLC6H5 | 0.010 | 2 |
| Ethylbenzene | ETC6H5 | 0.010 | 2 |
| 1,2-Dichloropropane | 12DCLP | 0.010 | 2 |
| cis-1,3-Dichloropropylene | C13DCP | 0.010 | 2 |
| Vinyl chloride | C2H3CL | 0.010 | 2 |
| Chloroethane | C2H5CL | 0.010 | 10 |
| Chloromethane | CH3CL | 0.010 | 2 |
| Bromoform | CHBR3 | 0.010 | 2 |
| Dibromochloromethane | DBRCLM | 0.010 | 2 |
| trans-1,3-Dichloropropene | T13DCP | 0.010 | 2 |
| 1,1,2,2-Tetrachloroethane | TCLEA | 0.010 | 2 |
| Bromodichloromethane | BRDCLM | 0.010 | 2 |
| Bromomethane | CH3BR | 0.010 | 2 |
| Acetone | ACET | 0.010 | 10 |
| Carbon disulfide | CS2 | 0.010 | 10 |
| 2-Butanone | MEK | 0.010 | 10 |
| 4-Methyl-2-pentanone | MIBK | 0.010 | 10 |
| Styrene | STYR | 0.010 | 2 |
| Xylene | XYLEN | 0.010 | 10 |

a Upper reporting limits are approximately 10 x the reporting limit.

b Quantitation limits listed for solids are based on wet weight. The quantitation limits calculated by the laboratory, calculated on dry weight basis as required by contract, will be higher.

## TABLE 6-11
## USAEC REPORTING LIMITS FOR TCL SEMIVOLATILE ORGANIC COMPOUNDS

| Analyte | USAEC Acronym | USAEC Reporting Limits[a] | |
|---|---|---|---|
| | | Solid (μg/g)[b] | Aqueous (μg/L) |
| Phenol | PHENOL | 0.14 | 2 |
| Bis(2-chloroethyl)ether | B2CLEE | 0.14 | 2 |
| 2-Chlorophenol | 2CLP | 0.14 | 2 |
| 1,3-Dichlorobenzene | 13DCLB | 0.14 | 2 |
| 1,4-Dichlorobenzene | 14DCLB | 0.14 | 2 |
| 1,2-Dichlorobenzene | 12DCLB | 0.14 | 2 |
| 2-Methylphenol | 2MP | 0.14 | 2 |
| Bis(2-chloroisopropyl)ether | B2CIPE | 0.14 | 2 |
| 4-Methylphenol | 4MP | 0.14 | 2 |
| N-Nitroso-di-n-propylamine | NNDNPA | 0.14 | 2 |
| Hexachloroethane | CL6ET | 0.14 | 2 |
| Nitrobenzene | NB | 0.14 | 2 |
| Isophorone | ISOPHR | 0.14 | 2 |
| 2-Nitrophenol | 2NP | 0.14 | 2 |
| 2,4-Dimethylphenol | 24DMPN | 0.14 | 2 |
| Bis(2-chloroethoxy)methane | B2CEXM | 0.14 | 2 |
| 2,4-Dichlorophenol | 24DCLP | 0.14 | 2 |
| 1,2,4-Trichlorobenzene | 124TCB | 0.14 | 2 |
| Naphthalene | NAP | 0.14 | 2 |
| 4-Chloroaniline | 4CANIL | 0.30 | 2 |
| Hexachlorobutadiene | HCBD | 0.14 | 2 |
| 4-Chloro-3-methylphenol | 4CL3C | 0.14 | 2 |
| 2-Methylnaphthalene | 2MNAP | 0.14 | 2 |
| Hexachlorocyclopentadiene | CL6CP | 1.0 | 10 |
| 2,4,6-Trichlorophenol | 246TCP | 0.30 | 2 |
| 2,4,5-Trichlorophenol | 245TCP | 0.30 | 2 |
| 2-Chloronaphthalene | 2CNAP | 0.14 | 2 |
| 2-Nitroaniline | 2ANIL | 0.67 | 10 |
| Dimethylphthalate | DMP | 0.14 | 2 |
| Acenaphthylene | ANAPYL | 0.14 | 2 |
| 2,6-Dinitrotoluene | 26DNT | 0.14 | 2 |
| 3-Nitroaniline | 3NANIL | 0.67 | 10 |

a Upper reporting limits are approximately 10 x the reporting limit.
b Quantitation limits listed for solids are based on wet weight. The quantitation limits calculated by the laboratory, calculated on dry weight basis as required by contract, will be higher.

## TABLE 6-11 (CONTINUED)
## USAEC REPORTING LIMITS FOR TCL SEMIVOLATILE ORGANIC COMPOUNDS

| Analyte | USAEC Acronym | USAEC Reporting Limits[a] | |
|---|---|---|---|
| | | Solid-Low Conc. (µg/g)[b] | Aqueous (µg/L) |
| Acenaphthene | ANAPNE | 0.14 | 2 |
| 2,4-Dinitrophenol | 24DNP | 1.35 | 2 |
| 4-Nitrophenol | 4NP | 1.35 | 20 |
| Dibenzofuran | FURANS | 0.14 | 2 |
| 2,4-Dinitrotoluene | 24DNT | 0.14 | 30 |
| Diethylphthalate | DEP | 0.14 | 2 |
| 4-Chlorophenyl-phenylether | 4CLPPE | 0.14 | 2 |
| Fluorene | FLRENE | 0.14 | 2 |
| 4-Nitroaniline | 4NANIL | 0.67 | 10 |
| 4,6-Dinitro-2-methylphenol | 46DN2C | 1.35 | 20 |
| N-Nitrosodiphenylamine | NNDPA | 0.14 | 2 |
| 4-Bromophenyl-phenyl ether | 4BRPPE | 0.14 | 2 |
| Hexachlorobenzene | CL6BZ | 0.14 | 2 |
| Pentachlorphenol | PCP | 0.67 | 10 |
| Phenanthrene | PHANTR | 0.14 | 2 |
| Anthracene | ANTRC | 0.14 | 2 |
| Di-n-butylphthalate | DNBP | 0.14 | 2 |
| Fluoranthene | FANT | 0.14 | 2 |
| Pyrene | PYR | 0.14 | 2 |
| Butylbenzylphthalate | BBZP | 0.14 | 2 |
| 3,3'-Dichlorobenzidine | 33DCBD | 0.67 | 10 |
| Benz[a]anthracene | BAANTR | 0.14 | 2 |
| Chrysene | CHRY | 0.14 | 2 |
| Bis(2-ethylhexyl)phthalate | B2EHP | 0.14 | 2 |
| Di-n-octylphthalate | DNOP | 0.14 | 2 |
| Benzo[b]fluoranthene | BBFAN | 0.14 | 2 |
| Benzo[k]fluoranthene | BKFANT | 0.14 | 2 |
| Benzo[a]pyrene | BAPYR | 0.14 | 2 |
| Indeno(1,2,3-cd)pyrene | ICDPR | 0.16 | 2 |
| Dibenz[a,h]anthracene | DBAHA | 0.16 | 2 |
| Benzo[g,h,i]perylene | BGHIPY | 0.16 | 2 |

a Upper reporting limits are approximately 10 x the reporting limit.

b Quantitation limits listed for solids are based on wet weight. The quantitation limits calculated by the laboratory, calculated on dry weight basis as required by contract, will be higher.

## TABLE 6-12
## USAEC REPORTING LIMITS FOR POLYNUCLEAR AROMATIC HYDROCARBONS

| Parameter | USAEC Acronym | USAEC Reporting Limits[a] | |
|---|---|---|---|
| | | Solid (μg/g)[b] | Aqueous (μg/L) |
| Naphthalene | NAP | 0.133 | 2.0 |
| Acenaphthylene | ANAPYL | 0.133 | 2.0 |
| Acenaphthene | ANALPNE | 0.133 | 2.0 |
| Fluorene | FLRENE | 0.033 | 0.5 |
| Phenanthrene | PHANTR | 0.033 | 0.5 |
| Anthracene | ANTRC | 0.0067 | 0.1 |
| Fluoranthrene | FANT | 0.0013 | 0.02 |
| Pyrene | PYR | 0.0067 | 0.1 |
| Benzo(a)anthracene | BAANTR | 0.0013 | 0.02 |
| Chrysene | CHRY | 0.0067 | 0.1 |
| Benzo(b)fluoranthene | BBFANT | 0.0013 | 0.02 |
| Benzo(k)fluoranthene | BKFANT | 0.0007 | 0.01 |
| Benzo(a)pyrene | BAPYR | 0.0007 | 0.01 |
| Dibenzo(a,h)anthracene | DBAHA | 0.0033 | 0.05 |
| Benzo(ghi)perylene | BGHIPY | 0.0067 | 0.1 |
| Indeno(1,2,3-dc)pyrene | ICDPYR | 0.0033 | 0.05 |

a Upper reporting limits are approximately 10 x the reporting limit.

b Quantitation limits listed for solids are based on wet weight. The quantitation limits calculated by the laboratory, calculated on dry weight basis as required by contract, will be higher.

## TABLE 6-13
## USAEC REPORTING LIMITS FOR TCL PESTICIDES/PCBs

| Analyte | USAEC Acronym | USAEC Reporting Limits[a] | |
|---|---|---|---|
| | | Solid (μg/g)[b] | Aqueous (μg/L) |
| alpha-BHC | ABHC | 0.003 | 0.005 |
| beta-BHC | BBHC | 0.003 | 0.005 |
| delta-BHC | DBHC | 0.003 | 0.005 |
| gamma-BHC (Lindane) | LIN | 0.003 | 0.005 |
| Heptachlor | HPLC | 0.003 | 0.005 |
| Aldrin | ALDRN | 0.003 | 0.005 |
| Heptachlor epoxide | HPCLE | 0.003 | 0.005 |
| Endosulfan I | AENSLF | 0.003 | 0.005 |
| Dieldrin | DLDRN | 0.003 | 0.005 |
| 4,4'-DDE | PPDDE | 0.003 | 0.007 |
| Endrin | ENDRN | 0.003 | 0.005 |
| Endosulfan II | BENSLF | 0.003 | 0.005 |
| 4,4'-DDD | PPDDD | 0.003 | 0.007 |
| Endosulfan sulfate | ESFSO4 | 0.003 | 0.005 |
| 4,4'-DDT | PDDDT | 0.003 | 0.007 |
| Endrin ketone | ENDRNK | 0.003 | 0.006 |
| Methoxychlor | MEXCLR | 0.003 | 0.009 |
| Endrin aldehyde | ENDRNA | 0.022 | 0.02 |
| alpha-Chlordane | ACLDAN | 0.003 | 0.005 |
| gamma-Chlordane | GCLDAN | 0.003 | 0.005 |
| Toxaphene | TXPHEN | 0.3 | 0.60 |
| AROCLOR-1016 | PCB016 | 0.013 | 0.13 |
| AROCLOR-1221 | PCB021 | 0.013 | 0.13 |
| AROCLOR-1232 | PCB232 | 0.013 | 0.13 |
| AROCLOR-1242 | PCB242 | 0.013 | 0.13 |
| AROCLOR-1248 | PCB248 | 0.013 | 0.13 |
| AROCLOR-1254 | PCB254 | 0.013 | 0.13 |
| AROCLOR-1260 | PCB260 | 0.013 | 0.13 |

a Upper reporting limits are approximately 10 x the reporting limit.

b Quantitation limits listed for solids are based on wet weight. The quantitation limits calculated by the laboratory, calculated on dry weight basis as required by the contract, will be higher.

**TABLE 6-14**
**USAEC REPORTING LIMITS FOR POLYCHLORINATED TERPHENYLS**

| Parameter | USAEC Acronym | USAEC Reporting Limit | |
|---|---|---|---|
| | | Solid (μg/g) | Aqueous (μg/L) |
| AROCLOR 5432 | PT5432 | 0.136 | 1.0 |
| AROCLOR 5442 | PT5442 | 0.136 | 1.0 |
| AROCLOR 5460 | PT5460 | 0.136 | 1.0 |

## TABLE 6-15
## USAEC REPORTING LIMITS FOR TAL METALS

| Analyte | USAEC Acronym | USAEC Reporting Limit[a] | |
|---|---|---|---|
| | | Solid (mg/kg)[b] | Aqueous (μg/L) |
| Aluminum | AL | 10 | 40 |
| Antimony | SB | 0.3 | 1.0 |
| Arsenic | AS | 0.25 | 1.0 |
| Barium | BA | 5.0 | 25.0 |
| Beryllium | BE | 0.2 | 0.2 |
| Cadmium | CD | 0.5 | 0.1 |
| Calcium | CA | 20 | 100 |
| Chromium | CR | 1.0 | 10.0 |
| Cobalt | CO | 2.0 | 20.0 |
| Copper | CU | 0.5 | 5.0 |
| Iron | FE | 10.0 | 45 |
| Lead | PB | 5.0 | 1.0 |
| Magnesium | MG | 10.0 | 50 |
| Manganese | MN | 0.5 | 5.0 |
| Mercury | HG | 0.1 | 0.15 |
| Nickel | NI | 2.0 | 15.0 |
| Potassium | K | 60.0 | 550 |
| Selenium | SE | 10.0 | 100 |
| Silver | AG | 0.5 | 0.1 |
| Sodium | NA | 20.0 | 100 |
| Thallium | TL | 10.0 | 0.1 |
| Vanadium | V | 1.0 | 10 |
| Zinc | ZN | 5.0 | 20 |

a Upper reporting limits are approximately 10 x the reporting limit.

b Quantitation limits listed for solids are based on wet weight. The quantitation limits calculated by the laboratory, calculated on dry weight basis as required by contract, will be higher.

## TABLE 6-16
## USAEC REPORTING LIMITS FOR TOTAL PETROLEUM HYDROCARBONS

| Parameter | USAEC Acronym | USAEC Reporting Limits[a] | |
|---|---|---|---|
| | | Solid (μg/g)[b] | Aqueous μg/L |
| Gas | GAS | 8 | 0.4 |
| Diesel (Includes JP series) | DIESEL | 8 | 0.4 |

a Upper reporting limits are approximately 10 x the reporting limit.

b Quantitation limits listed for solids are based on wet weight. The quantitation limits calculated by the laboratory, calculated on dry weight basis as required by contract, will be higher.

samples, adjusted to reflect matrix interferences and additional clean-up procedures.

## 6.3 LABORATORY CALIBRATION

Prior to sample analysis, chemical calibration of each target analyte must be performed to ensure analytical instrumentation is functioning within the established sensitivity range. The following sections outline the protocols for calibration for Class 1 and 1P USAEC approved methods which are based on USEPA CLP protocols. Calibration requirements and corrective action are summarized in Table 9-1.

### 6.3.1 Solution Validation

Calibration solutions and standards to be used in this program will be prepared and maintained under the normal laboratory standards tracking system. This system ensures preparation, checking, documentation, storage, and disposal of standards according to specified procedures and schedules appropriate for each analyte of interest.

### 6.3.2 Initial Calibration

Initial calibrations must be performed as specified in the analytical method. In addition, one standard at the MDL and one standard at the upper reporting limit (URL) must be analyzed. When no calibration requirements are specified by the method, then requirements will be defined by the USAEC Chemistry Branch. Initial calibration is required when the MDL is determined; the instrument is started (other than daily start-up and shut-down); the instrument has not been previously calibrated; or if the instrument fails either daily or continuing calibration.

### 6.3.3 Daily Calibration

Prior to sample analysis, instruments will be calibrated to ensure that the instrumental response has not changed from the previous calibration. Daily calibration must be performed for both target compounds and system monitoring compounds at the beginning of each 12-hour analysis period following the analysis of the instrument performance check and prior to the analysis of the method blank and samples. If calibration requirements are not specified the USEPA Region III, guidelines must be obtained from the USAEC Chemistry Branch. Daily calibration response must meet the following criteria:

Metals:

- Metals recovery, except mercury, must be within ±10%; and
- Mercury recovery must be within ±20%

Organics:

- GC/MS methods: The minimum Relative Response Factor (RRF) for semivolatile target compounds and surrogates must be greater than or equal to 0.05 and the percent difference (%D) between the initial calibration RRF and the continuing calibration RRF must be within ±25.0% for target compounds.
- Non GC/MS methods: The continuing calibration RRF for volatile target compounds and system monitoring compounds must be greater than or equal to 0.05, and the %D between the initial calibration RRF and the continuing calibration RRF must be within ±25.0%.

If the daily calibration does not meet the above response criteria, the calibration must be re-analyzed. If the response of the second analysis does not meet daily calibration criteria, an initial calibration must be performed prior to sample analysis.

After sample analyses are complete, a daily calibration standard must be analyzed. If the response does not meet calibration criteria, the calibration standard must be re-analyzed. If the second calibration standard does not meet calibration criteria, an initial calibration must be performed, and samples analyzed since the last acceptable calibration must be re-analyzed.

### 6.3.4 Continuing Calibration

Continuing calibration will be performed in accordance with USEPA CLP Statement of Work and will occur as follows (USEPA 1991):

- When inorganic analyses are performed, a blank and a continuing calibration standard should be analyzed after every 10th sample, or every 2 hours, whichever is more frequent.

- When GC/MS volatile analyses are conducted, a blank and a continuing calibration standard should be analyzed every 12 hours.

- When GC/MS semivolatiles are analyzed, a continuing calibration standard should be analyzed every 12 hours.

- When pesticides and PCBs are analyzed, a blank should be analyzed every 12 hours. The laboratory should also alternately analyze a Performance Evaluation Mixture or Standard Mixtures A and B as defined in the USEPA CLP requirements.

- For other organic methods, a blank and a continuing calibration standard should be analyzed every 12 hours.

In all cases, the standard should meet the limits of acceptability as specified by USAEC Guidelines.
If a continuing calibration standard does not meet limits of acceptability after two attempts, analysis should stop until such time as the cause of the abnormality can be corrected. Samples analyzed since the last acceptable calibration should be re-analyzed. Such occurrences will be documented in accordance with USAEC Guidelines.

## 6.4 FIELD EQUIPMENT CALIBRATION

The proper calibration and documentation of field equipment are designed to assure that the field equipment is functioning optimally. Equipment logbooks are required to record usage, maintenance, calibration, and repair.

### 6.4.1 Frequency of Field Calibration

Field instrumentation/equipment will be calibrated in the field according to the following schedule:

**6.4.1.1 Hydrolab**. The hydrolab will be calibrated upon arrival to the site and daily while in the field. The calibration of pH, conductivity, dissolved oxygen, and redox potential will include a daily initial measurement prior to calibration, a measurement after calibration, and measurement at the end of the day. Measurements will be documented at the end of the field parameter form logbook or in separate calibration log forms by the field personnel performing the calibration.

**6.4.1.2 Conductivity and pH Meters**. Conductivity and pH meters will be calibrated upon arrival and departure of the site and daily while in the field. The pH meter will be calibrated more frequently if temperature changes by 5°C or more. The calibration of pH and conductivity meters will include a daily initial measurement prior to calibration, a measurement after calibration, and measurement at the end of the day. Measurements will be documented at the end of the field parameter form logbook or in separate calibration log forms by the field personnel performing the calibration.

### 6.4.2 Calibration Standards

Equipment will be calibrated with the appropriate standards specified below, to be provided to the field team by the ICF KE Equipment Manager. Analytical accuracy is traceable to Standard Reference Materials (SRMs) from the National Bureau of Standards (NBS).

- ***Conductivity Solution:***
  1,000 Micromho/CM (+/- 0.50%) at 25.00°C, .053% Potassium Chloride, .0002% Iodine, and Water (CAS 7732-18-5).

- ***pH Buffers:***
  4.00 +/- 0.01 at 25°C, Color coded red. Potassium Hydrogen Phthalate (CAS 877-24-7), Formaldehyde (CAS 50-00-0), Water (CAS 7732-18-5).

  7.00 +/- 0.01 at 25°C, Color coded yellow. Sodium Phosphate, Dibasic (CAS 7558-79-4), Potassium Phosphate, Monobasic (CAS 7778-77-0), Water (CAS 7732-18-5).

  10.00 +/- 0.02 at 25°C, Color coded blue. Potassium Borate, Tetra (CAS 1332-77-0), Potassium Carbonate (CAS 584-08-7), Potassium Hydroxide (CAS 1310-58-3), Sodium (di) Ethylenediamine Tetraacetate (CAS 6381-92-6), Water (CAS 7732-18-5).

## 7.0 DATA REDUCTION, VALIDATION, AND REPORTING OF DATA

The reduction, validation, and reporting of WRF RI/FS sample results analyzed on site are described in this section. The intended use of the data and the associated acceptance criteria for data quality will be determined before the data collection effort begins. Reported data will include, when appropriate, statements of precision, accuracy, representativeness, completeness, and comparability. Data processing procedures will be documented, reviewed, and revised by the QA Manager, as required to meet USAEC and USEPA data quality requirements. The laboratory QA Manager will be responsible for data processing at the contract laboratory.

### 7.1 COLLECTION

Data are initially collected, converted to standard reporting units (i.e., mg/kg for solid media, and $\mu$g/L for aqueous media), and recorded in standard formats by the contract laboratory Project Chemist. The Project Chemist conducts preliminary data analyses using a variety of methods and procedures. Because many analytical instruments are microprocessor controlled, some of the requisite analyses can be performed directly in the instrument's operating or outputting mode. Those instruments interfaced to stand-alone computers or microprocessors often permit data analysis programs to be written and modified to produce data formats specifically suited to end user requirements. Data requiring manual recording, integration, and/or analysis may be converted to a more appropriate format prior to subsequent analyses. Through all stages and aspects of data processing, the data are double checked for translation or transcription errors and are initialed by both the recorder and the checker. The contract laboratory QA Manager or other designated individual not directly involved in the analysis reviews the data for acceptability.

### 7.2 REDUCTION

Data reduction frequently includes computation of analytical results from raw instrument data and summary statistics, including standard errors, confidence intervals, test of hypotheses relative to the parameters, and model validation. For routine analyses performed at the contract laboratory, ESE, sample response data will be entered into CLASS™ by the analyst or other designated individual(s). USAEC QC acceptance criteria are stored for each STORET number/method code combination.

Data reduction procedures address the reliability of computations and the overall accuracy of the data reduction. The numerical transformation algorithms used for data reduction will be verified against a known problem set to ensure that the reduction methods are correct. The equations and the typical calculation sequence that should be followed to reduce the data to the acceptable format are instrument and method-specific. Where standard methods are modified, data reduction techniques will be described in a report accompanying the data.

In addition, USAEC batch files produced for internal records and will review include the following information: laboratory worksheets, laboratory notebooks, sample tracking system forms, instrument logs, standard records, maintenance records, calibration records, sample results, and associated quality results. The batch files will document data reduction and will be available for inspection during a laboratory audit to determine the validity of data.

### 7.3 VALIDATION

Data validation is the process whereby data are determined to be of acceptable or unacceptable quality based on a set of predefined criteria. These criteria depend upon the type(s) of data involved and the purpose for which data are collected.

### 7.3.1 USEPA Data Validation

An independent review of 100% of the data will be performed electronically. Electronic data packages will be validated to ensure compliance with specified analytical, QA, and data reduction procedures; data reporting requirements; and required accuracy, precision, and completeness criteria as defined in the USEPA Region III Modifications to the National Functional Guidelines (NFGs). Data generated will be assessed for accuracy, precision, and completeness. The following items will be reviewed to electronically validate the data:

a. Sample holding times;
b. GC/MS or GC/ECD Instrument Performance Check;
c. Initial Calibration;
d. Continuing Calibration;
e. Blanks;
f. Matrix spike and duplicate recoveries;
f. Surrogate spike recoveries; and
g. Internal standards.

In addition to the 100% electronic data validation, 10% of the electronically validated data will be "hand validated" in accordance with USEPA Region III Modifications to the NFGs. This validation will be performed as system audit for the electronic validation procedure. In addition to the items identified above, the following items will also be reviewed :

a. Documentation that the analytical results are in control and within the certified range;
b. Documentation that data and calculations were checked by a reviewer who was not involved in the performance sampling, analysis, or data reduction;
c. Documentation on traceability of instrument standards, samples, and data;
d. Documentation on analytical methodology and QC methodology;
e. Documentation of routine maintenance activity to ensure analytical reliability; and
f. Documentation of sample preservation and transport.

### 7.3.2 USAEC Validation

In addition to the validation of data in accordance with USEPA Region III requirements, data will also be reviewed to ensure compliance with the USAEC Guidelines.

**7.3.2.1 Laboratory Review**. The contract laboratory (ESE) will be responsible for the validation of analytical results in accordance with USAEC Guidelines for the WRF RI/FS. Validation of the data will be performed by the following procedures:

- Review of 100% of the data by the bench analyst upon conversion of raw data into reportable data. The bench analyst reviews preliminary data entries, calculations, holding times, precision, accuracy, and calibration checks;

- Analyst's supervisor reviews the 100% of the sample preparation/digestion/extraction logsheets, instrument logsheets, any corrective actions provided by the analyst;

- The batch is then finalized by the Laboratory Information Management Services (LIMS) by computation of the following: regression line for standards, coefficients of variation for replicates, spike recoveries, reference sample concentrations, and sample concentrations. The LIMS then provides an automated review of sample and QC results as compared to criteria stored in the STORET/code method number combination;

- Lot folder review by group leader;

- Review of analytical data batches that have explanations and corrective actions associated with batch reports are reviewed by the Laboratory Coordinator. The Lab Coordinator reviews 100% of final data reports for inconsistencies and completeness. Upon review of batch files, qualification or flagging of data is applied if needed;

- Prior to release to the client, the final report is peer reviewed; and

- The Laboratory QA/QC Coordinator performs quarterly audits. This includes random review of analytical batches to see whether the QC designated for the analysis is consistency performed.

Control charts will be maintained to provide a timely assessment of precision for measurement functions. Precision and accuracy of sample results will be assessed as follows:

- Precision will be assessed from measurements of replicates of the same measurement at different times.

- Accuracy will be assessed from measurements of National Institute of Standards and Technology (NIST) Standard Reference Materials (SRMs) or samples spiked with known concentrations of reference materials. The assessment for accuracy will be independent of the routine calibration process (e.g., reference materials will be obtained from independent sources and will be prepared independently). Reference materials will be obtained through commercial sources when available. When commercial sources are not available, reference materials will be obtained through the USAEC Chemistry Branch.

**7.3.2.2 USAEC Review**. Data will be reduced and validated by the contract laboratory using an automated system. The data reduction and validation process will be systematically checked by the USAEC Project Chemist to ensure that the system is operating correctly. The system check will consist of the following procedures:

- QC Chart Review - The contract laboratory is required to generate and review daily QC charts for each day that analyses are performed. These charts are then forwarded weekly to the USAEC and 100% of QC charts are reviewed by the Project Chemist. This review shall consist of assessing trends, cycles, and patterns, etc. This review will also ensure that control problems have been correctly addressed by the laboratory and that appropriate corrective actions have been implemented.

- Data packages - Approximately 20% of analytical lots, with a minimum of two lots per method will be selected from each delivery order. In addition, at least one method per delivery order will be chosen for 100% audit of data packages. If lots have been identified as having control problems, this review will concentrate on these lots.

## 7.4 REPORTING

### 7.4.1 Chemical Data

Chemical data shall be reported in USAEC IRDMIS, as described in the USAEC Guidelines. The analyst shall quantify each analyte in the method blank and spiked QC sample each day of analysis. Method blank data shall generally be reported as "less than" the reporting limit for each analyte. Values detected above the reporting limit shall be reported as determined, with entry into the USAEC data management system in terms of concentration. Processing of additional sample lots will not occur until the results of the previous lots have been calculated, plotted on control charts as required, and the entire analytical method shown to be in control.

USEPA data validation results will be reported in the RI Report.

### 7.4.2 Geotechnical Data

Geotechnical and map data shall be reported in IRDMIS as described in the Data Management Plan. These procedures are in accordance with USAEC Geotechnical Requirement for Drilling, Monitor Wells, Data Acquisition, and Reports, March 1987.

## 8.0 INSTALLATION RESTORATION DATA MANAGEMENT INFORMATION SYSTEM (IRDMIS)

The Installation Restoration Data Management Information System (IRDMIS) is an integrated system for the collection, validation, storage, retrieval, and presentation of Installation Restoration and Base Closures data. IRDMIS PCTool is a major component of IRDMIS, which provides the ability to enter chemical, geotechnical, and map data in support of the USAEC Installation Restoration and Base Closure Programs. Each contractor is supplied with the appropriate microcomputer-based software to allow for record entry, error checking, and quality control for chemical, geotechnical and map data into IRDMIS. ICF KE will be responsible for transmitting the geotechnical data and map coordinates of sample locations to the Pyramid. The contract laboratory will be responsible for transmitting chemical analytical files to the Pyramid.

Records accepted by the local error checking program are then transmitted through a Bulletin Board system (BBS), AT&T Model 3B2 minicomputer, which is centrally located at USAEC's Edgewood, MD facility. Subsequent processing at the central site (duplicate error check) results in an elevation of the accepted records to a higher file "level" and the eventual updating of installation-specific data bases on a Pyramid System.

### 8.1 DATA MANAGEMENT

There are three levels of data recognized in IRDMIS. Level 1 consists of files on the ICF KE microcomputer that have been entered or generated by the error checking program. The only Level 1 files that are present on the Pyramid are program files. Program files are composed of several elements. An element may contain various contractor-written utilities or programs, add-streams, or other commonly used sets of commands.

It is anticipated that error-free files will be transmitted on a weekly basis to the Pyramid. The contract laboratory and the ICF KE terminal will be linked to the network using software supplied by USAEC and a Hayes modem. Terminal usage logs will be established and maintained as a permanent record of communications. To verify acceptance, each file will be processed through an error checking program that is identical to the one on the contract laboratory's and ICF KE's computers. Accepted files will then be sent to the Pyramid. Should any files fail this final error check, ICF KE will be notified and required to correct detected errors and retransmit the data.

Upon arrival at the Pyramid, the files will be classified as Level 2 files. These records will be protected by write keys and, therefore, they may not be modified by ICF KE. They may be read by ICF KE, provided the appropriate read key is specified. Level 2 files will be the responsibility of USAEC. Level 2 files will exist only until the data are loaded into the appropriate installation data base, normally within 10 working days.

Data in the installation data base are considered Level 3 data. They may be accessed by ICF KE using USAEC-supplied report programs and the appropriate read key; however, they are protected from changes by a write key. The installation data bases are the responsibility of USAEC.

Data management will begin when USAEC transmits a request for analytical services to the laboratory, stating the number, type, sample numbers, methods for analysis, and any other information necessary for the laboratory to plan a particular job. Data files of initial input information, including map location files, a certification status check, sample ID number, parameters, dates, etc. will be established as sample containers and chain of custody documentation are prepared for shipment to the field sampling team.

While in the process of collecting, documenting, packaging, and shipping samples to the laboratory, the field sampling team will transfer sample data from their notebooks to field parameter forms. Once the samples arrive at the laboratory, this information will be used to create Level 1 data files in IRDMIS. Status information (e.g., date sampled, date received, data extraction/analysis due) will form a part of the record.

Each step in the analytical process will result in updates to the data files. The operation performed (e.g., preparation, extraction, analysis, data review, data package prepared), the data obtained, and the date that each step was completed will be entered into the system and made available for status checks. The laboratory will validate the data, perform error-checking and correction using the USAEC routines, and transmit the Level 1 files to USAEC. Hard-copy documentation will also be transferred from the laboratory to USAEC.

Once the Level 1 files have been processed at USAEC, the Program Data Coordinator (PDC) will transmit any required corrections, then generate a backup tape copy. This step will be completed within 50 days after the samples have been collected. The laboratory will archive copies of the analytical data, including original instrument magnetic tapes, in perpetuity. Records will also be maintained so that historical summaries of the analyses may be generated by site, by client, or by sample type. Refer to Figure 8-1 for a summary diagram of how these data will be handled.

## 8.2 PROJECT DATA

Data for entry into IRDMIS and generated during this project will consist of geotechnical data and sampling/analytical data. The types, origin, IRDMIS files, and handling of these data are described below.

### 8.2.1 Geotechnical Data

Five types of IRDMIS geotechnical data files will be generated by the Field Team activities during the RI/FS investigation to be conducted at WRF. These files include:

- Geotechnical Map File (GMA) which contains locational information about groundwater monitoring wells and soil samples.
- Geotechnical Field Drilling File (GFD) which contains information about drilling operations, descriptions of lithology encountered, soil sampling descriptions, and depth at which groundwater was first encountered.
- Geotechnical Well Construction File (GWC) which contains information about installation of the monitoring well, and design and construction of the well to include: total depth, screen interval, annular materials (filter pack, bentonite, grout) stick-up, blank casing, and casing diameter.
- Geotechnical Groundwater Stabilized File (GGS) which contains data on depth to stabilized groundwater surface (from ground surface), date reading was collected, measurement tool, and source of data (instrument operator).
- Geotechnical Aquifer Testing File (GAQ) which contains data on the type of aquifer test conducted, date and duration of test, and calculated aquifer permeability result.

These files are generated from field logbooks, boring logs, and field parameter forms used by the Site Geologists.

### 8.2.2 Map File Data

The map file is a listing of sample sites and corresponding north and east coordinates. Map files must be created prior to entry of any other type of sample site data into IRDMIS. The well sites are surveyed, and the coordinates are submitted by the Site Geologist to the PDC, who creates the well map file. Before sampling is initiated, the soil sampling site coordinates are usually established and entered into another map file. A map file data form will be prepared from data contained in the surveyors report and from the field sampling logbooks. These data are entered into the computer by the PDC, and a computer printout of the file is checked and corrected by the Site Geologist. The data are submitted to USAEC in Level 1 and subsequently validated by the QA Supervisor. Once validated, this map file is elevated to Level 2. This must take place before any other data is processed.

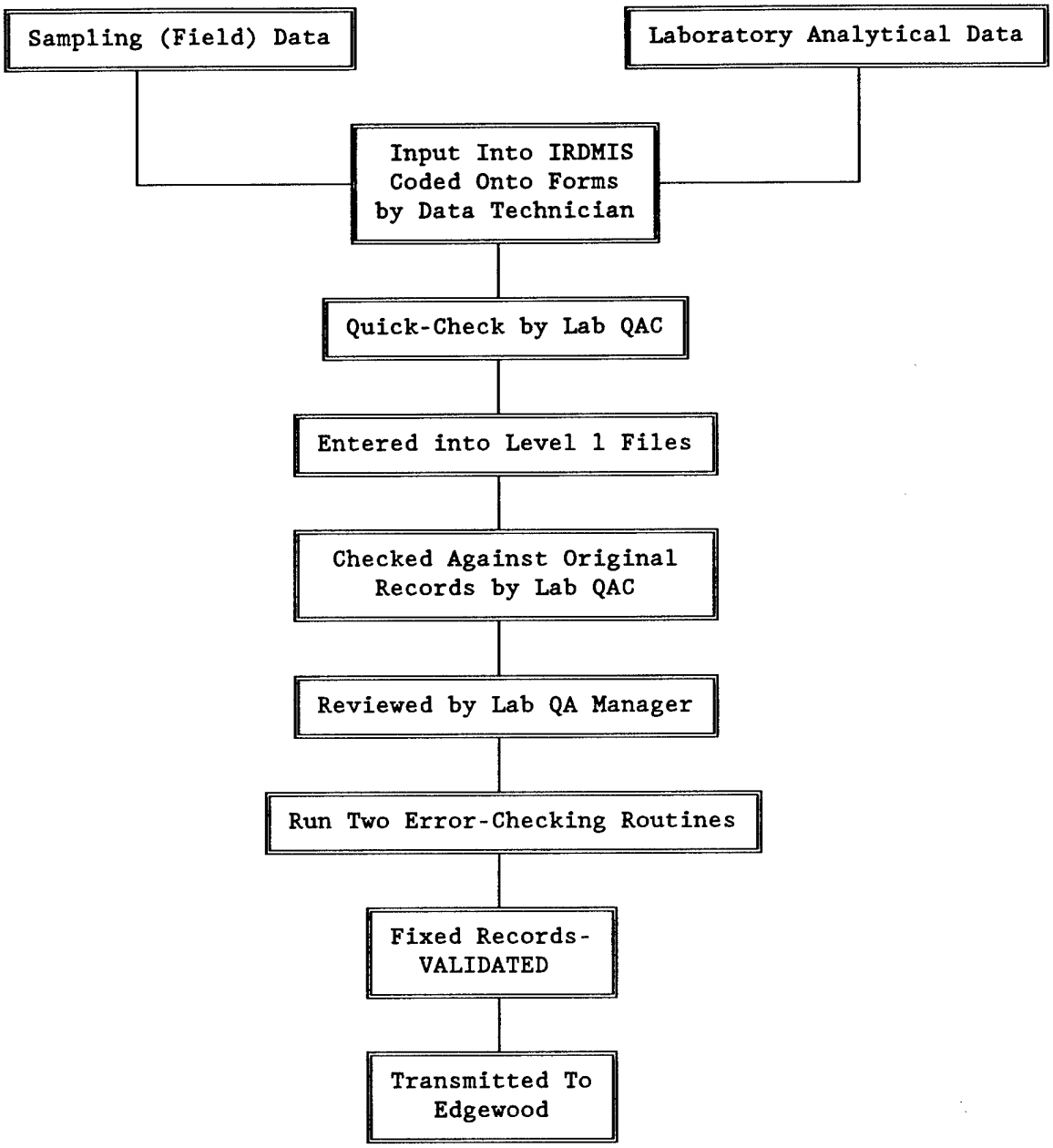


**FIGURE 8-1**
**DATA MANAGEMENT SCHEME**

### 8.2.3 Field Drilling and Well Construction Files

During and after completion of well drilling activities, the Site Geologist enters field drilling data on USAEC's IRDMIS forms and submits them to the PDC. The information is entered into the data management system, and a computer printout is generated and returned to the Site Geologist for proofing. Corrections are noted on the sheet, and the sheet is returned to the PCD. After corrections have been made, the data are submitted to USAEC and loaded onto the USAEC data system in Level 1. Once the field drilling and well construction files are submitted to USAEC in Level 1, the data are checked with USAEC's GEOTEST program, which checks for correspondence between sites in the map and field drilling files, accurate entry of data, and completeness in the field drilling and well construction files. Errors are printed out for correction in the Level 1 file. After the QA Supervisor has validated the field drilling and well map file, the data are elevated to Level 2.

### 8.2.4 Groundwater Stabilized File

The groundwater stabilized file is a compilation of static water levels in the wells at the time of sampling. It is submitted by the Site Geologist after the sampling trip, along with the map file information. The groundwater stabilized file is submitted on IRDMIS forms and undergoes the same entry, checking, and validation procedures as the field drilling and well construction files.

## 8.3 SAMPLING AND ANALYTICAL DATA

Data from analyses performed by the laboratory are input into various chemical data files, including CGW (groundwater data), CSO (soil data), CSE (sediment), CSW (surface water), CQC (QC data), and CAT (Chemical Analytical Tissue samples). The laboratory is also responsible for validation of the data and for generation of error-free files. Data from sampling activities that are required by the laboratory will be submitted by the sampling team on field parameter forms along with the samples. The sampling organization will also be responsible for generation of map files, as described above. A description of sampling and analytical data generation and manipulation is provided below.

Sampling data will be collected in the field in a permanently bound notebook (log). Portions of the information will be transferred to a two-part field parameter form. This information will include the site type, site ID, sampling date and time, field sample number, sample depth (if applicable), and the sampling technique. This form will accompany the samples to the laboratory so that the information can be encoded prior to sample analysis. A complete list of required information is presented in Table 8-1. In addition, each sample container will be annotated in waterproof ink with the installation name, sample number, sampling date, analytes, and preservatives. A COC form will be completed in the field and will accompany the samples to the laboratory, along with the FPF, (Section 5.0, Figure 5-1 and 5-3).

Collection of analytical data will begin when samples arrive at the laboratory. A laboratory technician will first verify that the samples noted on the chain-of-custody form coincide with the delivery of the sample containers. If any containers are broken or missing, the chain-of-custody form will be annotated and the Field Operations Leader will be notified immediately. Samples will then be logged into a project-specific notebook and the computerized laboratory data management system according to parameter code, site ID, and laboratory sample number. The field parameter and chain-of-custody forms will then be submitted to a laboratory data technician for later correlation with the analytical results. On receipt of the sample log information, the laboratory Quality Assurance Coordinator (QAC) will assign analytical lot numbers to the samples in accordance with USAEC procedures. The first four letters of the seven-character sample code will designate the analytical lot, while the remaining three digits will indicate the sample number within the lot (e.g., AAAB006 indicates the sixth sample in lot AAAB). Quality control samples required for each analytical lot (e.g., method blank) will also receive USAEC sample numbers. The data technician will enter the sample information into IRDMIS to generate partially-completed data coding forms.

**TABLE 8-1**
**LIST OF SAMPLING DATA**

- Installation
- Field Sample Number
- Matrix
- Sampling Depth (if applicable)
- Sampling Date and Time
- Sampling Location
- Method of Sampling
- Analytes
- Preservatives
- Significant Observations
- Printed Name and Signature of Sampler
- Number of Samples Taken
- Temperature, pH, and Conductivity of Well Water Sampled
- Groundwater Height Measurements and Calculations to Determine Standing Volume in the Well
- Number of Shipping Containers
- Date of Shipment

When the samples are taken from storage for analysis, the COC form will be signed by the Data Analyst to acknowledge receipt of the samples for processing. When analyses are complete, the Data Analyst will reduce the data for QC samples to determine if the analyses were in control. The QC results will then be reviewed by the Laboratory Section Manager and forwarded to the QAC for verification. If the QAC agrees that the data are in control, the Data Analyst will be directed to proceed with data reduction for the samples. Concentrations of contaminants in extracts will be determined from instrumental responses of the extracts applied to the instrument calibration curve. The resultant concentration will then be modified by applying the appropriate dilution/concentration and sample weight or volume to obtain a final reportable concentration in the original matrix. Aqueous results will be reported in units of micrograms per liter and solid samples will be reported in micrograms per gram.

The data will contain no more than three significant digits and will be rounded to the appropriate number of significant digits, based on certification class and dilution, only after all calculations have been completed. When samples are diluted into a performance demonstrated range, the reported concentration will contain one less significant digit than an undiluted sample. Values less than the certified reporting limit will be reported as "less than" the reporting limit. If a sample is diluted, the non-detected results will be reported as "less than" the reporting limit multiplied by the dilution factor to more accurately reflect the observable limit. The dilution factor will be reported with the data.

When data reduction has been completed for the samples, the data (whether on magnetic media or hard-copy) will be transmitted to USAEC. The correlation of the analytical and field data will be performed by Potomac Research Incorporated. Table 8-2 lists the information that is required for IRDMIS.

**TABLE 8-2**
**INFORMATION REQUIRED FOR GEOTECHNICAL AND CHEMICAL DATA ENTRY INTO IRDMIS**

| IRDMIS DATA ENTRY ELEMENTS | GEOTECHNICAL DATA ENTRY | CHEMICAL DATA ENTRY |
|---|---|---|
| Installation | X | X |
| Laboratory | | X |
| Sample | | X |
| Test Method | | X |
| Measurement Units | | X |
| Analyst | | X |
| Sample Number | | X |
| File Name | X | X |
| Site Type | X | X |
| Site ID | X | X |
| Field Sampler Number | X | X |
| Sample Date | X | X |
| Sample Program | X | |
| Sample Depth (cm) | X | |
| Sample Technique | X | |
| Lab Analysis Number | | X |
| Sample Preparation Date | | X |
| Analysis Date | | X |
| Test Name | | X |
| Measurement Boolean | | X |
| Uncorrected Measurement Value | | X |
| Dilution Factor | | X |
| Percent Moisture | | X |
| Internal Standard Code | | X |
| QC Test | | X |
| QC Spike Value | | X |

## 9.0 INTERNAL QUALITY CONTROL CHECKS

This section describes laboratory QC samples, field QC samples, and document control.

### 9.1 LABORATORY QC SAMPLES

#### 9.1.1 USEPA QC Samples

USEPA QC samples will be prepared in accordance with USEPA CLP protocol. Quality control samples must be analyzed to provide quantitative data to determine the performance of the method. Data generated from the control samples will be plotted on control charts, and used to monitor day-to-day variations in routine analyses.

Control samples are samples introduced into the train of environmental samples to monitor the performance of the analytical method. The following QC samples will be included in each analytical lot:

- Instrument calibration;
- Tuning (GC/MS);
- Continuing calibration check;
- Method blank;
- Matrix spikes and duplicates;
- Performance Evaluation Mixtures (pesticides);
- Resolution Check Mixtures (pesticides);
- Serial dilutions (metals);
- Laboratory Control Samples (metals).

In addition, every organic sample will be spiked with a surrogate spike. The stricter of the USEPA Region III Modifications to the NFGs for data validation and the USAEC Guidelines will be enforced for the WRF RI/FS (USEPA 1993 and 1994c). Where Region III does not maintain data validation criteria, criteria will default to the method.

#### 9.1.2 USAEC QC Samples

In addition to USEPA CLP QC samples, USAEC QC samples will be analyzed by the contract laboratory. QC results will be validated by the laboratory and reviewed by the USAEC Project Chemist. The following USAEC QC sample will be analyzed with every sample batch:

- Low and high standard spikes of control analytes: to verify performance for pesticides and metals.

TAL metals and TCL Pesticide/PCBs will have standard spikes at low and high concentrations to monitor analytical efficiency. The spike recovery will be monitored by weekly control charts. Upper (UWL) and lower warning limits (LWL) are established after 20 lots or 20 days of analysis. Warning limits are calculated as follows:

*Average* : $\bar{X} = ( \Sigma X_1 = ) \div K$

*Range* : $\bar{R} = ( \Sigma R ) \div K$

where:

$x_1$ = between group average of the pairs (within group) average recovery;

$\bar{x}$ = average within group recovery for data pairs;
R = within group difference between recoveries for data pairs; and
K = cumulative number of pairs in data base.

$$UWL\ on\ Average : UWL_X = \bar{X} + 1.25\bar{R}$$

$$LWL\ on\ Average : LWL_x = \bar{X} - 1.25\ \bar{R}$$

**9.1.2.1 Control Charts**. Were applicable, control charts will be used to monitor the trends and variations in the accuracy and precision of analytical analyses. The control chart shall contain the following:

a. Title, analyte, method number, and laboratory name;

b. Spike concentration;

c. Three-letter lot designation and analysis date for each point along the abscissa;

d. Percent recovery (X charts) or Range (R charts) along the ordinate;

e. Upper and lower control limits; and

f. Upper and lower warning limits.

Criteria and formats for control chart construction can be found in the USAEC Guidelines.

## 9.2 FIELD QC SAMPLES

Rinse blanks, field blanks, trip blanks, and field duplicates will be collected during the WRF environmental sample collection effort. Region III Modifications to the NFGs criterion for blank assessment will be enforced for the WRF RI/FS (USEPA 1993 and 1994c). The criterion is that associated blanks must be "clean." That is, no target analytes may be detected in the blank. Corrective action will initiate an investigation to determine the source of contamination; documentation of actions taken; and qualification of associated sample results based on Region III Modifications to the NFGs.

## TABLE 9-1
## SCHEDULED QC SAMPLES, CRITERIA, AND CORRECTIVE ACTION

| Procedure | Frequency of QC Procedure | Acceptance Criteria | | | Corrective Action |
|---|---|---|---|---|---|
| | | ***VOCs*** | | | |
| Initial Calibration 6-pt curve | Set-up, major maintenance, and quarterly | RRF ≥ 0.30 except bromoform ≥ 0.25<br><br>Response Factors < 30% | | | If RSD of the average RRF for calibration check compounds > 30%, the initial calibration must be repeated. |
| Daily calibration standard | Every 12 hours | RSD for RRF ≤ 25% for ⅔ of compounds, all compounds within ±40% except ketones, methylene chloride, and chlorethane | | | If daily calibration standard does not meet criteria, reanalyze daily standard. If it fails a second time, perform new initial calibration. |
| Continuing calibration check | Beginning of a sample sequence | RSD for RRF ≤ 25% for continuing calibration compounds | | | Samples cannot begin until this criterion is met. |
| Method blanks | Every 12 hours | No target analytes. | | | Document source of contamination. |
| Tuning | Prior to calibration | BFB Key Ions and Ion Abundance Criteria in SOP. | | | Analysis of the instrument must meet the ion abundance criteria. |
| Internal Standards | Every sample | Standards<br>bromochloromethane<br>1,4-difluorobenzene<br>chlorobenzene | Retention time ±30 seconds<br>Area changes by a factor of two (-50% to +100%) | | Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria. |
| Surrogate | Every sample, including QC samples. | Standards<br>4-bromofluorobenzene<br>1,2-dichloroethane-$d_4$<br>toluene-$d_8$ | Solid<br>74-113%<br>70-121%<br>84-117% | Aqueous<br>86-115%<br>76-114%<br>88-110% | If any surrogate compounds do not meet criteria, there should be a reanalysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies. |
| Matrix Spike and duplicates | 1 per 20 samples | Standards<br><br>1,1-dichloroethene<br>trichloroethene<br>benzene<br>toluene<br>chlorobenzene | Solid<br>%R / RPD<br>59-172 / ≤22<br>62-137 / ≤24<br>66-142 / ≤21<br>59-139 / ≤21<br>60-133 / ≤21 | Aqueous<br>R% / RPD<br>61-146 / ≤14<br>71-120 / ≤14<br>76-127 / ≤11<br>76-125 / ≤13<br>75-130 / ≤13 | MS and MSD results should be reviewed in conjunction with other QC criteria to determine the need for qualification of the data. |

## TABLE 9-1 (CONTINUED)
## SCHEDULED QC SAMPLES, CRITERIA, AND CORRECTIVE ACTION

| Procedure | Frequency of QC Procedure | Acceptance Criteria | | | Corrective Action |
|---|---|---|---|---|---|
| | | ***SVOCs*** | | | |
| Initial calibration curve | Set-up, major maintenance | RSD of RRF ≤ 30% | | | Must meet criteria prior to sample analysis |
| Daily calibration standard | 12 hours | RRF ≥ 0.05: the percent difference of the daily RRF compared to average RRF ≤ 25%, all compounds must by within ±40% of the average RRF from initial calibration. | | | If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, perform a new initial curve. |
| Continuing calibration check | After tune, prior to sample analysis | ⅔ RSD for RRFs ≤ 25% for the average RRF of initial calibration<br>All compounds must be ≤ 40% different from average RRF. | | | If criteria are not met, initial calibration must be repeated. |
| Internal standards | Every analysis | Standards<br>1,4-dichlorobenzene-$d_4$<br>naphthalene-$d_8$<br>acenaphthene-$d_8$<br>phenanthrene-$d_{10}$<br>chrysene-$d_{12}$<br>perylene-$d_{12}$ | Retention time ±30 seconds<br>Area changes by a factor of two (-50% to +100%) | | Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria. |
| Tuning DFTPP | 12 hours | Must meet tuning criteria in USEPA CLP OLMO1.8 | | | Re-tune, re-calibrate. |
| Method blanks | 12 hours | No target analytes. | | | Document source of contamination. |
| Surrogate spikes | Every sample | Standards | Aqueous | Solid | If any two base/neutral or acid surrogates are out of specification, or if any one base/neutral or acid extractable surrogate has a recovery of less than 10%, then there should be a reanalysis to confirm that the non-compliance is because of sample matrix effects rather than laboratory deficiencies. |
| | | nitrobenzene-$d_5$ | 35-120% | 23-120% | |
| | | 2-fluorobiphenyl | 43-116% | 30-115% | |
| | | p-terphenyl-$d_{14}$ | 33-141% | 18-137% | |
| | | phenol-$d_5$ | 10-94% | 24-113% | |
| | | 2-fluoroprophenol-$d_6$ | 21-110% | 25-121% | |
| | | 2,4,6-tribromophenol | 10-123% | 19-122% | |
| | | 2-chlorophenol-$d_4$ | 33-110% (advisory) | 20-130% (advisory) | |
| | | 1,2-dichlorobenzene-$d_4$ | 16-110% (advisory) | 20-130% (advisory) | |
| Matrix spike and duplicate | 1 per 20 samples | Standards | Aqueous %R / RPD | Solid %R / RPD | If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to determine if the problem is specific to the QC samples or systematic. |
| | | phenol | 12-110 / ≤42 | 26-90 / ≤35 | |
| | | 2-chlorophenol | 27-123 / ≤50 | 25-102 / ≤50 | |
| | | 1,4-dichlorobenzene | 36-97 / ≤28 | 28-104 / ≤27 | |
| | | n-nitroso-di-n-propylamine | 41-116 / ≤38 | 41-126 / ≤38 | |
| | | 1,2,4-trichlorobenzene | 39-98 / ≤28 | 38-107 / ≤23 | |
| | | 4-chloro-3-methylphenol | 23-97 / ≤42 | 26-103 / ≤33 | |
| | | acenaphthene | 46-118 / ≤31 | 31-137 / ≤19 | |
| | | 4-nitrophenol | 10-80 / ≤50 | 11-114 / ≤50 | |
| | | 2,4-dinitrotoluene | 24-96 / ≤38 | 28-89 / ≤47 | |
| | | pentachlorophenol | 9-103 / ≤50 | 17-109 / ≤47 | |
| | | pyrene | 26-127 / ≤31 | 35-142 / ≤36 | |

## TABLE 9-1 (CONTINUED)
## SCHEDULED QC SAMPLES, CRITERIA, AND CORRECTIVE ACTION

| Procedure | Frequency of QC Procedure | Acceptance Criteria | | | Corrective Action |
|---|---|---|---|---|---|
| ***Polynuclear Aromatic Hydrocarbons*** | | | | | |
| Initial calibration curve | Set-up, major maintenance | RSD of RRF ≤ 30% | | | Must meet criteria prior to sample analysis |
| Daily calibration standard | 12 hours | RRF ≥ 0.05: the percent difference of the daily RRF compared to average RRF ≤ 25%, all compounds must by within ±40% of the average RRF from initial calibration. | | | If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, perform a new initial curve. |
| Continuing calibration check | After tune, prior to sample analysis | ⅔ RSD for RRFs ≤ 25% for the average RRF of initial calibration<br>All compounds must be ≤ 40% different from average RRF. | | | If criteria are not met, initial calibration must be repeated. |
| Internal standards | Every analysis | Standards<br>naphthalene-$d_8$<br>acenaphthene-$d_8$<br>phenanthrene-$d_{10}$<br>chrysene-$d_{12}$<br>perylene-$d_{12}$ | Retention time ±30 seconds<br>Area changes by a factor of two (-50% to +100%) | | Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria. |
| Surrogate | Every sample | Standard<br>triphenylene | Aqueous[a]<br>60-124% | Solid[a]<br>30-124% | If surrogate does not meet recovery criteria, there should be a reanalysis to confirm that the non-compliance is because of sample matrix effects rather than laboratory deficiencies. |
| Method blanks | 12 hours | No target analytes. | | | Document source of contamination. |
| Matrix spike and duplicate | 1 per 20 samples | Standards | Aqueous %R / RPD | Solid %R / RPD | If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to determine if the problem is specific to the QC samples or systematic. |
| | | acenaphthene | 49-109% / ≤30 | 0-124% / ≤50 | |
| | | acenaphthylene | 53-103% / ≤25 | 0-139% / ≤50 | |
| | | anthracene | 44-124% / ≤40 | 0-126% / ≤50 | |
| | | benzo(a)pyrene | 45-121% / ≤38 | 27-151% / ≤62 | |
| | | benzo(k)fluoranthene | 41-123% / ≤41 | 22-132% / ≤55 | |
| | | fluorene | 40-110% / ≤35 | 25-123% / ≤49 | |
| | | naphthalene | 21-117% / ≤48 | 0-122% / ≤50 | |
| | | phenanthrene | 52-116% / ≤32 | 0-155% / ≤50 | |

[a] Based on ESE historical recovery of spiked method blanks.

## TABLE 9-1 (CONTINUED)
## SCHEDULED QC SAMPLES, CRITERIA, AND CORRECTIVE ACTION

| Procedure | Frequency of QC Procedure | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| | | ***Pesticides/PCBs*** | |
| Initial calibration curve single component, multi-component | Set-up, major maintenance | r ≥ 0.995<br><br>r: linear correlation coefficient | Must meet criteria prior to sample analysis |
| Daily calibration standard | 12 hours | r ≥ 0.995 | If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, perform a new initial curve. |
| Independent reference standard (calibration check) | Weekly | Recovery ± 25% | Initiate investigation and document actions taken. |
| Performance evaluation mixture | 12 hours, after analytical run | endrin/4,4-DDT degradation < 30% | If criterion is not met, system must be deactivated and the affected sample reanalyzed if endrin or 4,4-DDT or their degradation products are detected in the samples. |
| Resolution Check Mixture | 12 hours | Resolution between compounds is ≤ 60%. The depth of the valley between two adjacent peaks must be ≥ 60% of the height of the shorter peak. | Detected target compounds that were not adequately resolved should be qualified with "J". Qualitative identifications may also be questionable if coelution exists. Non-detect with retention times in the region of coelution may not be valid. Professional judgement should be used to determine the need to qualify data as unusable. |
| Instrument blank | 12 hours, after analytical run | No target analytes. | Demonstrated "clean". Affected sample will be reanalyzed. |
| Method blanks | 12 hours | No target analytes. | Document source of contamination. |
| Surrogate spikes | Every sample | Standard[a] / Aqueous / Solid<br>decachlorobiphenyl / 60-150% / 60-150%<br>tetrachloro-m-xylene / 60-150% / 60-150% | Investigate to determine cause and document actions taken; data are acceptable. |

## TABLE 9-1 (CONTINUED)
## SCHEDULED QC SAMPLES, CRITERIA, AND CORRECTIVE ACTION

| Procedure | Frequency of QC Procedure | Acceptance Criteria | | | | | Corrective Action |
|---|---|---|---|---|---|---|---|
| | | ***Pesticides/PCBs*** | | | | | |
| Matrix spike and duplicate | 1 per 20 samples | Standards | Aqueous | | Solid | | Data reviewer may use the MS and MSD results in conjunction with other QC sample results to determine the need for some qualification of the data. |
| | | | %R | RPD | %R | RPD | |
| | | gamma-BHC | 56-123 | ≤15 | 46-127 | ≤50 | |
| | | heptachlor | 40-131 | ≤20 | 35-130 | ≤31 | |
| | | aldrin | 40-120 | ≤22 | 34-132 | ≤43 | |
| | | dieldrin | 52-126 | ≤18 | 31-134 | ≤38 | |
| | | endrin | 56-121 | ≤21 | 42-139 | ≤45 | |
| | | 4,4'-DDT | 38-127 | ≤27 | 23-132 | ≤50 | |
| Standard spikes | 2 low spikes, two high spikes per sample lot | Standards<br>alpha-chlordane<br>endosulfan I<br>aldrin<br>dieldrin<br>endrin<br>heptachlor<br>lindane<br>methoxychlor<br>p,p-DDT | LWL < x < UWL<br>LWL: lower warning limit<br>UWL: upper warning limits | | | | Investigate to determine cause and document actions taken; data are acceptable. |

[a] Surrogate recovery acceptance criteria based precision and accuarcy data for USEPA SW-846 Method 8080.

## TABLE 9-1 (CONTINUED)
## SCHEDULED QC SAMPLES, CRITERIA, AND CORRECTIVE ACTION

| Procedure | Frequency of QC Procedure | Acceptance Criteria | | | | | Corrective Action |
|---|---|---|---|---|---|---|---|
| ***Polychlorinated Terphenyls*** | | | | | | | |
| Initial calibration curve single component, multi-component | Set-up, major maintenance | $r \geq 0.995$ | | | | | Must meet criteria prior to sample analysis |
| Daily calibration standard | 12 hours | $r \geq 0.995$ | | | | | If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, perform a new initial curve. |
| Independent reference standard (calibration check) | Weekly | Recovery ± 25% | | | | | Initiate investigation and document actions taken. |
| Instrument blank | 12 hours, after analytical run | No target analytes. | | | | | Demonstrated "clean". Affected sample will be reanalyzed. |
| Method blanks | 12 hours | No target analytes. | | | | | Document source of contamination. |
| Surrogate spikes | Every sample | Standard | Aqueous | | Solid | | If a surrogate compound has a recovery of outside the criteria, then there should be a reanalysis to confirm that the non-compliance is because of sample matrix effects rather than laboratory deficiencies. |
| | | decachlorobiphenyl | 75-125% | | 75-125% | | |
| | | tetrachloro-m-xylene | 75-125% | | 75-125% | | |
| Matrix Spike and duplicate | 1 per 20 samples | Standard | Aqueous[a] | | Solid | | Data reviewer may use the MS and MSD results in conjunction with other QC sample results to determine the need for some qualification of the data. |
| | | | %R | RPD | %R | RPD | |
| | | Aroclor 5432 | 50-150% | ≤30 | 50-150% | ≤30 | |
| | | Aroclor 5460 | 50-150% | ≤30 | 50-150% | ≤30 | |
| Standard spikes | 2 low spikes, two high spikes per sample lot | LWL < x < UWL<br>LWL: lower warning limit<br>UWL: upper warning limits | | | | | Investigate to determine cause and document actions taken; data are acceptable. |

[a] Acceptance criteria may be updated throughout the project as laboratory performance demonstrated data becomes available.

## TABLE 9-1 (CONTINUED)
## SCHEDULED QC SAMPLES, CRITERIA, AND CORRECTIVE ACTION

| Procedure | Frequency of QC Procedure | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| | | ***TAL Metals*** | |
| Initial calibration curve 5-pt curve | Major maintenance, instrument modification, replacement of the torch, replacement of the mirror | r > 0.995 for all elements | If r < 0.995 for any element, the standards for that element must be prepared again and/or lower upper range standard must be used. |
| Daily calibration standard (calibration blank & calibration verification) | 12 hours | slope within 10% of initial calibration recovery ±5% of true value | If criteria are not met, reanalyze the daily standards. If the daily standard fails a second time, perform an initial calibration. |
| Interference check | Beginning and end of each sample analytical run | Recovery ±20% of true value | Terminate the analysis, correct the problem, re-calibrate, reverify the calibration, and reanalyze the samples. |
| Continuing calibration verification (CCV) | Every 10 samples, end of analytical run | Recovery ±10% of true value | Reanalyze CCV. If the CCV fails second time, the analysis must be terminated, the problem corrected, the instrument re-calibrated, and the calibration reverified prior to continuing sample analyses. |
| Continuing calibration blank (CCB) | Every 10 samples, end of analytical run | Concentration < 3 X s of the background mean | If the average in not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze all samples analyzed since the last acceptable CCB. |
| Serial Dilution | 1 per 20 samples | Difference between diluted and undiluted sample <10%. | Chemical or physical interference should be suspected. Investigate to determine cause. |
| Preparation blank | 1 per 20 samples | No target analytes. | Documented source of contamination. |
| Laboratory Control Sample | 1 per 20 samples | | |
| Matrix spike and duplicate | 1 per 20 samples | 75% ≥ %R ≥ 125% | If matrix spike recovery does not meet criteria (except Ag), a post digestion spike is required for all methods except furnace. Qualify results in accordance with USEPA Region III criteria. |
| Control spikes | Four spikes per 20 samples | ±30% for low spikes[a]<br>±20% for high spikes | Initiate investigation, document actions taken; data are acceptable. |

[a] As stated by the ESE SOP.

## TABLE 9-1 (CONTINUED)
## SCHEDULED QC SAMPLES, CRITERIA, AND CORRECTIVE ACTION

| Procedure | Frequency of QC Procedure | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| ***Total Petroleum Hydrocarbons*** | | | |
| Initial and daily calibration curve<br>6-pt curve | Major maintenance or instrument modification | r > 0.995 for each compound | If r < 0.995 for any element, the standards for that compound must be prepared again and/or lower upper range standard must be used. |
| Independent reference | Weekly | Recovery within ±25% of true value | No corrective action cited. |
| Continuing calibration verification (CCV) | Every 10 samples, end of analytical run | Recovery ±25% of true value | Reanalyze CCV. If the CCV fails second time, the samples must be reanalyzed or documentation provided by the analyst as to why the sample data should be acceptable. |
| Method blank | 1 per 20 samples | No target analytes. | Documented source of contamination. |
| Standard spikes | 1 low & two high spikes per sample lot | LWL < x UWL | Investigate to determine cause and document action taken; data are acceptable. |

## 10.0 QUALITY ASSESSMENTS

This section discusses the surveillance program used to monitor the total measurement system to evaluate the quality of operation in the field and at the on-site laboratory. A performance surveillance is a planned independent check of the operation of a system to obtain a quantitative measure of the quality of data generated, and involves the use of standard reference samples or materials which are certified as to their chemical composition or physical characteristics. System surveillance is of a qualitative nature and consists of on-site review of a system's quality assurance system and physical facilities for sampling/analysis, calibration, and measurement. ICF KE will be responsible for checking activities associated with the WRF RI/FS.

### 10.1 DOCUMENT REVIEW

Project plans must be reviewed and approved by the ICF KE Project Manager, QA Manager, and Program Manager prior to implementation. The Project Manager and QA Manager will provide a qualitative self-evaluation for establish whether the prevailing management structure, polices, practices, and procedures are adequate to ensuring that the results needed are obtained. The Program Manager will provide an independent qualitative evaluation of a particular program operation and/or organization to establish whether the prevailing management structure, policies, practices, and procedures are adequate for ensuring that the results needed are obtained.

These reviews will be documented on a Technical Review Record for Project Documents Form presented in Figure 10-1. Completion of the document review will be indicated by a signed cover sheet for each plan or document. In addition, changes to the document are subject to the same review process. Changes must be recorded and include the name of the plan addressed, subject that changed, author of the change, approval signatures, date implemented, and a brief discussion of why the change was necessary. This information will be stored in Document Control.

### 10.2 DOCUMENT CONTROL

The goal of the ICF KE Document Control Program is to ensure that the project documents issued or generated will be accounted for upon completion of the project. The program includes a numerical document control system, document inventory procedure, and a central filing system with a designated person(s) responsible for its maintenance.

Documents used or generated during the course of the project are accounted for and become a part of the project files upon completion of the task. These may include but are not limited to the following:

a. Sample identification documents and field logbooks;
b. Chain-of-custody record;
c. Project Deliverables (i.e., Work Plans, audit reports, etc.);
d. Analytical logbooks, laboratory data, calculations, graphs, strip charts, field logs, and software;
e. Reports and correspondence material; and
f. Photographs, maps, and drawings.

When an error is made on an accountable document, corrections are made by drawing a single line through the error and entering the correct information. The correction must also be initialed and dated. A brief explanation is provided explaining the reason the correction was made.

Controlled documents which are sensitive to timing or approvals will use a document control format in the upper right corner which includes:

a. Document;
b. Section number;
c. Revision number;

| TO BE COMPLETED BY THE DOCUMENT AUTHOR | | |
|---|---|---|
| PROJECT NAME: | PROJECT NO. | CLIENT: |
| DOCUMENT NAME:<br>_____<br>_____<br>DRAFT_____<br>FINAL_____ | | |
| AUTHOR: | | |
| TECHNICAL REVIEWER: | | |
| MANAGEMENT REVIEWER: | | |
| HEALTH & SAFETY REVIEWER: | | |
| ENGINEERING REVIEWER: | | |
| OTHER REVIEWER: | | |
| RETURN REVIEW COPIES TO AUTHOR BY:<br>DUE DATE/TIME: | DATE IN/TIME: | |
| NUMBER OF COPIES/DISTRIBUTION: _____<br>_____ | | |

| THE APPROPRIATE SIGNATURE(S) MUST BE COMPLETED AND DATED BEFORE RELEASE OF THE PROJECT DOCUMENT | | |
|---|---|---|
| REVIEWER SIGNATURE | DATE | INITIAL IF N/A |
| TECHNICAL OK: | | |
| MANAGEMENT OK: | | |
| ENGINEERING OK: | | |
| HEALTH & SAFETY OK: | | |
| OTHER SPECIALIST*: | | |
| OTHER SPECIALIST*: | | |

* SPECIALIST TO BE WRITTEN IN AS REQUIRED

**FIGURE 10-1**
**TECHNICAL REVIEW RECORD FOR PROJECT DOCUMENTS**

d. Date of revision; and
e. Page__ of __.

A distribution list of controlled documents will be maintained within the document control system. This system will ensure that revisions are distributed to the addressees.

After technical work on a task has been completed, the accountable documents generated or used for the task work will be assembled and placed in a secure storage location. Accountable task documentation will then be inventoried by the QA Manager, or their designee.

## 10.3 READINESS REVIEWS

Documented readiness reviews will be performed by the ICF KE QA Manager prior to the scheduled work start date, prior to implementation of designs, and in the event of a quality-related stop work order. The readiness review will be performed to verify the following elements:

a. Work pre-requisites have been satisfied;

b. Detailed technical and QA procedures have been reviewed for adequacy and appropriateness;

c. Personnel have been suitably trained and qualified; and

d. The proper equipment, material, and resources are available.

Work prerequisites for remedial investigation include ensuring that necessary permits and licenses have been obtained. ICF KE will be responsible for site approvals and preparation, coordinating with WRF for the extension of utilities to the study site, and regulatory compliance (i.e., obtaining necessary permits and licenses to install and operate the treatability study system). Once site preparation is complete and permits are obtained, ICF KE will be responsible for monitoring these facilities and determining compliance with permit requirements.

During the readiness review, actions will be taken as necessary by the ICF KE QA Manager to ensure that RI/FS activities are conducted in accordance with the Sampling and Analysis Plan, QAPP, and Work Plan. The QA Manager will document deficiencies encountered during the readiness review and actions taken in the field to correct potential problems. Results of readiness reviews and corrective actions will be presented as a memorandum issued to the ICF KE Project Manager defining deficiencies noted during the inspection in order to implement actions as necessary to meet the QA requirements as defined by this QAPP.

## 11.0 CORRECTIVE ACTION

Corrective action will be initiated through the development and implementation of routine internal quality control checks. Specific limits beyond which corrective action is required will be established for each system. Corrective action requirements will be implemented in response to deficiencies encountered during system surveillances.

To enhance the timeliness of corrective action and thereby reduce the generation of unacceptable measurement data, problems identified by assessment procedures will be resolved at the lowest possible management level. Problems that cannot be resolved at this level will be reported to the ICF KE QA Manager for resolution. The QA Manager will determine at which management level the problem can best be resolved, and will notify the appropriate manager. Weekly progress reports will detail problems and subsequent resolutions.

Steps comprising a closed-loop corrective action system include:

a. Defining the problem;

b. Assigning responsibility for problem investigation;

c. Investigating and determining the cause of the problem;

d. Assigning responsibility for problem resolution; and

e. Verifying that the resolution has corrected the problem.

Documentation on the corrective action requirements, the assignment of responsibility for corrective action, due dates for completion of corrective action, and validation of completion will be maintained. Such documentation will be reviewed during system surveillances. Figure 11-1 is the Corrective Action Form to be completed by the ICF KE QA Manager when corrective actions are required.

### 11.1 LINE OF COMMUNICATION FOR CORRECTIVE ACTION

If a visitor to the site, including USEPA or oversight personnel, observe a QA problem at the site, or a deviation from the Work Plan, then the visitor should express his/her concern to the ICF KE QA Manager. The field personnel will either agree with the visitor, correct the perceived problem or deviation and continue working, or will disagree with the visitor and continue working. The visitor's comments will be documented in the appropriate field logbook. If the visitor's comment is not acted upon, then the visitor may communicate with the USAEC COR. It should be noted that the ICF KE QA Manager will comply with directions given by the USAEC COR, but not necessarily with visitors to the site or regulatory oversight personnel.

### 11.2 STOP WORK PROTOCOLS

The ICF KE Program Manager, Project Manager, and QA Manager have the authority to issue a stop work order. A stop work order will be issued under conditions such that the quality of work jeopardizes the attainment of the project objectives. A stop work order must not create an operational, safety, public health, or environmental hazard.

CORRECTIVE ACTION REPORT FORM

Document Control Number: _____

Date of Problem: _____ Originator: _____

Description of Problem and Effect on System: _____

Persons Notified: _____ Title _____ Date: _____

Description of Corrective Action: _____

Person Completing Action:

Signature _____ Title _____ Date _____

Approval: _____ Title _____ Date _____

**FIGURE 11-1**
**CORRECTIVE ACTION REPORT FORM**

Under a stop work order, work may not be conducted within affected activities until the responsible manager acknowledges the implementation of a corrective action in accordance with the resolution criteria of the order, and a readiness review is conducted and documented as specified in Section 10.3. Immediate notification of work stoppage will be made to the USAEC COR.

## 12.0 QUALITY CONTROL REPORTS TO MANAGEMENT

### 12.1 REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Quality control reports will be prepared weekly by either the ICF KE Field Operations Leader or the ICF KE QA Manager during field activities in support of the WRF RI/FS. This report will be distributed to the ICF KE Project Manager and the ICF KE Program Manager. These weekly reports will include the following information:

- Information concerning environmental sampling;
- Departures from the FSP, QAPP, and/or Work Plan;
- Any corrective actions taken;
- Documentation that the sampling, packaging, and shipping elements for samples were used; and
- Any inspections or surveillances performed and associated results.

### 12.2 QA DELIVERABLES

The following documents and deliverables will be submitted to the USAEC in support of the project work performed at WRF.

a. Pre-certification and certification data packages;
b. Audit reports;
c. Weekly QA/QC reports during field activities;
d. IRDMIS submissions;
e. Monthly status reports of QC activities;
f. QC charts (during periods of analytical analyses);
g. Logbooks;
h. QA section of the project final report; and
i. Project final report

USAEC will be responsible for the final storage and security of data files. If changes are to be made to the QAPP prior to the close of the project, the proposed changes will be submitted to the USAEC Project Officer.

## 13.0 REFERENCES


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# LIST OF ACRONYMS

4,4-DDD - 4,4-1,1-Dichloro-2,2-bis(p-chlorophenyl)-ethylene
4,4-DDE - 4,4-Dichlorodiphenylethane
4,4-DDT - 4,4-Dichlorodiphenyltrichloroethane
ARARs - applicable or relevant and appropriate requirements
As - Arsenic
ASTM - American Society of Testing Materials
AWQC - Ambient Water Quality Criteria
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COR - Contracting Officer's Representative
CVAA - Cold Vapor Atomic Adsorption
DIUF - deionized ultrafiltered
ER-L - effects range low
ER-M - effects range median
ESE - Environmental Science and Engineering
FEMA - Federal Emergency Management Agency
FID - flame ionization detector
GC - Gas Chromatography
GC/ECD - gas chromatography with electron capture detector
GC/MS - Gas Chromatograph/Mass Spectrometer
GFAA - Graphite Furnace Atomic Adsorption
ICF KE - ICF Kaiser Engineers, Inc.
ICP - Inductively Coupled Argon Plasma
IDL - Instrument Detection Limit
IRDMIS - Installation Restoration Data Management Information System MCLs - Maximum Contaminant Levels
MCLGs - Maximum Contaminant Level Goals
MDL - Method Detection Limit
MHz - megahertz
MS - Mass Spectrometer
MSs - matrix spikes
MSDs - matrix spike duplicates
NOAA - National Oceanic and Atmospheric Administration
NOAEL - no-observable-adverse-effect level
OSHA - Occupational Safety and Health Administration
OSWER - Office of Solid Waste and Emergency Response
PC - personal computer
PCBs - polychlorinated biphenyls
PCTs - polychlorinated terphenyls
PID - photoionization detector
QAPP - Quality Assurance Project Plan
QA/QC - Quality Assurance/Quality Control
RA - Risk Assessment
RCRA - Resource Conservation Recovery Act
RI - Remedial Investigation
RI/FS - Remedial Investigation/Feasibility Study
RPDs - relative percent difference
SOPs - standard operating procedures
SOW - Statement of Work
SQC - Sediment Quality Criteria
SQL - Sample Quantitation Limit
SSL - Special Screening Levels
SVOC - semivolatile organic compound
SWMUs - Solid Waste Management Units
TAL - Target Analyte List
TBC - to-be-considered
TCL - Target Compound List
TICs - tentatively identified chemicals
TSS - Total Suspended Solids
USAEC - United States Army Environmental Center
USACE - United States Army Corps of Engineers
USCS - Unified Soil Classification System
USEPA - U.S. Environmental Protection Agency
USFWS - U.S. Fish and Wildlife Service
USGS - United States Geological Survey
VADEQ - State of Virginia, Department of Environmental Quality
VOCs - volatile organic compounds
WRF - Woodbridge Research Facility

# Appendix A - Standard Operating Procedures

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019 Sample Preservation

020 Hydrolab Multiparameter Water Quality Monitoring Instrument

021 Monitoring Well Installation

022 Collection of Monitoring Well Samples

023 Decontamination

# STANDARD OPERATING PROCEDURE 001
# SAMPLE LABELS

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for the use of sample labels. Every sample will have a sample label uniquely identifying the sampling point and analysis parameters. An example label is included as Figure 001-1. Other formats with similar levels of detail are acceptable.

## 2.0 Material

a. Sample Label
b. Indelible lab marker

## 3.0 Procedure

The following steps describe how to use the sample labelling system:

**3.1** As each sample is collected/selected, fill out a sample label. Enter the following information on each label:

a. Project Name

b. Project Number

c. Location/Site I.D. - enter the well # or surface water sampling #, and other pertinent information concerning where the sample was taken.

d. Date of Sample Collection

e. Time of Sample Collection

f. Analyses to be Performed (Note: due to number of analytes, details of analysis should be arranged with lab *a priori.)*

g. Whether Filtered or Unfiltered (water samples only)

h. Preservatives (water samples only)

i. The Number of Containers for the Sample (*e.g.* 1 of 2, 2 of 2)

**3.2** Double-check the label information to make sure it is correct. Detach the label, remove the backing and apply the label to the sample container. Cover the label with clear tape, ensuring that the tape completely encircles the container.

**3.3** Record the Sample Number and designated sampling point in the field logbook, along with the following sample information:

a. Time of sample collection (each logbook page should be dated)

b. The location of the sample

c. Organic vapor meter or photoionization meter readings for the sample (when appropriate)

d. Any unusual or pertinent observations (oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, etc.)

e. Number of containers required for each sample

f. Whether the sample is a QA sample (split, duplicate or blank)

**3.3.1** A typical logbook entry might look like this:

7:35 AM Sample No. MW-3. PID = 35 PPM
Petroleum odor present. Sample designated MW-3-001.

The suffix duplicate will be added to Sample ID for duplicating samples.

**3.4** Place the sample upright in the designated sample cooler. Make sure there is plenty of ice in the cooler at all times.

## 4.0 Maintenance

Not Applicable.

## 5.0 Precautions

**5.1** Note that although incidental odors should be noted in the logbook, it is unwise from a health and safety standpoint to routinely "sniff test" samples for contaminants.

## 6.0 References

U.S. EPA. 1980, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80

**FIGURE 001-1**
**SAMPLE LABEL**

PROJECT NAME _____ PROJECT NUM. _____

SAMPLE LOCATION/SITE ID _____

DATE: ___/___/___ TIME: ____:____

ANALYTES: VOC SVOC P/P PCT METALS PAHs CN

FILTERED: [NO] [YES]

PRESERVATIVE: [NONE] [$HNO_3$] [OTHER _____]

SAMPLER: _____

# STANDARD OPERATING PROCEDURE 002
# CHAIN-OF-CUSTODY FORM

---

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for use of the Chain-of-Custody (COC) Form. An example is provided as part of this SOP. Other formats with similar levels of detail are acceptable.

## 2.0 Material

a. Chain-of-Custody Form
b. Indelible ink pen

## 3.0 Procedure

3.1 Give the site name and project name/number.

3.2 Enter the sample identification code.

3.3 Indicate the sampling dates for all samples.

3.4 List the sampling times (military format) for all samples.

3.5 Indicate "grab" or "composite" sample with an "X."

3.6 Specify the sample location.

3.7 Enter the total number of containers per cooler.

3.8 List the analyses/container volume.

3.9 Obtain the signature of sample team leader.

3.10 State the carrier service and airbill number, analytical laboratory, and custody seal numbers.

3.11 Sign, date, and time the "relinquished by" section.

3.12 Upon completion of the form, retain the shipper copy, and affix the other copies to the inside of the sample cooler, in a zip seal bag to protect from moisture, to be sent to the designated laboratory.

## 4.0 Maintenance

Not Applicable.

## 5.0 Precautions

None.

## 6.0 References

U.S. EPA. 1990. Sampler's Guide to the Contract Laboratory Program. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C., December 1990.

U.S. EPA. 1991. User's Guide to the Contract Laboratory Program. EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January 1991.

U.S. EPA. 1980, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80

| Proj. no. | Site Name | | | | Num. of Con-tain-ers | | | | | | | | | | LAB : |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | AIRBILL No: |
| Samplers: | | | | | | | | | | | | | | | Courier: |
| Date | Time | C o m p | G r a b | Field Sample No. | | | | | | | | | | | REMARKS |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | TOTAL | | | | | | | | | | | |

| Relinquished by: | Date/ time | Received by: | Relinquished by: | Date/ Time | Received by: |
|---|---|---|---|---|---|
| Relinquished by: | Date/ time | Received by: (for lab) | Date/Time | Remarks | |

**FIGURE 002-1**
**EXAMPLE CHAIN-OF-CUSTODY FORM**

# STANDARD OPERATING PROCEDURE 003
# FIELD LOGBOOK

---

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for recording field survey and sampling information in the Field Logbook.

## 2.0 Material

a. Field Logbook (Teledyne 415 Level Book, or equivalent)
b. Indelible ink pen

## 3.0 Procedure

Information pertinent to a field survey or sampling effort other than soil boring data will be recorded in a bound logbook. All boring/well installation procedures and observations will be recorded directly onto the original boring copy without transcribing from a field book. Each page/form will be consecutively numbered, dated, and signed. All entries will be made in indelible ink and all corrections will consist of line-out deletions that are initialed and dated. There should be no blank lines on a page. A single blank line or a partial blank line (such as at the end of a paragraph) should be lined to the end of the page. If only part of a page is used, the remainder of the page should have an "X" drawn across it. At a minimum, entries in the logbook will include but not be limited to the following:

a. Project number.

b. Unique, sequential field sample number.

c. Purpose of sampling.

d. Location, description, and each sampling point.

e. Details of the sample site (for example, the elevation of the casing, casing diameter and depth, integrity of the casing, etc.)

f. Name and address of field contact.

g. Documentation of procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., filters and absorbing reagents).

h. Identification of sample crew members.

i. Type of sample (for example, groundwater or surface water).

j. Suspected waste composition.

k. Number and volume of sample taken.

l. Sampling methodology, including distinction between grab and composite sample.

m. Sample preservation.

n. Date and time of collection.

o. Collector's sample identification number(s).

p. Sample shipment (for example, name of the laboratory and cartage agent: Federal Express, United Parcel Service, etc.)

q. References such as maps of the sampling site.

r. Field observations (*e.g.* oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, moisture content, layering, U.S.C.S. classification, etc.)

s. Any field measurements made (for example, pH, conductivity, explosivity, water depth, OVA readings, etc.)

t. Signature and date by the personnel responsible for observations.

u. Decontamination procedures.

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a logbook. However, records should contain sufficient information so that someone can reconstruct the sampling activity without relying on the collector's memory. The Project Manager will keep a master list of all field logbooks assigned to the Sampling Team Leaders. One logbook kept by the Project Manager will be a master site log of daily activities and will contain the list of field logbooks assigned to Sampling Team Leaders.

## 4.0 Maintenance

Not Applicable.

## 5.0 Precautions

None.

## 6.0 References

U.S. EPA. 1990. Sampler's Guide to the Contract Laboratory Program. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C., December 1990.

U.S. EPA. 1991. User's Guide to the Contract Laboratory Program. EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January 1991.

U.S. EPA. 1980, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80

# STANDARD OPERATING PROCEDURE 004
# SAMPLE PACKING AND SHIPPING

## 1.0 Scope and Application

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

## 2.0 Material

a. Waterproof coolers (hard plastic or metal)
b. Metal cans with friction-seal lids (*e.g.* paint cans)
c. Custody seals
d. Packing material [1]
e. Sample Documentation
f. Ice
g. Plastic Garbage Bags
h. Clear Tape
i. Zip seal plastic bags

## 3.0 Procedure

**3.1** Check cap tightness and verify that clear tape covers label and encircles container.

**3.2** Wrap sample container in bubble wrap or closed cell foam sheets.

**3.3** Enclose each sample in a clear zip-seal plastic bag.

**3.4** Place several layers of bubble wrap, or at least 1" of vermiculite on the bottom of the cooler. Line cooler with open garbage bag, place all the samples upright inside a garbage bag and tie the bag.

**3.5** Double bag and seal loose ice to prevent melting ice from soaking the packing material. Place the ice outside the garbage bags containing the samples.

**3.6** Pack shipping containers with packing material (closed-cell foam, vermiculite, or bubble wrap). Place this packing material around the sample bottles or metal cans to avoid breakage during shipment.

---

[1] Permissible packing materials are: a) (non-absorbent) bubble wrap or closed cell foam packing sheets; b) (absorbent) vermiculite. Organic materials such as paper, wood shavings (excelsior), and cornstarch packing "peanuts" will not be used.

3.7 Enclose all sample documentation (i.e., Field Parameter Forms, COCs) in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is being used, each cooler will have its own documentation.

3.8 Seal the coolers with signed and dated custody seals so that if the cooler were opened, the custody seal would be broken. Place clear tape over the custody seal to prevent damage to the seal.

3.9 Tape the cooler shut with packing tape over the hinges and place tape over the cooler drain.

3.10 Ship all samples via overnight delivery on the same day they are collected if possible.

## 4.0 Maintenance

Not Applicable.

## 5.0 References

U.S. EPA. 1990. Sampler's Guide to the Contract Laboratory Program. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C., December 1990.

U.S. EPA. 1991. User's Guide to the Contract Laboratory Program. EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January 1991.

U.S. EPA. 1980, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80

**STANDARD OPERATING PROCEDURES 005**
**USE OF THE IRDMIS NETWORK**

---

## 1.0 LOGIN/LOGOUT OF THE IRDMIS (PRI) NETWORK

**1.1** Files may be transferred to, or copied from, the PRI LAN through remote terminals. The connection requires a Hayes-compatible modem operating at 1200 baud, and 3COM network software. The contractor will purchase the 3COM 3+ Remote package, and PRI will supply a "Remote Login Disk" which contains DOS startup files (AUTOEXEC.BAT, COMMAND.COM, IBMBIO.COM, IBMDOS.COM, etc.) and 3COM network programs for startup, remote dialing, etc.

**1.2** To connect to the PRI LAN, the PC must be rebooted from the Remote Login Disk #1. After the standard DOS startup routines are completed, you will get the A> prompt. Change to the drive containing the IRDMIS files (C or D).

| | |
|---|---|
| Type | D: <CR> |
| Get | D> |

Next, you will start the 3COM linking program.

Type: 3COM XXX (include the space) (where XXX is the contractor i.d.) <CR> Get (after pauses - you will hear the phone ring and data transmission):

```
Login 1.1 - Copyright (etc.) 3COM
XXX:PRI:IRDMIS logged in
D> 3f link e:
E: Linked to \\XXX:PRI:IRDMIS
D>
```

(NOTE: The Remote Login Disk may now be removed from the A: drive)

You are now linked to the E: drive on the PRI LAN, which can be treated as any other drive. For example, you can switch to the E: drive by typing E: <CR>. After a pause (sometimes several seconds), you should get the E> prompt.

Under E: is a subdirectory \TRANSFER where all files are sent (*.TRN) to be transferred. To copy a file SEMAP.TRN from drive D and directory DATA to the network,

| | |
|---|---|
| Type | E: <CR> |
| Get | E> |
| Type | CD\TRANSFER <CR> |
| Get | E> (The subdirectories do not show on the prompt) |
| Type | copy D:\DATA\SEMAP.TRN <CR> |

(NOTE: any valid DOS COPY format can be used)

After a while, you may get a message saying that the network is still trying, and allows you to do an abort. Eventually, you should get a file(s) copied message:

| | |
|---|---|
| Get | 1 file(s) copied |

To verify that the file was transmitted, you can print the directory listings.
If you are not on the E> (actually E\TRANSFER) prompt, type E: <CR>, then

CD\TRANSFER <CR>, then

| | |
|---|---|
| Type | DIR <CR> |
| Get | (a listing of the \TRANSFER directory contents. SEMAP.TRN should be in the listing.) |

To log out after all files have been transmitted:

| | |
|---|---|
| Type | D; <CR> |
| Get | D> |
| Type | LOGOUT <CR> |
| Get | a "logged out" message |

You can now (a) do other things with the IRDMIS programs, or (b) reboot the machine with the Remote Login Disk removed, to return the PC to local control.

AFTER EVERY TRANSFER OF DATA TO THE PRI LAN, call PRI at (410) 679-3030 (ask for the contact for the specific installation) and give them the installation and file type (e.g., SL map file data) and the DOS name of the file that was transmitted. The contractor should receive by Fax a confirmation that the data was received; if not, call PRI and ask for it.

# STANDARD OPERATING PROCEDURE 006
# SURFACE WATER SAMPLING

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for sampling surface water. This procedure can be applied to the collection of surface water samples from streams, rivers, ditches, lakes, ponds and lagoons. Surface water samples provide an indication of the amount of contaminant in the surface water. It is therefore important to collect a representative sample.

## 2.0 Material

a. Sample bottles
b. Cooler with ice

## 3.0 Procedure

**3.1** For all surface water samples, mark the sampling locations on a site map. Describe each location, and place a numbered stake above the visible high water mark on the bank closest to the sampling location, and/or mark adjacent trees with surveyor's flagging. Descriptions must be adequate to allow the sampling station to be relocated at some future date by someone other than the original sampling crew. Use the long handled dip sampler where access is poor or non-contact with water is suggested in the health and safety plan.

**3.2** Sampling should performed deliberately and methodically to minimize disturbance of bottom sediments, yet as quickly as possible to ensure a representative sample. To prevent contamination of the exterior of the sample container, and/or potential contamination of the surface water sample by laboratory contaminants on the exterior of the bottle, the sample container should never be dipped into the water, rather a decontaminated, long-handled or measuring cup-type PTFE or stainless steel sampler, or a sampling bucket should be used to collect unfiltered samples.

### 3.3 Sampling Procedures

**3.3.1** Remove the cap from the sample bottle.

**3.3.2** Triple rinse sample bottles using sample water prior to collection of actual sample.

**3.3.3** Turn bottle upside down and immerse it several inches below the surface of the water.

**3.3.4** Slowly turn bottle upright allowing the air to be released gently and the bottle to fill

**3.3.5** Samples being collected for VOC analysis must have a reverse meniscus in order to prevent air from entering the bottle upon capping.

**3.3.6** If air bubbles are present in the bottle once it is capped, the sample will be recollected.

**3.3.7** Add preservative as required by SOP 019. Replace cap, and place sample in cooler immediately.

## 4.0 Maintenance

Refer to manufacturer's specifications for maintenance procedures on generators and pumps.

## 5.0 Precautions

**5.1** Avoid disturbing bottom sediments.

**5.2** Consult the health and safety plan (HASP) prior to collecting any samples for PPE such as dermal and respiratory protection and personal flotation devices when sampling in or near deep water or from boats.

**5.3** Always decontaminate the sampling and filtration equipment, and change gloves between sampling locations to minimize the risk of cross contamination.

## 6.0 References

None.

# STANDARD OPERATING PROCEDURE 007
# WATER LEVEL AND WELL-DEPTH MEASUREMENTS

---

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for measuring water level and well-depth. This procedure is applicable to the sampling of monitoring wells and must be performed prior to any activities which may disturb the water level, such as purging or aquifer testing.

## 2.0 Material

a. Electric Water Level Indicator (dipmeter) with cable measured at 0.01 foot increments.

**-or-**

Weighted Steel Tape and chalk.

b. Oil-water interface probe

c. Plastic Sheeting

d. Photoionization detector (PID) or intrinsically safe flame ionization detector (FID)

## 3.0 Procedure

### 3.1 Preliminary Steps

**3.1.1** Locate the well and verify its position on the site map. Record whether positive identification was obtained, including the well number and any identifying marks or codes contained on the well casing or protective casing. Gain access to the top of the well casing.

**3.1.2** Locate the permanent reference mark at the top of the casing. This reference point will be scribed, notched or otherwise noted on the top of the casing. If no such marks are present, measure to the top of the highest point of the well casing and so note this fact in field logbook. Determine from the records and record in the notebook the elevation of this point.

**3.1.3** Record any observations and remarks regarding the completion characteristics and well condition, such as evidence of cracked casing or surface seals, security of the well (locked cap), and evidence of tampering.

**3.1.4** Keep all equipment and supplies protected from gross contamination; use clean plastic sheeting. Keep the water level indicator probe in its protective case when not in use.

### 3.2 Operation

**3.2.1** Sample the air in the well head for gross organic vapors by lifting the well cap only high enough for an organic vapor meter (PID or FID) probe to be entered into the well casing. This will indicate the presence of gross volatile contaminants as well as indicating potential sampler exposure.
Remove cap. Allow well to vent for 60 to 90 seconds. Resample headspace. Record both readings. If the second reading is lower than the first, use the second reading to determining whether respiratory protection will be required during subsequent water level and well depth determinations, and sampling. Note that all headspace sampling must be performed at arm's length and from the upwind side of the well if possible.

**3.2.2** If non-aqueous phase liquid (NAPL) contamination is suspected [2], use an interface probe to determine the existence and thickness of NAPLs.

**3.2.2.1** Open the probe housing, turn the probe on, and test the alarm. Slowly lower the probe into the well until the alarm sounds. A continuous alarm indicates a NAPL while an intermittent alarm indicates water. If a NAPL is detected, record the initial level (first alarm). Mark the spot by grasping the cable with the thumb and forefingers at the top of the casing. If a mark is present on the casing, use the mark as the reference point. If no mark is present, use the highest point on the casing as the reference point. Withdraw the cable sufficiently to record the depth.

**3.2.2.2** Continue to slowly lower the probe until it passes into the water phase. Slowly retract the probe until the NAPL alarm sounds and record that level in the manner as described above.

**3.2.2.3** Record the thickness of the LNAPL (see section 3.3.1).

**3.2.2.4** Continue to slowly lower the interface probe through the water column to check for the presence of DNAPL.

**3.2.2.5** Measure and record the thickness of the DNAPL layer (if any) as described above.

**3.2.2.6** Slowly raise the interface probe, recording the depth to each interface as the probe is withdrawn. If there is a discrepancy in depths, clean the probe sensors and re-check the depths.

**3.2.2.7** NOTE: Air/liquid interface depth is more reliable if probe is lowered into liquid. NAPL/water drepths are more accurate if probe is moved from water into NAPL.

---

[2] Interface probes will be used in all wells for first round sampling, regardless of site history. If no NAPLs are detected during the first round of sampling, this step may be omitted during subsequent sampling events **unless** conditions such as site history or headspace vapors would indicate otherwise.

**3.2.2.8** Always lower and raise interface probe slowly to prevent undue mixing of media.

**3.2.2.9** Always perform NAPL check in wells installed in areas with suspected NAPL contamination. Always perform NAPL check if headspace test reveals presence of volatiles. Always perform NAPL check the first time a well is sampled. **If** a well has been sampled previously **and** no NAPLs were present **and** none of the preceeding conditions are met, the NAPL check may be omitted.

**3.2.3** If no NAPL is present use an electronic water level detector as follows.

**3.2.3.1** Remove the water level indicator probe from the case, turn on the sounder, and test check the battery and sensitivity scale by pushing the red button. Adjust the sensitivity scale until you can hear the buzzer.

**3.2.3.2** Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the meter buzzes. Very slowly, raise and lower the probe until the point is reached where the meter <u>just</u> buzzes. Marking the spot by grasping the cable with the thumb and forefingers at the top of the casing. If a mark is present on the casing, use the mark as the reference point. If no mark is present, use the highest point on the casing as the reference point. Withdraw the cable and record the depth.

**3.2.4** Alternatively use a steel tape with an attached weight if aquifer gradients are lower than 0.05 ft/ft. Due to the possibility of adding unknown contaminants from chalk colorants, only white chalk is permitted.

**3.2.4.1** Rub chalk onto the first 1 foot of the steel tape and slowly lower the chalked end into the well until the weighted end is below the water surface. (A small splash can be heard when the weighted end hits the water surface.)

**3.2.4.2** Using the method described above read and record the length from the steel tape.

**3.2.4.3** Remove the steel tape. The chalk will be wet or absent where the tape was below the water surface. Locate, read, and record this length. Subtract wetted length from total length and record the difference. This is the depth to water table.

**3.2.6** To measure the well depth, lower electric water level indicator probe or tape until slack is noted. Very slowly raise and lower the cable until the exact bottom of the well is "felt." Measure (cable) or read the length :(tape) and record the depth.

Note that if the electric water level indicator is used to determine depth of well, the offset distance between the tip of the probe and the electrode must be added to the reading to determine actual depth.

3.2.7 Withdraw the probe or tape.

3.2.8 Decontaminate the probe(s) and cable(s).

**3.3 Data Recording and Manipulation**

3.3.1 Record the following computations:

date and time
weather
method of measurement
casing elevation
NAPL surface elevation = casing elevation - depth to NAPL
NAPL thickness = depth to bottom of NAPL - depth to top of NAPL
water level elevation = casing elevation - depth to water
well bottom elevation = casing elevation - depth to bottom (or read directly from tape)

## 4.0 Calibration

No calibration is needed.

## 5.0 Precautions

5.1 Depending upon the device used, correction factors may be required for some measurements.

5.2 Check instrument batteries prior to each use.

5.3 Exercise care not to break the seals at the top of the electric water level indicator probe.

## 6.0 References

M^cAlary, T. A., and Barker, J. F., 1987. "Volitalization Losses of Organics During Ground Water Sampling from Low Permeability Materials" in Ground Water Monitoring Review, Fall,1987

Thornhill, Jerry T., 1989. Accuracy of Depth to Groundwater Measurements; In "EPA Superfund Ground Water Issue" EPA/540/4-89/002

# STANDARD OPERATING PROCEDURE 008
# PHOTOIONIZATION DETECTOR (HNu Model PI-101 and HW-101)

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for field operations with a photoionization detector (HNu Systems Model PI-101 or HW-101). The photoionization detector (PID) detects total ionizables, hence it is used to monitor both organic and inorganic vapors and gases to determine relative concentrations of air contaminants. This information is used to establish level of protection and other control measures such as action levels. The PID cannot effectively detect compounds having ionization potentials above the photon energy level of the lamp used; therefore, methane, which has an ionization potential of 12.98 eV, is undetectable by PIDs, whose lamps are capable of producing 9.5, 10.2, or 11.7 eV.

Use of brand names in this SOP is in nowise intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor shall provide applicable and comparable SOPs for the maintenance and calibration of same.

## 2.0 Material

a. HNu Systems Model PI-101 or HW-101 survey probe with 9.5, 10.2, or 11.7 eV lamp.
b. Lead-acid gel-cell battery
c. Calibration Gas (*e.g.* isobutylene - 101 ppm) w/regulator
d. Tygon tubing
e. Tedlar bag (optional)
f. Instrument logbook

## 3.0 Procedure

These procedures are to be followed when using the HNu in the field.

### 3.1 Start Up Procedures

**3.1.1** Before attaching the probe, check the function switch on the control panel to ensure that it is in the off position. Attach the probe by plugging it into the interface on the top of the readout module.

**3.1.2** Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scale. If not, recharge the battery. If the red indicator light comes on, the battery needs recharging or service may be indicated.

**3.1.3** Turn the function switch to any range setting. Listen for the hum of the fan motor. Check meter function by holding a solvent based marker pen near the sample intake. If there is no needle deflection, look briefly into the end of the

probe (no more than one or two seconds) to see if the lamp is on. If it is on, it will give a purple glow. Do not stare into the probe any longer than two seconds. Long term exposure to UV light can damage the eyes. (See also note 5.4)

3.1.4 To ZERO the instrument, turn the function switch to the standby position and rotate the zero adjustment until the meter reads zero. A calibration gas is not needed since this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. Allow the instrument to warm up for 3-5 minutes to ensure that the zero reading is stable. If necessary, readjust the zero.

**3.2 Operational Check**

3.2.1 Follow the start up procedure in section 3.1

3.2.2 With the instrument set on the 0-20 range, hold a solvent-based magic marker near the probe tip. If the meter deflects upscale, the instrument is working.

**3.3 Field Calibration Procedure**

3.3.1 Follow the start-up procedures in section 3.1 and the operational check in section 3.2.

3.3.2 Set the function switch to the range setting for the concentration of the calibration gas.

3.3.3 Attach a regulator HNu P/N 101-351 or equivalent (flow = 200 to 300 ml/min) to a disposable cylinder of isobutylene (HNu 101-351 or equivalent). Connect the regulator to the probe of the HNu with a piece of clean Tygon tubing. Turn on the valve of the regulator.

3.3.4 After five seconds, adjust the span dial until the meter reading equals the benzene concentration of the calibration gas used, corrected to its equivalence which should be marked on the canister (Isobutylene ~0.7X benzene).

3.3.5 Record in the field log: the instrument ID No.; serial number; the initial and final span settings; the date; time; location; concentration and type of calibration gas used; and the signature of the person who calibrated the instrument.

3.3.6 If the HNu does not function, check-out, or calibrate properly, the project equipment manager is to be notified as soon as possible. Under no circumstances is work requiring monitoring with a PI-101 or HW-101 to be done with a malfunctioning instrument.

**3.4 Calibration to a Gas Other Than Isobutylene**

The HNu may be calibrated to any certified calibration gas. However, after calibration all subsequent instrument readings will be relative to the calibration gas used.

**3.4.1** Calibrate according to procedure 3.3

**3.4.2** Partially fill and flush to two times a gas bag (Tedlar recommended) with the certified National Institute of Standards and Technology (NIST) (formerly NBS) traceable calibration gas. Then fill the bag with one to three liters of the calibration gas. If the gas is toxic, this must be done in a fume hood.

**3.4.3** Feed the calibration gas into the probe with the range set for the value of the gas. After five seconds, adjust the span control until the meter reads the value of the calibration gas.

**3.4.4** Record the results of the calibration on the calibration/maintenance log and attach a new calibration sticker (if available) or correct the existing sticker to reflect the new calibration data. All subsequent readings will be relative to the new calibration gas.

**3.5 Operation**

**3.5.1** Follow the start up procedure, operational check and calibration check (refer to 3.1).

**3.5.2** Set the function switch to the appropriate range. If the concentration of gases of vapors is unknown, set the function switch to 0-20 ppm range. Adjust if necessary.

**3.5.3** While taking care not to permit the HNu to be exposed to excessive moisture, dirt, or contaminants, monitor the work activity as specified in the Site Health and Safety Plan.

**3.5.4** When the activity is completed or at the end of the day, carefully clean the outside of the HNu with a damp disposable towel to remove all visible dirt. Return the HNu to a secure area and place on charge. Place the instrument on charge after each use; the lead acid batteries cannot be ruined by over charging.

**3.5.5** With the exception of the probe's inlet and exhaust, the HNu can be wrapped in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside in the event of precipitation. If the instrument becomes contaminated, make sure to take necessary steps to decontaminate it. Call the Equipment Administrator if necessary; under no circumstances should and instrument be returned from the field in a contaminated condition.

**3.6** Refer to SOP 003 and 010.

## 4.0 Maintenance

The following sections cover basic maintenance and servicing procedures; they are to be performed only by persons who have been specifically trained in the procedures. In general, disassembly procedures not covered in this text are to be left to trained service personnel, including the contractor's equipment administrator or equipment managers as appropriate.

The appropriate calibration/maintenance logs are to be filled in completely whenever a PI-101 or HW-101 receives servicing. This is true of both contractor-owned and rental instruments.

The equipment manager should be called to arrange for a fresh instrument when necessary. The contractor's equipment facility is responsible for arranging all repairs which cannot be performed by the project equipment manager.

## 4.1 Routine Service

The PID's performance is affected by a number of factors. These include but are not limited to the decay of the UV lamp output over time and the accumulation of dust and other particulate material and contaminates on the lamp and in the ion chamber. Because of these factors, the PID should not be left in the field for a period of more than two weeks before being replaced with a fresh instrument. If a site is going to be inactive for a period of more than a week, all monitoring instruments are to be returned to the project equipment manager or his trained designee for servicing and/or reassignment. The following procedures are to be performed at the designated intervals for routine service.

| Procedure | Frequency |
|---|---|
| Operational Check | Prior to use and at instrument return |
| Field Calibration | Prior to use and at instrument return |
| Full Calibration | Bi-weekly (return instrument to equipment manager for replacement with a fresh unit) |
| Clean UV Lamp and Ion Chamber | Bi-weekly or as needed |
| Replace UV Lamp | As needed |

### 4.1.1 UV Lamp and Ion Chamber Cleaning

During periods of analyzer operation, dust and other foreign materials are drawn into the probe forming deposits on the surface of the UV lamp and in the ion chamber. This condition is indicated by meter readings that are low, erratic, unstable, non-repeatable, drifting, and which show apparent moisture sensitivity. These deposits interfere with the ionization process and cause erroneous readings. Check for this condition regularly to insure that the HNu is functioning properly. If the instrument is malfunctioning, call your respective equipment manager to arrange to have a fresh replacement.

**4.1.2** Lamp eV Change

If different applications for the analyzer would require different eV lamps, separate probes, each with its own eV lamp, must be used. A single readout assembly will serve for any of the probes (9.5, 10.2 and 11.7 eV). A change in probe will require resetting of the zero control and recalibrating the instrument. The 11.7 eV lamp will detect more compounds than either of the two lower eV lamps. However, the 11.7 eV probe needs more frequent calibration, it burns out much faster than the lower eV lamps.

## 5.0 Precautions

**5.1** The HNu PI-101 and HW-101 are designed to sample air or vapors only. DO NOT allow any liquids or low boiling vapors to get into the probe or meter assembly.

**5.2** High concentrations of any gas can cause erroneous readings. High humidity can also cause the instrument readings to vary significantly from the actual concentration of gases or vapors present. This is true even through the HNu cannot react to water vapor.

**5.3** High humidity, dust, and exposure to concentrations of low boiling vapors will contaminate the ion chamber, causing a steady decrease in sensitivity.

**5.4** Continued exposure to ultraviolet light generated by the light source can be harmful to eyesight. If a visual check of the UV lamp is performed: Do not look at the light source from a distance closer than 6 inches with unprotected eyes. Use eye protection (UV-blocking sunglasses or safety glasses). Only look briefly - never more than about 2 seconds.

**5.5** Place the instrument on charge after each use; the lead batteries cannot be ruined by over charging.

**5.6** If at any time the instrument does not check out or calibrate properly in the field, the equipment manager is to be notified immediately and a replacement provided for the malfunctioning instrument. Under no circumstances should field work requiring continuous air monitoring for organic vapors and/or gases be done with a malfunctioning HNu, without a HNu or an approved comparable instrument.

## 6.0 References

Manufacturer's Equipment Manual(s).

# STANDARD OPERATING PROCEDURE 009
# DOCUMENT CONTROL SYSTEM

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for identifying and storing a complete set of documents relating to project tasks. Each document will receive a unique identification number made up of elements describing the document.

## 2.0 Materials

Not applicable.

## 3.0 Procedure

3.1 Each project-related document will be given to the Document Control Officer.

3.2 The Document Control Officer will record information for each document on a Document Control Sheet which will be retained as a backup record.

3.3 The information from each Document Control Sheet will be maintained in a computer database.

3.4 The individual Document Control Number will be entered on the Document Log Sheet and will be written on the document.

3.5 The storage location for each document will be recorded on the Document Control Logsheet and the documents will be stored in the recorded location.

3.6 The database file will be backed up on a regular basis to prevent accidental loss of the data.

## 4.0 Maintenance

Not Applicable.

## 5.0 Precautions

None.

## 6.0 References

None.

# STANDARD OPERATING PROCEDURE 010
# SURFACE WATER, GROUNDWATER, AND SOIL/SEDIMENT FIELD LOGBOOKS

## 1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure is to delineate protocols for recording surface water, groundwater, soil/sediment sampling information, as well as instrument calibration data in the Field Logbooks. Example forms are given. Alternate, equivalent forms are acceptable.

## 2.0 MATERIAL

a. Applicable Field Logbook
b. Indelible ink pen

## 3.0 PROCEDURE

All information pertinent to soil/sediment, groundwater, or surface water sampling will be recorded in the appropriate logbook. Each page/form of the logbook is consecutively numbered. All entries will be made with an indelible ink pen. All corrections will consist of line-out deletions that are initialed and dated.

A. Soil/Sediment Logbook

1. Field Parameters (refer to forms 10-a and b)

a. If using carbon paper or self-duplicating forms, before entering data in logbook, insert a sheet protector between form sets to isolate first blank form from remaining forms.

b. HIGH CONCENTRATION EXPECTED?: answer "Yes" or "No."

c. HIGH HAZARD?: answer "Yes" or "No."

d. INSTALLATION/SITE: record the complete name of the installation or site.

e. AREA: record the area designation of the sample site.

f. INST CODE: record the 2 letter installation code appropriate for the installation or site. Correct abbreviations can be found on pages 3-6 of the IRDMIS User's Guide for chemical data entry.

g. FILE NAME: record "CSO" for a soil sample or "CSE" for a sediment sample.

h. SITE TYPE: record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on pages 18-21 of the IRDMIS User's Guide for chemical data entry. This entry must match the Site Type on the map file form.

i. SITE ID: record a code up to 10 characters or numbers which is unique to the site.

j. FIELD SAMPLE NUMBER: record a code specific for the sample.

k. DATE: enter the date the sample was taken.

l. TIME: enter the time (12 hour or 24 hour clock acceptable as long as internally consistent) the sample was taken.

m. AM PM: circle "AM" or "PM" to designate morning or afternoon (12 hour clock).

n. SAMPLE PROG: record "GQA" (Groundwater Quality Assessment) or other appropriate sample program.

o. DEPTH (TOP): record the total depth sampled.

p. DEPTH INTERVAL: record the intervals at which the plug will be sampled.

q. UNITS: record the units of depth (feet, meters)

r. SAMPLE MEASUREMENTS: check the appropriate sampling method.

s. CHK: check off each container released to a laboratory.

t. ANALYSIS: record the type of analysis to be performed on each sample container.

u. SAMPLE CONTAINER: record the sample container type and size.

v. NO.: record the number of containers.

w. REMARKS: record any remarks about the sample

x. TOTAL NUMBER OF CONTAINERS FOR SAMPLE: record the total number of containers.

y. SITE DESCRIPTION: describe the location where the sample was collected.

z. SAMPLE FORM: record the form of the sample (i.e., clay, loam, etc.) using The Unified Soil Classification System (USCS).

aa. COLOR: record the color of the sample as determined from standard Munsell Color Charts.

bb. ODOR: record the odor of the sample or "none". See SOP 001 § 5.0 "Precautions".

cc. PID (HNu): record the measured PID(HNu) values.

dd. UNUSUAL FEATURES: record anything unusual about the site or sample.

ee. WEATHER/TEMPERATURE: record the weather and temperature.

ff. SAMPLER: record your name.

2. Map File Form (refer to form 10-c)

a. The mapfile logbook form will be located on the reverse of the field parameter logbook form, or on an adjoining page of the field logbook (if level book is used)

b. SITE ID: record the Site ID from the field parameter form.

c. POINTER: record the field sample number for the sample being pointed to.

d. DESCRIPTION/MEASUREMENTS: describe the location where the sample was taken, along with distances to landmarks.

e. SKETCH/DIMENSIONS: diagram the surroundings and record the distances to landmarks.

f. MAP REFERENCE: record which U.S.G.S. Quad Map references the site.

g. COORDINATE DEFINITION: write the compass directions the X- and Y-Coordinates of the map run.

h. COORDINATE SYSTEM: write "UTM" (Universal Transverse Mercator).

i. SOURCE: record the 1 digit code representing the Map Reference.

j. ACCURACY: give units (*e.g.*write "1-M" for 1 meter).

k. X-COORDINATE: record the X-Coordinate of the sample site location.

l. Y-COORDINATE: record the Y-Coordinate of the sample site location.

m. UNITS: record the units map sections are measured in.

n. ELEVATION REFERENCE: record whether topography was determined from a map or a topographical survey.

o. ELEVATION SOURCE: record the 1 digit code representing the elevation reference.

p. ACCURACY: record the accuracy of the map or survey providing the topographical information.

q. ELEVATION: record the elevation of the sampling site.

r. UNITS: write the units in which the elevation is recorded.

s. SAMPLER: write your name.

B. Surface Water Logbook (refer to form 10-b and c)

1. Field Parameter Logbook

a. CAL REF: record the calibration reference for the pH meter.

b. pH: record the pH of the sample.

c. TEMP: record the temperature of the sample in degrees Celsius.

d. COND: record the conductivity of the water.

e. For all other sections, see 3.B.1.

2. Map File Form - See 3.A.2.

C. Groundwater Logbook (refer to form 10-b and d)

1. Field Parameter form - See 3.B.1.

2. Map File form (refer to form 10-c)

a. WELL NO. OR ID: record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on pages 18-21 of the IRDMIS User's Guide for chemical data entry.

b. SAMPLE NO.: record the reference number of the sample.

c. WELL/SITE DESCRIPTION: describe the location where the sample was taken, along with distances to landmarks.

d. X-COORD and Y-COORD: record the survey coordinates for the sampling site.

e. ELEV: record the elevation where the sample was taken.

f. UNITS: record the units the elevation was recorded in.

g. DATE: record the date in the form MM/DD/YY.

h. TIME: record the time, including a designation of AM or PM.

i. AIR TEMP.: record the air temperature, including a designation of C or F (Celsius or Fahrenheit).

j. WELL DEPTH: record the depth of the well in feet and inches.

k. CASING HT.: record the height of the casing in feet and inches.

l. WATER DEPTH: record the depth (underground) of the water in feet and inches.

m. WELL DIAMETER: record the diameter of the well in inches.

n. WATER COLUMN HEIGHT: record the height of the water column in feet and inches.

o. SANDPACK DIAM.: record the diameter of the sandpack. Generally, this will be the same as the bore diameter.

p. EQUIVALENT VOLUME OF STANDING WATER: use one of the following equations, to determine one equivalent volume (EV):

1 EV = volume in casing + volume in saturated sand pack. Or to restate:

$$1\ EV = (\pi R_w^2 h_w + 0.30\pi(R_s^2 - R_w^2)h_s) * (0.0043)$$

where: $R_s$ = radius of sandpack in inches
$R_w$ = radius of well casing in inches
$h_s$ = height of sandpack in inches
$h_w$ = water depth in inches

$$0.0043 = gal/in^3$$

and filter pack porosity is assumed as 30%

**-- OR --**

Volume in casing = $(0.0043\ gal/in^3)(\pi)(12\ in/ft)(R_c^2)(W_h)$

where $R_c$ = radius of casing in inches, and
$W_h$ = water column height in feet

$$\text{Vol. in sandpack} = (0.0043\ \text{gal/in}^3)(\pi)(12\ \text{in/ft})(R_b^2 - R_c^2)(W_h)(0.30)$$

(if $W_h$ is less than the length of the sandpack),

**-- PLUS --**

$$\text{Vol. in sandpack} = (0.0043\ \text{gal/in}^3)(\pi)(12\ \text{in/ft})(R_b^2 - R_c^2)(S_h)(0.30)$$

(if $W_h$ is greater than the length of the sandpack).

where $R_b$ = radius of the borehole, and
$S_h$ = length of the sandpack.

Show this calculation in the comments section.

q. VOLUME OF BAILER OR PUMP RATE: record bailer volume or pump rate.

r. TOTAL NUMBER OF BAILERS OR PUMP TIME: record the number of bailers required to remove 3 equivalent volumes (EV) of water from the well or the total purge time and volume as applicable.

s. WELL WENT DRY? write "YES" OR "NO."

t. NUMBER OF BAILERS OR PUMP TIME: record the number of bailers or pump time which made the well go dry.

u. VOLUME REMOVED: record the volume of water (gal) removed before the well went dry.

v. RECOVERY TIME: record the time required for the well to refill.

w. PURGE AGAIN?: answer "YES" or "NO."

x. TOTAL VOL. REMOVED: record the total volume of water (in gallons) removed from the well.

y. CAL REF.: record the calibration reference for the pH meter.

z. TIME: record time started (INITIAL T(0)), 2 times DURING the sampling and the time sampling ended (FINAL).

aa. pH: record the pH at start of sampling (INITIAL), twice DURING the sampling and at the end of sampling (FINAL).

bb. TEMP: record the water temperature (Celsius) at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

cc. COND: record the conductivity of the water at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

dd. D.O.: record the dissolved oxygen level in the water at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

ee. TURBIDITY: record the readings from the turbidity meter (nephelometer) and units at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

ff. ORD: record the oxidation/reduction(RedOx) potential of the water sample at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

gg. HEAD SPACE: record any positive readings from organic vapor meter reading taken in well headspace prior to sampling.

hh. NAPL: Record the presence and thickness of any non aqueous phase liquids (LNAPL and DNAPL)

ii. COMMENTS: record any pertinent information not already covered in the form.

jj. SIGNATURE: sign the form.

D. Field Calibration Forms (refer to form 10-e)

a. Record time and date of calibration.

b. Record calibration standard reference number.

c. Record meter I.D. number

d. Record initial instrument reading, recalibration reading (if necessary), and final calibration reading on appropriate line.

e. Record value of reference standard (as required).

f. COMMENTS: Record any pertinent information not already covered on form.

g. SIGNATURE: sign form.

## 4.0 MAINTENANCE

Not Applicable.

## 5.0 PRECAUTIONS

None.

## 6.0 REFERENCES

User's Guide to the Contract Laboratory Program, USEPA, July, 1984.

**FIELD PARAMETER/LOGBOOK FORM 10-a**
**SOIL AND SEDIMENT SAMPLES**

HIGH CONCENTRATION EXPECTED? _____ HIGH HAZARD? _____

INSTALLATION/SITE _____ AREA _____

INST CODE _____ FILE NAME _____

SITE TYPE _____ SITE ID _____

FIELD SAMPLE NUMBER _____

DATE (MM/DD/YY) ____/____/____ TIME _____ AM PM SAMPLE PROG. _____

DEPTH (TOP) _____ DEPTH INTERVAL _____ UNIT _____

SAMPLING METHOD:

SPLIT SPOON _____ AUGER _____ SHELBY TUBE _____ SCOOP _____ OTHER _____

| CHK | ANALYSIS | SAMPLE CONTAINER | NO. | REMARKS |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

TOTAL NUMBER OF CONTAINERS FOR SAMPLE _____

**DESCRIPTION OF SITE AND SAMPLE CONDITIONS**

SITE DESCRIPTION : _____

SAMPLE FORM _____ COLOR _____ ODOR _____

PID (HNu) _____ UNUSUAL FEATURES _____

WEATHER/TEMPERATURE _____

SAMPLER _____

## FIELD PARAMETER/LOGBOOK FORM 10-b
## GROUNDWATER AND SURFACE WATER SAMPLES

HIGH CONCENTRATION EXPECTED? _____ HIGH HAZARD? _____

INSTALLATION/SITE _____ AREA _____

INST CODE _____ FILE NAME _____

SITE TYPE _____

SITE ID _____ FIELD SAMPLE NUMBER _____

DATE (MM/DD/YY) ____/____/____ TIME _____ AM PM SAMPLE PROG. _____

DEPTH (TOP) _____ DEPTH INTERVAL _____ UNITS _____

### SAMPLING MEASUREMENTS

CAL REF. _____ pH _____ TEMPERATURE °C _____ CONDUCTIVITY _____

OTHER _____

| CHK | ANALYSIS | SAMPLE CONTAINER | NO. | REMARKS |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

TOTAL NUMBER OF CONTAINERS FOR SAMPLE _____

### DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION _____

SAMPLING METHOD _____

SAMPLE FORM _____ COLOR _____ ODOR _____

PID (HNu) _____

UNUSUAL FEATURES _____

WEATHER/TEMPERATURE _____ SAMPLER _____

**MAP FILE LOGBOOK FORM 10-c**
**SURFACE WATER, SOIL, AND SEDIMENT SAMPLES**

SITE ID _____ POINTER _____

DESCRIPTION/MEASUREMENTS _____

_____

_____

_____

SKETCH/DIMENSIONS :

MAP REFERENCE _____

COORDINATE DEFINITION (X is _____ Y is _____)

COORDINATE SYSTEM _____ SOURCE _____

ACCURACY _____

X-COORDINATE _____ Y-COORDINATE _____ UNITS _____

ELEVATION REFERENCE _____

ELEVATION SOURCE _____ ACCURACY _____

ELEVATION _____ UNITS _____

SAMPLER _____

**MAP FILE AND PURGING LOGBOOK FORM 10-d**
**GROUNDWATER SAMPLES**

WELL COORD. OR ID _____ SAMPLE NO. _____
WELL/SITE DESCRIPTION _____

X-COORD. _____ Y-COORD. _____ ELEV. _____ UNITS _____
DATE ___/___/___ TIME _____ AIR TEMP. _____

WELL DEPTH _____ FT. _____ IN. CASING HT. _____ FT. _____ IN.
WATER DEPTH _____ FT. _____ IN. WELL DIAMETER _____ IN.
WATER COLUMN HEIGHT _____ FT. _____ IN. SANDPACK DIAM. _____ IN.
EQUIVALENT VOLUME OF STANDING WATER _____ (GAL) (L)
VOLUME OF BAILER _____ (GAL) (L) or PUMP RATE _____ (GPM) (LPM)
TOTAL NO. OF BAILERS (5 EV) _____ or PUMP TIME _____ MIN.
WELL WENT DRY? [Yes] [No] NUM. OF BAILERS _____ or PUMP TIME _____
VOL. REMOVED _____ (GAL) (L) RECOVERY TIME _____
PURGE AGAIN? [Yes] [No] TOTAL VOL. REMOVED _____ (GAL) (L)

| DATE & TIME | QUANTITY REMOVED | TIME REQ'D | pH | Cond | Temp | ORD | Turb | DO | Character of water (color / clarity / odor / partic.) |
|---|---|---|---|---|---|---|---|---|---|
| (before) | | | | | | | | | |
| (during) | | | | | | | | | |
| (during) | | | | | | | | | |
| (during | | | | | | | | | |
| (after) | | | | | | | | | |

COMMENTS _____

SIGNATURE _____

# EXAMPLE
# FIELD CALIBRATION FORM 10-e
# FOR
# pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY, ORD, AND DISSOLVED OXYGEN METERS

| INITIAL CALIBRATION | FINAL CALIBRATION |
|---|---|
| DATE: | DATE: |
| TIME: | TIME: |

## pH METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _____

METER ID

| pH STANDARD | INITIAL READING | RECALIB. READING | FINAL READING |
|---|---|---|---|
| 7.0 | | | |
| 10.0 | | | |
| 4.0 | | | |

## CONDUCTIVITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _____

METER ID

| COND. STANDARD | INITIAL READING | RECALIB. READING | FINAL READING |
|---|---|---|---|
| | | | |
| | | | |

## TEMPERATURE METER CALIBRATION

METER ID

| TEMP. STANDARD | INITIAL READING | RECALIB. READING | FINAL READING |
|---|---|---|---|
| ICE WATER | | | |
| BOILING WATER | | | |
| OTHER _____ | | | |

# EXAMPLE
# FIELD CALIBRATION FORM 10-e
# FOR
# pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY, ORD, AND DISSOLVED OXYGEN METERS

## TURBIDITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _____

METER ID

| STANDARD | INITIAL READING | RECALIB. READING | FINAL READING |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

## ORD METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _____

METER ID

| STANDARD | INITIAL READING | RECALIB. READING | FINAL READING |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

## DISSOLVED OXYGEN METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _____

METER ID

| STANDARD | INITIAL READING | RECALIB. READING | FINAL READING |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

COMMENTS _____

_____

_____

_____

SIGNATURE _____

# STANDARD OPERATING PROCEDURE 011
# SEDIMENT SAMPLING

## 1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure is to delineate protocols for sampling sediments. Sediments include solid matter derived from rocks or biological materials which are suspended in, or settled from, water. This procedure can be applied to the collection of sediment samples from areas of deposition such as streams, rivers, ditches, lakes, ponds and lagoons. Sediment samples indicate the amount of contamination adsorbed on sediment particles and/or the amount of wastes transported from the site. It is therefore important to collect a representative sample.

## 2.0 MATERIAL

a. Stainless steel, Polytetrafluoroethelyne (PTFE), or PTFE-lined sampling tray or bowl
b. Stainless steel or PTFE dip sampler, scoops, trowels, spoons, ladles
c. PVC pipe, 2 in. diameter
d. Hand core sediment sampler, liners (optional) and extensions
e. Pipe dredge sampler
f. Jaw type sampler
g. Sample bottles
h. Rubber boots/waders
i. Plastic sheeting
j. Utility knife
k. Rope
l. Boat
m. PPE
n. Personal flotation devices (PFDs)

## 3.0 PROCEDURE

The water content of the sediment may vary greatly. Likewise, the sediments themselves may range from very soft to dense. It may be necessary to use a variety of equipment to obtain the required samples, even at a single site.

**3.1** Upon arrival at the site, immediately set up and organize the equipment downstream (where applicable) from sampling point.

**3.1.1** Cut a section of plastic sheet approximately 6 ft. x 6 ft. Place plastic on ground to use as a clean staging area for sampling equipment.

**3.1.2** Arrange sample containers, samplers, preservatives, and decon equipment on the plastic sheet. Exercise caution not to step on, or otherwise contaminate this clean working surface.

**3.1.4** Don personal protective equipment in accordance with the site safety and health plan.

**3.1.5** Collect surface water sample.

**3.1.6** Collect sediment sample. The preferred method of collecting sediment samples will be by hand corer (section 3.2), or PVC pipe (section 3.3). If using a scoop, trowel, spoon, or ladle, refer to section 3.5. If using a dredge sampler see section 3.4.

**3.2 If using a hand corer, proceed as follows:**

**3.2.1** Ensure that the corers and (optional) liners are properly cleaned.

**3.2.2** Force the corer into the sediment with a smooth continuous motion to a depth of approximately 9 inches.

**3.2.3** Twist the corer to detach the sample; then withdraw the corer in a single smooth motion.

**3.2.4** Remove top of corer and decant excess water into a 1-L sample bottle. This water sample will be labelled and analyzed as an additional unfiltered surface water sample.

**3.2.5** Remove the nosepiece and deposit the sample onto a stainless steel, PTFE, or PTFE-lined tray.

**3.2.6** Transfer the sample into sample containers (see 3.3.6) using a stainless steel laboratory spoon (or equivalent device). The transfer equipment may be disposable to avoid decontamination costs, and the risk of cross-contamination.

**3.2.7** The top 6 inches of the core will be sampled into 3 separate containers - 2 inches per container - to ensure that an accurate chronology of contamination can be determined.[3]

**3.2.8** Ensure each container will be properly labeled, appropriate preservatives added (see SOP 019), and placed in cooler with ice packs.

**3.2.9** Decontaminate equipment according to SOP 023.

**3.3 A two-inch diameter PVC pipe can be effectively used instead of a hand corer in very soft sediments as follows:**

**3.3.1** Force pipe into sediment with a smooth continuous motion to a depth of approximately 9 inches

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[3] If specific data quality objectives mandate, the sample may be homogenized in bowl using sampling spoon, then samples will placed in containers, preserved (as required) and packed on ice.

**3.3.2** Cap the pipe, forming an airtight seal, to create a vacuum as it is withdrawn from the water

**3.3.3** Decant excess water as in 3.2.4 above.

**3.3.4** Deposit the sample onto a stainless steel or PTFE tray, and sample as in steps 3.2.5 through 3.2.7 above.

**3.3.5** Decontaminate equipment according to SOP 023.

**3.4** In deeper water, sampling will be accomplished from a boat.

**3.4.1** **If a pipe dredge is used**, it will be thrown outward, then dragged across the bottom to collect sediment. The sampler will be emptied into a stainless steel or PTFE tray. The composite sample will be placed in the sample bottle by pouring, or through the use of a stainless steel spoon or trowel.

**3.4.2** **If a jaw type bottom sampler is used**, refer to SOP 012 for details.

**3.4.3** Decontaminate equipment according to SOP 023 § 3.3.2 "Solid materials samplers".

**3.5** If using a scoop, trowel, spoon, or ladle, sample as follows:

**3.5.1** Insert the sampling device into the material at the selected point and slowly remove the sample. Care should be taken to retain as much of the clay component as possible.

**3.5.2** Transfer the sample into the appropriate container, add preservative as required in SOP 019, cap the container, and place in ice chest.

**3.5.3** Decontaminate equipment according to SOP 023 § 3.3.2 "Solid materials samplers".

**3.7** For all samples, mark the sampling location on a site map. Photograph (optional, recommended) and describe each location, and place a numbered stake above the visible high water mark on the bank closest to the sampling location. The photographs and description must be adequate to allow the sampling station to be relocated at some future date.

**3.8** Dispose of all sampling wastes in properly labelled containers.

## 4.0 MAINTENANCE

Not Applicable.

## 5.0 PRECAUTIONS

5.1 Both surface water and sediment samples are to be collected at the same location.

5.2 Take the surface water sample first (SOP 006). Sediment sampling usually results in disturbance of the sediments which may influence the analytical results of the surface water samples.

5.3 Wear gloves when collecting sediment samples. Be sure to consult the health and safety plan for the proper dermal and respiratory protection prior to collecting any samples.

5.4 Higher levels of personal protective equipment may be required by the HASP.

5.5 If sampling from a boat or near water bodies with a depth of four feet or more, the sampling team shall wear personal flotation devices (life jackets).

5.6 Collect samples first from those areas that are suspected of being the least contaminated, thus minimizing the risk of cross contamination.

5.7 Collecting sediment samples directly into sample bottles is not recommended.

## 6.0 REFERENCES

EPA/540/P-87/001, A Compendium of Superfund Field Operations Methods.

# STANDARD OPERATING PROCEDURE 012
# SEDIMENT AND BENTHIC MACROINVERTEBRATE SAMPLING WITH ECKMAN GRAB

## 1.0 Scope and Application

This standard operating procedure covers the protocol for obtaining qualitative or quantitative samples of soft sediments and macroinvertebrates inhabiting soft sediments in lakes, reservoirs, and other water bodies. The Eckman grab sampler is well suited to collecting samples in deeper (up to 100 feet) water bodies.

Use of brand names in this SOP is in nowise intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor shall provide applicable and comparable SOPs for the maintenance and calibration of same.

## 2.0 Materials

a. Eckman grab sampler: a box-shaped device with two scoop-like jaws.
b. Boat
c. Sample containers
d. Sieve - 500 $\mu$ (U.S. std. #30)
e. Stainless steel spoon or trowel
f. Personal protective equipment (PPE)
g. Personal flotation devices (PFDs)

## 3.0 Procedure

**3.1** Cock the sampler by raising each jaw upward into the cocked position using the attached cable and secure the cable to the catch pin located at the top of the sampler.

**3.2** Once cocked, lift the sampler overboard and lower slowly but steadily to the bottom.

**3.3** Once on the bottom, indicated by a slack line, the weighted messenger is sent down the line tripping the catch mechanism, causing the spring loaded jaws to close the bottom of the sampler, containing the sediment.

**3.4** Raise the sample at a slow but steady rate to prevent sample loss or washout.

**3.5** Once the sample is on board, empty the sample into a stainless steel, PTFE, or PTFE-lined bowl or tray for processing.

**3.5.1** If the sediment will be analyzed for VOCs, transfer the sample into the appropriate sample containers immediately.

**3.5.2** If the sediment will not be analyzed for VOCs, use Stainless steel spoon to thoroughly homogenize sample, then transfer sample into appropriate containers. Add preservative as directed in SOP 019. Place in ice-filled chest.

3.5.3 If benthic macroinvertebrates are to be collected, sieve sample and transfer macroinvertebrates into appropriate container. Preserve sample as directed in SOP 019.

3.6 Thoroughly decontaminate the device as described in SOP 023 § 3.3.2 "Solid Materials Samplers".

## 4.0 Maintenance

Maintain according to manufacturers suggestions.

## 5.0 Precautions

5.1 Inspect the device for mechanical deficiencies prior to its use.

5.2 This sampler is inefficient in waters deeper than approximately 75 to 100 feet, under adverse weather conditions, and in waters of moderate to strong currents or wave action.

5.3 Exercise caution at all times once the grab is loaded or cocked because a safety lock is not part of the standard design.

5.4 Operate the sampler from a boat with a winch and cable.

5.5 Wear gloves when collecting sediment samples. Be sure to consult the health and safety plan for the proper dermal and respiratory protection prior to collecting any samples.

5.6 Higher levels of personal protective equipment may be required by the HASP.

5.7 While sampling from a boat in water bodies with a depth of five feet or more, the sampling team shall wear personal flotation devices (life jackets).

5.8 Collect samples first from those areas that are suspected of being the least contaminated, thus minimizing the risk of cross contamination.

## 6.0 References

ASTM Standard 2.1. D4387 Guide for Selecting Grab Sampling Devices for Collecting Benthic Macroinvertebrates

USEPA. 1990. Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters. Office of Research and Development. EPA/600/4-90/030. November, 1990.

# STANDARD OPERATING PROCEDURE 013
# PHOTOIONIZATION DETECTOR (MICROTIP HL-200)

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for field operations with the photoionization detector (Microtip HL-200). The photoionization detector (PID) uses an ultraviolet emitting lamp designed to detect, measure and display the total concentration of airborne ionizable gases and vapors. This information is used to determine control measures such as protection and action levels.

Use of brand names in this SOP is in no wise intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor shall provide applicable and comparable SOPs for the maintenance and calibration of same.

## 2.0 Material

a. Microtip
b. Battery Pack
c. Calibration Gas (100ppm Isobutylene)
d. Tedlar Bag
e. Tygon Tubing
f. Regulator

## 3.0 Startup/Calibration Procedure

**3.1** Turn the instrument on by pressing the back of the power switch located on the handle of the Microtip.

**3.2** The message "Warming up now, please wait" will be displayed for up to three minutes. After normal display appears, the Microtip is ready for calibration.

**3.3** Fill a tedlar bag with the desired calibration gas (usually 100ppm Isobutylene).

**3.4** Press SETUP button and select the desired Cal Memory using the arrow keys (normally set to 200ppm). Press EXIT button to leave setup function.

**3.5** Press CAL button and expose Microtip to Zero Gas. (Usually clean outdoor air will be suitable. If any doubt exists as to the cleanliness of the background air a commercial source of zero gas should be used.).

**3.6** The Microtip then asks for the Span Gas concentration. Enter the known span gas concentration and then connect the tedlar bag containing the Span Gas.

**NOTE: THE SPAN GAS CONCENTRATION IS DEPENDENT UPON BOTH THE CONCENTRATION OF THE SPAN GAS USED AND THE RATING OF THE UV LAMP IN THE**

**MICROTIP AT TIME OF CALIBRATION. IF USING 100ppm ISOBUTYLENE AND THE STANDARD 10.6 eV LAMP, THE SPAN GAS CONCENTRATION WILL BE 56ppm.**

3.7 Press enter and the Microtip sets its sensitivity. Once the display reverts to normal the Microtip is calibrated and ready for use. Remove the Span Gas from the inlet probe. The instrument should be calibrated at least once a day.

## 4.0 Battery charging

4.1 Ensure Microtip is off.

4.2 Set the voltage selector switch on the bottom of the battery charger to the appropriate AC line voltage.

4.3 Press the release button on the bottom of the Microtip and remove the battery pack by sliding it backwards.

4.4 Plug charger into the battery pack and then into an AC outlet and allow the battery to charge for at least 8 hours.

4.5 After charging, remove the charger, first from the outlet then from the battery pack, and slide the battery pack back onto the Microtip.

## 5.0 Precautions

5.1 Microtip does not carry an Intrinsic Safety Rating and must not be used in a hazardous location where flammable concentrations of gases or vapors are constantly present.

5.2 All calibration, maintenance and servicing of this device, including battery charging, must be performed in a safe area away from hazardous locations.

5.3 Do not open or mutilate battery cells

5.4 Do not defeat proper polarity orientation between the battery pack and battery charger.

5.5 Substitution of components may affect safety rating.

## 6.0 References

Microtip HL-200 User's Manual, February, 1990.

# STANDARD OPERATING PROCEDURE 014
# SOIL SAMPLING

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for sampling surface and subsurface soils. Soil samples give an indication of the area and depth of site contamination, so a representative sample is very important.

## 2.0 Materials

a. Stainless steel spoon, trowel, knife, spatula, (as needed)
b. Split-spoon, Shelby tube, or core barrel sampler
c. Bucket auger or push tube sampler
d. Drill rig and associated equipment
e. Stainless steel bowl
f. PPE as required by the HASP

## 3.0 Procedure

### 3.1 Subsurface Samples

**3.1.1** Don PPE. Collect split-spoon, core barrel, or Shelby Tube samples during drilling.

**3.1.2** Upon opening sampler, or extruding sample, immediately screen soil for volatile organic compounds using either a PID or FID. If sampling for VOCs, determing the area of highest concentration, use a stainless steel knife, trowel or lab spatula to peel and sample this area.

**3.1.3** Log the sample in boring log, while it is still in the sampler.

**3.1.4** Peel and transfer the remaining sample in a decontaminated stainless steel bowl. Mix thoroughly with a decontaminated stainless steel spoon or trowel.

**3.1.5** Place the sample into the required number of sample jars.

**3.1.6** Preserve samples as required in SOP 019.

**3.1.7** Discard any remaining sample into the drums being used for collection of cuttings.

**3.1.8** Decon sampling implements according to SOP 023 § 3.3.2.

**3.1.9** All borings will be abandoned according to procedures in SOP 015.

NOTES: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same, except that two split-spoon samples will be mixed together. The boring log should clearly state that the samples have been composited, which samples were composited, and why the compositing was done.

Samples taken for geotechnical analysis will be undisturbed samples, collected using a thin-walled (shelby tube) sampler.

**3.2 Surficial Soil Samples**

**3.2.1** Don PPE. Remove vegetative mat. Collect a sample from under the vegetative mat with a stainless steel trowel, push tube sampler, or bucket auger.

**3.2.2** If a representative sample is desired over the depth of a shallow hole or if several shallow samples are to be taken to represent an area, composite as follows:

**3.2.2.1** As each sample is collected, place a standard volume in a stainless steel bowl.

**3.2.2.2** After all samples from each hole or area are in the bucket, homogenize the sample thoroughly with a decontaminated stainless steel spoon, trowel or spatula.

**3.2.3** If no compositing is to occur place sample directly into the sample jars.

**3.2.4** Place the leftover soil in the auger borings and holes left by sampling. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas.

**3.2.5** Samples for VOCs will not be composited. A separate sample will be taken from a central location of the area being composited and transferred directly from the sampler to the sample container.

**3.2.6** Preserve samples as required in SOP 019.

**3.2.7** Decon sampling implements according to SOP 023 § 3.3.2

**3.3 Refer to SOP 1-5, and 10.**

## 4.0 Maintenance

Not Applicable.

## 5.0 Precautions

5.1 Refer to the Health and Safety Plan.

5.2 Soil samples will not include vegetative matter, rocks, or pebbles, unless the latter are part of the overall soil matrix.

## 6.0 References

ASTM Method D1586-84, Penetration Test and Split-Barrel Sampling of Soils.

ASTM Method D1587-83, Thin Walled Sampling of Soils.

Department of the Army, Office of the Chief of Engineers, Engineer Manual 1110-2-1907 Soil Sampling, 31 March 1972

# STANDARD OPERATING PROCEDURE 015
# WELL AND BORING ABANDONMENT

## 1.0 Scope and Application

The purpose of this standard operating procedure is to establish the protocols by which all borings and wells will be safely abandoned. The primary objective of well abandonment is to ensure that the abandoned well or boring does not provide a conduit for the vertical migration of contamination between aquifers.

## 2.0 Materials

a. Drill Rig
b. Pure Sodium Bentonite With no Additives (bentonite) Powder (grout)
c. Bentonite Pellets (seal)
d. Cement (Portland Type II)
e. Approved Water

## 3.0 Well and Boring Abandonment Procedures

The procedures used in boring abandonment will ideally accomplish two objectives: 1) protect aquifers from cross-contamination by sealing the borehole 2) restore the strata in the borehole to nearly original conditions by selective placement of fill material.

Any casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, grout will be placed from the bottom of the hole until undiluted grout flows to the ground surface, and allowed to settle for 24 hours. After 24 hours, any settlement depression will be filled with grout and rechecked 24 hours later. This process will be repeated until firm grout remains at the ground surface. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site or cluster.

### 3.1 Grout

Grout used in construction will be composed by weight of:

- 20 parts cement (Portland cement, type II or V);
- 0.4 to 1 part (max.)(2-5%) bentonite; and
- 8-gallons (max.) approved water per 94-lb bag of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

All grout material will be combined in an above-ground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump prior to placement.

Grout placement will be performed using a commercially available grout pump and a rigid tremie pipe removal and grouting will be accomplished in stages, aquifer by aquifer, sealing the boring from the bottom to ground surface. This will be accomplished by placing a grout pipe to the bottom and pumping grout through the pipe until undiluted grout reaches the bottom of the next higher section of casing or, for the top-most section, until grout flows from the boring at ground surface.

After 24 hours, the abandoned drilling site will be checked for grout settlement. On that day, any settlement depression will be filled with grout and rechecked 24 hours later. This process will be repeated until firm grout remains at the ground surface.

### 3.2 Borings

The term "Borings" as used in this SOP applies to any drilled hole made during the course of RI which is not completed as a well. This includes soil test borings, soil sampling borings, and deep stratigraphic borings. Whether completed to the planned depth or aborted for any reason prior to reaching that depth, borings will be grouted and will normally be closed within 4 hours, or within 12 hours.

## 4.0 Precautions

None.

## 5.0 References

COMAR 26.04.04 Regulation of Water Supply, Sewage Disposal, and Solid Waste § .11 Abandonment Standards

USATHAMA, 1987. Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports, March 1987

# STANDARD OPERATING PROCEDURE 016
# SAMPLE CONTAINER CLEANING

## 1.0 Scope and Application

The purpose of this standard operating procedure is to define laboratory protocols to be used in cleaning and preparing containers used to collect environmental samples.[4]

## 2.0 Materials

a. Polyethylene bottles
b. Amber glass bottles
c. 40 ml vials
d. Bottle caps
e. Polytetrafluoroethelyne (PTFE) liners
f. 5% NaOH
g. 5% Ultrex $HNO_3$
h. Deionized water
i. Alconox detergent
j. Hexane (Nanograde or equivalent)
k. Acetone
l. Methelyne Chloride

## 3.0 Procedures

### 3.1 Polyethylene bottles

3.1.1 Rinse bottles and lids sequentially with 5% NaOH, with deionized water, with 5% Ultrex nitric acid, and with deionized water.

3.1.2 Drain and allow to air dry.

### 3.2 Amber glass bottles and 40 ml vials

3.2.1 Wash bottles in detergent and rinse with copious amounts of distilled water.

3.2.2 Rinse with acetone

3.2.3 Rinse with methelyne chloride

3.2.4 Rinse with hexane

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[4] This SOP is included for completeness only. It is anticipated that sample containers will either be provided by the laboratory, or that the sampling contractor will purchase new, certified clean sample containers.

3.2.5 Allow bottles to air dry.

3.2.6 Place bottles in a drying oven and heat to 200°C.

3.2.7 Allow bottles to cool prior to sealing with clean caps and PTFE liners.

**3.3 Bottle Caps**

3.3.1 If applicable, remove paper liners from caps.

3.3.2 Wash caps with detergent, followed by a distilled water rinse.

3.3.3 Dry caps in drying oven at 40°C.

**3.4 PTFE liners**

3.4.1 Always handle liners with forceps or tweezers, never use fingers.

3.4.2 Wash liners with detergent, followed by distilled water rinse.

3.4.3 Rinse the liners with acetone, followed by hexane (Nanograde or equivalent).

3.4.4 Allow liners to air dry prior to placing in clean caps, then heat liner and caps in drying oven at 40°C for 2 hours.

3.4.5 Allow caps and liners to cool prior to placing on clean bottles.

**3.5** A statistically representative number of randomly selected clean sample containers shall be analyzed for TAL/TCL analytes (GWP Tables 8.2 - 8.5). Results of these analyses shall be provided to the contracting officer's representative (COR).

## 4.0 Maintenance

Not Applicable.

## 5.0 Precautions

None.

## 6.0 References

None

# STANDARD OPERATING PROCEDURE 017
# PIEZOMETER INSTALLATION

## 1.0 Scope and Application

The installation of piezometers is contingent upon the existing conditions at the project site. The purpose of this Standard Operating Procedure is to delineate the quality control measures required to ensure the accurate installation of piezometers. The Field Sampling Plan should be consulted for specific installation instructions. For the purpose of this investigation, piezometers will be drilled and completed the same as the shallow monitoring wells.

## 2.0 Material

### 2.1 Drilling Equipment

a. Appropriately sized drill adequately equipped with augers, bits, drill stem, etc.
b. Steam cleaner and water obtained from approved source for decontaminating drilling equipment.
c. PID: Microtip HL-200 (or equivalent)
d. Water level indicator
e. Weighted Steel tape measure
f. Steel drums for intrusion derived wastes (drill cuttings, contaminated PPE, decon solutions, etc.)
g. Source of approved water
h. Heavy plastic sheeting
i. Sorbent pads and/or logs

### 2.2 Piezometer Installation Materials[5]

a. Piezometer screen:

PVC: JOHNSON (or equivalent); PVC Vee Wire Continuous slot, wire wrapped screen; 2-inch diam.; SCH 40; flush-threaded (leak-proof) joints; PVC complies with ASTM D2665, ASTM D1784, and ASTM F480; free of ink markings; cleaned and prepackaged by manufacturer

b. Riser pipe:

PVC: JOHNSON (or equivalent); STD. PVC; 2-inch diam.; SCH 40; flush-threaded (leak-proof) joints; PVC complies with ASTM D2665, ASTM D1784, and ASTM F480; free of ink markings; cleaned and prepackaged by manufacturer

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[5] Technical information on all installed materials (screens, riser pipe, filter pack, bentonite, cement, etc.) and representative samples of the proposed filter pack, will be supplied to the Contracting Officer's Representative (COR).

c. Plugs/Caps: JOHNSON (or equivalent); standard PVC
d. Filter pack: MORIE, 100 well gravel (or equivalent)
e. Bentonite seal: BAROID, bentonite pellets (3/8-inch diam.)
f. Cement: Type II Portland Cement [6]
g. Bentonite powder: BAROID
h. Steel Protective Casing: BRAINARD-KILMAN (or equivalent) zinc-plated steel, lockable, painted.[7]
i. Containers for purged water, as required.
j. Conductivity, pH, and temperature meters
k. Electric well sounder and measuring tape.
l. Portland Type II cement (see footnote)
m. Steel Posts (pickets), Painted (see footnote)

### 2.3 Documentation

a. Copy of Work Plan
b. Copy of Field Sampling Plan
c. Copy of approved Health And Safety Plan
d. Copies of well and excavation permits
e. Copy of the QAPP
f. Copy of USAES Geotechnical Requirements

### 2.4 Geologist's personal equipment

a. 1OX handlens
b. Unified Soil classification System chart
c. Munsell color chart
d. PPE as required by HASP

## 3.0 Procedure

### 3.1 Materials Approval

3.1.1 Water sources for drilling, grouting, sealing, filter placement, peizometer installation, and equipment decontamination must be approved by the COR prior to arrival of the drilling equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, Cost per gallon (if applicable), dates and results associated with all available chemical analyses over the past two years, and the name and address of the analytical laboratory (if applicable).

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[6] If sulfates are higher than 1500ppm type IV Portland Cement will be used

[7] All painted components (protector casing, steel pickets) will be painted high-visibility orange and allowed to dry completely prior to being brought onsite.

**3.1.2** Pure sodium bentonite with no additives (bentonite) will be the only drilling fluid additive allowed, and its use must be approved by the COR prior to the arrival of the drilling equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer's address and telephone number, product description, and intended use for the product.

**3.1.3** Granular Filter Pack material must be approved by the COR prior to drilling. A one-pint representative sample must be supplied to the COR. Information required includes: lithology, grain size distribution, brand name, source, processing method, and size of intended screen.

**3.1.4** Portland Type II cement will be used for grout (see footnote).

## 3.2 Drilling

**3.2.1** The objective of the selected drilling technique is To ensure that the drilling method provides representative data while minimizing subsurface contamination, cross contamination, and drilling costs. The drilling method used will be hollow stem auger. The method used at a specific site will be proposed in the work plan and evaluated by the COR.

**3.2.2** A Site Geologist will be present during all borehole drilling and installation activities and will fully characterize all tasks performed in support of these activities into the piezometer logbook. The Site Geologist will be responsible at only one operating rig for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and borehole diagrams, and recording the piezometer installation procedures of the rig. The Site Geologist will have onsite sufficient equipment in operable condition to perform efficiently his/her duties.

**3.2.3** No lubricants will be used on downhole drilling equipment. Additives containing either lead or copper will not be allowed. In addition, polychlorinated biphenyls will not be permitted in hydraulic fluids or other fluids used in the drilling rig, pumps, or other field equipment and vehicles.

**3.2.4** Surface runoff or other fluids will not be allowed to enter any boring or piezometer during or after drilling/construction.

**3.2.5** Antifreeze used to keep equipment from freezing will not contain rust inhibitors and sealants. Antifreeze is prohibited in an areas in contact with drilling fluid. The ground surface at the piezometer site will be protected from possible coolant, fuel, and hydraulic fluid spills and/or leakage by placement of plastic sheeting with raised edges, draining into a lined catch basin large enough to contain spills and/or leakage from motors, radiators, or vehicle tanks. Sorbent pillows will be placed to catch obvious leaks from the drill rig. Sorbent logs may be used instead of, or in conjunction with a lined catch basin to contain spills.

**3.2.6** Drilling will be terminated before penetrating the basal aquitard. The basal aquitard is defined as the first 2 foot-thick clay below the water table, or below 5 feet in the case of a shallow aquifer.

3.2.7 **<u>If DNAPL contamination is detected during drilling</u>**, the piezometer will be terminated and completed at the base of the aquifer. Drilling will not continue through the confining unit.

3.2.7.1 DNAPL sampling cups are prohibited. The piezometer screen will be capped, and set 0.3 ft (0.5 ft. max.) into the top of the confining bed and rest on the bottom of the hole or bentonite backfill (if used). No sand will be placed below the screen.

3.2.7.2 The remainder of the piezometer installation and completion will be accomplished according to section 3.4.

## 3.3 Logging

3.3.1 Borings for piezometers will be logged by a geologist. Logs will be recorded in a boring log. Field notes are to include, as a minimum:

a. Boring Number
b. Material Description (as discussed below)
c. Weather conditions
d. Evidence of Contamination
e. Water Conditions (including measured water levels)
f. Daily Drilling Footage and Quantities (for billing purposes)
g. Notations on Man-Placed Materials
h. Drilling Method and Bore Hole Diameter
i. Any Deviations from Established Field Plans
i. Blow Counts for Standard Penetration Tests
k. Core and Split-Spoon Recoveries

3.3.2 Material description for soil samples must include:

a. Classification
b. Unified Soil Classification Symbol
c. Secondary Components and Estimated Percentages
d. Color
e. Plasticity
f. Consistency
g. Density
h. Moisture Content
i. Texture/Fabric/Bedding and Orientation
j. Grain Angularity
k. Depositional Environment and Formation
l. Incidental odors
m. PID reading(s)
n. Staining

3.3.3 Material description for rock samples must include:

a. Classification
b. Lithologic Characteristics

c. Bedding/Banding Characteristics
d. Color
e. Hardness
f. Degree of Cementation
g. Texture
h. Structure and Orientation
i. Degree of Weathering
i. Solution or Void Conditions
k. Primary and Secondary Permeability
l. Sample Recovery
m. Incidental odors
n. PID reading(s)
o. Staining

See also SOP003 for details on logbook entries.

**3.4 Piezometer Construction and Installation**

Normal screen placement for the water table aquifer will be with 3 ft. of the screen extending above the static water level. The bottom of the screen will rest no more than 6 in. from the bottom of the hole or backfill material, whichever is applicable.

Note: the end cap in DNAPL piezometers will rest on the bottom of the bottom of the hole, or bentonite backfill if applicable.

**3.4.1** The installation of piezometer will begin within 12 hours of completion of drilling. Once installation has begun, work will continue until the Bentonite seal is installed.

**3.4.2** Piezometer screens, casings, and fittings will conform to National Sanitation Foundation Standard 14 or American Society for Testing and Materials (ASTM) equivalent for potable water usage. These materials will bear the appropriate rating logo. If the logos are not present, a written statement from the manufacturer/supplier stating that the materials contain the appropriate rating must be obtained. Material used will be new and essentially chemically inert to the site environment.

**3.4.2.1** Piezometer screen and casing should be inert with respect to the ground water; therefore, the selection of screen and casing material will be based on select field tests of aquifer chemistry and potential contaminants. The screen will be capped without sediment trap or DNAPL sampling cup, and lowered into the hole. The piezometer casing will be pre- cut to extend 2 to 2.5 ft above the ground surface. Prior to placement of the last piece of piezometer casing, a notch or other permanent reference point will be cut, filed, or scribed into the top edge of the casing.

**3.4.2.2** Screen slot size will be appropriately sized to retain 90 to 100% of the filter pack material, the size of which will be determined by sieve analysis of formational material.

3.4.2.3 The tops of all casing will be capped with loose fitting PVC cap. These caps should be secure enough to preclude the introduction of foreign material into the piezometer, yet allow pressure equalization between the piezometer and the atmosphere.

3.4.3 Filter pack material will be tremied into place. Filter pack will extend from the bottom of the hole to a height of 5 feet above the top of the screen.

3.4.3.1 Granular filter packs will be chemically and texturally clean, inert, and siliceous.

3.4.4 Bentonite seals will be a minimum of five feet thick as measured immediately after placement. The final depth to the top of the bentonite seal will be measured and recorded.

3.4.5 GROUT

Grout used in construction will be composed by weight of:

- 20 parts cement (Portland cement, type II)(see footnote)
- 0.4 to 1 part (max.)(2-5%) bentonite
- 8-gallons (max.) approved water per 94-lb bag of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

3.4.5.1 Grout material will be combined in an above-ground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump prior to placement.

3.4.5.2 Grout placement will be performed using a commercially available grout pump and a rigid, tremie pipe.

3.4.5.3 The following will be noted in the Boring Log: exact amounts of cement, bentonite, and water used in mixing grout, and actual volume of grout placed in the hole.

3.4.6 Piezometer protective casings will be installed around all piezometers on the same day as the initial grout placement around the piezometer. Any annulus formed between the outside of the protective casing and the borehole will be filled to ground surface with cement.

3.4.7 The construction of each piezometer will be depicted as built in a piezometer construction diagram. The diagram will be attached to the boring log and will graphically denote:

a. Screen location, length
b. Granular filter pack
c. Seal

d. Grout
e. Cave-in
f. Height of riser
g. Protective casing detail

**3.5 Piezometer completion**

**3.5.1** Assemble appropriate decontaminated lengths of pipe and screen. Make sure these are clean and free of grease, soil, and residue.

**3.5.2** Lower each section of pipe and screen into the borehole, one at a time, screwing each section securely into the section below it. No grease, lubricant, polytetrafluoroethelyne (PTFE) tape or glue, may be used in joining the pipe and screen sections.

**3.5.3** Prior to installation, cut the riser so that it will extend approximately 2-2.5 ft. above grade. Notch, file, or otherwise permanently mark a reference point on the top of the casing. All pipe cuts MUST be square to ensure that the elevation between the highest and lowest point of the piezometer casing is less than or equal to 0.02 ft.

**3.5.4** When the piezometer is set to the bottom of the hole, temporarily place a cap on top of the pipe to keep the piezometer interior clean.

**3.5.5** Place the appropriate filter pack into using a tremie pipe. Monitor the rise in the annulus with a weighted tape to assure that bridging is not occurring.

**3.5.6** After the pack is in place, wait three to five minutes for the material to settle, and check its depth weighted steel tape.

**3.5.7** Install the bentonite seal by dropping bentonite pellets into the hole gradually. If the piezometer is deeper than 30 feet, a tremie pipe will be used to place the pellets. Check depth with a weighted tape as above.

**3.5.8** Wait 2 hours for the pellets to hydrate and swell. If the pellets are above the water level in the hole, add several buckets of clean water to the boring. Document the amount of water added to the hole.

**3.5.9** Mix an appropriate cement-bentonite slurry. Be sure the mixture is thoroughly mixed and as thick as is practicable.

**3.5.10** Lower a rigid tremie pipe into the annulus to the level of the pellet seal.

**3.5.11** Pump the grout slurry into the annulus while withdrawing the tremie pipe and temporary casing.

**3.5.12** Continue the grout fill to the ground surface. When installing piezometer in hollow stem augers, incrementally place grout and remove auger so as to constantly maintain 10 feet of grout (minimally) within the auger yet to be removed from the ground. Seat the protective casing in the grout, allowing no

more than 0.2 - ft between the top of the piezometer casing and the bottom of the protective casing cap. Lock the cap.

-and-

**3.5.13** Allow the grout slurry to set overnight.

**3.5.14** Fill the outer annulus (between the casing and the borehole) with neat grout. Finish surface with cement to mound above ground level and finish to slope away from the casing.

**3.5.15** Slope the ground surface away from the casing for a distance of two feet, at a rate of no less than 1 inch in two feet.

**3.5.16** Set pre-painted protective steel pickets (3 or 4) evenly around and 4 feet out from piezometer.

## 4.0 Maintenance

Not Applicable.

## 5.0 Precautions

Refer to the site-specific Health and Safety Plan for discussion of hazards and preventive measures during piezometer installation activities.

## 6.0 References

Aller, Linda, *et al.*, 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, National Water Well Association

Cohen, Robert M., and Mercer, James W. 1993. DNAPL Site Evaluation, CRC Press, Inc.

COMAR 26.04.04 Well Construction

EPA Groundwater Handbook 1989

Nielsen, David M., 1993. Correct Well Design Improves Monitoring, in "Environmental Protection", Vol.4, No.7, July, 1993.

USATHAMA. 1987. Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition. and Reports, March 1987.

ASTM D 2487-92 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 5092-90 Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers

WELL DESIGNATION: _____ DATE(S) OF INSTALLATION:____/____/____

SITE GEOLOGIST: _____ DEVELOPMENT DATE(S):____/____/____

STATIC WATER LEVELS BEFORE AND AFTER DEVELOPMENT * :

BEFORE _____ DATE _____ 24 HR. AFTER _____ DATE_____

DEPTH TO SEDIMENT BEFORE AND AFTER DEVELOPMENT * :

BEFORE _____ DATE _____ 24 HR. AFTER _____ DATE_____

DEPTH TO WELL BOTTOM *: _____ SCREEN LENGTH _____

HEIGHT OF WELL CASING ABOVE GROUND SURFACE: _____

QUANTITY OF MUD/WATER:

| | | |
|---|---|---|
| LOST DURING DRILLING | (+)_____ | gallons |
| REMOVED PRIOR TO WELL INSERTION | (-)_____ | gallons |
| LOST DURING THICK FLUID DISPLACEMENT | (+)_____ | gallons |
| ADDED DURING FILTER PACK PLACEMENT | (+)_____ | gallons |
| TOTAL LOSSES | _____ | gallons |

(a) Water column ht. (ft.) _____ (b) Well radius (in.)_____

(c) Screen length (ft.) _____ (d) Borehole radius (in.)_____

(e) QUANTITY OF FLUID STANDING IN WELL

$(12*a*\pi*b^2*0.0043)=$

_____ gallons
(Show Calculation)

(f) QUANTITY OF FLUID IN ANNULUS

$[12*c*\pi 8(d^2-b^2)*0.0043*0.30]$

_____gallons
(Show Calculation)

DEVELOPMENT VOLUME = (5 * TOTAL LOSSES) + [5 * (e + f)] = _____ gallons
(Show Calculation)

*** ALL DEPTHS MEASURED FROM TOP OF WELL CASING**

EXAMPLE WELL DEVELOPMENT RECORD
(PAGE 2 OF 2)

WELL DESIGNATION _____ DATE(S) OF DEVELOPMENT: ____/____/____

TYPE AND SIZE OF PUMP: _____

TYPE AND SIZE OF BAILER: _____

DESCRIPTION OF SURGE TECHNIQUE:
_____
_____

RECORD OF DEVELOPMENT

| DATE & TIME | QUANTITY REMOVED | TIME REQ'D | pH | Cond | Temp | ORD | Turb | DO | Character of water (color / clarity / odor / partic.) |
|---|---|---|---|---|---|---|---|---|---|
| (before) | | | | | | | | | |
| (during) | | | | | | | | | |
| (during) | | | | | | | | | |
| (during | | | | | | | | | |
| (after) | | | | | | | | | |

TYPICAL PUMPING RATE _____ GAL./HR. EST. RECHARGE RATE _____

TOTAL QUANTITY OF WATER REMOVED _____ TIME REQUIRED _____

REMARKS _____
_____
_____

SIGNATURE OF SITE GEOLOGIST _____

# STANDARD OPERATING PROCEDURE 018
# TURBIDITY MEASUREMENTS (DRT 100)

## 1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure is to delineate protocols for measuring the turbidity of all types of aqueous solutions, including drinking water, saline water, and industrial and domestic wastes. Turbidity is an indication of the optical properties that cause light to be scattered or absorbed through an aqueous sample. Turbidity is largely a function of the refractive index and the size and shape of the particles suspended or dissolved in the solution. Turbidity meters do not produce an "absolute" measurement, but one that is "relative" to the optical nature of the solids in solution.

Use of brand names in this SOP is in nowise intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor shall provide applicable and comparable SOPs for the maintenance and calibration of same.

## 2.0 MATERIAL

a. Turbidity meter (DRT 100 or equivalent)
b. Lint free laboratory wipes (Kimwipes or equivalent)
c. Formazin standards (from manufacturer)
d. Sample bottle
e. Cuvettes

## 3.0 PROCEDURE

**3.1** Calibration of the turbidity meter will be checked on a daily basis as follows.

**3.1.1** Set the range switch to 1000 range before turning the turbidity meter on and whenever the light shield is not in place over the sample well.

**3.1.2** Allow the turbidity meter 15 to 60 minutes to warm-up.

**3.1.3** Clean the reference standard with kimwipes.

**3.1.4** Place the formazin suspension or reference standard in the turbidity meter sample well.

**3.1.5** Place the light shield over the reference standard.

**3.1.6** Rotate the front panel range switch counterclockwise to the appropriate NTU range.

**3.1.7** Adjust the reference adjust knob counterclockwise to read the same value as the reference standard value. This value is stamped on top of the reference standard.

**3.1.8** The turbidity meter is now standardized on all ranges to the factory formazin calibration and unknown samples may be read directly in NTU, FTU, or JTU.

**3.1.9** Rotate the range switch clockwise to the 1000 range before removing the reference standard.

**3.1.10** Record reading in Field Logbook. (Refer to SOPs 003, and 010.)

**3.1.11** Do not leave the reference standard in the sample well for long periods.

**3.2** Turbidity will be measured as follows.

**3.2.1** Pour aqueous sample into a new cuvette assuring no air bubbles.

**3.2.2** Place the cuvette into the sample well.

**3.2.3** Place the light shield over the sample.

**3.2.4** Rotate the range switch counterclockwise to the range which provides best readability and sensitivity for the sample being measured.

**3.2.5** Allow the turbidity meter to stabilize before recording the NTU value.

**3.2.6** Turn the range switch clockwise to the 1000 range and then remove the sample.

**3.2.7** Do not leave the filled cuvette in the sample well for long periods.

**3.2.8** Repeat steps 3.2.1 - 3.2.7 for additional samples.

**3.3** Cuvette cleaning procedure is as follows.

**3.3.1** Cuvette must be clean and free of rubs or scratches.

**3.3.2** Wash the cuvette in a detergent solution.

**3.3.3** Rinse thoroughly 8-10 times, preferably with distilled water to remove all streaks.

**3.3.4** Polish with kimwipes.

**3.3.5** Cuvettes must be stored in a clean dust-free environment.

## 4.0 MAINTENANCE

**4.1** Source Lamp may be replaced as follows.

**4.1.1** Remove the instrument case per manufacturer instruction.

**4.1.2** Remove the bulb by loosening a screw and removing the electrical leads.

**4.1.3** Insert the new bulb and reconnect the electrical leads.

**4.1.4** Before tightening the screw, be sure to position the filament so that it will be parallel to the axis of the sample well.

**4.1.5** Insert the lamp alignment tool in the sample well to focus the new bulb.

**4.1.6** Move the lamp bracket assembly in or out until a focused image of the filament is within the rectangular box on the lamp alignment tool.

**4.1.7** Once the filament image has been aligned and focused within the rectangular box on the lamp adjustment tool, tighten all screws snugly.

**4.1.8** Replace the instrument case

## 5.0 PRECAUTION

**5.1** Handle the reference standard or sample cuvettes by the top to prevent surface scratches or finger smudges which will cause analysis errors.

**5.2** Check the mechanical meter zero when the instrument is in a vertical position and the power switch is off. Adjust to zero only if necessary by means of the black screw on the meter face.

**5.3** The turbidity meter should be left on for the entire work shift to minimize warm-up and recalibration delays.

**5.4** Do not leave the reference standard or filled cuvette in the sample well for long periods.

**5.5** Leave the light shield in place on the instrument when it is not in use in order to protect the sample well for long periods.

**5.6** Always set the range switch to 1000 range before turning the instrument on and whenever the light shield is not in place over the well.

## 6.0 REFERENCES

Manufacturer's Manual

# STANDARD OPERATING PROCEDURE 019
# SAMPLE PRESERVATION AND CONTAINER REQUIREMENTS

## 1.0 Purpose and Scope

The purpose of this standard operating procedure is to define the preservatives and techniques to be employed in preserving environmental samples between collection and analysis.

## 2.0 Material

a. Containers (see § 3.0 below for description)
b. $HNO_3$
c. $H_2SO_4$
d. NaOH
f. Ice chests
g. Ice

## 3.0 Definition of Container Types

**Type A Container**: 80 oz amber glass, ring handle bottle/jug, 38-mm neck finish.
**Closure**: White polypropylene or black phenolic, baked polyethylene cap, 38-430 size, 0.015-mm Polytetrafluoroethelyne (PTFE) liner.

**Type B Container**: 40-mL glass vial, 24 mm neck finish
**Closure**: White polypropylene or black phenolic, open top, screw cap, 15-mm opening, 24-400 size.
**Septum**: 24-mm disc of 0.005-in PTFE bonded to 0.120-in silicon for total thickness of 0.125-in.

**Type C Container**: 1-L high density polyethylene, cylinder-round bottle, 28-mm neck finish.
**Closure**: White polyethylene cap, white ribbed, 28-410 size; F217 polyethylene liner.

**Type D Container**: 120-mL wide mouth glass vial, 48-mm neck finish.
**Closure**: White polyethylene cap, 40-480 size; 0.015-mm PTFE liner.

**Type E Container**: 250-mL boston round glass bottle
**Closure**: White polypropylene or black phenolic, open top, screw cap.
**Septum**: Disc of 0.005-in PTFE bonded to 0.120-in silicon for total thickness of 0.125-in.

**Type F Container**: 8-oz short, wide mouth, straight -sided, flint glass jar, 70-mm neck finish.
**Closure**: White polypropylene or black phenolic, baked polyethylene cap, 48-400 size; 0.030-mm PTFE liner.

**Type G Container**: 4-oz tall, wide mouth, straight -sided, flint glass jar, 48-mm neck finish.

**Closure**: White polypropylene or black phenolic, baked polyethylene cap, 48-400 size; 0.015-mm PTFE liner.

**Type H Container**: 1-L amber, Boston round, glass bottle, 33-mm pour-out neck finish.
**Closure**: White polypropylene or black phenolic, baked polyethylene cap, 33-430 size; 0.015-mm PTFE liner.

**Type K Container**: 4-L amber glass ring handle bottle/jug, 38-mm neck finish.
**Closure**: White polypropylene or black phenolic, baked polyethylene cap, 38-430 size; 0.015-mm PTFE liner.

**Type L Container**: 500-mL high-density polyethylene, cylinder bottle, 28-mm neck finish.
**Closure**: White polypropylene, white ribbed, 28-410 size; F217 polyethylene liner.

## 4.0 Procedure

4.1 Containers must be certified clean, with copies of laboratory certification furnished to the contracting officer's representative (COR).

4.2 Water samples will be collected according to procedures detailed in SOPs 006 and 022 into containers appropriate to the intended analyte as given in Table 039-1.

4.2.1 Samples taken for VOC analysis will be collected in pre-pressured VOC vials. Sufficient HCl will have been added to the vial prior to the addition of the sample such that the pH<2.

4.2.2 Samples taken for metals analysis will be acidified in the field to a pH < 2 by the addition of $HNO_3$. Filtered samples will be acidified after filtration. After acidifying the sample, the container should be lightly capped, then swirled to thoroughly mix the sample. The cap will then be loosened to release any excess pressure this operation may have generated.

4.2.3 Samples taken for cyanide will be alkalized to a pH > 12 by the addition of NaOH.

4.2.4 No preservatives will be added to any other water samples. These samples will be immediately placed on ice and cooled to 4°C.

4.3 Soil and sediment, samples will be collected according to procedures detailed in SOPs 011, 012, and 014 into containers appropriate to the intended analyte as given in Table 019-2.

4.3.1 No chemical preservatives will be added to soil or sediment samples. These samples will be immediately placed on ice and cooled to 4°C.

## 5.0 Maintenance

Not Applicable.

## 6.0 Precautions

Note that acidifying a sample containing cyanide may liberate HCN gas.

- Avoid breathing any fumes emanating from acidified samples.
- Acidify samples only in the open, rather than in closed spaces such as a vehicle.
- See the HASP for other safety measures

## 7.0 References

Test Methods for Evaluating Solid Waste, SW-845, (EPA 1986)
A Compendium of Superfund Field Operations Methods, EPA 540-P87-001
A Compendium of ERT Soil Sampling and Surface Geophysics Procedures, (EPA 1991)

Table 019-1
Preservation Requirements for Water Samples

| Analyte | Bottle Requirement, Volume | Required Headspace | Preservative | Holding Time |
|---|---|---|---|---|
| Volatile Organic Compounds | (2)Type B, 80-mL total | 0% | Cool to 4°C<br>HCl pH<2 | 7 days |
| Semivolatile Organic Compounds | Type A, K, or (2)H, 2-L total | 10% | Cool to 4°C | 7 days to extraction, 40 days after extraction |
| Pesticides/ Arochlors | Type A, K, or (2)H, 2-L total | 10% | Cool to 4°C | 7 days to extraction, 40 days after extraction |
| Total Metals | Type C, H, or (2)L, 1-L total | 10% | $HNO_3$ to pH < 2<br>Cool to 4°C | 6 months except Mercury (28 days) |
| Cyanide | Type C, H, or (2)L, 1-L total | 10% | NAOH to pH > 12<br>Cool to 4°C | 14 days |

Table 019-2
Preservation Requirements for Soil and Sediment Samples

| **Analyte** | **Bottle Requirement, Volume** | **Required Headspace** | **Preservative** | **Holding Time** |
|---|---|---|---|---|
| Volatile Organic Compounds | (2) Type D, 240-mL total | 0% | Cool to 4°C | 14 days |
| Semivolatile Organic Compounds | Type F or G, 3 oz. | 10% | Cool to 4°C | 7 days to extraction, 40 days after extraction |
| Pesticides/ Arochlors | Type F or G, 3 oz. | 10% | Cool to 4°C | 7 days to extraction, 40 days after extraction |
| Total Metals | Type F or G, 3 oz. | 10% | Cool to 4°C | 6 months except Mercury (28 days) |
| Cyanide | Type I, 1-L | 10% | Cool to 4°C | 14 days |

# STANDARD OPERATING PROCEDURE 020
# HYDROLAB MULTIPARAMETER WATER QUALITY MONITORING INSTRUMENT

## 1.0 Hydrolab Multiparameter Water Quality Monitoring Instrument

### 1.1 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for field operation with the multiparameter water quality logging system (H20 data son and SCOUT 2 receiver). The System can monitor up to eight basic parameters including dissolved oxygen, % saturation, temperature, pH, specific conductance, resistivity, salinity, total dissolved solids, redox, level, and depth.

### 1.2 Materials

- SCOUT 2 Display
- H20 Water Quality Data Transmitter
- Underwater Cables
- Accessories

### 1.3 Calibration

Calibration may be performed at the lab or in the field daily before use.

**1.3.1** Fill the Calibration Cup with the appropriate standard as follows:

a. temperature - none required
b. specific conductance - KCl or seawater standards
c. pH - pH 7 buffer plus a slope buffer
d. dissolved oxygen - saturated air or saturated water
e. redox - quinhydrone or tranosfer
f. depth - set zero in air
g. level - set zero in air
h. salinity - uses calibration for specific conductance

**1.3.2** Press the blue Calibrate button.

**1.3.3** Enter the value of the standard.

**1.3.4** Accept the new calibration number.

### 1.4 Procedures

**1.4.1** Attach the Cable to the Transmitter.

**1.4.2** Connect the other end of the cable to the Display.

**1.4.3** Press the On/Off key on the Display's panel. Allow a few seconds for the Transmitter to start sending data to the Display screen.

**1.4.4** Calibrate the transmitter as shown in Section 1.5.

**1.4.5** Deploy the sensor over the side of the vessel in a minimum of 4" of water.

**1.4.6** Write data values displayed on the display screen in the appropriate field logbook.

**1.4.7** Retrieve sensor.

**1.4.8** Move to the next sampling location. If travel time is great, turn off display by pressing On/Off key. Check condition of probes after each deployment.

**1.4.9** When finished sampling for the day disconnect the Transmitter.

## 2.0 Precautions

- Check condition of probes frequently between sampling.
- Don't force pins into the connectors, note the keying sequence.

## 3.0 References

Hydrolab Scout 2 Reference Manual, December 1991.

# STANDARD OPERATING PROCEDURE 021
# MONITORING WELL INSTALLATION

## 1.0 Scope and Application

The installation of monitoring wells is contingent upon the existing conditions at the project site. The purpose of this Standard Operating Procedure is to delineate the quality control measures required to ensure the accurate installation of monitoring wells. The Field Sampling Plan should be consulted for specific installation instructions. The term "monitoring wells", as used herein is defined to denote any environmental sampling well.

## 2.0 Material

### 2.1 Drilling Equipment

a. Appropriately sized drill adequately equipped with augers, bits, drill stem, etc.
b. Steam cleaner and water obtained from approved USAEC source for decontaminating drilling equipment.
c. PID: Microtip HL-200 (or equivalent)
d. Water level indicator (electrical)
e. Weighted Steel tape measure
f. Steel drums for intrusion derived wastes (drill cuttings, contaminated PPE, decon solutions, etc.)
g. Source of approved water
h. Heavy plastic sheeting
i. Sorbent pads and/or logs

### 2.2 Well Installation Materials [8]

a. Well screen : [9]

PVC: JOHNSON (or equivalent); PVC Vee Wire Continuous slot, wire wrapped screen; 4-inch diam.; SCH 40; SCH 80; flush-threaded (leak-proof) joints; PVC complies with ASTM D2665, ASTM D1784, and ASTM F480; free of ink markings; cleaned and prepackaged by manufacturer

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[8] Technical information on all installed materials (screens, riser pipe, filter pack, bentonite, cement, etc.) and representative samples of the proposed filter pack, will be supplied to the Contracting Officer's Representative (COR).

[9] Well screen slot size and filter pack gradation will be determined from sieve analysis of aquifer materials. Screen and calling material type will be determined based on field tests of groundwater chemistry and contaminants.

Stainless Steel: JOHNSON (or equivalent); Brainless steel Vee-Wire ContinuOUs BlOt, wire wrapped screen; 304 stainless steel [10]; ASTM F480 flush threads; cleaned, wrapped, and heat sealed by manufacturer.

b. Riser pipe:

PVC: JOHNSON (or equivalent); STD. PVC; 4-inch diam.; SCH 40; SCH 80; flush-threaded (leak-proof) joints; PVC complies with ASTM D2665, ASTM D1784, and ASTM F480; free of ink markings; cleaned and prepackaged by manufacturer

Stainless Steel: JOHNSON (or equivalent); SCH 5; 304 stainless steel; ASTM type A312 material; 4-inch diam.; cleaned, wrapped and heat sealed by manufacturer.

c. Plugs/Caps: JOHNSON (or equivalent); standard PVC or stainless steel
d. Filter pack: MORIE, 100 well gravel (or equivalent) Note: final gradation may vary as a function of the gradation of the formation (see footnote 13)
e. Bentonite seal: BAROID, bentonite pellets (3/8-inch diam.)
f. Cement: Type II Portland Cement [11]
g. Bentonite powder: BAROID, Aquagel Gold Seal
h. Steel Protective Casing: BRAINARD-KILMAN (or equivalent) zinc-plated steel, lockable, painted.[12]
i. Containers for purged water, as required.
j. Submersible pump or bailer of appropriate capacity, and surge block sized to fit well
k. Hach DREL 2000 portable laboratory (or equivalent)
l. Hydrolab
m. Electric well sounder and measuring tape.
n. Portland Type II cement (see footnote)
o. Steel Posts (pickets), Painted (see footnote)

**2.3 Documentation**

a. Copy of appropriate Work Plan
b. Copy of Field Sampling Plan
c. Copy of USAEC Geotechnical Requirements
d. Copy of approved Health And Safety Plan
e. Copies of well and excavation permits

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[10] Unless the sum of $Cl^-$, $F^-$, and $Br^-$ is >1000ppm, in which case type 316 should be used (see also "Field Investigation Plan" Section 6.8.6 and Appendix A, "Field Sampling Plan" § 3.3.2.)

[11] If sulfates are higher than 1500ppm type IV Portland Cement will be used

[12] All painted components (protector casing, steel pickets) will be painted high-visibility orange and allowed to dry completely prior to being brought onsite.

f. Copies of QAPP
g. Boring log forms
h. Well completion diagram form
i. Well development form

**2.4 Geologist's personal equipment**

a. 1OX handlens
b. Unified Soil classification System chart
c. Munsell color chart
d. PPE as required by HASP

## 3.0 Procedure

### 3.1 Materials Approval

**3.1.1** Water sources for drilling, grouting, sealing, filter placement, well installation, and equipment decontamination must be approved by the Contracting Officer Representative (COR) prior to arrival of the drilling equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, Cost per gallon (if applicable), dates and results associated with all available chemical analyses over the past two years, and the name and address of the analytical laboratory (if applicable).

**3.1.2** Pure sodium bentonite with no additives (bentonite) will be the only drilling fluid additive allowed, and its use must be approved by the COR prior to the arrival of the drilling equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer's address and telephone number, product description, and intended use for the product.

**3.1.3** Granular Filter Pack material must be approved by the COR prior to drilling. A one-pint representative sample must be supplied to the COR. Information required includes: lithology, grain size distribution, brand name, source, processing method, and size of intended screen.

**3.1.4** Portland Type II cement will be used for grout (see footnote).

### 3.2 Drilling

**3.2.1** The objective of the selected drilling technique is to ensure that the drilling method provides representative data while minimizing subsurface contamination, cross contamination, and drilling costs. The drilling method used will be hollow

stem auger or water/mud rotary[13] . No other methods will be considered as available without approval of EPA and ADEQ. The method used at a specific site will be proposed in the work plan and evaluated by the COR.

3.2.2 A Site Geologist will be present during all well drilling and installation activities and will fully characterize all tasks performed in support of these activities into the monitoring well logbook. The Site Geologist will be responsible at only one operating rig for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of the rig. The Site Geologist will have onsite sufficient equipment in operable condition to perform efficiently his/her duties.

3.2.3 No lubricants will be used on downhole drilling equipment. Additives containing either lead or copper will not be allowed. In addition, polychlorinated biphenyls will not be permitted in hydraulic fluids or other fluids used in the drilling rig, pumps, or other field equipment and vehicles.

3.2.4 Surface runoff or other fluids will not be allowed to enter any boring or well during or after drilling/construction.

3.2.5 Antifreeze used to keep equipment from freezing will not contain rust inhibitors and sealants. Antifreeze is prohibited in any areas in contact with drilling fluid. The ground surface at the well site will be protected from possible coolant, fuel, and hydraulic fluid spills and/or leakage by placement of plastic sheeting with raised edges, draining into a lined catch basin large enough to contain spills and/or leakage from motors, radiators, or vehicle tanks. Sorbent pillows will be placed to catch obvious leaks from the drill rig. Sorbent logs may be used instead of, or in conjunction with a lined catch basin to contain spills.

Anticipated depths of wells are given in well specific work plans. In case the previously defined criteria have not been met before the depth range for a given hole is reached, the geologist will stop the drilling and confer with her/his supervisor. The current boring conditions (depth, nature of the stratigraphic unit, and water-table depth) will be compared to those of other wells nearby to decide to continue drilling or to terminate and complete the well.

3.2.7 **<u>If the well is to be installed in the surficial aquifer:</u>** Drilling will be terminated before penetrating the basal aquitard. The basal aquitard is defined as the first 2 foot-thick clay below the water table, or below 5 feet in the case of a shallow aquifer.

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[13] Due to the potential for aquifer contamination and plugging, mud rotary drilling is not recommended for monitoring wells. If; however, the well is a deep monitoring well and/or is screened in a "running sand" , and the aquifer is expected to have a relatively high flow rate, then mud rotary may be approved on a case-by-case basis.

**3.2.8** **<u>If the well is to be installed in a lower, confined aquifer:</u>**

**3.2.8.1** Penetrations of aquifers located lower than the watertable aquifer will be limited to avoid cross-contamination.

**3.2.8.2** An outer, surface casing will be set 2 to 5 ft into the confining layer to minimize the potential for cross-contamination from the unconfined aquifer during drilling activities.

**3.2.8.3** The surface casing will be driven into the confining bed and grouted into place. A grout plug at least 2 feet thick will be tremied into the bottom of the surface casing. The grout will be permitted to cure for 24 hours. Drilling fluids within the surface casing will then be removed, and the casing will be flushed with clean potable water.

**3.2.8.4** The drilling equipment will be decontaminated, a smaller bit or auger selected, and the hole will be continued through the grout plug into the confined aquifer.

**3.2.9** **<u>If DNAPL contamination is detected during drilling</u>**, the well will be terminated and completed at the base of the aquifer. Drilling will not continue through the confining unit.

**3.2.9.1** DNAPL sampling cups are prohibited. The well screen will be capped, and set 0.3 ft (0.5 ft. max.) into the top of the confining bed and rest on the bottom of the hole or bentonite backfill (if used). No sand will be placed below the screen.

**3.2.9.2** The remainder of the well installation and completion will be accomplished according to section 3.4.

## 3.3 Logging

**3.3.1** Borings for monitoring wells will be logged by a geologist. Logs will be recorded in a boring log. Field notes are to include, as a minimum:

a. Boring Number
b. Material Description (as discussed below)
c. Weather conditions
d. Evidence of Contamination
e. Water Conditions (including measured water levels)
f. Daily Drilling Footage and Quantities (for billing purposes)
g. Notations on Man-Placed Materials
h. Drilling Method and Bore Hole Diameter
i. Any Deviations from Established Field Plans
i. Blow Counts for Standard Penetration Tests
k. Core and Split-Spoon Recoveries

3.3.2 Material description for soil samples must include:

a. Classification
b. Unified Soil Classification Symbol
c. Secondary Components and Estimated Percentages
d. Color
e. Plasticity
f. Consistency
g. Density
h. Moisture Content
i. Texture/Fabric/Bedding and Orientation
j. Grain Angularity
k. Depositional Environment and Formation
l. Incidental odors
m. PID reading(s)
n. Staining

3.3.3 Material description for rock samples must include:

a. Classification
b. Lithologic Characteristics
c. Bedding/Banding Characteristics
d. Color
e. Hardness
f. Degree of Cementation
g. Texture
h. Structure and Orientation
i. Degree of Weathering
i. Solution or Void Conditions
k. Primary and Secondary Permeability
l. Sample Recovery
m. Incidental odors
n. PID reading(s)
o. Staining

See also SOP003 and SOP010 for details on logbook entries.

### 3.4 Well Construction and Installation

After the hole is drilled and logged, backfill hole as required for proper screen placement. The integrity of the aquitard will be restored by placing a bentonite plug of an appropriate thickness, either to the top of the aquitard (normal well installation) or to within 0.3 ft. of the top of the aqitard (DNAPL well). Aquifer fill will be clean filter pack.

Normal screen placement for the water table aquifer will be with 3 ft. of the screen extending above the static water level. The bottom of the screen will rest no more than 6 in. from the bottom of the hole or backfill material, whichever is applicable.

Note: the end cap in DNAPL wells will rest on the bottom of the bottom of the hole, or bentonite backfill if applicable.

**3.4.2** The installation of monitoring wells will begin within 12 hours of completion of drilling. Once installation has begun, work will continue until the Bentonite seal is installed.

**3.4.3** Well screens, casings, and fittings will conform to National Sanitation Foundation Standard 14 or American Society for Testing and Materials (ASTM) equivalent for potable water usage. These materials will bear the appropriate rating logo. If the logos are not present, a written statement from the manufacturer/supplier stating that the materials contain the appropriate rating must be obtained. Material used will be new and essentially chemically inert to the site environment.

**3.4.3.1** Well screen and casing should be inert with respect to the ground water; therefore, the selection of screen and casing material will be based on select field tests of aquifer chemistry and potential contaminants. The screen will be capped without sediment trap or DNAPL sampling cup, and lowered into the hole. The well casing will be pre- cut to extend 2 to 2.5 ft above the ground surface. Prior to placement of the last piece of well casing, a notch or other permanent reference point will be cut, filed, or scribed into the top edge of the casing.

**3.4.3.2** Screen slot size will be appropriately sized to retain 90 to 100% of the filter pack material, the size of which will be determined by sieve analysis of formational material.

**3.4.3.3** The tops of all well casing will be capped with covers composed of materials compatible with the products used in the well installation. Caps will be loose fitting, constructed to preclude binding to the well casing caused by tightness of fit, unclean surfaces, or weather conditions. In either case it should be secure enough to preclude the introduction of foreign material into the well, yet allow pressure equalization between the well and the atmosphere.

**3.4.4** Filter pack material will be tremied into place. Filter pack will extend from the bottom of the hole to a height of 5 ft above the top of the screen. The filter pack will be capped with 1 ft of fine (Ottawa) sand to prevent the bentonite seal from infiltrating the filter pack.

**3.4.4.1** Granular filter packs will be chemically and texturally clean, inert, and siliceous.

**3.4.5** Bentonite seals will be a minimum of five feet thick as measured immediately after placement. The final depth to the top of the bentonite seal will be measured and recorded before grouting.

**3.4.6 GROUT**

Grout used in construction will be composed by weight of:

- 20 parts cement (Portland cement, type II)(see footnote)
- 0.4 to 1 part (max.)(2-5%) bentonite
- 8-gallons (max.) approved water per 94-lb bag of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

**3.4.6.1** All grout material will be combined in an above-ground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump prior to placement.

**3.4.6.2** Grout placement will be performed using a commercially available grout pump and a rigid, tremie pipe.

**3.4.6.3** The following will be noted in the Boring Logs: 1) exact amounts of cement, bentonite, and water used in mixing grout, 2) actual volume of grout placed in the hole.

**3.4.7** Well protective casings will be installed around all monitoring wells on the same day as the initial grout placement around the well. Any annulus formed between the outside of the protective casing and the borehole will be filled to ground surface with cement.

**3.4.8** The construction of each well will be depicted as built in a well construction diagram. The diagram will be attached to the boring log and will graphically denote:

a. Screen location, length
b. Granular filter pack
c. Seal
d. Grout
e. Cave-in
f. Centralizers
g. Height of riser
h. Protective casing detail

**3.5 Monitoring well completion**

**3.5.1** Assemble appropriate decontaminated lengths of pipe and screen. Make sure these are clean and free of grease, soil, and residue.

**3.5.2** Lower each section of pipe and screen into the borehole, one at a time, screwing each section securely into the section below it. No grease, lubricant, polytetrafluoroethelyne (PTFE) tape or glue, may be used in joining the pipe and screen sections.

**3.5.3** Prior to installation, cut the riser so that it will extend approximately 2-2.5 ft. above grade. Notch, file, or otherwise permanently mark a reference point on the top of the casing. All pipe cuts MUST be square to ensure that the elevation between the highest and lowest point of the well casing is less than or equal to 0.02 ft.

**3.5.4** When the well is set to the bottom of the hole, temporarily place a cap on top of the pipe to keep the well interior clean.

**3.5.5** Place the appropriate filter pack into the borehole using a tremie pipe. Monitor the rise of the annulus with a weighted tape to assure that bridging is not occurring.

**3.5.6** After the filter pack is in place, wait three to five minutes for the material to settle, and check its depth with a weighted steel tape.

**3.5.7** Install the bentonite seal (2 ft to 5 ft thick) by dropping bentonite pellets into the hole gradually. If the well is deeper than 30 feet, a tremie pipe will be used to place the pellets. Check depth with a weighted tape as above.

**3.5.8** Wait a minimum of 2 hours for the pellets to hydrate and swell. If the pellets are above the water level in the hole, add several buckets of clean water to the boring. Document the amount of water added to the hole.

**3.5.9** Mix an appropriate cement-bentonite slurry (§ 3.4.6). Be sure the mixture is thoroughly mixed and as thick as is practicable.

**3.5.10** Lower a side discharge tremie pipe into the annulus to the top of the Bentonite outer seal.

**3.5.11** Pump the grout slurry into the annulus while withdrawing the tremie pipe and temporary casing. When installing wells inside augers, 10 feet of grout must be maintained within auger.

**3.5.12** Continue the grout fill to 2.5 feet below the ground surface. Seat the protective casing in the grout, allowing no more than 0.2 - ft between the top of the well casing and the bottom of the protective casing cap. Lock the cap.

-and-

**3.5.13** Allow the grout slurry to set overnight.

**3.5.14** Fill the outer annulus (between the casing and the borehole) with neat cement. Allow the cement to mound above ground level and finish to slope away from the casing.

**3.5.15** Slope the ground surface away from the casing for a distance of two feet, at a rate of no less than 1 inch in two feet.

**3.5.16** Set pre-painted protective steel pickets (3 or 4) evenly around and 2 feet out from well.

## 3.6 Well Development

**3.6.1** Well development is the process by which drilling fluids, solids, and other mobile particulates within the vicinity of the newly installed monitoring well have been removed while restoring the aquifer hydraulic conductivity. Development corrects any damage to or clogging of the aquifer caused by drilling, increases the porosity of the aquifer in the vicinity of the well, and stabilizes the formation and filter pack sands around the well screen.

**3.6.2** Well development will be initiated after 48 consecutive hours but no longer than 7 calendar days following grouting and.or placement Of surface protection.

**3.6.3** Two well development techniques - over pumping and surging will be employed in tandem. over pumping is simply pumping the well at a rate higher than recharge. Surging is the operation of a plunger up and down within the well casing similar to a piston in a cylinder.

**3.6.4** Materials Required

a. Well Development Form
b. Boring Log and Well Completion Diagram for the well
c. Submersible pump or bailer of appropriate capacity, and surge block
d. Conductivity, pH, temperature meters
e. Electric well sounder and measuring tape.
f. Containers for purged water, if required.

**3.6.5 Summary of Procedures and Data Requirements.**

**3.6.5.1** Pump or bail the well to ensure that water flows into it, and to remove some of the fine materials from the well. Removal of a minimum of one equivalent volume (EV) is recommended at this point. The rate of removal should be high enough to stress the well by lowering the water level to approximately 1/2 its original level.

**3.6.5.2** Slowly lower a close-fitting surge block into the well until it rests below the static water level, but above the screened interval. (Note: this latter is not required in the case of an LNAPL well.)

**3.6.5.3** Begin a gentle surging motion which will allow any material blocking the screen to break up, go into suspension, and move into the well. Continue surging for 5-10 minutes, remove surge block, and pump or bail the well, rapidly removing at least one EV.

**3.6.5.4** Repeat previous step at successively lower levels within the well screen until the bottom of the well is reached. Note that development should

always begin above, or at the top of, the screen and move progressively downward to prevent the surge block from becoming sand locked in the well casing. As development progresses, successive surging can be more vigorous and of longer duration as long as the amount of sediment in the screen is kept to a minimum.

**3.6.5.5** Development is expected to take at least 2 hours in a small well installed in a clean sand, and may last several days in large wells, or in wells set in silts with low permeabilities.

**3.6.5.6** Development will continue until little or no sediment can be pulled into the well, and target values for parameters listed in 3.6.4.9 (e.) (below) are met.

**3.6.5.7** At a minimum, development will remove 3 to 5 EV, plus 3 to 5 times the amount of fluid lost during drilling, and 3 to 5 times the volume used in filter pack placement.

**3.6.5.8** All water removed must be disposed of as directed by the Sampling Design Plan.

**3.6.5.9** Record all data as required on a Well Development Record Form (see example), which is made a part of the complete Well Record. These data include:

a. Depths and dimensions of the well, the casing, and the screen, obtained from the Well Diagram.

b. Water losses and uses during drilling, obtained from the boring log for the well.

c. Water contained in the well, obtained from calculations using the depth of the water column and the well radius, plus the radius and height of the filter pack and an assumed 30% porosity.

d. Measurements of the following indicator parameters: turbidity, pH, conductivity, and temperature before, twice during, and after development.

e. Target values for the indicator parameters listed above are as follows: pH - stabilize, conductivity - stabilize, temperature - stabilize

f. Notes on characteristics of the development water.

g. Data on the equipment and technique used for development.

h. Estimated recharge rate and rate/quantity of water removal during development. (See SOP 013 section 3.2.)

## 4.0 Maintenance

Not Applicable.

## 5.0 Precautions

Refer to the site-specific Health and Safety Plan for discussion of hazards and preventive measures during well development activities.

## 6.0 References

Aller, Linda, *et al.*, 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, National Water Well Association

Cohen, Robert M., and Mercer, James W. 1993. DNAPL Site Evaluation, CRC Press, Inc.

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EPA Groundwater Handbook 1989

Nielsen, David M., 1993. Correct Well Design Improves Monitoring, in "Environmental Protection", Vol.4, No.7, July, 1993.

USATHAMA. 1987. Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition. and Reports, March 1987.

ASTM D 2487-92 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 5092-90 Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers

WELL DESIGNATION: _____ DATE(S) OF INSTALLATION:____/____/____

SITE GEOLOGIST: _____ DEVELOPMENT DATE(S):____/____/____

STATIC WATER LEVELS BEFORE AND AFTER DEVELOPMENT * :

BEFORE _____ DATE _____ 24 HR. AFTER _____ DATE_____

DEPTH TO SEDIMENT BEFORE AND AFTER DEVELOPMENT * :

BEFORE _____ DATE _____ 24 HR. AFTER _____ DATE_____

DEPTH TO WELL BOTTOM *: _____ SCREEN LENGTH _____

HEIGHT OF WELL CASING ABOVE GROUND SURFACE: _____

QUANTITY OF MUD/WATER:

| | | |
|---|---|---|
| LOST DURING DRILLING | (+)_____ | gallons |
| REMOVED PRIOR TO WELL INSERTION | (-)_____ | gallons |
| LOST DURING THICK FLUID DISPLACEMENT | (+)_____ | gallons |
| ADDED DURING FILTER PACK PLACEMENT | (+)_____ | gallons |
| TOTAL LOSSES | _____ | gallons |

(a) Water column ht. (ft.) _____ (b) Well radius (in.)_____

(c) Screen length (ft.) _____ (d) Borehole radius (in.)_____

(e) QUANTITY OF FLUID STANDING IN WELL

$(12*a*\pi*b^2*0.0043)=$

_____ gallons
(Show Calculation)

(f) QUANTITY OF FLUID IN ANNULUS

$[12*c*\pi 8(d^2-b^2)*0.0043*0.30]$

_____gallons
(Show Calculation)

DEVELOPMENT VOLUME = (5 * TOTAL LOSSES) + [5 * (e + f)] = _____ gallons
(Show Calculation)

*** ALL DEPTHS MEASURED FROM TOP OF WELL CASING**

EXAMPLE WELL DEVELOPMENT RECORD
(PAGE 2 OF 2)

WELL DESIGNATION _____ DATE(S) OF DEVELOPMENT: ____/____/____

TYPE AND SIZE OF PUMP: _____

TYPE AND SIZE OF BAILER: _____

DESCRIPTION OF SURGE TECHNIQUE:
_____
_____

RECORD OF DEVELOPMENT

| DATE & TIME | QUANTITY REMOVED | TIME REQ'D | pH | Cond | Temp | ORD | Turb | DO | Character of water (color / clarity / odor / partic.) |
|---|---|---|---|---|---|---|---|---|---|
| (before) | | | | | | | | | |
| (during) | | | | | | | | | |
| (during) | | | | | | | | | |
| (during | | | | | | | | | |
| (after) | | | | | | | | | |

TYPICAL PUMPING RATE _____ GAL./HR. EST. RECHARGE RATE _____

TOTAL QUANTITY OF WATER REMOVED _____ TIME REQUIRED _____

REMARKS_____
_____
_____

SIGNATURE OF SITE GEOLOGIST _____

Hole No.

| DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS |
|---|---|---|---|

1. PROJECT
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number)
5. NAME OF DRILLER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

| ELEVATION a | DEPTH b | LEGEND c | CLASSIFICATION OF MATERIALS (Description) d | % CORE RECOVERY e | BOX OR SAMPLE NO. f | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g |
|---|---|---|---|---|---|---|
| | | | | | | |

ENG FORM 1836 MAR 77 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

# STANDARD OPERATING PROCEDURE 022
# COLLECTION OF MONITORING WELL SAMPLES

## 1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for the collection of groundwater samples from monitoring wells.

## 2.0 Material

a. Hydrolab (see SOP 020)
b. Water-level indicator
c. Transparent bailer with a double check valve
d. PVC bailer (for purging only)
e. Stainless steel bailer (for purging and sampling)
f. Polytetrafluoroethelyne (PTFE) bailer with PTFE-coated stainless steel cable, double check valve top and controlled flow bottom discharge attachment[14] for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles) (for purging and sampling)
g. Polypropylene rope
h. Submersible pump and hose (for purging only)
i. Variable speed, low flow submersible pump (*e.g.* Grundfos MP1 ground-water sampling pump) (for purging and sampling)
j. Sample bottles and labels
k. Logbook or book of field parameter forms
l. Generator
m. Tygon tubing
n. Plastic sheeting
o. Photoionization Detector (PID)

## 3.0 Procedure

**3.1 General:** Ground-water sampling will follow these general steps:

- Arrive on site
- Set up apparatus (generators, pumps, etc.)
- Glove
- Perform all steps of SOP 010 - organic vapor check, water level and well depth measurements
- Sample NAPLs (as required)
- Begin purge procedure
  - If using bailer to purge and sample see § 3.6.
  - If using pump to purge and bailer to sample see § 3.7.
  - If using bladder or low-flow pump to purge and sample see § 3.8.
- Decon/reglove
- Take samples
  - If with bailer see § 3.6.5
  - If with bladder or low flow pumps see §3.8
- Decon/dispose of wastes, move equipment to next site.

[14] Although use of a controlled flow bottom discharge valve is historically preferred, use of such a device can cause aeration of the sample.

3.2 **General Rules for Groundwater Field Parameter Logbook** (see SOP 010 for further procedures):

3.2.1 Only one site or installation per logbook, and only one sampling location per page or form (if using pre-printed forms). The same book maybe used for more than one sampling event.

3.2.2 First five pages will be reserved for index, general notes, etc. Sign and date each entry.

3.2.3 Last five pages will be reserved for recording calibration data for the pH, temperature, turbidity, ORD, DO, and conductivity meters. Use the page number or a separately recorded "Cal Reference Number" to refer to each calibration.

3.2.4 (As appropriate). Insert the cardboard flap under the form being filled out, so that writing does not go through to the pages below.

3.2.5 (As appropriate). Fill in the forms from front to back of the logbook, tearing out the white copy for each sample when the sample has been collected. This copy goes in the cooler with the sample, directly to the laboratory. The original copy must be torn out before you write on the back of the duplicate form.

3.2.6 (As appropriate). Duplicate copies, index pages, and calibration sheets remain intact.

3.3 **Groundwater Sampling General Rules**

3.3.1 Refer to SOPs 001-005 and 008-010.

3.3.2 Groundwater samples will be collected from the least contaminated wells first, progressing to the most contaminated [15].

3.3.3 Upon arrival at the well site, immediately set up and organize the purging, sampling, and filtration equipment. If needed, due to muddy or contaminated ground, remoteness from sampling vehicle, and\or for placement of hose(s) and\or power cord if a pump is used, place clean plastic sheeting at, or around the well, to serve as a clean staging area for purging and sampling equipment, as conditions warrant. Care must be exercised not to step on plastic sheeting.

3.3.4 If the well is remote from the sampling vehicle set up the filtration equipment and place rope, wrapped bailer, and pre-labeled sample containers on the plastic sheet, uphill from the well.

3.3.5 When a pump is to be used situate the portable generator on level ground approximately 15 feet away from and downwind from the well. All generator maintenance (oil and fueling) is to be performed off site. If the hose(s) and/or

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[15] First round samples are to be collected from upgradient wells first, moving to downgradient wells under the assumption that upgradient wells will be less contaminated than downgradient wells. Results of first round analysis may mandate a change in sampling sequence.

power cord of the pump are not on a reel, place the pump with its hose and power cord on the plastic sheeting downhill from the well.

**3.3.6** Glove. Check well headspace for organic vapor which may pose a health and safety hazard and indicate the presence of NAPL. Measure depth(s) to and thickness(es) of NAPL(s) as appropriate. Measure the depth to water and depth of well. From the water depth, well diameter, sand pack length, etc., calculate the equivalent volume (1 EV) of water in the well.

1 EV = volume in casing + volume in saturated sand pack. Therefore; if the **water table lies below the top of the sandpack**, use the following equation:

$$\mathbf{1\ EV = (\pi R_w^2 h_w) + (0.30\pi(R_s^2 - R_w^2)h_w) * (0.0043)}$$

If the **water table lies above the top of the sandpack** use this equation:

$$\mathbf{1\ EV = [(\pi R_w^2 h_w) + (0.30\pi(R_s^2 - R_w^2)h_s)] * (0.0043)}$$

where: $R_s$ = radius of sandpack in inches
$R_w$ = radius of well casing in inches
$h_s$ = height of sandpack in inches
$h_w$ = water depth in inches

0.0043 gal/in$^3$
Assumed filter pack porosity = 30%

Tables and graphs showing equivalent volumes for typical well constructions are available.

Alternate equations for calculating EV are acceptable, two alternates are given in SOP 010

**3.3.7** Samples will always be collected in order of decreasing volatility (*i.e.*, the samples to be analyzed for the volatile constituents should be collected first.) Deliver the VOC sample to the vial by allowing the water to trickle down the inside wall of the vial at a rate no greater than approximately 100 ml/min. Other samples may be delivered at a faster rate. Sampling rates will at no time exceed 1 L/min. Procedures for each class of samples are contained in SOP 019.

**3.3.8** When collecting samples for volatile analysis care should be taken to prevent analyte loss by volatilization. The following procedures should be adhered to when collecting these samples:

**3.3.8.1** Avoid excessive aeration and agitation of sample.

**3.3.8.2** Fill vial so that a reverse meniscus is present by adjusting the flow rate from the sampling device.

**3.3.8.3** Place septum on vial so that the PTFE side is in contact with the sample. After the cap is on the bottle, check for air bubbles in the sample. If air bubbles are present, properly dispose of that sample and recollect the sample in the same vial.

**3.3.8.4** Make sure vial is labeled and immediately transfer the vial to the cooler with ice.

**3.3.9** Unfiltered samples will be collected by slowly pouring the sample water into the appropriate sample container, being careful not to agitate or cause bubbles to form. Do not overfill bottles. Make sure sample bottle is labeled and the cap is on tightly. Then place the sample in cooler with ice immediately.

**3.3.10** Samples will be delivered to the laboratory as soon as possible. If possible, samples will be shipped on the same day as they are collected. If samples must be retained due to weekend sampling (Sunday), the lab shall be notified as to the time sensitive nature of the samples.

## 3.4 Sampling of Non-Aqueous Phase Liquids

**3.4.1** If NAPLs are detected in the well, a sample from all layers must be collected prior to any purging activities. Non-aqueous phase liquids (NAPLs) may be indicated by the presence of volatiles in the well headspace, and confirmed by the oil/water interface probe.

**3.4.1.1** Collecting LNAPLs will be accomplished using a transparent bailer with a double check valve. This bailer will be slowly lowered until the bottom of the bailer is 1-2 in. below the LNAPL-water interface, as determined in SOP 010 then slowly withdrawn. Verify that the interface was sampled by visual inspection of the bailer contents through the side of the bailer. Measure the thickness of the LNAPL in the bailer and note in the Field Notebook. Sample for laboratory analysis. An additional field verification may be performed by decanting the remainder of the contents of the bailer into a glass jar, adding a hydrophobic dye such as Sudan IV, or Redoil, shaking the sample and looking for coloration of NAPL. Alternate field tests are: examine the sample under ultra violet light (many fluoresce), or allow the sample to stand overnight, and examine for interface and/or volatiles in the headspace the following day. Refer to following sections on purging and sample collection for set up and general operation.

**3.4.1.2** Collecting dense non-aqueous phase liquids (DNAPLs) will be accomplished using a transparent bailer with a double check valve. The bailer must be lowered very slowly to the bottom of the well and raised slowly out of the well in a controlled fashion. Sample for analysis as above. The same field check described above may be employed for DNAPL. Refer to following sections on purging and sample collection for set up, and general operation.

**3.4.1.3** If NAPLs are present in the well, **and** a low-flow pump is to be used for purging and sampling, the well will be allowed to re-equilibrate prior to purging and sampling. This will be accomplished by allowing the well to stand undisturbed for at least 8 hours prior to purging and sample collection.

## 3.5 Well Purging - General Rules

Water within the casing of a well will stagnate, degas, lose volatiles, possibly precipitate metals due to changes in redox potential, and may react with the screen and/or casing material. It is therefore necessary to purge a sufficient volume of this stagnant water from the well and/or casing to ensure that a representative sample of formation water can be obtained. Traditionally, the volume of water to be purged was arbitrarily set at 3 to 5 equivalent volumes. Recent advances in sampling technologies have caused a re-thinking of such arbitrary purge volumes. It is for this reason that Monitoring of select chemical and physical properties of the sample medium will be used instead of strict volumes to determine when a representative sample may be taken from a well.

**3.5.1** Acceptable purge/sampling devices include: bailers and variable speed, low-flow pumps which include both submersible pumps (purge and sample), and dedicated bladder pumps (purge and sampling). It is recommended to purge and sample at similar rates with one type device per well.

**3.5.2** Peristaltic, gas-lift, and centrifugal pumps can cause volatilization, produce high pressure differentials, and can result in variability in the analysis of some analytes of interest. These types of pumps shall not be used to purge or sample wells.

**3.5.3** To prevent ground-water from cascading down the sides of the screen in to an open hole, thereby aerating the sample, purge rates will closely match recharge rates. If the static water level is within the casing, the initial purge rates may be set high enough to lower the water level to the top of the screen, then reduced to maintain that level.

**3.5.4** Purging will be accomplished with either a submersible pump, a low-flow (submersible or bladder) pump, or bailer. The choice of bailer or pump will be based on depth to water table, volume to be purged, and permeability of the aquifer. If the well recharges rapidly and/or has greater than 20 gallons (estimated EV) to be purged, water may be removed with a submersible pump or a low-flow pump. If the well recharges slowly and/or has less than 20 gallons to be purged, water will be removed with a bailer or a low-flow pump.

**3.5.5** Purging will be accomplished with as minimal disturbance to the surrounding formation as possible.

**3.5.6** Purge water will be containerized on site until analysis of samples is completed. At that time, if the samples are non-hazardous, the water may be disposed of through Mooney Treatment Facility. If the purge water exceeds the pretreatment standards for all the purge water or individual wells, a subcontractor will be contacted to dispose of the water at a waste water recycling facility.

**3.5.7** If the water level is within the screened interval and the well recharge rate is less than 0.1 L/min purge the well using a low-flow pump as follows:

**3.5.7.1** Draw the water down to within 1 foot of the top of the pump.

**3.5.7.2** Allow the well to recover.

**3.5.7.3** Check and record field parameters.

**3.5.7.4** Repeat steps 3.5.7.1 through 3.5.7.3 then collect samples.

## 3.6 Purging and Sampling With Bailers

**3.6.1** Bailers may be used for both purging and sampling wells if: a) the well recharge rate is less than 4 L/min, b) depth to the water table is less than 50 ft, and c) less then 20 gal are to be purged (5 EV < 20 gal) [16].

**3.6.2** When purging with a bailer, either a PVC, PTFE, or stainless steel bailer may be used. The bailer will be attached to either a spool of PTFE-coated stainless steel cable or polypropylene rope. If using cable, attach it to the bailer using stainless steel cable clamps. Thoroughly decon the cable after each use, prior to rewinding cable onto spool. Cable clamps and raw cable ends may serve to trap contamination. Exercise particular caution in decontaminating these areas. If using rope, attach the rope to the bailer using a bowline knot, dispense the needed length (a few feet more than the well depth) and cut the remainder away, then, at the end opposite the bailer, make a slip knot and place it around the well casing or protective posts to prevent losing the bailer and rope down the well. The polypropylene rope will be not reused, it will be properly disposed of. Either type of bailer will be repeatedly lowered gently into the well until it fills with water, removed, and the water will be discharged into an appropriate container until purging is complete. Care must be taken not to unduly agitate the water, as this tends to aerate the sample, increase turbidity, makes stabilization of required parameters (3.6.3) difficult to achieve, and generally prolongs purging.

**3.6.3** After purging 2 EV, obtain a sample of groundwater and measure the following stabilization parameters: temperature, conductivity, pH, turbidity, redox potential (Eh), and dissolved oxygen level using hydrolab (SOP 020) at each successive half-well volume. When three of these stabilization parameters are in agreement within approximately 10% in three consecutive half-well volume samples, sufficient water has been purged from the well. The results of these tests should be recorded in the sampling logbook. Should these parameters not reach agreement, no more than five well volumes will be purged.

**3.6.4** Immediately upon completion of purging, collect samples for laboratory analysis using a PTFE bailer on a PTFE-coated stainless steel cable. The bailer will be equipped with double check valve top and controlled flow bottom discharge attachments for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles).

**3.6.5** Slowly, so as not to agitate the water, lower the bailer into the well, using a spool of PTFE-coated cable. Allow bailer to fill, withdraw smoothly. Refill bailer as needed.

**3.6.5.1** If the controlled flow bottom discharge attachment is used for VOC sampling, attach it to the bottom of the bailer. Using the stopcock valve on the bailer to control the flow, fill sample vials as described above in § 3.3.8.

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[16] These numbers are based on the following assumptions: 1) In purging, it is preferable to remove water at approximately the recharge rate. 2) Four L/min is estimated as the approximate maximum rate at which water can be removed with a bailer from depths of 20-50 feet. 3) Twenty gallons is estimated to be at the limit of the sampler's endurance, at which point fatigue and sloppiness of technique begin.

**3.6.5.2** Remove check valve top and pour unfiltered sample into inorganics sample bottles.

**3.6.6** Decon bailer and cable in accordance with SOP 020 § 3.3.1.1

## 3.8 Purging and Sampling With Low-Flow Pump

To obtain representative samples, subsurface disturbances should be kept to a minimum, thereby preventing sample alteration due to sampling actions. The reasoning behind the use of low-flow pumps to purge and sample monitoring wells is that these pumps minimize physical disturbance (turbulence) at the sampling point and chemical changes (aeration) in the medium. For these reasons, the low-flow pump is the preferred method for both purging and sampling in most cases. For the purposes of this SOP, "low-flow pumps" are defined as either dedicated bladder pumps or variable speed submersible pumps. Practical operational flow rates for these sampling devices range from 0.1 L/min to 30 L/min.

**3.8.1** Low-flow pumps may be used for purging and sampling any well having recharge greater than 0.1 L/min, which is the practical lower limit of pump performance. Below that pumping rate, pump inefficiencies and/or overheating may alter the physical and chemical properties of the sample. If the pump is continuously operated at sampling rates higher than the well recharge rate, the water level will be lowered in the well, possibly allowing aeration of the sample which is unacceptable sampling procedure. Low-flow pumps are suitable for sampling wells with recharge rates lower than 0.1 L/min if precautions are taken to avoid aeration of the sample.

**3.8.2** Low flow submersible pumps will be used as follows:

**3.8.2.1** Lower the pump into the well, <u>slowly</u> so as not to agitate the water, until the pump is at the mid-point of the screened interval or the mid-point of the water column if the static water table lies below the top of the screen [17]

**3.8.2.2** Attach the pump's umbilical cord (which will consist of power cord and sampling tubing) to the protective casing, or lock the cord spool so that the pump cannot move vertically in the well during sampling.

**3.8.2.3** Lower the water level probe into the well behind the pump until it just touches water. This will allow the sampler to monitor the water level while purging and sampling, and prevent the inadvertent drying of the well.

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[17] This assumes a 10-ft. screened interval. If the screened interval is greater than 10-ft., multiple samples should be taken as follows:

- If the screen is 10 - 12 ft., sample the canter of the water column, as outlined above.
- If the screen is longer than 12-ft., and the water column is 10-ft or less, sample the center of the water column.
- If the screen is longer than 12-ft., and the water column fills the screen, or extends above the screen, sample at 1/3 and 2/3 the height of the water column, or about every 6-ft.

**3.8.2.4** Begin purging at the pump's lowest setting, then gradually increase rate[18] until the pumping rate matches the aquifer recharge rate. **If the water level is above the top of the screen**, the pumping rate may be allowed to slightly exceed recharge rate, lowering the water level to no less than 1 foot above the screen, then reduced until it matches recharge rate and purging continued. **If the water level is below the top of the screen**, always keep the purge rate lower than well's recharge rate.

**3.8.2.5** Monitor stabilization parameters listed in § 3.6.3 beginning immediately, using an in-line monitoring system. Record parameters regularly, at a rate of one set of parameters per each 1-3 liters of water removed from the well. When these parameters stabilize to within 10% over 3 consecutive readings, reduce[19] flow rate to 0.1 L/min (if needed) and begin collecting VOC samples directly from the discharge line.

**3.8.2.6** If the well recharges at a rate less than 0.1 L/min, purge until the water level is even with the top of the screen, allow the well to recover and sample immediately.

**3.8.2.7** Remove and decon water level probe (SOP 020 § 3.3.1.5) and pump (SOP 020 § 3.3.1.2).

**3.8.3** The length of tubing used in conjunction with the low-flow pump will be appropriate to the depth of the well (*i.e.* A 100 ft roll of tubing may not be used in sampling a 30 ft well. A 50 ft roll would be used instead, thereby generating less decon solution, and providing less opportunity for physical and chemical changes in the sample due to contact with the spooled tubing (see § 3.8.4)). This means that the contractor will have on hand: a) spools of varying length (*e.g.* 25, 50, 75, and 100 ft spools) or b) several short *e.g.* 10 ft lengths of tubing with a secure means of connecting them end-to-end.

**3.8.4** When a sampling event occurs during summer months, in full sun, shade will be provided for the spooled tubing. Otherwise the tubing will be an effective water heater, warming the ground-water sample, creating the potential for volatilization of organics.

**3.8.5** Spooled tubing will be monitored to ensure that no air bubbles are trapped at the top of a coil. Trapped air bubbles can enhance volatilization of organics.

## 4.0 Maintenance

Refer to manufacturer's requirements for maintenance of pumps and generators.

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[18] Some sources indicate that the pumping rate should not exceed 1 L/min, with 0.5 L/min being preferable. The optimal purge rate is highly aquifer dependent, and may range from less than 0.5 L/min to greater than 10 L/min. The purge rate for a given well will; therefore, be a field decision, based on well development, purge, and sampling records rather than SOP mandate.

[19] Sampling should occur at the same rate as purging as long as aeration of sample does not occur.

## 5.0 Precautions

Refer to the HASP for appropriate PPE.

## 6.0 References

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# STANDARD OPERATING PROCEDURE 023
# DECONTAMINATION

## 1.0 Scope and Application

All personnel or equipment involved in intrusive sampling, or which enter a hazardous waste site during intrusive sampling must be thoroughly decontaminated prior to leaving the site to minimize the spread of contamination and prevent adverse health effects. This procedure describes the normal decontamination of sampling equipment and site personnel.

## 2.0 Material

a. Plastic sheeting, buckets, etc. to collect wash water and rinsates.
b. USAEC approved water.
c. deionized ultrafilter water (DIUF)
d. 0.10N Nitric Acid.
e. Non-phosphate laboratory detergent.
f. Reagent grade hexane
g. Aluminum foil or clean plastic sheeting.
h. Pressure sprayer, rinse bottles, brushes.
i. Plastic garbage bags.

## 3.0 Procedure

### 3.1 Sample Bottles

At the completion of each sampling activity the exterior surfaces of the sample bottles must be decontaminated as follows:

**3.1.1** Be sure that the bottle lids are on tight.

**3.1.2** Wipe the outside of the bottle with a paper towel to remove gross contamination.

### 3.2 Personnel Decontamination

Review the project Health and Safety Plan for the appropriate decontamination procedures.

### 3.3 Equipment Decontamination

#### 3.3.1 Water Samplers

**3.3.1.1 Bailers.**
After each use, Polytetrafluoroethelyne (PTFE) double check valve bailers used for groundwater sampling will be decontaminated as follows:

a. Discard all ropes used in sampling in properly marked sealable container, or as directed by the health and safety plan. Note: no tubing is to be used in conjunction with a bailer in collecting samples.

b. Scrub the bailer to remove gross(visible) contamination, using appropriate brush(es), approved water, and non-phosphate detergent.

c. Rinse off detergent with approved water.

d. Rinse bailer with reagent grade hexane.

e. Rinse bailer with USAEC approved water.

f. Rinse bailer with 0.10N Nitric Acid solution.

g. Rinse bailer with DIUF-grade water.

h. Allow bailer to air dry.

i. Wrap bailer in aluminum foil or clean plastic sheeting, or store in a clean, dedicated PVC or PTFE storage container.

j. Dispose of used decon solutions with drummed purge water.

**3.3.1.2 Pumps**

Submersible pumps will be decontaminated as follows:

a. Scrub the exterior of the pump to remove gross (visible) contamination, using appropriate brush(es) , approved water, and non-phosphate detergent. (Steam cleaning may be substituted for detergent scrub).

b. Calculate the volume of pump plus any tubing which is not disposable and not dedicated to a single well. Pump 3 volumes of non-phosphate laboratory detergent solution to purge and clean the interior of the pump.

c. Rinse by pumping no less than 9 volumes of approved water to rinse.

d. Rinse pump exterior with reagent grade hexane.

e. Rinse pump exterior with USAEC approved water.

f. Rinse pump exterior with DIUF water.

g. Allow pump to air dry.

h. Wrap pump in aluminum foil or clean plastic sheeting, or store in a clean, dedicated PVC or PTFE storage container.

**3.3.1.3 Dip samplers**

All dip samplers, whether bucket, long-handled, or short-handled (see SOP-007 "Surface Water Sampling") will be decontaminated in the same manner as given in section 3.3.1.1 "bailers" above.

**3.3.1.4 Labware**

Labware such as beakers which are used to hold samples for field measurements, water chemistry, etc. will be decontaminated according to the procedures in 3.3.1.1 "bailers" above.

**3.3.1.5 Water level indicators**

Electric water level indicators, weighted measuring tapes, or piezometers used in the determination of water levels, well depths, and/or NAPL levels will be decontaminated in accordance with section 3.3.1.1 "bailers" above. Clean laboratory wipes may be substituted for brushes. Tapes, probes, and piezometers should be wiped dry with clean laboratory wipes, and coiled on spools or clean plastic sheeting rather than allowed to air dry.

**3.3.2 Solid materials samplers**

Solid materials samplers include soil sampling probes, augers, trowels, shovels, sludge samplers, and sediment samplers. Equipment will be decontaminated as follows:

a. Scrub the sampler to remove gross(visible) contamination, using appropriate brush(es), approved water, and non-phosphate laboratory detergent.

b. Rinse off detergent with USAEC approved water.

c. Rinse sampler with reagent grade hexane.

d. Rinse sampler with USAEC approved water.

e. (Non-metallic samplers only) Rinse sampler with 0.10N Nitric Acid solution.

f. (Non-metallic samplers only) Rinse sampler with DIUF water.

g. Allow sampler to air dry.

h. Wrap sampler in aluminum foil clean plastic sheeting, or store in a new zip-seal bag (size permitting) or clean, dedicated PVC or PTFE storage container.

i. Dispose used decon solutions properly according to the site health and safety plan.

**3.3.3 Other sampling and measurement probes**

**3.3.3.1** Temperature, pH, conductivity, Redox, and dissolved oxygen probes will be decontaminated according to manufacturer's specifications. If no such specifications exist, remove gross contaminant and triple rinse probe with DIUF water.

**3.3.3.3** Measuring tapes which become contaminated through contact with soil during field use will be decontaminated as follows:

a. Wipe tape with a clean cloth or laboratory wipe which has been soaked with non-phosphate laboratory detergent solution to remove gross contamination. Rinse cloth in the solution and continue wiping until tape is clean.

b. Wipe tape with a second clean, wet cloth (or lab wipe) to remove soap residues.

c. Dry tape with a third cloth (or lab wipe) and rewind into case, or re-coil tape.

**3.3.4 Drilling Rigs**

Drilling rigs and associated equipment such as augers, drill casing, rods, samplers, tools, recirculation tank, and water tank (inside and out) will be decontaminated prior to site entry after over-the-road mobilization and immediately upon departure from a site after drilling a hole. Supplementary cleaning will be performed prior to site entry there is a likelihood that contamination has accumulated on tires and as spatter or dust enroute from one site to the next.

a. Place contaminated equipment in an enclosure designed to contain all decontamination residues (water, sludge, etc.).

b. Steam clean equipment until all dirt, mud, grease, asphaltic, bituminous, or other encrusting coating materials (with the exception of manufacturer-applied paint) have been removed.

c. Water used will be taken from an approved source.

d. Containerize, sample, characterize, and dispose of all decontamination residues properly.

## 4.0 Precautions

**4.1** Dispose of all wash water, rinse water, rinsates, and other sampling wastes (tubing, plastic sheeting, etc.) in properly marked, sealable containers, or as directed by the health and safety plan.

**4.2** Once a piece of equipment has been decontaminated, be careful to keep it in such condition until needed.

**4.3** Do not eat, smoke or drink on site.

## 5.0 References

Site-specific health and safety plan.

# REPORT DOCUMENTATION PAGE

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U.S. Army Woodbridge Research Facility (WRF) was used in the past as a major military communications center and a research and development laboratory where electromagnetic pulse energy was tested on military and other equipment. WRF is presently an inactive facility on the Base Realignment and Closure (BRAC) list. Past investigation activities indicate that PCBs are a primary chemical of concern. The WRF is presently in the process of being turned over to the USFWS to be used as a wildlife refuge and training facility. This task calls for provision of the necessary staff and equipment to provide remedial investigation/ feasibility support for the USAEC BRAC Program investigation at WRF. The scope of work includes Focused Feasibility studies, Remedial Investigations, Feasibility studies, ecological assessments, risk assessments, proposed plans, RODS and community relations support. This Sampling and Analysis Plan, Vol II: Quality Assurance Project Plan presents the data quality objectives, proposed laboratory methods for chemical and physical methods, and standard operating procedures for field operations.

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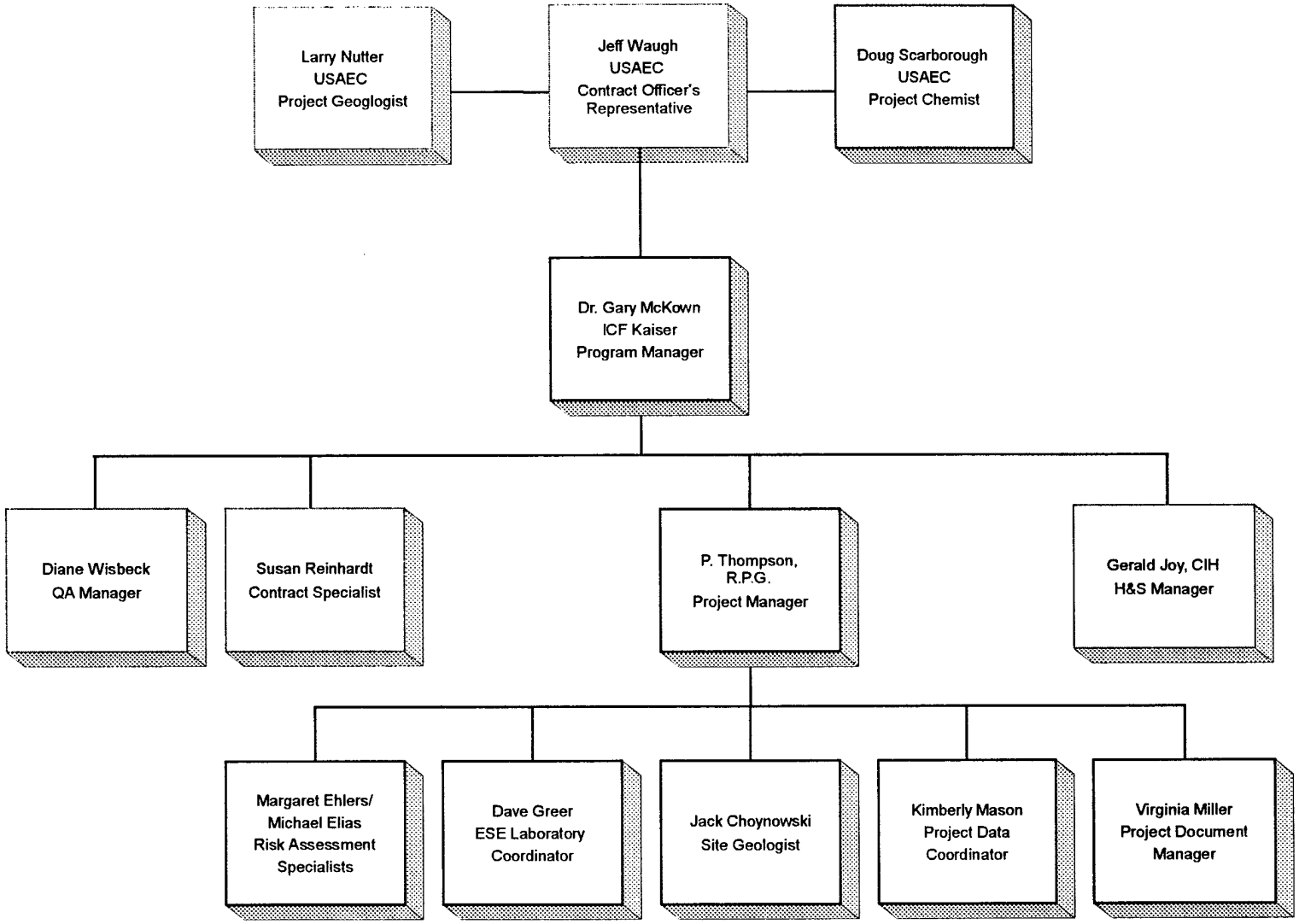


**Figure 3-1. Project Organizational Chart**

## Appendix B - Statements of Qualification

**Jack Choynowski** is a geologist with experience in environmental site characterization and investigation. His primary area of expertise is in hydrogeology. He has experience in sampling many types of media (soil, sediment, groundwater, and surface water) for chemical parameters. He has been the field operations leader of several monitoring well programs at a U.S. Army facility and in private industry. Mr. Choynowski is also experienced in sample design and the analysis of data from groundwater investigations.

**Margaret Ehlers** is a Senior Environmental Scientist with the Risk Assessment Division of ICF Kaiser Engineers (ICF KE). She holds an M.S. in Environmental Science from the George Washington University, Washington, D.C., and a B.A. in French, with a minor in Biology, from Dickinson College, Carlisle, Pennsylvania. Her work at ICF Kaiser has focused on preparing and managing quantitative risk assessments of human health impacts for CERCLA sites for both the private and public sectors. She has also conducted numerous quantitative human health risk assessments for hazardous waste and municipal solid waste incineration facilities. She has worked with local officials to communicate to the public the meaning of risk for these facilities. In addition, she has conducted environmental audits for environmental liability assessments. Before joining ICF Kaiser, she was employed by Applied Environmental Health and Safety, Inc., where she performed environmental audits, conducted health and safety monitoring on construction sites, and performed laboratory analysis for air pollutants.

**Michael C. Elias** joined ICF Kaiser Engineers in 1991. He holds an M.S.P.H. in Environmental Chemistry and Biology from the University of North Carolina, Chapel Hill and an M.A. in Aquatic Biology from the University of California, Santa Barbara. His background encompasses environmental toxicology, aquatic biology, ecology, and public health. While at ICF Kaiser Engineers, Mr. Elias has focused on conducting ecological and human health risk assessments of hazardous waste sites, developing site-specific sampling plans, designing bioassessment plans, and performing environmental impact assessments for proposed activities. Prior to joining ICF Kaiser Engineers, Mr. Elias worked at the University of North Carolina Wastewater Research Center. His research consisted of evaluating the effect of environmental variables on the validity of aquatic toxicity tests. Mr. Elias also worked at the University of California Marine Science Institute where he conducted research in the Antarctic to determine the effect of selected environmental parameters on the survival, growth, and development of the Antarctic krill.

**Marilyn Garcia** has four years of experience as a research biologist, working primarily in ecological and environmental science, and over two years experience as a professional educator. Her professional research experience ranges from wildlife biology and natural resource management, to ecological assessments, to cell biology. Ms. Garcia has acquired a variety of skills through her experience, including methods of habitat assessment, vegetation surveys, wildlife population studies, field collection of soil, sediment, and surface water for chemical and bioassay analyses, and numerous laboratory techniques. As a staff scientist with ICF Kaiser Engineers, she is responsible for developing work plans for human and ecological risk assessments at Aberdeen Proving Ground, Maryland, directing field sampling activities to support these risk assessments, analyzing data, preparing technical reports from field investigations, and providing support for human health and ecological risk assessments. She has received training for the Installation Restoration Data Management Information System (IRDMIS), the 40-hour hazardous materials site worker and the 8-hour refresher courses as required by OSHA 29 CFR 1910.120, and wetlands delineation to be eligible for the U.S Army Corps of Engineers certification.

**Gerald J. Joy, CIH, CSP,** has over 11 years experience in occupational safety and health, with the majority of that time spent in hazardous waste management and related activities. He has conducted or supervised over 100 industrial hygiene surveys, and has participated in dozens of hazardous waste investigations and remedial actions, both as emergency response operations, and scheduled projects. Mr. Joy has also acted in management roles as project manager on several emergency response actions, and as a contract administrator for public and private clients. His experience in health and safety program management includes policy and procedure development, technical support to operations, program

audits, recordkeeping, and regulatory liaison. Mr. Joy is the director of industrial hygiene for ICF Kaiser Engineers, Inc. Prior to joining ICF Kaiser Engineers, Mr. Joy held several positions with International Technology (IT) Corporation, culminating as corporate manager of health and safety. He was previously a senior industrial hygienist with the New York State Department of Labor, OSHA Consultation Division. He holds a bachelor's degree in chemistry from West Virginia University, a master's degree in chemistry from the University of Pittsburgh, and a master's degree in industrial hygiene from the Graduate School of Public Health at the University of Pittsburgh.

**Jay C. Kuhn** joined ICF in 1990. He has a M.S. degree in Environmental Sciences and Engineering from Virginia Polytechnic Institute and State University. He holds a B.S. degree in Chemistry from Denison University. As Senior Scientist with ICF Kaiser, Mr. Kuhn's work emphasizes the development of quality assurance plans, WRF RI/FS, and validation of environmental analytical data. In addition, Mr. Kuhn has substantial experience as an environmental chemist. This experience includes the subdisciplines of sample preparation, analysis of environmental samples, and the interpretation of environmental data.

**Dr. Gary McKown** is a Vice-President at ICF and is the Program Manager for the work under the USAEC ESPS contract. He holds B.S. and Ph.D. degrees in chemistry and has performed extensive research and postdoctoral work in chemical physics. Dr. McKown has more than 15 years of experience in hazardous waste characterization and remediation technology, process systems safety engineering, hazard/risk analysis, and hazardous materials research, development, test and evaluation. At ICF, Dr. McKown has been involved in performing RI/FS, RFA and RFI work for the U.S. Army and for the waste management industry, performing cost-benefit analysis of RCRA listing programs, developing instrumentation for pollution control equipment, managing laboratory support services for USEPA, managing and performing quality assurance programs, performing hazardous materials research, and supporting DOE and DOD hazardous waste site characterization programs. Prior to joining ICF, Dr. McKown was project manager for DOD and USEPA CERCLA investigations at more than a dozen sites throughout the country. These programs included evaluation of process wastes and disposal methods; extensive chemical and geohydrologic site characterization activities; development of feasible remedial measures; establishment of mathematical models for prediction of the fate of toxic chemicals in soils and groundwater and for evaluating remedial action benefits; analysis of resultant health and environmental endangerments and residual risks; specification and preliminary design of remedial processes; and analysis of the reliability of remedial designs based on uncertainties in the data collected during remedial investigations and feasibility studies.

For seven years, Dr. McKown led a team of engineers and technicians in evaluating the hazards associated with manufacturing, storage, supply and use of highly reactive materials, and in developing process equipment designed to minimize risks. He also has several years of experience in academic instruction and chemical physics research, including study of the structure of gaseous molecules and free-radical fragments.

**R. Joseph Neubauer** has four years of experience in estuarine and environmental science, particularly in the areas of estuarine and coastal invertebrate ecology, hazardous waste site assessment and estuarine management. He holds a B.S. with honors in Biology from Towson State University, MD and an M.A. in Marine Science from the Virginia Institute of Marine Science, College of William and Mary, VA. Mr. Neubauer is currently working under a U.S. Army contract involving the human health and ecological/biological risk assessment of several terrestrial and aquatic study areas on the military installation. Mr. Neubauer's primary responsibilities are designing and conducting ecological investigations for the Risk Assessment of several creeks and sub-estuaries of the Chesapeake Bay that are on a U.S. Army Installation. Before joining ICF Kaiser Mr. Neubauer worked for the Chesapeake Bay Estuary Program of the U.S. Fish and Wildlife Service. Other pertinent experience includes a number a field surveys of the marine and estuarine benthos through a variety of methods as well as the technical review of several Chesapeake Bay Program documents. Mr. Neubauer has participated in numerous field and laboratory studies concerning marine and estuarine environments, and is skilled in the collection of

sediments, surface water, soil, and ground water. Mr. Neubauer has professional training in the delineation of jurisdictional wetlands based on methods consistent with the U.S. Army Corps of Engineers. Mr. Neubauer is also experienced in the identification of marine and freshwater plants, invertebrates, and vertebrates. Mr. Neubauer is certified as a PADI Advanced Open Water Diver and has over 200 dives for research of coastal environments. Mr. Neubauer is also NOAA Nitrox (mixed gas) certified.

**Susan Reinhardt** is a Contract Specialist with six years of experience in finance, contracts, and business planning. She holds a B.B.A. in finance from James Madison University, Harrisonburg, VA. and a M.S.B. in International Business from Johns Hopkins University, Baltimore, MD. Ms. Reinhardt is currently working under two multi-task order projects for the U.S. Army. The contracts total over $50M and work is performed at various Army installations in the U.S. Ms. Reinhardt is the contract, subcontract and financial manager for these programs. Ms. Reinhardt also provides the property and warehouse management for these programs. In addition, she provides business unit financial support for the Abingdon office. Ms. Reinhardt has recently increased her responsibilities by assisting the Director of Finance in the EEG Southeast reporting capacity.

**Larry Thebeau** is a Project Manager in the Abingdon, Maryland office and is presently leading several efforts on the overall APG Biological/Ecological Program. Mr. Thebeau is one of ICF Kaiser's more accomplished field biologists. He has over eighteen years of experience in the environmental field, with seventeen of these in environmental consulting. Mr. Thebeau has a broad range of experience in the biological/ecological field, including research on plants, birds, alligators and deer, ranging from wildlife management studies to oil spill impacts to bioassays. In 1989, Mr. Thebeau was the field team leader, oil spill expert and the senior biological investigator on a project relating to the EXXON VALDEZ oil spill. For the past seven years, his experience has primarily been in the area of hazardous waste site cleanup and assessment, oil and hazardous material spill response, response contingency planning, and incident damage assessment. Since joining ICF in 1987, Mr. Thebeau has been the Assistant Field Investigation Team Office Manager for the Field Investigation Team (FIT) contract, and the Deputy Program Manager for the ARCS VI, VII, VIII contract and the Subcontractor Program Manager for the TES X contract; both multi-year, multi-million dollar contracts. In addition, Mr. Thebeau was the Health and Safety Officer for the USEPA Region VI Emergency Response Contract, and has written and reviewed numerous Health and Safety Plans.

**Patricia Thompson, R.P.G.,** is a Project Manager for ICF Kaiser and has twenty years of experience in the fields of environmental geology, hydrogeologic investigations, base metal exploration, and oil and gas research. Ms. Thompson is currently the Project Manager for Aberdeen Proving Ground, O-Field RI/FS. Ms. Thompson's previous experience includes design and management of geological/hydrogeological investigations according to RCRA regulations for landfill and incineration sites for hazardous waste management facilities in Mississippi and Tennessee. Primary author of the Groundwater Monitoring Section of a Part B Permit Application which included interpretation of all field investigation activities, groundwater monitoring design for the hazardous waste facility and RCRA groundwater monitoring activities for facility operation. She has managed several CERCLA Removal Actions and conducted hydrogeologic investigations under CERCLA. Ms. Thompson was a Project Manager and consultant for a RCRA Facility Investigation. Activities include installation of groundwater monitoring wells, groundwater and soil sampling. Responsible for arranging residential well sampling for a two mile radius around the RCRA site. She continues to provide technical assistance for ongoing work and is responsible for public relations for the RFI. Ms. Thompson has a B.A. in Geology from the University of Northern Colorado, Greeley, Colorado. She is a registered Professional Geologist in Tennessee and Kentucky and has applications pending in Pennsylvania and Virginia.

**Tammy Williams** has three years of experience in environmental engineering, particularly in the areas of site and remedial investigations, conceptual design, feasibility studies, report preparation, and environmental sampling. Her academic background includes course work in hazardous waste management, environmental regulations, geotechnical engineering, water and wastewater treatment,

limnology, air pollution control, and site investigation/remediation. Previous work experience includes seven years as a public school teacher of secondary mathematics and science.

**Diane Wisbeck** has 4 years of experience with the analysis of environmental samples. Her work has included the development of Quality Assurance Project Plans, collection of samples, on-site analysis of environmental samples using several different and novel methodologies, data review, and validation of data using the National Functional Guidelines for Data Validation. Ms. Wisbeck has served as the Quality Assurance Manager for several projects for the USAEC. She also has experience in provide support during the installation of monitoring wells, field sampling of groundwater, sediment, surface soil and surface water.

# Appendix C - WRF RI/FS LOCs and Reporting Limits Comparison Tables

## TCL VOC COMPARISON TABLE FOR SOIL AND SEDIMENT

| Analyte | Level of Concern µg/g | | ESE Reporting Limits µg/g |
|---|---|---|---|
| | Soil | Sediment | |
| Methylene chloride | 760(2) | --- | 0.010 |
| 1,1-Dichlororethane | 200,000(2) | --- | 0.010 |
| trans-1,2-Dichloroethene | 41,000(2) | --- | 0.010 |
| 1,1-Dichloroethylene | 9.5(2) | --- | 0.010 |
| Chloroform | 100(1) | --- | 0.010 |
| 1,2-Dichloroethane | 63(2) | --- | 0.010 |
| 1,1,1-Trichloroethane | 180,000(2) | --- | 0.010 |
| Carbon tetrachloride | 44(2) | --- | 0.010 |
| Trichloroethylene | 520(2) | --- | 0.010 |
| Benzene | 200(2) | --- | 0.010 |
| 1,1,2-Trichloroethane | 100(2) | --- | 0.010 |
| Tetrachloroethylene | 110(2) | --- | 0.010 |
| Toluene | 20,000(1) | --- | 0.010 |
| Chlorobenzene | 2000(1) | --- | 0.010 |
| Ethylbenzene | 8000(1) | --- | 0.010 |
| 1,2-Dichloropropane | 84(2) | --- | 0.010 |
| cis-1,3-Dichloropropylene | 33(2) | --- | 0.010 |
| Vinyl chloride | 3(2) | --- | 0.010 |
| Chloroethane | 82,000(2) | --- | 0.010 |
| Chloromethane | 440(2) | --- | 0.010 |
| Bromoform | 720(2) | --- | 0.010 |
| Dibromochloromethane | 68(2) | --- | 0.010 |
| trans-1,3-Dichloropropene | 33(2) | --- | 0.010 |
| 1,1,2,2-Tetrachloroethane | 29(2) | --- | 0.010 |
| Bromodichloromethane | 0.5(1) | --- | 0.010 |
| Bromomethane | 2900(2) | --- | 0.010 |
| Acetone | 8000(1) | --- | 0.010 |
| Carbon disulfide | 200,000(2) | --- | 0.010 |
| 2-Butanone | 4000(1) | --- | 0.010 |
| 4-Methyl-2-pentanone | -- | --- | 0.010 |
| Styrene | 410,000(2) | --- | 0.010 |
| Xylene | $1E^{+6}$(2) | --- | 0.010 |

## TCL SVOC COMPARISON TABLE FOR SOIL AND SEDIMENT

| Analyte | Level of Concern µg/g | | ESE Reporting Limits µg/g |
|---|---|---|---|
| | Sediment | Soil | |
| Phenol | -- | $1E^{+6}$(2) | 0.14 |
| Bis(2-chloroethyl)ether | -- | 5.2(2) | 0.14 |
| 2-Chlorophenol | -- | 10,000 (2) | 0.14 |
| 1,3-Dichlorobenzene | -- | 180,000(2) | 0.14 |
| 1,4-Dichlorobenzene | -- | 240(2) | 0.14 |
| 1,2-Dichlorobenzene | -- | 180,000(2) | 0.14 |
| 2-Methylphenol | -- | 100,000(2) | 0.14 |
| Bis(2-chloroisopropyl)ether | -- | 82(2) | 0.14 |
| 4-Methylphenol | -- | 10,000(2) | 0.14 |
| N-Nitroso-di-n-propylamine | -- | 0.82(2) | 0.14 |
| Hexachloroethane | -- | 410(2) | 0.14 |
| Nitrobenzene | -- | 1000(2) | 0.14 |
| Isophorone | -- | 6000(2) | 0.14 |
| 2-Nitrophenol | -- | -- | 0.14 |
| 2,4-Dimethylphenol | -- | -- | 0.14 |
| Bis(2-chloroethoxy)methane | -- | -- | 0.14 |
| 2,4-Dichlorophenol | -- | -- | 0.14 |
| 1,2,4-Trichlorobenzene | -- | 2000(21) | 0.14 |
| Naphthalene | 0.16/2.10 | 82,000(2) | 0.14 |
| 4-Chloroaniline | -- | -- | 0.30 |
| Hexachlorobutadiene | -- | 73(2) | 0.14 |
| 4-Chloro-3-methylphenol | -- | -- | 0.14 |
| 2-Methylnaphthalene | 0.07/0.67 | -- | 0.14 |
| Hexachlorocyclopentadiene | -- | 14,000(2) | 1.0 |
| 2,4,6-Trichlorophenol | -- | 520(2) | 0.30 |
| 2,4,5-Trichlorophenol | -- | 200,000(2) | 0.30 |
| 2-Chloronaphthalene | -- | -- | 0.14 |
| 2-Nitroaniline | -- | 120(2) | 0.67 |
| Dimethylphthalate | -- | -- | 0.14 |
| Acenaphthylene | -- | -- | 0.14 |
| 2,6-Dinitrotoluene | -- | 2000(2) | 0.14 |
| 3-Nitroaniline | -- | 6100(2) | 0.67 |

## TCL SVOC COMPARISON TABLE FOR SOIL AND SEDIMENT (CONT)

| Analyte | Level of Concern µg/g | | ESE Reporting Limits µg/g |
|---|---|---|---|
| | Sediment | Soil | |
| Acenaphthene | 0.016/0.50 | 120,000(2) | 0.14 |
| 2,4-Dinitrophenol | -- | -- | 1.35 |
| 4-Nitrophenol | -- | 130,000(2) | 1.35 |
| Dibenzofuran | -- | -- | 0.14 |
| 2,4-Dinitrotoluene | -- | -- | 0.14 |
| Diethylphthalate | -- | $1E^{+6}$(2) | 0.14 |
| 4-Chlorophenyl-phenylether | -- | -- | 0.14 |
| Fluorene | -- | 82,000(2) | 0.14 |
| 4-Nitroaniline | -- | 6100(2) | 0.67 |
| 4,6-Dinitro-2-methylphenol | -- | -- | 1.35 |
| N-Nitrosodiphenylamine | -- | 1200(2) | 0.14 |
| 4-Bromophenyl-phenyl ether | -- | 120,000(2) | 0.14 |
| Hexachlorobenzene | -- | 4100(2) | 0.14 |
| Pentachlorphenol | -- | -- | 0.67 |
| Phenanthrene | 0.24/1.50 | -- | 0.14 |
| Anthracene | 0.085/1.10 | 610,000(2) | 0.14 |
| Di-n-butylphthalate | -- | 200,000(2) | 0.14 |
| Fluoranthene | 0.60/3.60 | 82,000(2) | 0.14 |
| Pyrene | 0.667/2.60 | 61,000(2) | 0.14 |
| Butylbenzylphthalate | -- | 41,000(2) | 0.14 |
| 3,3'-Dichlorobenzidine | -- | 13(2) | 0.67 |
| Benz[a]anthracene | 0.261/1.60 | 7.8(2) | 0.14 |
| Chrysene | 0.384/2.80 | 78(2) | 0.14 |
| Bis(2-ethylhexyl)phthalate | -- | 50(1) | 0.14 |
| Di-n-octylphthalate | -- | 41,000(2) | 0.14 |
| Benzo[b]fluoranthene | -- | 78(2) | 0.14 |
| Benzo[k]fluoranthene | -- | 7.8(2) | 0.14 |
| Benzo[a]pyrene | 0.43/1.60 | 0.78(2) | 0.14 |
| Indeno(1,2,3-cd)pyrene | -- | -- | 0.16 |
| Dibenz[a,h]anthracene | 0.063/0.26 | 0.78(2) | 0.16 |
| Benzo[g,h,i]perylene | -- | -- | 0.16 |

## PAHs COMPARISON TABLE FOR SOIL AND SEDIMENT

| Parameter | Level of Concern µg/g | | ESE Reporting Limits µg/g |
|---|---|---|---|
| | Sediment | Soil | |
| Naphthalene | 0.16 | -- | 0.133 |
| Acenaphthylene | NA | -- | 0.133 |
| Acenaphthene | 0.016 | 4700 | 0.133 |
| Fluorene | 0.190 | -- | 0.033 |
| Phenanthrene | 0.560 | -- | 0.033 |
| Anthracene | 0.220 | 23000 | 0.0067 |
| Fluoranthrene | 0.750 | 3100 | 0.013 |
| Pyrene | 0.490 | 2300 | 0.0067 |
| Benzo(a)anthracene | 0.320 | 0.88 | 0.0013 |
| Chrysene | 0.320 | 88 | 0.0067 |
| Benzo(b)fluoranthene | NA | 0.88 | 0.0013 |
| Benzo(k)fluoranthene | 0.240 | 8.8 | 0.0007 |
| Benzo(a)pyrene | 0.370 | 0.088 | 0.0007 |
| Dibenzo(a,h)anthracene | 0.060 | 0.088 | 0.0033 |
| Benzo(ghi)perylene | 0.170 | -- | 0.0067 |
| Indeno(1,2,3-dc)pyrene | 0.200 | -- | 0.0033 |

## TAL INORGANICS COMPARISON TABLE FOR SOIL AND SEDIMENT SAMPLES

| Analyte | Level of Concern µg/g | | ESE Reporting Limits µg/g |
|---|---|---|---|
| | Sediment | Soil | |
| Aluminum | -- | $1E^{+6}$(2) | 10 |
| Antimony | 2(1) | 30(1) | |
| Arsenic | 33 | 80(1) | .025 |
| Barium | -- | -- | 5.0 |
| Beryllium | -- | 0.2(1) | 0.5 |
| Cadmium | 5 | 40(1) | 0.5 |
| Calcium | -- | -- | 20 |
| Chromium | 80 | 400(1) | 1.0 |
| Cobalt | -- | 120,000(2) | 2.0 |
| Copper | 70 | 76,000(2) | 0.5 |
| Cyanide | -- | 41,000(2) | 5.0 |
| Iron | -- | -- | 10.0 |
| Lead | 35 | -- | 5.0 |
| Magnesium | -- | -- | 10.0 |
| Manganese | -- | 10,000(2) | 0.5 |
| Mercury | -- | 610(2) | |
| Nickel | 30 | 2,000(1) | 2.0 |
| Potassium | -- | -- | 60.0 |
| Selenium | -- | 10,000(2) | 10.0 |
| Silver | 1.0 | 10,000(2) | 0.5 |
| Sodium | -- | -- | 20.0 |
| Thallium | -- | -- | 10.0 |
| Vanadium | -- | 14,000(2) | 1.0 |
| Zinc | 120 | 150(1) | 5.0 |

## TCL PESTICIDES/PCBs COMPARISON TABLE FOR SOIL AND SEDIMENT SAMPLES

| Analyte | Level of Concern µg/g* | | ESE Reporting Limits[a] µg/g |
|---|---|---|---|
| | Sediment[b] | Soil | |
| alpha-BHC | -- | 0.91(d) | 0.003 |
| beta-BHC | -- | 3.2(d) | 0.003 |
| delta-BHC | -- | -- | 0.003 |
| gamma-BHC (Lindane) | -- | 4.4(d) | 0.003 |
| Heptachlor | -- | 1.3(d) | 0.003 |
| Aldrin | -- | -- | 0.003 |
| Heptachlor epoxide | -- | 0.63(d) | 0.003 |
| Endosulfan I | -- | 12,000(d) | 0.003 |
| Dieldrin | 0.00002/0.008 | 0.04(c) | 0.003 |
| 4,4'-DDE | 0.002/0.015 | 2(c) | 0.003 |
| Endrin | 0.00002/0.045 | 610(d) | 0.003 |
| Endosulfan II | -- | -- | 0.003 |
| 4,4'-DDD | 0.002/0.020 | 3(c) | 0.003 |
| Endosulfan sulfate | -- | -- | 0.003 |
| 4,4'-DDT | 0.001/0.007 | 2(c) | 0.003 |
| Endrin ketone | -- | -- | 0.003 |
| Methoxychlor | -- | -- | 0.003 |
| Endrin aldehyde | -- | -- | 0.022 |
| alpha-Chlordane | -- | 0.5(c) | 0.003 |
| gamma-Chlordane | -- | 4.4(d) | 0.003 |
| Toxaphene | -- | 5.2(d) | 0.3 |
| AROCLOR-1016 | -- | -- | 0.013 |
| AROCLOR-1221 | -- | -- | 0.013 |
| AROCLOR-1232 | -- | -- | 0.013 |
| AROCLOR-1242 | -- | 0.09(c) | 0.013 |
| AROCLOR-1248 | -- | -- | 0.013 |
| AROCLOR-1254 | -- | 0.09(c) | 0.013 |
| AROCLOR-1260 | -- | 0.09(c) | 0.013 |
| TOTAL PCBs | 0.05/0.40 | -- | -- |

## POLYCHLORINATE TRIPHENYL COMPARISON TABLE FOR SOIL AND GROUNDWATER SAMPLES

| Analyte | Level of Concern µg/g | | ESE Reporting Limits µg/g |
|---|---|---|---|
| | Sediment | Soil | |
| AROCLOR-5432 | -- | 1.3 (1) | 0.136 |
| AROCLOR-5442 | -- | 1.3 | 0.136 |
| AROCLOR-5460 | -- | 1.3 | 0.136 |

**Soil and Sediment Legend:**

-- No LOC for this compound.

[a] Quantitation limits for solids are based on wet weight. The quantitaiton limits calculated by the laboratory, calculated on dry weight basis as required by the contract, will be higher.

[b] Sediment values referrenced are Long and Morgan, 1990, ER-L/ER-M values.

[c] Information obtained from USEPA Proposed RCRA Corrective Action Levels for SWMUs at Hazardous Waste Management Facilities (1990) and are to be considered as guidance.

[d] USEPA Risk-Based Concentration Table, January - June 1995. RBC for Soil Ingestion under Industrial scenario.

## TCL VOC COMPARISON TABLE FOR SURFACE WATER AND GROUNDWATER

| Analyte | Level of Concern µg/L | | ESE Reporting Limits µg/L |
|---|---|---|---|
| | Surface Water | Groundwater | |
| Methylene chloride | -- | 5(m) | 5* |
| 1,1-Dichlororethane | -- | -- | 2 |
| trans-1,2-Dichloroethene | -- | 100(d,e) | 2 |
| 1,1-Dichloroethylene | -- | 7(e) | 2 |
| Chloroform | 1,240(1) | 80(n,o) | 2 |
| 1,2-Dichloroethane | -- | 5(e) | 2 |
| 1,1,1-Trichloroethane | -- | 200(e) | 2 |
| Carbon tetrachloride | -- | 5(e) | 2 |
| Trichloroethylene | 21,800(1) | 5(e) | 2 |
| Benzene | -- | 5(e) | 2 |
| 1,1,2-Trichloroethane | 9,400(1) | 5(m) | 2 |
| Tetrachloroethylene | 940(1) | 5(d,e) | 2 |
| Toluene | -- | 1000(d,e) | 2 |
| Chlorobenzene | 50(1) | 100(d,e) | 2 |
| Ethylbenzene | -- | 30(b,j) | 2 |
| 1,2-Dichloropropane | 5,700(1) | 5(d,e) | 2 |
| cis-1,3-Dichloropropylene | 244(1) | -- | 2 |
| Vinyl chloride | -- | 2(e) | 2 |
| Chloroethane | -- | -- | 10 |
| Chloromethane | 4,700(1) | 3(l) | 2 |
| Bromoform | -- | 80(n,o) | 2 |
| Dibromochloromethane | -- | 60(b,n) | 2 |
| trans-1,3-Dichloropropene | 244(1) | -- | 2 |
| 1,1,2,2-Tetrachloroethane | 2,400(1) | -- | 2 |
| Bromodichloromethane | -- | 60(b,n) | 2 |
| Bromomethane | -- | 10(l) | 2 |
| Acetone | -- | -- | 10 |
| Carbon disulfide | -- | -- | 10 |
| 2-Butanone | -- | -- | 10 |
| 4-Methyl-2-pentanone | -- | -- | 10 |
| Styrene | -- | -- | 2 |
| Xylene | -- | 10,000(d,e) | 10 |

* Methylene chloride will be reported to the criterion of detection (COD) which is approximately one-half the reporting limit. Results reported between the COD and the reporting limit will be considered estimated and are suitable for risk assessment use.

## TCL SVOC COMPARISON TABLE FOR SURFACE WATER AND GROUNDWATER

| Analyte | Level of Concern µg/L | | ESE Report Limit µg/L |
|---|---|---|---|
| | Surface Water | Groundwater | |
| Phenol | 2,560(1) | 1(a) | 2 |
| Bis(2-chloroethyl)ether | -- | -- | 2 |
| 2-Chlorophenol | 2,000(1) | 40(p,q) | 2 |
| 1,3-Dichlorobenzene | 763(1) | 600(p) | 2 |
| 1,4-Dichlorobenzene | 763(1) | 5(e) | 2 |
| 1,2-Dichlorobenzene | 763(1) | 600(d,e) | 2 |
| 2-Methylphenol | -- | -- | 2 |
| Bis(2-chloroisopropyl)ether | -- | 300(l) | 2 |
| 4-Methylphenol | -- | -- | 2 |
| N-Nitroso-di-n-propylamine | -- | -- | 2 |
| Hexachloroethane | 540(1) | 1(p) | 2 |
| Nitrobenzene | -- | -- | 2 |
| Isophorone | -- | 100(z) | 2 |
| 2-Nitrophenol | 150(1) | -- | 2 |
| 2,4-Dimethylphenol | -- | -- | 2 |
| Bis(2-chloroethoxy)methane | -- | -- | 2 |
| 2,4-Dichlorophenol | 365(1) | 20(p,q) | 2 |
| 1,2,4-Trichlorobenzene | -- | 70(m) | 2 |
| Naphthalene | 620(1) | 20(k) | 2 |
| 4-Chloroaniline | -- | -- | 2 |
| Hexachlorobutadiene | 9,3(1) | 1(l) | 2 |
| 4-Chloro-3-methylphenol | -- | -- | 2 |
| 2-Methylnaphthalene | -- | -- | 2 |
| Hexachlorocyclopentadiene | 5.2(1) | 8(b,c) | 10 |
| 2,4,6-Trichlorophenol | 65(2) | -- | 2 |
| 2,4,5-Trichlorophenol | -- | -- | 2 |
| 2-Chloronaphthalene | -- | -- | 2 |
| 2-Nitroaniline | -- | -- | 10 |
| Dimethylphthalate | 520(1) | -- | 2 |
| Acenaphthylene | -- | -- | 2 |
| 2,6-Dinitrotoluene | -- | -- | 2 |
| 3-Nitroaniline | -- | -- | 10 |

## TCL SVOC COMPARISON TABLE FOR SURFACE WATER AND GROUNDWATER (CONT)

| Analyte | Level of Concern µg/L | | ESE Reporting Limits µg/L |
|---|---|---|---|
| | Surface Water | Groundwater | |
| Acenaphthene | -- | -- | 2 |
| 2,4-Dinitrophenol | 150(1) | -- | 2 |
| 4-Nitrophenol | 150(1) | -- | 20 |
| Dibenzofuran | -- | -- | 2 |
| 2,4-Dinitrotoluene | -- | -- | 30 |
| Diethylphthalate | -- | -- | 2 |
| 4-Chlorophenyl-phenylether | -- | -- | 2 |
| Fluorene | 14,000(2) | -- | 2 |
| 4-Nitroaniline | -- | -- | 10 |
| 4,6-Dinitro-2-methylphenol | -- | -- | 20 |
| N-Nitrosodiphenylamine | -- | -- | 2 |
| 4-Bromophenyl-phenyl ether | -- | -- | 2 |
| Hexachlorobenzene | -- | 1(m) | 2 |
| Pentachlorphenol | 13(1) | 1(e,g) | 10 |
| Phenanthrene | -- | -- | 2 |
| Anthracene | 110,000(2) | -- | 2 |
| Di-n-butylphthalate | -- | -- | 2 |
| Fluoranthene | 370(2) | -- | 2 |
| Pyrene | 11,000(2) | -- | 2 |
| Butylbenzylphthalate | -- | 100(p) | 2 |
| 3,3'-Dichlorobenzidine | -- | -- | 10 |
| Benz[a]anthracene | 0.311(2) | 0.1(b,p) | 2 |
| Chrysene | -- | 0.2(p) | 2 |
| Bis(2-ethylhexyl)phthalate | 59(2) | 6(m) | 2 |
| Di-n-octylphthalate | -- | -- | 2 |
| Benzo[b]fluoranthene | 0.311(2) | 0.2(b,p) | 2 |
| Benzo[k]fluoranthene | 0.311(2) | 0.2(b,p) | 2 |
| Benzo[a]pyrene | 0.311(2) | 0.2(m) | 2 |
| Indeno(1,2,3-cd)pyrene | 0.311(2) | 0.4(b,p) | 2 |
| Dibenz[a,h]anthracene | -- | 0.3(b,p) | 2 |
| Benzo[g,h,i]perylene | -- | -- | 2 |

## PAHs COMPARISON TABLE FOR SURFACE WATER AND GROUNDWATER

| Parameter | Level of Concern µg/L | | ESE Reporting Limits µg/L |
|---|---|---|---|
| | Surface Water | Groundwater | |
| Naphthalene | 620(1) | -- | 2.0 |
| Acenaphthylene | -- | -- | 2.0 |
| Acenaphthene | -- | 520(b,p) | 2.0 |
| Fluorene | 14,000(2) | -- | 0.5 |
| Phenanthrene | -- | -- | 0.5 |
| Anthracene | 110,000(2) | -- | 0.1 |
| Fluoranthrene | 370(2) | -- | 0.02 |
| Pyrene | 11,000(2) | -- | 0.1 |
| Benzo(a)anthracene | 0.311(2) | -- | 0.02 |
| Chrysene | -- | 0.2(b,p) | 0.1 |
| Benzo(b)fluoranthene | 0.311(2) | 0.2(b,p) | 0.02 |
| Benzo(k)fluoranthene | 0.311(2) | 0.2(b,p) | 0.01 |
| Benzo(a)pyrene | 0.311(2) | 0.2 (m) | 0.01 |
| Dibenzo(a,h)anthracene | -- | 0.4(b,p) | 0.05 |
| Benzo(ghi)perylene | -- | 0.3(b,p) | 0.1 |
| Indeno(1,2,3-dc)pyrene | 0.311(2) | 0.4(b,p) | 0.05 |

## TCL PESTICIDES/PCBs COMPARISON TABLE FOR SURFACE WATER AND GROUNDWATER SAMPLES

| Analyte | Level of Concern µg/L | | ESE Reporting Limits µg/L |
|---|---|---|---|
| | Surface Water | Groundwater | |
| alpha-BHC | -- | -- | 0.005 |
| beta-BHC | -- | -- | 0.005 |
| delta-BHC | -- | -- | 0.005 |
| gamma-BHC (Lindane) | 0.08(3) | 0.01(r) | 0.005 |
| Heptachlor | -- | 0.001(r) | 0.005 |
| Aldrin | 0.3(3) | 0.003(r) | 0.005 |
| Heptachlor epoxide | 0 .0038(1) | 0.001(r) | 0.005 |
| Endosulfan I | 0.056(3) | -- | 0.005 |
| Dieldrin | 0.0019(4) | --(p,v) | 0.005 |
| 4,4'-DDE | -- | -- | 0.007 |
| Endrin | 0.0023(3,4) | 0.004(r) | 0.005 |
| Endosulfan II | 0.056(3,4) | -- | 0.005 |
| 4,4'-DDD | -- | -- | 0.007 |
| Endosulfan sulfate | -- | -- | 0.005 |
| 4,4'-DDT | 0.001(3,4) | -- | 0.007 |
| Endrin ketone | -- | -- | 0.006 |
| Methoxychlor | 0.03(1) | 0.03(r) | 0.009 |
| Endrin aldehyde | -- | -- | 0.02 |
| alpha-Chlordane | 0.0043(4) | 0.01(r) | 0.005 |
| gamma-Chlordane | 0.0043(4) | 0.01(r) | 0.005 |
| Toxaphene | 0.0002(1) | -- | 0.60 |
| AROCLOR-1016 | 0.014(4) | 0.5(d,e) | 0.13 |
| AROCLOR-1221 | 0.014(4) | 0.5(d,e) | 0.13 |
| AROCLOR-1232 | 0.014(4) | 0.5(d,e) | 0.13 |
| AROCLOR-1242 | 0.014(4) | 0.5(d,e) | 0.13 |
| AROCLOR-1248 | 0.014(4) | 0.5(d,e) | 0.13 |
| AROCLOR-1254 | 0.014(4) | 0.5(d,e) | 0.13 |
| AROCLOR-1260 | 0.014(4) | 0.5(d,e) | 0.13 |

POLYCHLORINATE TRIPHENYL COMPARISON TABLE FOR SOIL AND GROUNDWATER SAMPLES

| Analyte | Level of Concern µg/L | | ESE Reporting Limits µg/L |
|---|---|---|---|
| | Surface Water | Groundwater | |
| AROCLOR-5432 | -- | 0.5 | 1.0 |
| AROCLOR-5442 | -- | 0.5 | 1.0 |
| AROCLOR-5460 | -- | 0.5 | 1.0 |

## TAL INORGANICS* COMPARISON TABLE FOR SURFACE WATER AND GROUNDWATER SAMPLES

| Analyte | Level of Concern µg/L | | ESE Reporting Limits µg/L |
|---|---|---|---|
| | Surface Water | Groundwater | |
| Aluminum | -- | 50(d) | 40 |
| Antimony | 9,000(1) | 3(l) | 1.0 |
| Arsenic | 360(1) | 50(e) | 1.0 |
| Barium | -- | 2000(e,f,g) | 25.0 |
| Beryllium | 130(1) | 4(m) | 0.2 |
| Cadmium | 3.9(5) | 5(d,e) | 0.1 |
| Calcium | -- | -- | 100 |
| Chromium | 1,700(5) | 50(r) | 10.0 |
| Cobalt | -- | -- | 20.0 |
| Copper | 18(5) | 1300(h,i) | 5.0 |
| Iron | -- | 300(l) | 45 |
| Lead | 82(5) | 15(h,i) | 1.0 |
| Magnesium | -- | -- | 5.0 |
| Manganese | -- | 50(l) | 5.0 |
| Mercury | 2.4(5) | 0.05(r) | 0.15 |
| Nickel | 1,400(5) | 100(m) | 15.0 |
| Potassium | -- | -- | 550 |
| Selenium | 20(5) | -- | 100 |
| Silver | 4.1(5) | 50(r) | 0.1 |
| Sodium | -- | -- | 100 |
| Thallium | 1,400(1) | 0.4(l) | 0.1 |
| Vanadium | -- | -- | 10.0 |
| Zinc | 120(5) | 50(r) | 20.0 |

**Groundwater Legend:**

-- = Standard not developed for this chemical.

(a) Virginia Department of Environmental Quality (VA DEQ). Water Quality Standards for Groundwater. VR 680-21-05.1
(b) Proposed.
(c) Environmental Protection Agency (EPA). 1990. National Primary and Secondary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals. Proposed Rule. Federal Register. Vol. 53, No. 143, Wed. July 25, 1990.
(d) Environmental Protection Agency (EPA). 1991. National Primary Drinking Water Regulations; Final Rule. Federal Register. Vol. 56, No. 20, Wednesday, January 30, 1991. 3526-3597.
(e) 40 CFR, Part 141-National Primary Drinking Water Regulations. 559-563, 620-621.
(f) The MCL for barium of 1,000 $\mu$g/l shall remain effective until January 1, 1993 when the MCL of 2,000 $\mu$g/l will take its place.
(g) Environmental Protection Agency (EPA). 1991. National Primary Drinking Water Regulations - Monitoring for Volatile Organic Chemicals; MCLGs and MCLs for Aldicarb, Aldicarb Sulfoxide, Aldicarb Sulfone, Pentachlorophenol, and Barium; Final Rule. Federal Register. Vol. 56, No. 126, Monday, July 1, 1991. 30266-30281.
(h) Action Level; exceeded if the level of concentration in more than 10 percent of the targeted tap samples is greater than the specified value (90th percentile).
(i) Standards effective December 7, 1992.
Environmental Protection Agency (EPA). 1991. Drinking Water Regulations; Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper; Final Rule. Federal Register. Vol. 56, No. 110, 26460-26564, Friday, June 7, 1991.
(j) Environmental Protection Agency (EPA). 1989. National Primary and Secondary Drinking Water Regulations; Proposed Rule. Federal Register. Vol. 54, No. 97, Monday, May 22, 1989. 22062-22160.
(k) Environmental Protection Agency (EPA). 1990. Health Advisory for Naphthalene. Office of Drinking Water. Washington, D.C. March, 1990.
(l) Environmental Protection Agency (EPA). 1992. Drinking Water Regulations and Health Advisories. Office of Water, Washington, D.C. November, 1992.
(m) Standards effective January 17, 1994 (except endrin, standards effective August 17, 1992. Environmental Protection Agency (EPA). 1992. National Primary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals. Final Rule. Federal Register. Vol. 57, No. 188, Friday, July 17, 1992. 31776-31849.
(n) Environmental Protection Agency (EPA). 1994. National Primary Drinking Water Regulations; Disinfectants and Disinfection Byproducts; Proposed Rule. July 29, 1994.
(o) The value of 80 ug/l is for total trihalomethanes (i.e., the sum of chloroform, bromodichloromethane, bromoform, and dibromochloromethane).
(p) Environmental Protection Agency. 1993. Summary Table of Drinking Water Regulations and Health Advisories. Office of Water. May 1993.

(q) As of November 1992, this Health Advisory was a draft.

(r) Commonwealth of Virginia State Board of Health. 1993. Waterworks Regulations. VR 355-18-000.

**Surface Water Legend:**

-- = Standard not developed for this chemical.

(1) Ambient Water Quality Criteria as listed in Federal Register, Vol, 57, No. 246, December 22, 1992.

(2) Virginia Water Quality Standards for Protection of Aquatic Life and Human Health (VR680-21-40.3).

(3) Federal criteria are for total dichlorobenzenes.

(4) Federal criteria are for nitrophenols.

(5) Criteria for these metals are expressed as a function of the water effect ratio, WER, as defined in 40 CFR 131.36(c).

## Appendix D - ESE's Laboratory Quality Assurance Manual

LCQAP August 1994

# Laboratory Comprehensive Quality Assurance Plan

Prepared by:

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.
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Gainesville, Florida 32602-1703
(904) 332-3318

Control No. 024

LCQAP August 1994

# Laboratory Comprehensive Quality Assurance Plan

Prepared by:

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ESE, 1994

# APPROVALS

This Quality Assurance/Quality Control (QA/QC) Manual has been read and understood and approved for use in the Gainesville Laboratory of Environmental Science & Engineering, Inc. (ESE).

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| 5-59 | Reporting Limit Data for Organochlorine Pesticides and PCBs in Water, EPA 617 | 5.116 | 8/22/94 |
| 5-60 | Analyte, Precision, and Accuracy Data for Tetrazene, EPA 8331 | 5.118 | 8/22/94 |
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| 6-1 | Sample Container Cleaning Procedures Within the Laboratory | 6.2 | 8/22/94 |
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| 13-1 | Summary of Corrective Action Procedures for Metals Analyzed by Graphite Furnace and Cold Vapor Atomic Absorption Spectroscopy | 13.4 | 8/22/94 |
| 13-2 | Summary of Corrective Action Procedures for Metals Analyzed by Inductively Coupled Plasma Emission Spectroscopy | 13.6 | 8/22/94 |
| 13-3 | Summary of Corrective Action Procedures for Inorganics, Oil and Grease, Petroleum Hydrocarbons, and TOX | 13.8 | 8/22/94 |
| 13-4 | Summary of Corrective Action Procedures for Radionuclides | 13.10 | 8/22/94 |
| 13-5 | Summary of Corrective Action Procedures for Organics Analyzed by Gas Chromatography and High Pressure Liquid Chromatography | 13.12 | 8/22/94 |
| 13-6 | Summary of Corrective Action Procedures for Organics by Gas Chromatography/Mass Spectrometry | 13.15 | 8/22/94 |

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AAS | atomic absorption spectrophotometry |
| AIHA | American Industrial Hygiene Association |
| ASTM | American Society for Testing and Materials |
| BFB | bromofluorobenzene |
| BOD | biochemical oxygen demand |
| °C | degrees Celsius |
| CCC | calibration check compounds |
| CCV | continuing calibration verification |
| CLASS | Chemical Laboratory Analysis and Scheduling System |
| COD | chemical oxygen demand |
| D | detection limit |
| DBCP | 1,2-Dibromo-3-chloropropane |
| DFTPP | decafluorotriphenylphosphine |
| DHRS | Department of Health and Rehabilitative Services |
| DI | deionized |
| DO | dissolved oxygen |
| DOT | Department of Transportation |
| ECD | electron capture detector |
| EDB | 1,2-Dibromoethane |
| ELAP | Environmental Laboratory Approval Program |
| EPA | U.S. Environmental Protection Agency |
| ESE | Environmental Science & Engineering, Inc. |
| eV | electronvolt |
| FDER | Florida Department of Environmental Regulation |
| FID | flame ionization detector |
| FPD | flame photometric detector |
| FR | fraction code |

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 2 of 5)

| | |
|---|---|
| FRN | frame reference number |
| ft | foot |
| g | gram |
| g/kg | grams per kilogram |
| GC | gas chromatography |
| GC/FID | GC employing flame ionization detection |
| GC/FPD | GC employing flame photometric detection |
| GC/HPLC | gas chromatography/high performance liquid chromatography |
| GC/MS | gas chromatograph/mass spectrometer |
| GC/MS/DS | gas chromatography/mass spectrometry/data system |
| GC/NPD | GC employing nitrogen-phosphorus detection |
| GLP | Good Laboratory Practice |
| HCL | hydrochloric acid |
| $HNO_3$ | nitric acid |
| HPLC | high performance liquid chromatography |
| $H_2SO_4$ | sulfuric acid |
| ICAP | inductively coupled argon plasma |
| ICS | interference check solution |
| ICV | initial calibration verification |
| ID | identification |
| IR | infrared |
| KCl | potassium chloride |
| kg | kilogram |
| KOH | potassium hydroxide |
| L | liter |

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 3 of 5)

| | |
|---|---|
| LC50 | 50 percent lethal concentration |
| MBAS | methylene blue active substances |
| MDL | method detection limits |
| mg/kg | milligrams per kilogram |
| mg/L | milligrams per liter |
| mL | milliliter |
| mm | millimeter |
| $mm^2$ | square millimeter |
| MSC | matrix spike compound |
| NaOH | sodium hydroxide |
| $Na_2S_2O_3$ | sodium thiosulfate |
| ng | nanogram |
| NIOSH | National Institute of Occupational Safety and Health |
| NIST | National Institute of Standards and Technology |
| NTU | nephelometric turbidity unit |
| PAT | Proficiency Analytical Testing Program |
| PCB | polychlorinated biphenyl |
| PCP | pentachlorophenol |
| PCU | platinum-cobalt unit |
| % RSD | percent relative standard deviation |
| PFS | prefield setup |
| PID | photoionization device |
| PNA | polynuclear aromatic hydrocarbon |
| ppb | parts per billion |

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 4 of 5)

| | |
|---|---|
| ppt | parts per thousand |
| psi | pounds per square inch |
| PVC | polyvinyl chloride |
| QA | quality assurance |
| QA/QC | quality assurance/quality control |
| QC | quality control |
| QCC | quality control check |
| RF | response factor |
| RPD | relative percent difference |
| S | surrogate |
| SCT | salinity, conductivity, and temperature |
| SDS | sodium dodecyl sulfate |
| SOP | standard operating procedure |
| STORET | storage and retrieval |
| THMS | trihalomethanes |
| TIC | tentatively identified compound |
| TOC | total organic carbon |
| TOX | total organic halides |
| TRPH | total recoverable petroleum hydrocarbons |
| μg/g | micrograms per gram |
| μg/L | micrograms per liter |
| μL | microliter |
| μmho/cm | micromhos per centimeter |
| UPS | United Parcel Service |
| USACE | U.S. Army Corps of Engineers |
| USGS | U.S. Geological Survey |

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 5 of 5)

| | |
|---|---|
| UV | ultraviolet |
| VOC | volatile organic compound |
| YSI | Yellow Springs Instruments |

# 3.0 STATEMENT OF POLICY

## 3.1 QUALITY ASSURANCE (QA) STATEMENT OF POLICY

It is the policy of Environmental Science & Engineering, Inc. (ESE), Gainesville Laboratory, to maintain an active quality assurance/quality control (QA/QC) program to provide the highest quality information and ensure the highest professional standards in deliverables for every project undertaken. An established QA/QC philosophy and program are essential for any organization to consistently produce valid laboratory data. To be valid, data must be generated under controlled conditions which do not adversely affect data quality. Data must also be interpreted by capable professionals who are trained in appropriate scientific disciplines, maintain a current knowledge of their field, and are experts in the applications for which the data will be used. The objectives of the QA/QC program are to estimate the quality of each analytical system including precision, accuracy, and sensitivity sufficient for each project. The QA/QC program also assists in the early recognition of deficiencies which might affect data quality, validate data, and define data usability.

ESE's commitment to the QA/QC process is evidenced by the establishment of a separate QA/Safety Division which is responsible for overseeing QA activities and an internal QA/QC department which is responsible for overseeing QA and QC activities within the Gainesville Laboratory. QA is a management system which ensures the completion of predetermined activities. All activities are recorded including traceability, completeness, and document security. QC refers to specific actions taken to ensure that system performance is consistent with established limits. These actions ensure precision, accuracy, comparability, and completeness of analytical data.

ESE supports a corporate-wide Quality Education System (QES). All employees are trained in the quality improvement process. This training is supplemented at the departmental level by instructing employees on the importance of QA/QC and the price of nonconformance.

## 3.2 SCOPE

All major environmental studies and analyses conducted by ESE Gainesville Laboratory for projects under the guidance of the Department of Energy (DOE), the Naval Energy And Environmental Support Activity (NEESA), the Hazardous Waste Remedial Actions Program (HAZWRAP), the Florida Department of Environmental Regulations (FDER) or any state and federal government agency must be performed in accordance with this Laboratory Comprehensive Quality Assurance Plan (LCQAP).

This LCQAP will be the basis for all project-specific QA plans except where alternate QA plans are required. When appropriate, this LCQAP will be filed with a client and/or regulatory agency and, once approved, may be referenced in lieu of repetitive submission of plans in which only a portion of the information is changed.

## 3.3 DOCUMENT CONTROL

This LCQAP will be revised periodically as procedural changes become necessary. Changes will be documented by the date and revision number of each section. ESE's QA/QC Department will keep a distribution list and assign a unique number to each copy of the LCQAP. When a section is revised, the revision date will replace the original date in the heading code, the revision number will be changed, and the table of contents will be updated. Copies of the revised sections will be provided to each individual on the distribution list.

These procedures will apply once the plan has been finalized and implemented; these procedures will not apply to draft documents.

# 4.0 ORGANIZATION AND RESPONSIBILITIES

## 4.1 LABORATORY OPERATIONS CAPABILITIES

ESE laboratory operations include the following capabilities:

1. Groundwater and surface water analysis,
2. Soil and sediment analysis,
3. Wastewater analysis,
4. Air monitoring screening,
5. Drum analysis, and
6. Underground storage tank analysis.

## 4.2 KEY PERSONNEL

This section includes ESE's Gainesville Laboratory key personnel identified by title and a brief summary of each individuals responsibilities. An organization chart of the Gainesville Laboratory is presented in Figure 4-1.

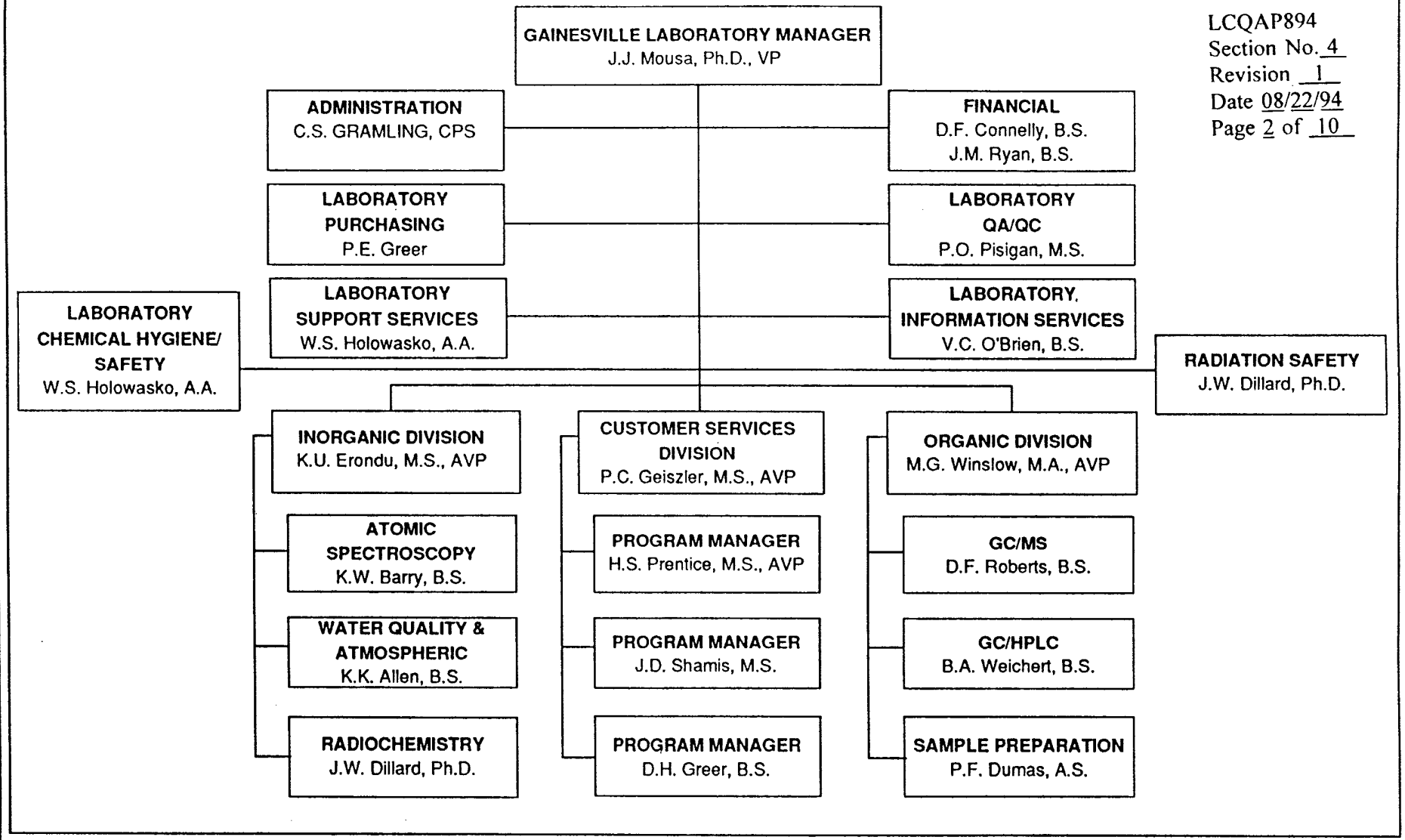
### 4.2.1 LABORATORY OPERATIONS PERSONNEL

#### 4.2.1.1 Laboratory Director

The Laboratory Director is responsible for the overall management of the analytical laboratory, including the appointment and supervision of the Laboratory Information Services Manager, Laboratory Division Managers, Customer Service Manager, and Laboratory QA/QC Manager. He is responsible for approving all analytical procedures and associated QA/QC procedures.

#### 4.2.1.2 Laboratory QA/QC Manager

The Laboratory QA/QC Manager is responsible for the overall management of the laboratory QA/QC operations, including the appointment and supervision of the Laboratory QA/QC Coordinators.




**ADMINISTRATIVE ORGANIZATION**
**ANALYTICAL SERVICES LABORATORY,**
**GAINESVILLE, FLORIDA**

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

#### 4.2.1.3 Laboratory QA/QC Coordinator

The Laboratory QA/QC Coordinator is responsible for coordinating the certification programs of the Gainesville Laboratory. The Laboratory QA/QC Coordinator also performs laboratory and data audits, and maintains QC records for inspection by ESE project management and the Project QA Coordinator. The Laboratory QA/QC Coordinator provides guidance and coordination to resolve any QA/QC deficiencies and reviews precision, accuracy, and blind samples for projects to ensure completeness of the QC data.

#### 4.2.1.4 Laboratory Information Services Manager

The Laboratory Information Services Manager oversees ESE's computerized data management system and is responsible for the following:

1. Maintaining ESE's Chemical Laboratory Analysis Scheduling System (CLASS™) (refer to Section 10.1);
2. Approval of all changes made to CLASS™; and
3. Storage of chain-of-custody logsheets, analytical batch folders for all departments in one central location, and all other computerized data.

#### 4.2.1.5 Laboratory Division Managers

The Analytical Laboratory Division Managers are responsible for the overall management of their respective analytical inorganic and organic sections or including the appointment and supervision of their Department Managers. The Customer Service Manager is responsible for the overall management of the project operations within the laboratory including the appointment and supervision of the Laboratory Program Manager.

#### 4.2.1.6 Laboratory Program Manager

The Laboratory Program Manager is responsible for the overall management of the project operations within the Gainesville Laboratory, including the appointment and supervision of the Laboratory Coordinators and Sample Custodian.

#### 4.2.1.7 Laboratory Coordinator

The Laboratory Coordinator acts as liaison between field and laboratory operations and is responsible for the following:

1. Coordination of sample analyses to meet project or client objectives;
2. Preparation of analytical reports, including coordination with the QA Division or Laboratory QA/QC Manager and laboratory management to ensure that the data are validated prior to release to the client;
3. Review of any QA/QC deficiencies reported by the Laboratory Department Manager; and
4. Coordination of any data changes resulting from review by the Laboratory QA/QC Coordinator, and/or Project Manager.

#### 4.2.1.8 Sample Custodian

The Sample Custodian checks in the samples from the field upon receipt by the laboratory. The Sample Custodian compares all samples contained in the shipment to the logsheet(s) to ensure that all samples designated on the logsheet have been received. The Sample Custodian will note any special remarks concerning the shipment and deliver the logsheet to the Laboratory Information Services Manager. The Sample Custodian places samples in appropriate storage areas and notifies the appropriate Laboratory Coordinators and Laboratory Department Managers, or designee.

#### 4.2.1.9 Laboratory Department Managers

The Laboratory Department Managers are responsible for providing consistent and accurate laboratory data and technical reports produced by their analysts. These individuals are responsible to the Project Manager to ensure that all personnel under their direction are knowledgeable of the QA/QC requirements of the project and that all QC and technical review procedures are followed and documentation is provided.

**4.2.1.10 Laboratory Analyst**

Laboratory Analysts must perform preliminary QC checks to ensure that each batch of data being generated passes all the required QC criteria.

**4.2.1.11 Radiation Safety Officer**

The Radiation Safety Officer is responsible for enforcing company policy in handling radioactive materials in order to ensure protection of all ESE employees and facilities from exposure to radiation. He is responsible for evaluating new requirements by Florida DHRS and/or NRC to ensure that ESE's Radioactive Materials License is in compliance and reviewing and evaluating standard operating procedures and sections of the Laboratory Safety Manual involving the use of radioactive materials for appropriateness. He is also responsible for monitoring spills and leaks in areas where radioactive materials are used, leak testing and documenting all sealed and unsealed radiation sources, and issuing, collecting and shipping personal monitoring devices. He conducts radiation safety training of all personnel prior to their handling of radioactive materials, and maintains an inventory of all radioactive materials. He will remove and maintain documentation for the removal of radioactive samples as necessary to a temporary storage area within the company facility.

**4.2.1.12 Laboratory Chemical Hygiene Officer**

The Chemical Hygiene Officer (CHO) will assist laboratory supervisors in implementing the Chemical Hygiene Program. He will provide training (in accordance with Health and Safety (H&S) SOP 112- Chemical Hygiene Program Training), review laboratory safety manuals and SOPs, and perform safety audits of laboratory procedures and safety inspections of laboratory protective equipment to determine compliance. Areas of non-compliance will be reported to the appropriate supervisor or manager. The CHO will make this Program readily available to laboratory workers and supervisors. He will evaluate worker chemical exposure (in accordance with H&S SOP 140) and will provide a written report of each exposure assessment or determination to the Laboratory Director for action

as necessary. Any over exposure shall be reported to the Regional Health and Safety Coordinator (RHSC).

## 4.3 ANALYTICAL CHEMISTRY FACILITIES

ESE's Gainesville laboratory currently comprises 41,000 $ft^2$ of laboratory and office space. In order to facilitate the movement of samples through the laboratory and maintain uncompromised chain-of-custody, the laboratory has separate functional areas dedicated to sample receipt, sample storage, sample preparation, and sample analysis.

The laboratory has approximately 500 $ft^2$ of space dedicated to sample check-in, where samples are unpacked and logged into the laboratory tracking system. Large walk-in cold rooms are used for storage of environmental samples at 4 $\pm$ °C, and approximately 1,100 $ft^3$ of walk-in and reach-in freezers are available for storing biota samples at -10°C or lower. Throughout the laboratory facilities, numerous smaller refrigerator and freezer units are maintained for storage of standards, spiking solutions, and sample extracts.

The laboratory has dedicated areas for organic extractions, inorganic preparation, metals digestion, GC/MS and HPLC/MS analysis, inductively coupled plasma (ICP) and AAS analysis, classical water quality analysis, radiological analysis, asbestos analysis, toxic chemicals handling, special projects, and additional support areas housing ovens, analytical balances, glassware washing, kit preparation, chemicals storage, waste storage, etc.

The laboratory is supplied with demineralized water for glassware washing and other functions. Demineralized-distilled water is available for reagent preparation, and supplies of organic-free water are maintained at all times for use in trace organic analysis.

The laboratory facility is equipped throughout with a full range of safety equipment, including fume hoods, eye washes, emergency showers, emergency lights, fire extinguishers, spill cleanup kits, emergency breathing equipment, fire pull boxes, smoke alarms, warning signs, lighted exit signs, safety glasses, and fire blankets.

## 4.4 ANALYTICAL CHEMISTRY INSTRUMENTATION

ESE's Gainesville laboratory utilizes state-of-the-art analytical instrumentation for multi-matrix chemical analyses. Table 4-1 lists the laboratory's major analytical instrumentation.

Currently, 27 GCs with FIDs, nitrogen-phosphorus detectors (NPD), FPDs, PIDs, HECDs, and ECDs are available for project use. In addition, there are twelve HPLCs with UV, fluorometric, conductivity, electrochemical, and radiochemical detectors. Several units are equipped with post-column derivitization modules and fluorescence spectrometers. A photodiode array spectrometer is also available for simultaneous multi-wavelength monitoring. Autosamplers are used with the GCs and HPLCs for sample handling efficiency, increased sample throughput, and greater precision and accuracy. Automated data acquisition systems are dedicated to each chromatographic unit.

ESE's Gainesville laboratory has ten GC/MSs: four are dedicated to volatile organic analyses, four to semivolatile organic analyses, and two to air analysis. All GC/MS systems are equipped with automatic samples and state-of-the-art computer data systems. The mass spectral libraries are the combined Wiley/NIST library with 77,000 reference spectra and the EPA/NIST library with 42,000 reference spectra. The GC/MS facilities also have standalone GC/FIDs for sample screening. In addition, the laboratory has an HPLC/MS for specialized analysis of thermally labile, polar/water soluble, and macro-molecular organic species.

Table 4-1. Major Analytical Instrumentation

| Instrument | Total | Manufacturer | Model | Year Purchased |
|---|---|---|---|---|
| Organics | | | | |
| GC/MS | 10 | Finnigan (2) | Incos 50, 500 | 1987 |
| | | Hewlett-Packard (7) | 5970 (3) | 1985, 88, 90 |
| | | | 5987 (2) | 1977, 78 |
| | | | 5988 | 1984 |
| | | | 5996 | 1984 |
| LC/MS | 1 | Hewlett-Packard | 59980 | 1990 |
| GC | 27 | Hewlett-Packard (18) | 5730 (3) | 1978, 79, 89 |
| | | | 5880 | 1982 |
| | | | 5890 (14) | 1984 (3), 85 (2), 86 (5), 91, 93 (2), 94 (1) |
| | | Tracor (5) | 540 | 1986 (3), 87 (2) |
| | | Varian (2) | 3400 | 1985 |
| | | Shimadzu (2) | GC-14 | 1991 |
| HPLC | 12 | Altex (2) | 332 | 1979 |
| | | | 420 | 1980 |
| | | Shimadzu (6) | SCL-6A (6) | 1988, 89, 90 (3), 91 |
| | | Hewlett-Packard (4) | 1090 | 1992 |
| | | | 1050 | 1992, 93, 94 |
| Metals | | | | |
| ICP/MS | 1 | Perkin Elmer | Elan 5000 | 1992 |
| ICP | 3 | Jarrell-Ash (2) | 1100, 61 | 1981, 89 |
| | | Perkin-Elmer | P2000 | 1987 |
| AAS | 9 | Buck Scientific (2) | 400 | 1987, 89 |
| | | Perkin-Elmer (6) | 4100 (2) | 1992, 93 |
| | | | 3100 | 1991 |
| | | | 5100 (3) | 1986, 87, 90 |

Table 4-1. Major Analytical Instrumentation (Continued, Page 2 of 2)

| Instrument | Total | Manufacturer | Model | Year Purchased |
|---|---|---|---|---|
| Metals | | | | |
| AAS | | Questron | Merlin | 1993 |
| Water Quality | | | | |
| TOC | 1 | Dohrman | DC-190 | 1991 |
| TOX | 1 | MCI | TOX-10 | 1989 |
| IC | 4 | Dionex | 2120 (2)<br>4000 (2) | 1983<br>1986 |
| Autoanalyzer | 6 | Technicon | II (5)<br>TRAACS 800 | 1980, 83, 85<br>1986 |
| IR | 1 | Perkin-Elmer | 1420 | 1983 |
| UV-VIS | 3 | Bausch & Lomb (2)<br>Perkin-Elmer | 20<br>552 | 1982, 84<br>1984 |
| Radiochemistry | | | | |
| A-B Proportional Counter | 2 | Berthold | LB-770<br>LB-700-2 | 1983<br>1991 |
| Alpha Spectrometer | 20 | Tennelec (2) | TC256 | 1989, 1992 |
| Alpha Scintillation Counter | 12 | Ludlum | 1000 | 1976 |
| Liquid Scintillation Counter | 1 | Beckman | LS-1801 | 1987 |
| GeLi Detector | 2 | EG&G Ortec | GEM20180 | 1987 |
| Nal Dectector | 1 | Bicron | P-14-W | 1987 |
| Biological Oxidizer | 1 | R.J. Harvey | OX-600 | 1990 |

Source: ESE.

Extensive capability for inorganic metals analysis is provided by three ICAPs, both simultaneous and sequential, nine AASs, and one ICP/MS. The bulk of the metals work is acomplished with the ICAPs. The AASs are available with flame, graphite furnace, hydride, and cold vapor capabilities as needed. The ICAPs, ICP/MS, and AASs are equipped with automated sample introduction and data handling systems.

For water quality and air/industrial hygiene studies, a total of six autoanalyzers are available for the routine analysis of sulfur dioxide, nitrite, nitrate, phosphate, sulfate, nitrogen, and silica. Four ICs are also available to enhance ESE's capabilities to analyze for trace level anionic species; munition and chemical agent degradation products; and for a variety of ionic materials, including organic salts and acids.

ESE maintains a state-of-the-art radiation counting laboratory and a wet laboratory reserved specifically for radiochemical analysis. The available instrumentation includes a Gamma-Ray Spectrometer consisting of a 3-inch by 3-inch sodium-iodide scintillation detector housed in a 4-inch steel shield and coupled to a 1,024-channel pulse height analyzer, two Berthod Gas-Flow Proportional Low Background Alpha/Beta Counting System with a cosmic ray guard detector surrounded by a 4-inch shield of low background lead bricks, a Radon Gas Counting System consisting of a Ludlum Radon Flash Photomultiplier Tube coupled to an amplifier scaler-timer, a Thermoluminescence Dosimeter, and Geiger counters. Other instrumentation, including a GeLi Spectrometer, a liquid scintillation counter, and a tissue oxidizer are also available in the radiochemistry laboratory.

Supporting equipment available includes GPC autoprep units for extract cleanup, sonicators with sonaboxes for soil extractions, centrifuges, shaking devices, blenders, tissuemisers, balances, ovens, etc., and a full range of laboratory glassware necessary for all aspects of environmental analytical chemistry.

# 5.0 QA OBJECTIVES FOR MEASUREMENT DATA

## 5.1 LABORATORY ANALYSIS

Analyses are performed according to standard U.S. Environmental Protection Agency (EPA) analytical procedures for analysis of water and soil/sediment unless otherwise specified (Tables 5-1 through 5-65). EPA precision and accuracy data and historic ESE data were used as the basis for developing criteria to assess laboratory method performance and the precision and accuracy of sample data, as noted. These limits are subject to change based on actual historic and current performance; updates will be provided for insertion into all control copies of our site-specific QAPPs, as appropriate. Specific compounds are used for controlling purposes in multianalyte methods and are identified in Tables 5-2 through 5-65. Laboratory method performance is evaluated using calibration checks, blanks, and QC check samples; sample accuracy and precision are evaluated using matrix spike and matrix spike duplicate data.

The reporting limits (RLs) achievable for all parameters are listed in Tables 5-3 through 5-65 (odd numbered tables). These RLs were developed in accordance with specific procedures referenced for each analytical method. The RLs for waters and calculated for solids are typically reported as RLs, if no matrix and/or other interferences (i.e., instrument noise) are found to be present (subject to adjustment for dilutions and/or moisture contents).

The following is a brief explanation of the terms that appear in Tables 5-2 through 5-65. Items that are not applicable are denoted by NA.

Reference: The reference of the standard analytical methodology used for each procedure.

Precision: Evaluated based on the relative percent difference (RPD) of duplicate spikes (see Section 11.0 for definitions).

Accuracy: Evaluated based on the percent recovery of each spike (see Section 11.0 for definition).

Units: Volume in liters (L) [e.g., micrograms per liter ($\mu$g/L)] indicates a water matrix; control spikes are added to either sample matrices or to organic-free laboratory water. Mass in grams (g) or kilograms (kg) [e.g., milligrams per kilogram (mg/kg)] indicates a soil/sediment matrix; control spikes are added to sample matrices, soil, or blank water, depending on the analytical procedure.

Table 5-1. Sample Preparation Methods

| Sample Preparation Method Number | Description | Matrix | Sample Preparation for Methods |
|---|---|---|---|
| EPA 3005 | Acid Digestion | Aqueous | EPA 6010, 7020, 7200, 7210, 7450, 7480, 7610, 7770 |
| EPA 3010 | Acid Digestion | Aqueous | EPA 6010, 7020, 7200, 7210, 7450, 7480, 7610, 7770 |
| EPA 3015 | Acid Digestion | Aqueous | EPA 6020 |
| EPA 3020 | Acid Digestion | Aqueous | EPA 7041, 7060, 7091, 7131, 7191, 7201, 7210, 7421, 7470, 7471, 7481, 7740, 7841, 7911 |
| EPA 3050 | Acid Digestion | Solid | EPA 6010, 7020, 7200, 7210, 7450, 7480, 7610, 7770, 7041, 7060, 7091, 7131, 7191, 7201, 7210, 7421, 7470, 7471, 7481, 7740, 7841, 7911 |
| EPA 3051 | Acid Digestion | Solid | EPA 6020 |
| EPA 3510 | Separator Funnel Liquid-Liquid Extraction | Aqueous | EPA 8040, 8060, 8080, 8120, 8140, 8270, 8310 |
| EPA 3520 | Continuous Liquid-Liquid Extraction | Aqueous | EPA 8040, 8060, 8080, 8120, 8140, 8270, 8310 |
| EPA 3540 | Soxhlet Extraction | Solid | EPA 8040, 8060, 8080, 8120, 8140, 8270, 8310 |
| EPA 3550 | Sonication Extraction | Solid | EPA 8040, 8060, 8080, 8120, 8140, 8270, 8310 |
| EPA 5030 | Purge-And-Trap | Aqueous, Solid | EPA 8010, 8020, 8240, 8260 |
| EPA 3630 | Silica Gel Cleanup | Aqueous, Solid | EPA 8080 |
| EPA 3640 | Gel-Permeation Cleanup | Aqueous, Solid | EPA 8080, 8140, 8270* |
| EPA 3660 | Sulfur Cleanup | Aqueous, Solid | EPA 8080, 8120 |

*Only used for fish, oily, or highly contaminated samples.
Source: ESE.

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, Oil and Grease, TRPH, TOX, and Radiochemical Analysis

| Parameter | Units | Reference | Method Criterion[b,l] Precision (Max RPD) | Method Criterion[b,l] Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Aluminum, Total | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Aluminum, Total | µg/L | EPA 200.7, 202.2, 3005, 3010, 6010 | 16 | 81-113 |
| Aluminum, Solid | mg/kg | EPA 3050, 7020, 6010[a] | 21[e] | 75-117[e] |
| Aluminum, Solid | mg/kg | EPA 3051, 6020 | 25[d] | 75-125[d] |
| Antimony, Total[j] | µg/L | EPA 204.2, 3020, 7041 | 25[d] | 75-125[d] |
| Antimony, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 15 | 79-109 |
| Antimony, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Antimony, Solid[j] | mg/kg | EPA 3050, 6010 | 15 | 79-109 |
| Antimony, Solid[j] | mg/kg | EPA 3050, 7041 | 25[d] | 75-125[d] |
| Antimony, Solid[j] | mg/kg | EPA 3051, 6020 | 25[d] | 75-125[d] |
| Arsenic, Total[j] | µg/L | EPA 206.2, 3005, 3010, 6010[a], 3020, 7060 | 24 | 72-120 |
| Arsenic, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Arsenic, Solid[j] | mg/kg | EPA 3050, 7060, 6010[a] | 24 | 72-120 |
| Arsenic, Solid[j] | mg/kg | EPA 3051, 6020 | 25[d] | 75-125[d] |
| Barium, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Barium, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 10 | 86-106 |
| Barium, Solid[j] | mg/kg | EPA 3050, 6010 | 10 | 86-106 |
| Barium, Solid[j] | mg/kg | EPA 3051, 6010 | 25[d] | 75-125[d] |
| Beryllium, Total[j] | µg/L | EPA 210.2, 3020, 7091 | 25[d] | 75-125[d] |
| Beryllium, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 15 | 78-108 |
| Beryllium, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Beryllium, Solid[j] | mg/kg | EPA 3050, 6010 | 15 | 78-108 |
| Beryllium, Solid[j] | mg/kg | EPA 3050, 7091 | 25[d] | 75-125[d] |
| Beryllium, Solid[j] | mg/kg | EPA 3051, 6020 | 25[d] | 75-125[d] |
| Cadmium, Total[j] | µg/L | EPA 213.2, 3020, 7131 | 25[d] | 75-125[d] |
| Cadmium, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 14 | 80-108 |
| Cadmium, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Cadmium, Solid[j] | mg/kg | EPA 3050, 6010 | 14 | 80-108 |
| Cadmium, Solid[j] | mg/kg | EPA 3050, 7131 | 25[d] | 75-125[d] |
| Cadmium, Solid[j] | mg/kg | EPA 3051, 6020 | 25[d] | 75-125[d] |
| Calcium, Total[j] | mg/L | EPA 200.7[a], 3005, 3010, 6010[a] | 19 | 78-116 |
| Calcium, Solid[j] | mg/kg | EPA 3050, 6010[a] | 28[e] | 60-116[e] |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, and Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 2 of 12)

| Parameter | Units | Reference | Method Criterion[b,l] Precision (Max RPD) | Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Chromium, Total[j] | µg/L | EPA 218.1, 3020, 7191 | 16 | 80-112 |
| Chromium, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 15 | 79-109 |
| Chromium, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Chromium, Solid[j] | mg/kg | EPA 3050, 6010 | 15 | 79-109 |
| Chromium, Solid[j] | mg/kg | EPA 3050, 7191 | 16 | 80-112 |
| Chromium, Solid[j] | mg/kg | EPA 3051, 6020 | 25[d] | 75-125[d] |
| Cobalt, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Cobalt, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 10 | 85-105 |
| Cobalt, Solid[j] | mg/kg | EPA 3050, 6010 | 10 | 85-105 |
| Cobalt, Solid[j] | mg/kg | EPA 3051, 6020 | 25[d] | 75-125[d] |
| Copper, Total[j] | µg/L | EPA 220.1, 220.2, 3020, 7210 | 25[d] | 75-125[d] |
| Copper, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 12 | 84-108 |
| Copper, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Copper, Solid[j] | mg/kg | EPA 3050, 6010 | 12 | 84-108 |
| Copper, Solid[j] | mg/kg | EPA 3050, 7210 | 25 | 75-125 |
| Copper, Solid[j] | mg/kg | EPA 3051, 6020 | 25[d] | 75-125[d] |
| Iron, Total | µg/L | EPA 200.7, 3005, 3010, 6010 | 18 | 77-113 |
| Iron, Solid | mg/kg | EPA 3050, 6010[a] | 11[e] | 86-108[e] |
| Lead, Total[j] | µg/L | EPA 239.2, 3020, 7421 | 27 | 71-125 |
| Lead, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 15 | 79-109 |
| Lead, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Lead, Solid[j] | mg/kg | EPA 3050, 6010, | 15 | 79-109 |
| Lead, Solid[j] | mg/kg | EPA 3050, 7421 | 27 | 71-125 |
| Lead, Solid[j] | mg/kg | EPA 3051, 6020, | 25[d] | 75-125[d] |
| Magnesium, Total | mg/L | EPA 200.7[a], 242.1, 3005, 3010, 6010[a] | 10 | 86-106 |
| Magnesium, Solid | mg/kg | EPA 3050, 7450, 6010[a] | 53[e] | 28-134[e] |
| Manganese, Total | µg/L | EPA 243.2 | 25[d] | 75-125[d] |
| Manganese, Total | µg/L | EPA 200.7, 3005, 3010, 6010 | 12 | 83-107 |
| Manganese, Total | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Manganese, Solid | mg/kg | EPA 3050, 6010 | 12 | 83-107 |
| Manganese, Solid | mg/kg | EPA 3050, 7460 | 25[d] | 75-125[d] |
| Manganese, Solid | mg/kg | EPA 3051, 6020 | 25[d] | 75-125[d] |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, and Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 3 of 12)

| Parameter | Units | Reference | Method Criterion[b,l] Precision (Max RPD) | Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Mercury, Total[j] | µg/L | EPA 245.1, 7470 | 21 | 83-125 |
| Mercury, Solid[j] | mg/kg | EPA 7471 | 21 | 83-125 |
| Mercury, Solid[j] | mg/kg | EPA 7471 (Modified) | 21 | 83-125 |
| Molybdenum, Total | µg/L | EPA 200.7[a], 246.2, 3005, 3010, 6010[a] | 25[d] | 75-125[d] |
| Molybdenum, Solid | mg/kg | EPA 3050, 6010[a], 7480, 7481 | 25[d] | 75-125[d] |
| Nickel, Total | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Nickel, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 14 | 78-106 |
| Nickel, Solid[j] | mg/kg | EPA 3050, 6010[a] | 14 | 78-106 |
| Nickel, Solid[j] | mg/kg | EPA 3051, 6020[a] | 25[d] | 75-125[d] |
| Potassium, Total | mg/L | EPA 200.7[a], 3005, 3010, 6010[a] | 19 | 75-113 |
| Potassium, Solid | mg/kg | EPA 3050, 6010[a] | 19 | 75-113 |
| Potassium, Solid | mg/kg | EPA 3050, 7610 | 14 | 81-109 |
| Selenium, Total[j] | µg/L | EPA 200.7[a], 3005, 3010, 6010[a] | 12 | 85-109 |
| Selenium, Total[j] | µg/L | EPA 270.2, 3020, 7740 | 29 | 71-129 |
| Selenium, Solid[j] | mg/kg | EPA 3050, 7740 | 29 | 71-129 |
| Selenium, Solid[j] | mg/kg | EPA 3050, 6010[a] | 12 | 85-109 |
| Silicon, Total | µg/L | EPA 200.7[a], 3005, 3010, 6010[a] | 25 | 75-125 |
| Silicon, Solid | mg/kg | EPA 3050, 6010[a] | 25 | 75-125 |
| Silver, Total | µg/L | EPA 272.2 | 24 | 68-116 |
| Silver, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 17 | 73-107 |
| Silver, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Silver, Solid[j] | mg/kg | EPA 3050, 6010 | 17 | 73-107 |
| Silver, Solid[j] | mg/kg | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Sodium, Total | mg/L | EPA 273.1 | 25[d] | 75-125[d] |
| Sodium, Total | mg/L | EPA 200.7[a], 3005, 3010, 6010[a] | 15 | 82-112 |
| Sodium, Solid | mg/kg | EPA 3050, 6010[a], 7770 | 51[e] | 29-131[e] |
| Strontium, Total | µg/L | EPA 200.7[a], 3005, 3010, 6010[a,c] | 12[f] | 95-115[f] |
| Strontium, Solid | mg/kg | EPA 3050, 6010[a] | N/A | N/A |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, and Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 4 of 12)

| Parameter | Units | Reference | Method Criterion[b,l] Precision (Max RPD) | Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Thallium, Total[j] | µg/L | EPA 279.2, 3020, 7841 | 27 | 74-128 |
| Thallium, Total[j] | µg/L | EPA 200.7[a], 3005, 3010, 6010[a] | 18 | 75-111 |
| Thallium, Total[j] | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Thallium, Solid[j] | mg/kg | EPA 3050, 6010[a] | 18 | 75-111 |
| Thallium, Solid[j] | mg/kg | EPA 3050, 7841 | 27 | 74-128 |
| Thallium, Solid[j] | mg/kg | EPA 3051, 6020[a] | 25[d] | 75-125[d] |
| Titanium, Total | µg/L | EPA 200.7[a], 283.2[a], 3005, 3010, 6010[a,c] | 24 | 68-116 |
| Titanium, Solid | mg/kg | EPA 3050, 6010[a] | 24 | 68-116 |
| Tin, Total[j] | µg/L | EPA 200.7[a], 3005, 3010, 6010[a] | 25 | 75-125 |
| Tin, Solid[j] | mg/kg | EPA 3050, 6010[a] | 25 | 75-125 |
| Uranium, Total | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Uranium, Solid | mg/kg | EPA 3051, 6020[a] | 25[d] | 75-125[d] |
| Vanadium, Total[j] | µg/L | EPA 286.2, 3020, 7911 | 25[d] | 75-125[d] |
| Vanadium, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 9 | 87-105 |
| Vanadium, Solid[j] | mg/kg | EPA 3050, 6010 | 9 | 87-105 |
| Vanadium, Solid[j] | mg/kg | EPA 3050, 7911 | 25[d] | 75-125[d] |
| Zinc, Total | µg/L | EPA 3015, 6020 | 25[d] | 75-125[d] |
| Zinc, Total[j] | µg/L | EPA 200.7, 3005, 3010, 6010 | 18 | 76-112 |
| Zinc, Solid[j] | mg/kg | EPA 3050, 6010 | 18 | 76-112 |
| Zinc, Solid[j] | mg/kg | EPA 3050, 6010 | 25[d] | 75-125[d] |
| Alkalinity, Total | mg/L-$CaCO_3$ | EPA 310.1 | 13 | 86-112 |
| COD, high-level | mg/L | HACH 8000 | 10 | 93-113 |
| COD, low-level | mg/L | HACH 8000 | 18 | 82-118 |
| Cyanide[j] | mg/L | EPA 335.3, 9010 | 26 | 71-123 |
| Cyanide, Solid[j] | µg/g | EPA 9010 (Mod) | 22 | 75-119 |
| Moisture | % Wet Weight | ASTMD 2216-71 | 23 | NA |
| Bromide | mg/L | EPA 300, 9056 | 6 | 95-107 |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, and Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 5 of 12)

| Parameter | Units | Reference | Method Criterion[b] Precision (Max RPD) | Method Criterion[b] Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Chloride | mg/L | EPA 325.3 | 12 | 88-112 |
| Chloride | mg/L | EPA 300, 9056 | 8 | 92-108 |
| Chloride | mg/kg | EPA 9056 | 8 | 93-109 |
| Nitrogen, $NO_2$ + $NO_3$ | mg/L-as N | EPA 353.2 | 10 | 88-108 |
| Nitrogen, $NO_2$ + $NO_3$ | mg/kg-as N | EPA 353.2 (Modified) | 10 | 87-107 |
| Nitrogen, $NO_3$[h] | mg/L-as N | EPA 353.2, 9200 | 5 | 95-105 |
| Nitrogen, $NO_3$ | mg/L-as N | EPA 300, 9056 | 9 | 92-110 |
| Nitrogen, $NO_2$ | mg/L-as N | EPA 353.2 | 8 | 93-109 |
| Nitrogen, $NO_2$ | mg/L-as N | EPA 300, 9056 | 8 | 93-109 |
| Nitrogen, $NH_3$ + $NH_4$ | mg/L-as N | EPA 350.1 | 26 | 76-128 |
| Nitrogen, TKN | mg/L-as N | EPA 351.2 | 23 | 78-124 |
| Nitrogen, TKN, Solid | mg/kg | CE-81-1, p. 3-201, Method 1 | 40 | 57-137 |
| Phosphorus, T | mg/L-as P | EPA 365.1 | 12 | 88-112 |
| Phosphorus, Ortho | mg/L-as P | EPA 300, 9056 | 13 | 86-112 |
| Phosphorus, Ortho | mg/L-as P | EPA 365.1 | 10 | 90-110 |
| Silica | mg/L | EPA 370.1 | 10 | 91-111 |
| Sulfate | mg/L | EPA 300, 9056 | 7 | 93-107 |
| Sulfate | mg/L | EPA 375.4 | 13 | 87-113 |
| Sulfide[j] | mg/L | EPA 376.2, 9030 | 33 | 60-126 |
| Sulfide, Solid[j] | mg/kg | EPA 9030 | 33 | 60-126 |
| Acidity, Total | mg/L-$CaCO_3$ | EPA 305.1 | 8 | 92-108 |
| BOD, 5-day | mg/L | EPA 405.1 | 40 | 63-143 |
| BOD, 14-day | mg/L | EPA 405.1 | 40 | 63-143 |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, and Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 6 of 12)

| Parameter | Units | Reference | Method Criterion[b] Precision (Max RPD) | Method Criterion[b] Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Carbon, Total | mg/L | EPA 415.1, 9060 | 13 | 87-113 |
| Carbon, TOC | mg/L | EPA 415.1, 9060 | 13 | 87-113 |
| Carbon, TOC, Solid | g/kg | EPA 9060 (mod) | 17 | 82-116 |
| Carbon, TOC, Solid | % Organic Content | ASTM-D 2974[i] | 20 | NA |
| Chromium (+6) | µg/L | EPA 7196 | 15 | 83-113 |
| Chromium (+6), Solid | mg/kg | EPA 3060, 7196 (Mod) | 15 | 83-113 |
| Color, True | PCU | EPA 110.2 | NA | NA |
| Corrosivity | mm/yr | EPA 1110, SM 2330 | NA | NA |
| Dissolved Oxygen (DO) | mg/L | EPA 360.1 | 20 | NA |
| Fluoride | mg/L | EPA 340.2 | 17 | 81-115 |
| Fluoride | mg/L | EPA 300, 9056 | 6 | 95-107 |
| Hardness | mg/L-$CaCO_3$ | EPA 130.2 | 25 | 85-115 |
| Ignitability | °C | EPA 1010 | NA | NA |
| Odor, 25°C | Thrsh No | EPA 140.1 | NA | NA |
| Oil and Grease, Grav | mg/L | EPA 413.1 | 20 | 79-119 |
| Oil and Grease, IR | mg/L | EPA 9073[g, 413.2] | 37 | 54-128 |
| Oil and Grease, IR, Solid | µg/g | EPA 9071, 9073[g] | 22 | 78-122 |
| pH | Std Units | EPA 150.1, 9040 | 4 | NA |
| pH, Solid | Std Units | EPA 9045 | 8 | NA |
| Phenols | µg/L | EPA 420.2, 9066 | 20 | 73-112 |
| Phenols, Solid | µg/g | CE-81-1, p. 3-555 | 25 | 72-122 |
| Residue, Susp. (TSS) | mg/L | EPA 160.2 | 34 | NA |
| Residue, Diss., Total (TDS) 105 Deg | mg/L | EPA 160.1 | 19 | NA |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, and Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 7 of 12)

| Parameter | Units | Reference | Method Criterion[b] Precision (Max RPD) | Method Criterion[b] Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Residue, Total (TS) | mg/L | EPA 160.3 | 19 | NA |
| MBAS (foaming agents) | mg/L | EPA 425.1 | 18 | 75-111 |
| Petroleum hydrocarbons (TRPH) | mg/L | EPA 418.1 | 37 | 54-128 |
| Petroleum hydrocarbons, Solid | µg/g | EPA 9073[g] | 23 | 76-122 |
| Petroleum hydrocarbons, Solid | µg/g | EPA 3550, 418.1 (Mod) | 34 | 67-135 |
| Specific Conductivity | µmhos/cm | EPA 120.1, 9050 | 15 | NA |
| Temperature | °C | EPA 170.1 | NA | NA |
| TOX | µg/L-Cl | EPA 9020A | 26 | 73-125 |
| TOX, Solid | µg/kg | EPA 9020A (Mod) | 31 | 66-128 |
| Turbidity | NTU | EPA 180.1 | 16 | NA |
| TCLP | -- | EPA 1311 | NA | NA |
| Americium-241 | pCi/L | ER 120, HASL G-03 | 25 | 85-115 |
| Americium-241, Solid | pCi/g | ER 120, HASL G-03 | 25 | 85-115 |
| Lead-210 | pCi/L | EPA-EERF | 25 | 80-120 |
| Lead-210, Solid | pCi/g | EPA-EERF | 25 | 80-120 |
| Gamma, gross | pCi/L | ER 150 | 25 | 80-120 |
| Gamma, gross, Solid | pCi/g | ER 150 | 25 | 80-120 |
| Plutonium-238 | pCi/L | ER 160, HASL G-03 | 25 | 85-115 |
| Plutonium-238, Solid | pCi/g | ER 160, HASL G-03 | 25 | 85-115 |
| Plutonium-239 | pCi/L | ER 160, HASL G-03 | 25 | 85-115 |
| Plutonium-239, Solid | pCi/g | ER 160, HASL G-03 | 25 | 85-115 |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, and Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 8 of 12)

| Parameter | Units | Reference | Method Criterion[b] Precision (Max RPD) | Method Criterion[b] Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Plutonium-240 | pCi/L | ER 160, HASL G-03 | 25 | 85-115 |
| Plutonium-240, Solid | pCi/g | ER 160, HASL G-03 | 25 | 85-115 |
| Plutonium-241 | pCi/L | ER 160, HASL G-03 | 25 | 75-125 |
| Plutonium-241, Solid | pCi/g | ER 160, HASL G-03 | 25 | 75-125 |
| Thorium-234 | pCi/L | ER 130 | 25 | 85-115 |
| Thorium-234, Solid | pCi/g | ER 130 | 25 | 85-115 |
| Thorium-227 | pCi/L | EPA-EERF | 25 | 85-115 |
| Thorium-227, Solid | pCi/g | EPA-EERF | 25 | 85-115 |
| Thorium-228 | pCi/L | EPA-EERF | 25 | 85-115 |
| Thorium-228, Solid | pCi/g | EPA-EERF | 25 | 85-115 |
| Thorium-230 | pCi/L | EPA-EERF | 25 | 85-115 |
| Thorium-230, Solid | pCi/g | EPA-EERF | 25 | 85-115 |
| Thorium-232 | pCi/L | EPA-EERF | 25 | 85-115 |
| Thorium-232, Solid | pCi/g | EPA-EERF | 25 | 85-115 |
| Strontium-90 | pCi/L | EML Sr-01 | 25 | 80-120 |
| Strontium-90, Solid | pCi/g | EML Sr-01 | 25 | 80-120 |
| Strontium 90 | pCi/L | EPA 905.0 | 16 | 81-113 |
| Strontium 89 | pCi/L | EPA 905.0 | 14 | 83-111 |
| Uranium-233 | pCi/L | ER 310, HASL G-03 | 25 | 85-115 |
| Uranium-233, Solid | pCi/g | ER 310, HASL G-03 | 25 | 85-115 |
| Uranium-234 | pCi/L | ER 310, HASL G-03 | 25 | 85-115 |
| Uranium-234, Solid | pCi/g | ER 310, HASL G-03 | 25 | 85-115 |
| Uranium-235 | pCi/L | ER 310, HASL G-03 | 25 | 85-115 |
| Uranium-235, Solid | pCi/g | ER 310, HASL G-03 | 25 | 85-115 |
| Uranium-236 | pCi/L | ER 310, HASL G-03 | 25 | 85-115 |
| Uranium-236, Solid | pCi/g | ER 310, HASL G-03 | 25 | 85-115 |
| Uranium-238 | pCi/L | ER 310, HASL G-03 | 25 | 85-115 |
| Uranium-238, Solid | pCi/g | ER 310, HASL G-03 | 25 | 85-115 |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, and Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 9 of 12)

| Parameter | Units | Reference | Method Criterion[b] Precision (Max RPD) | Method Criterion[b] Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Uranium, Natural | pCi/L | EPA 908.0 | 15 | 85-115 |
| Uranium | pCi/L | EPA 908.0 | 25 | 75-125 |
| Uranium, Total, Solid | pCi/g | EPA 3050/908.0 | 25 | 75-125 |
| Tritium | pCi/L | ER 210 | 25 | 80-120 |
| Tritium, Solid | pCi/g | ER 210 | 25 | 80-120 |
| Tritium, Total | pCi/L | EPA 906.0 | 29 | 71-129 |
| Cadmium-109 | pCi/L | ER 130 | 25 | 80-120 |
| Cadmium-109, Solid | pCi/g | ER 130 | 25 | 80-120 |
| Cobalt-57 | pCi/L | ER 130 | 25 | 80-120 |
| Cobalt-57, Solid | pCi/g | ER 130 | 25 | 80-120 |
| Cerium-139 | pCi/L | ER 130 | 25 | 80-120 |
| Cerium-139, Solid | pCi/g | ER 130 | 25 | 80-120 |
| Yttrium-88 | pCi/L | ER 130 | 25 | 80-120 |
| Yttrium-88, Solid | pCi/g | ER 130 | 25 | 80-120 |
| Cobalt-60 | pCi/L | ER 130 | 25 | 80-120 |
| Cobalt-60, Solid | pCi/g | ER 130 | 25 | 80-120 |
| Cesium-137 | pCi/L | ER 130 | 25 | 85-115 |
| Cesium-137, Solid | pCi/g | ER 130 | 25 | 80-120 |
| Neptunium-237 | pCi/L | EPA 907.0 | 25 | 85-115 |
| Neptunium-237, Solid | pCi/g | EPA 3050(Mod),907.0 | 25 | 85-115 |
| Polonium-210 | pCi/L | HASL Po-01 | 25 | 85-115 |
| Polonium-210, Solid | pCi/g | HASL Po-01 | 25 | 85-115 |
| Technetium-99 | pCi/L | HASL Tc-01 | 25 | 70-130 |
| Technetium-99, Solid | pCi/g | HASL Tc-01 | 25 | 70-130 |
| Alpha, Gross | pCi/L | EPA 900.0, 9310 | 38 | 58-134 |
| Alpha, Gross, Solid | pCi/g | EPA 3050 (Mod), 9310 | 31 | 67-129 |
| Beta, Gross | pCi/L | EPA 900.0, 9310 | 36 | 58-130 |
| Beta, Gross, Solid | pCi/g | EPA 3050 (Mod), 9310 | 36 | 58-130 |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 10 of 12)

| Parameter | Units | Reference | Method Criterion[b,l] Precision (Max RPD) | Accuracy (Percent Recovery) |
|---|---|---|---|---|
| Radium Alpha, Gross | pCi/L | EPA 900.1 | 25 | 75-125 |
| Radium, 226 | pCi/L | EPA 903.1, 9320 | 25 | 72-122 |
| Radium, 226, Alpha emit | pCi/L | EPA 903.0, 9315 | 17 | 83-117 |
| Radium, 226, Solid | pCi/g | EPA 3050 (Mod), 9320 | 29 | 70-128 |
| Radium, 226, Alpha emit, Solid | pCi/g | EPA 3050 (Mod), 9315 | 17 | 83-117 |
| Radium 228 | pCi/L | Brooks and Blanchard | 25 | 75-125 |
| Radium 228 | pCi/L | EPA 904.0, 9320 | 15 | 84-114 |
| Radium 228, Solid | pCi/g | EPA 3050 (Mod), 9320 | 15 | 84-114 |
| Radium, Total | pCi/L | EPA 903.0, 9315 | 45[k] | 55-145[k] |
| Actinium-227 | pCi/L | ER 130, EPA 901.1 | 25 | 85-115 |
| Actinium-227, Solid | pCi/g | ER 1301 | 25 | 85-115 |
| Actinium-228 | pCi/L | ER 130, EPA 901.1 | 25 | 85-115 |
| Actinium-228, Solid | pCi/g | ER 1301 | 25 | 85-115 |
| Beryllium-7 | pCi/L | ER 130, EPA 901.1 | 25 | 85-115 |
| Beryllium-7, Solid | pCi/g | ER 130 | 25 | 85-115 |
| Bismuth-214 | pCi/L | ER 130, EPA 901.1 | 25 | 85-115 |
| Bismuth-214, Solid | pCi/g | ER 130 | 25 | 85-115 |
| Lead-212 | pCi/L | ER 130, EPA 901.1 | 25 | 85-115 |
| Lead-212, Solid | pCi/g | ER 130 | 25 | 85-115 |
| Lead-214 | pCi/L | ER 130, EPA 901.1 | 25 | 85-115 |
| Lead-214, Solid | pCi/g | ER 130 | 25 | 85-115 |
| Palladium-234 | pCi/L | ER 130, EPA 901.1 | 25 | 85-115 |
| Palladium-234, Solid | pCi/g | ER 130 | 25 | 85-115 |
| Potassium-40 | pCi/L | ER 130, EPA 901.1 | 25 | 85-115 |
| Potassium-40, Solid | pCi/L | ER 130 | 25 | 85-115 |

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 11 of 12)

| Parameter | Units | Reference | Method Criterion[b,l] Precision (Max RPD) | Accuracy (Percent Recovery) | |
|---|---|---|---|---|---|
| Gamma Emitters* | pCi/L | ER-130, EPA 901.1 | 25 | NA | |
| Gamma Emitters* | pCi/g | ER-130, | 25 | NA | |

*The gamma emitters are Barium-133 (Ba-133), Beryllium-7 (Be-7), Potassium-40 (K-40), Cesuim-134 (Cs-134), Cesium-137 (Cs-137), Cobalt-60 (Co-60), Lead-212 (Pb-212), Lead-214 (Pb-214), Bismuth-214 (Bi-214), Actinium-227 (Ac-227), Actinium-228 (Ac-228), Palladium-234 (Pa-234), Thorium-234 (Th-234), Ruthenium-106 (Ru-106), and Zinc-65 (Zn-65).

Note:
CLP = EPA Contract Laboratory Program.
MAS = million asbestos structures.
NA = not applicable.
N/A = spiking and recovery information are not available.
SOW = statement of work.
TCLP = toxicity characteristics leaching procedure.
TOX = total organic halides.
TRPH = total recoverable petroleum hydrocarbons.

Table 5-2. Summary of Precision and Accuracy Criteria for Inorganics Analysis, Metals Analysis, and Oil and Grease, TRPH, TOX, and Radiochemical Analysis (Continued, Page 12 of 12)

References:

ASTM D2974--American Society for Testing and Materials Designation: D2974-87, July 1987.
EPA 100-400--Methods for Chemical Analyses of Water and Waste. EPA 600/4-79-20--Revised March 1983.
EPA 900--Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA 600/4-80-032, August 1980.
EPA 1310-9073--Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition (Method 9073, draft 1989: oil and grease methods exclude 7.8 and 7.10).
CE-81-1--Procedures for Handling and Chemical Analysis of Sediment and Water Samples, EPA/USACE, May 1981.
EPA CLM--Chemistry Laboratory Manual of Bottom Sediments, PB-215192, Federal Water Quality Administration, December 1969.
Hach 8000--Hach Handbook of Water Analysis, 1979. Hach Chemical Company, P.O. Box 389, Loveland, Colorado 80537.
EPA 600 M4-82-020--Interim Method for Determination of Asbestos in Bulk Insulation Samples.
NIOSH--National Institute of Occupational Safety and Health (NIOSH) Manual of Analytical Methods, 3rd Edition, Volume 1, 1984.
SM 4500-N--Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989.
EML Sr-01 = Environmental Measurements Laboratory- Health and Safety Laboratory - 300 (HASL-300), 27th Edition.
EPA-EERF = Eastern Environmental Radiation Facility Radiochemistry Procedures Manual (EPA 520/5-84-006).
ER 100-310 = Environmental Analytical Procedures- Radiochemical (ER), Los Alamos-10300-Manual, Health and Environmental Chemistry; Analytical Techniques, Data Management, and Quality Assurance.
HASL G-03 = Health and Safety Laboratory Manual, Environmental Measurements Laboratory, Department of Energy, New York, New York.

[a]The parameter may be analyzed by the referenced methodology, but it is not a control parameter for this referenced method.
[b]ESE historical data.
[c]SOP derived from referenced method is used for this unlisted analyte.
[d]Criteria from EPA CLP SOW 3/90.
[e]Data from ESE method certification.
[f]ESE performance evaluation data for EPA's Water Supply Studies.
[g]EPA Method 9073, draft method, EPA 1989, for oil and grease exclude steps 7.8 and 7.10.
[h]$NO_3$ (as N) by EPA 353.2 is calculation of $(NO_2 + NO_3) - (NO_2)$; also, method criteria do not apply.
[i]Percent organic carbon is calculated from the percent organic content data obtained from the ASTMD method using the equation: $\% \text{ Organic Carbon} = \frac{\% \text{ Total Organic Content}}{1.724}$
[j]Appendix IX compounds.
[k]Criteria from EPA Method 903.0--Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA 600/4-80-032, August 1980.
[l]CLP precision and accuracy acceptance criteria for metals will be used for Los Alamos projects.

Source: ESE.

Table 5-3. Reporting Limit Data for Metals, Inorganics, Oil and Grease, TRPH, TOX, and Radiochemical Analyses

| Parameter | Reference | Reporting Limit Aqueous* (µg/L) | Reporting Limit Solid* (mg/kg) |
|---|---|---|---|
| Aluminum | EPA 200.7, 3005, 3010, 3050, 6010 | 50 | 10 |
| Aluminum | EPA 202.2, 3050, 7020 | 5.0** | 0.5** |
| Aluminum | EPA 3015, 3051, 6020 | 25 | 10 |
| Antimony | EPA 200.7, 3005, 3010, 3050, 6010 | 50 | 5.0 |
| Antimony | EPA 204.2, 3050, 7041 | 3.0** | 0.5** |
| Antimony | EPA 3015, 3051, 6020 | 0.5 | 0.005 |
| Arsenic | EPA 200.7, 3005, 3010, 3050, 6010 | 100 | 10 |
| Arsenic | EPA 206.2, 3020, 3050, 7060 | 2.5 | 0.25 |
| Arsenic | EPA 3015, 3051, 6020 | 1.0 | 0.10 |
| Barium | EPA 200.7, 3005, 3010, 3050, 6010 | 20 | 2.0 |
| Barium | EPA 3015, 3051, 6020 | 0.5 | 0.20 |
| Beryllium | EPA 200.7, 3015, 3010, 3050, 6010 | 5.0 | 0.5 |
| Beryllium | EPA 210.2, 3020, 3050, 7091 | 0.20 | 0.02 |
| Beryllium | EPA 3015, 3051, 6020 | 0.20 | 0.02 |
| Cadmium | EPA 200.7, 3005, 3010, 3050, 6010 | 3.9 | 0.39 |
| Cadmium | EPA 213.2, 3050, 7131 | 0.20 | 0.02 |
| Cadmium | EPA 3015, 3051, 6020 | 0.20 | 0.05 |
| Calcium | EPA 200.7, 3005, 3010, 3050, 6010 | 100 | 75 |
| Chromium | EPA 200.7, 3005, 3010, 3050, 6010 | 10 | 1.0 |
| Chromium | EPA 218.2 | 2.5 | 0.5 |
| Chromium | EPA 3015, 3051, 6020 | 1.0 | 0.10 |
| Cobalt | EPA 200.7, 3005, 3010, 3050, 6010 | 20 | 2.0 |
| Cobalt | EPA 3015, 3051, 6020 | 0.5 | 0.20 |
| Copper | EPA 200.7, 3005, 3010, 3050, 6010 | 5 | 0.5 |
| Copper | EPA 3015, 3051, 6020 | 0.5 | 0.10 |
| Iron | EPA 200.7, 3005, 3010, 3050, 6010 | 45 | 25 |
| Lead | EPA 200.7, 3005, 3010, 3050, 6010 | 50 | 10 |
| Lead | EPA 239.2, 3020, 3050, 7421 | 2.0 | 0.5 |
| Lead | EPA 3015, 3051, 6020 | 0.5 | 0.10 |
| Magnesium | EPA 200.7, 3005, 3010, 3050, 6010 | 50 | 25 |

Table 5-3. Reporting Limit Data for Metals, Inorganics, Oil and Grease, TRPH, TOX, and Radiochemical Analyses (Continued, Page 2 of 8)

| Parameter | Reference | Reporting Limit Aqueous* (µg/L) | Reporting Limit Solid* (mg/kg) |
|---|---|---|---|
| Manganese | EPA 200.7, 3005, 3010, 3050, 6010 | 5.0 | 2.5 |
| Manganese | EPA 3015, 3051, 6020 | 0.5 | 5.0 |
| Mercury | EPA 245.1, 7470, 7471 | 0.2 | 0.1 |
| Mercury, Low Level | EPA 245.1, 7471 | 0.01 | 0.001 |
| Molybdenum | EPA 200.7, 3005, 3010, 3050, 6010 | 10 | 1.0 |
| Molybdenum | EPA 3050, 7480, 7481 | 5.0** | 0.5** |
| Nickel | EPA 200.7, 3005, 3010, 3050, 6010 | 15 | 2.0 |
| Nickel | EPA 3015, 3051, 6020 | 1.0 | 0.10 |
| Potassium | EPA 200.7, 3005, 3010, 3050, 6010 | 600 | 100 |
| Potassium | EPA 3010, 3050, 7610 | 5.0** | 0.5** |
| Selenium | EPA 270.2, 6010, 200.7, 3005, 3010, 3050 | 100 | 10 |
| Selenium | EPA 200.7, 3050, 7740 | 2.5 | 0.25 |
| Silicon | EPA 200.7, 3005, 3010, 3050, 6010 | 200 | 20 |
| Silver | EPA 200.7, 3005, 3010, 3050, 6010 | 5.0 | 0.50 |
| Silver | EPA 272.2 | 0.25 | 0.05 |
| Silver | EPA 6020 | 0.1 | 0.02 |
| Sodium | EPA 200.7, 3005, 3010, 3050, 6010 | 100 | 50 |
| Sodium | EPA 273.1, 3050, 7770 | 100** | 10.0** |
| Strontium | EPA 200.7, 6010, 3005, 3010, 3050 | 2.5 | 2.0 |
| Thallium | EPA 200.7, 3005, 3010, 3050, 6010 | 200 | 20 |
| Thallium | EPA 279.2, 3050, 7841 | 5.0 | 0.5 |
| Thallium | EPA 3015, 3051, 6020 | 0.5 | 0.10 |
| Tin | EPA 200.7, 3010, 3050, 6010 | 50 | 5 |
| Titanium | EPA 200.7, 3005, 3010, 6010 | 10 | 2.0 |
| Uranium | EPA 3015, 3051, 6020 | 0.1 | 0.1 |
| Vanadium | EPA 200.7, 3005, 3010, 3050, 6010 | 10 | 1.0 |
| Vanadium | EPA 286.2, 3050, 7911 | 5.0 | 0.5 |
| Zinc | EPA 200.7, 3005, 3010, 3050, 6010 | 30 | 5.0 |
| Zinc | EPA 3015, 3051, 6020 | 1.0 | 0.20 |

Table 5-3. Reporting Limit Data for Metals, Inorganics, Oil and Grease, TRPH, TOX, and Radiochemical Analyses (Continued, Page 3 of 8)

| Parameter | Units | Reference | Reporting Limit |
|---|---|---|---|
| Alkalinity, Total | mg/L-$CACO_3$ | EPA 310.1 | 5.0*** |
| COD, high-level | mg/L | HACH 8000 | 50++ |
| COD, low-level | mg/L | HACH 8000 | 5.0++ |
| Cyanide | mg/L | EPA 335.3 | 0.005** |
| Cyanide, Solid | µg/g | EPA 335.3. 9010 | 0.25** |
| Moisture | % Wet Wt | ASTM-D 2216-71 | 0.5** |
| Bromide | mg/L | EPA 9056 | 0.2** |
| Bromide | mg/L | EPA 300 | 1.0** |
| Chloride | mg/L | EPA 325.3 | 1.0*** |
| Chloride | mg/L | EPA 300, 9056 | 0.5** |
| Nitrogen, $NO_2$ + $NO_3$ | mg/L-as N | EPA 353.2 | 0.010** |
| Nitrogen, $NO_3$ | mg/L-as N | EPA 300, 353.2, 9056 | 0.010** |
| Nitrogen, $NO_2$ | mg/L-as N | EPA 300, 353.2, 9056 | 0.010** |
| Nitrogen, $NH_3$ + $NH_4$ | mg/L-as N | EPA 350.1 | 0.05** |
| Nitrogen, TKN | mg/L-as N | EPA 351.2 | 0.10** |
| Nitrogen, TKN, Solid | mg/kg | CE-81-1, p. 3-201, Method 1 | 10** |
| Phosphorus, T | mg/L-as P | EPA 300, 9056 | 0.01** |
| Phosphorus, T | mg/L-as P | EPA 365.1 | 0.01** |
| Phosphorus, T Solid | mg/kg-as P | EPA 365.1 | 2.5** |
| Phosphorus, Ortho, D | mg/L-as P | EPA 365.1 | 0.01** |
| Phosphorus, Ortho, D | mg/L-as P | EPA 300, 9056 | 0.01** |
| Total O-$PO_4$ | mg/L-as P | EPA 365.1 | 0.01** |
| Silica, Diss | mg/L | EPA 370.1 | 2.0** |
| Sulfate | mg/L | EPA 375.4 | 5.0** |
| Sulfate | mg/L | EPA 300, 9056 | 0.50** |
| Sulfide | mg/L | EPA 376.2 | 0.05** |
| Sulfide, Solid | mg.kg | EPA 9030 | 0.25** |

Table 5-3. Reporting Limit Data for Metals, Inorganics, Oil and Grease, TRPH, TOX, and Radiochemical Analyses (Continued, Page 4 of 8)

| Parameter | Units | Reference | Reporting Limit |
|---|---|---|---|
| Acidity, Total | mg/L-$CaCO_3$ | EPA 305.1 | 5** |
| BOD, 5-day | mg/L | EPA 405.1 | 1.0** |
| BOD, 14-day | mg/L | EPA 405.1 | 1.0*** |
| Carbon, Total | mg/L | EPA 415.1, 9060 | 1.0** |
| Carbon, TOC | mg/L | EPA 415.1, 9060 | 1.0** |
| Carbon, TOC, Solid | g/kg | EPA 9060 (Mod) | 360***** |
| Carbon, TOC, Solid | % Organic Content | ASTM- D 2974 | 0.1** |
| Chromium (+6) | µg/L | EPA 7196 | 2.0** |
| Chromium (+6), Solid | mg/kg | EPA 3060, 7196 (Mod) | 0.2** |
| Color, true | PCU | EPA 110.2 | 5.0** |
| Fluoride | mg/L | EPA 340.2 | 0.10** |
| Fluoride | mg/L | EPA 300, 9056 | 0.50** |
| Hardness | mg/L-$CaCO_3$ | EPA 130.2 | 1.0††† |
| Odor, 25°C | Thrsh No. | EPA 140.1 | 1.0††† |
| Corrosivity | mm/yr | EPA 1110, SM2330 | |
| Dissolved Oxygen | mg/L | EPA 160.1 | |
| Turbidity | NTU | EPA 180.1 | 0.4** |
| MBAS (foaming agents, surfactants) | mg/L | EPA 425.1 | 0.1** |
| Oil and Grease, IR | mg/L | EPA 413.2 | 0.17** |
| Oil and Grease, Gravimetric | mg/L | EPA 413.1 | 5.0** |
| Oil and Grease, IR, Solid | µg/g | EPA 9071, 9073 | 21** |

Table 5-3. Reporting Limit Data for Metals, Inorganics, Oil and Grease, TRPH, TOX, and Radiochemical Analyses (Continued, Page 5 of 8)

| Parameter | Units | Reference | Reporting Limit |
|---|---|---|---|
| Phenols | µg/L | EPA 420.2, 9056 | 5.0** |
| Phenols, Solid | µg/g | CE-81-1, p. 3-555 | 100** |
| Residue, Diss., Total (TDS) 105 Deg | mg/L | EPA 160.1 | 10*** |
| Residue, Susp. (TSS) | mg/L | EPA 160.2 | 4*** |
| Residue, Total (TS) | mg/L | EPA 160.3 | 10** |
| Petroleum Hydrocarbons (TRPH) | mg/L | EPA 418.1 | 0.17** |
| Petroleum Hydrocarbons, Solid | µg/g | EPA 9071, 9073 | 21** |
| Petroleum Hydrocarbons, Solid | µg/g | EPA 3550, 418.1 | 21** |
| Specific Conductivity | µmho/cm | EPA 120.1 | 10** |
| TOX | µg/L-Cl | EPA 9020A | 10** |
| TOX, Solid | µg/kg | EPA 9020A (Mod) | 30** |
| Americium-241 | pCi/L | EPA 120, AM-03 | 0.1 |
| Americium-241, Solid | pCi/g | EPA 120, AM-03 | 0.01 |
| Lead-210 | pCi/L | EPA-EERF | 1.0 |
| Lead-210, Solid | pCi/g | EPA-EERF | 1.0 |
| Gamma, gross | pCi/L | EPA 150 | 100 |
| Gamma, gross, Solid | pCi/g | EPA 150 | 2 |
| Plutonium-238 | pCi/L | ER 160 | 0.1 |
| Plutonium-238, Solid | pCi/g | ER 160 | 0.01 |
| Plutonium-239 | pCi/L | ER 160 | 0.1 |
| Plutonium-239, Solid | pCi/g | ER 160 | 0.01 |
| Plutonium-240 | pCi/L | ER 160 | 0.1 |
| Plutonium-240, Solid | pCi/g | ER 160 | 0.01 |
| Plutonium-241 | pCi/L | ER 160 | 2.0 |
| Plutonium-241 Solid | pCi/g | ER 160 | 1.0 |

Table 5-3. Reporting Limit Data for Metals, Inorganics, Oil and Grease, TRPH, TOX, and Radiochemical Analyses (Continued, Page 6 of 8)

| Parameter | Units | Reference | Reporting Limit |
|---|---|---|---|
| Thorium-234 | pCi/L | ER 130 | 20 |
| Thorium-234, Solid | pCi/g | ER 130 | 1.0 |
| Thorium-227 | pCi/L | EPA-EERF | 0.1 |
| Thorium-227, Solid | pCi/g | EPA-EERF | 0.1 |
| Thorium-228 | pCi/L | EPA-EERF | 0.1 |
| Thorium-228, Solid | pCi/g | EPA-EERF | 0.1 |
| Thorium-230 | pCi/L | EPA-EERF | 0.1 |
| Thorium-230, Solid | pCi/g | EPA-EERF | 0.1 |
| Thorium-232 | pCi/L | EPA-EERF | 0.1 |
| Thorium-232, Solid | pCi/g | EPA-EERF | 0.1 |
| Strontium-90 | pCi/L | EML Sr-01 | 1.0 |
| Strontium-90, Solid | pCi/g | EML Sr-01 | 0.5 |
| Strontium 90 | pCi/L | EPA 905.0 | 2.0[++++] |
| Strontium 89 | pCi/L | EPA 905.0 | 2.0[++++] |
| Uranium-233 | pCi/L | ER 310 | 0.1 |
| Uranium-233, Solid | pCi/g | ER 310 | 0.1 |
| Uranium-234 | pCi/L | ER 310 | 0.1 |
| Uranium-234, Solid | pCi/g | ER 310 | 0.1 |
| Uranium-235 | pCi/L | ER 310 | 0.1 |
| Uranium-235, Solid | pCi/g | ER 310 | 0.1 |
| Uranium-236 | pCi/L | ER 310 | 0.1 |
| Uranium-236, Solid | pCi/g | ER 310 | 0.1 |
| Uranium-238 | pCi/L | ER 310 | 0.1 |
| Uranium-238, Solid | pCi/g | ER 310 | 0.1 |
| Uranium, Natural | pCi/L | EPA 908.0 | 1.0 |
| Uranium, Total | pCi/L | EPA 908.0 | 1.0 |
| Uranium, Total, Solid | pCi/g | EPA 3050/908.0 | 0.3 |
| Tritium | pCi/L | ER 210 | 300 |
| Tritium, Solid | pCi/g | ER 210 | 300 |
| Tritium | pCi/L | EPA 906.0 | 600 |

Table 5-3. Reporting Limit Data for Metals, Inorganics, Oil and Grease, TRPH, TOX, and Radiochemical Analyses (Continued, Page 7 of 8)

| Parameter | Units | Reference | Reporting Limit |
|---|---|---|---|
| Cadmium-109 | pCi/L | ER 130 | 421 |
| Cadmium-109, Solid | pCi/g | ER 130 | 14 |
| Cobalt-57 | pCi/L | ER 130 | 12 |
| Cobalt-57, Solid | pCi/g | ER 130 | 0.5 |
| Cerium-139 | pCi/L | ER 130 | 10 |
| Cerium-139, Solid | pCi/g | ER 130 | 0.4 |
| Yttrium-88 | pCi/L | ER 130 | 21 |
| Yttrium-88, Solid | pCi/g | ER 130 | 0.9 |
| Cobalt-60 | pCi/L | ER 130 | 22 |
| Cobalt-60, Solid | pCi/g | ER 130 | 0.9 |
| Cesium-137 | pCi/L | ER 130 | 3.0 |
| Cesium-137, Solid | pCi/g | ER 130 | 20 |
| Neptunium-237 | pCi/L | EPA 907.0 | 0.5 |
| Neptunium-237 | pCi/g | EPA 3050(Mod). 907.0 | 0.2 |
| Polonium-210 | pCi/L | HASL Po-01 | 1.0 |
| Polonium-210 | pCi/g | HASL Po-02 | 0.5 |
| Technetium-99 | pCi/L | HASL Tc-01 | 2.0 |
| Technetium-99 | pCi/g | HASL Tc-01 | 1.0 |
| Alpha, Gross | pCi/L | EPA 900.0 | 1.0$^{++++}$ |
| Alpha, Gross, Solid | pCi/g | EPA 3050, 9310 (Mod) | 1.0$^{++++}$ |
| Beta, Gross | pCi/L | EPA 900.0, 9310 | 3.0$^{++++}$ |
| Beta, Gross, Solid | pCi/g | EPA 3050, 9310 (Mod) | 3.0$^{++++}$ |
| Radium Alpha, Gross | pCi/L | EPA 900.1 | 1.0$^{++++}$ |
| Radium 226 | pCi/L | EPA 903.1, 903.0, 9315, 9320 | 0.1$^{++++}$ |
| Radium 226, Alpha emit | pCi/L | EPA 903.0, 9315 | 1.0$^{+++}$ |
| Radium 226, Solid | pCi/g | EPA 3050, 9315, 9320 (Mod) | 0.1$^{++++}$ |
| Radium 226, Alpha emit, Solid | pCi/g | EPA 3050, 9315 (Mod) | 1.0$^{+++}$ |
| Radium 228 | pCi/L | Brooks and Blanchard | |
| Radium 228 | pCi/L | EPA 904.0, 9320 | 2.0$^{++++}$ |
| Radium 228, Solid | pCi/g | EPA 3050, 9320 (Mod) | 2.0$^{++++}$ |

Table 5-3. Reporting Limit Data for Metals, Inorganics, Oil and Grease, TRPH, TOX, and Radiochemical Analyses (Continued, Page 8 of 8)

| Parameter | Units | Reference | Reporting Limit |
|---|---|---|---|
| Radium, Total | pCi/L | EPA 903.0, 9315 | 1.0†††† |
| Gamma Emitters | | | |
| Beryllium-7 | pCi/L | ER 130, EPA 901.1 | 20 |
| Beryllium-7 | pCi/g | ER 130 | 140 |
| Potassium-40 | pCi/L | ER 130, EPA 901.1 | 43 |
| Potassium-40 | pCi/g | ER 130 | 300 |
| Lead-212 | pCi/L | ER 130, EPA 901.1 | 7.0 |
| Lead-212 | pCi/g | ER 130 | 50 |
| Lead-214 | pCi/L | ER 130, EPA 901.1 | 7.0 |
| Lead 214 | pCi/g | ER 130 | 50 |
| Cesium-137 | pCi/L | ER 130, EPA 901.1 | 3.0 |
| Cesium-137 | pCi.g | ER 130 | 20 |
| Bismuth-214 | pCi/L | ER 130, EPA 901.1 | 8.0 |
| Bismuth-214 | pCi/g | ER 130 | 55 |
| Actinium-227 | pCi/L | ER 130, EPA 901.1 | 25 |
| Actinium-227 | pCi/g | ER 130 | 175 |
| Actinium-228 | pCi/L | ER 130, EPA 901.1 | 10 |
| Actinium-228 | pCi/g | ER 130 | 70 |
| Palladium-234 | pCi/L | ER 130, EPA 901.1 | 600 |
| Palladium-234 | pCi/g | ER 130 | 4200 |
| Thorium-234 | pCi/L | ER 130, EPA 901.1 | 100 |
| Thorium-234 | pCi/g | ER 130 | 700 |

Note:
µg/L = micrograms per liter.
mg/kg = milligrams per kilogram.
mg/L = milligrams per liter.
pCi/L = picocuries per liter.
pCi/g = picocuries per gram.
g/kg = grams per kilogram.
NTU = nephelometric turbidity unit.
PCU = platinum-cobalt unit.
µg/g = micrograms per gram.
µmho/cm = microhmos per centimeter.

*Based on ESE's instrument detection limit (IDL) studies unless indicated differently. The EPA Contract Laboratory Program (CLP) SOW 3/90 requirements are followed when the IDL studies are conducted.
†Based on aqueous IDL studies times a factor of 0.1 to take into account sample weight and final volume of digestate, unless indicated differently.

** Based on the lowest standard that ESE routinely uses. For solids, the reporting limits are adjusted for sample weight and final volume.

†† HACH instrument recommended detection limit, HACH Co., Box 389, Loveland, CO 80537.

*** Methods for Chemical Analyses of Water and Waste, EPA 600/4-79-020, Revised, March 1983.

††† Obtained from Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989. The reporting limits for petroleum hydrocarbon and oil and grease already take into account sample volume or sample weight and final extract volume.

**** Based on one-half of the major increments of the titration.

†††† Based on EPA's detection limits calculation procedure recommended for radiochemical analyses. (Reference: Carbon-14 in Aqueous Samples, Environmental Measurements Laboratory Manual, 1981.)

***** Based on MDL Study.

Source: ESE.

Table 5-4. Analytes, Precision, and Accuracy Data For Trihalomethanes, EPA 501.2

| Parameter | Aqueous | |
|---|---|---|
| | Precision (RPD) | Accuracy (% Recovery) |
| Chloroform | 33 | 77-143 |
| Bromodichloromethane | 33 | 79-137 |
| Dibromochloromethane | 33 | 23-125 |
| Bromoform | 33 | 43-106 |
| THMs, total* | 33† | 62-128† |

Reference: Accuracy: EPA Method 501.2--The Analysis of Trihalomethanes in Drinking Water by Liquid/Liquid Extraction, EPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH, May 15, 1979.

Precision: ESE, meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method EPA 501.2.

*Matrix spike and QC check sample compound.
†Accuracy and precision criteria are based on ESE historical data.

Source: ESE.

Table 5-5. Reporting Limit Data for Trihalomethanes, EPA 501.2

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| Chloroform | 0.6 |
| Bromodichloromethane | 0.2 |
| Dibromochloromethane | 0.1 |
| Bromoform | 0.1 |
| THMs, total | 1.0 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume.

Source: ESE.

Table 5-6. Analytes, Precision, and Accuracy Data For EDB and DBCP, EPA 504 and Modified 504*

| Parameter | Aqueous** | | Solid** | |
|---|---|---|---|---|
| | Precision (RPD) | Accuracy (%Recovery) | Precision (RPD) | Accuracy (%Recovery) |
| 1,2-Dibromoethane (EDB)† | 20 | 80-120 | 33 | 65-131 |
| DBCP (nemagon)† | 30 | 67-127 | 45 | 54-144 |

*See Appendix B for Modified Method 504.
†Matrix spike and QC check sample compound.
**Accuracy and precision criteria are based on ESE historical data.

Source: ESE.

Table 5-7. Reporting Limit Data for EDB and DBCP, EPA 504 and Modified 504

| Parameter | Reporting Limits* Aqueous (µg/L) | Solid (µg/kg) |
|---|---|---|
| 1,2-Dibromoethane (EDB)† | 0.02 | 30 |
| DBCP (nemagon)† | 0.02 | 30 |

*Based on the lowest standard that ESE routinely uses.
The solid detection limits are expressed on a wet weight basis.
†Appendix IX compounds.

Source: ESE.

Table 5-8. Analytes, Precision, and Accuracy Data For Organohalide Pesticides and Arochlors in Drinking Water, EPA 508

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (%Recovery) |
|---|---|---|
| Aldrin* | 29 | 57-115 |
| Chlordane, alpha | 36 | 63-135 |
| Chlordane, gamma | 36 | 63-135 |
| Chlordane | 36 | 63-135 |
| 4,4'-DDD | 19 | 88-126 |
| 4,4'-DDE | 36 | 63-135 |
| 4,4'-DDT | 50 | 62-162 |
| Dieldrin* | 26 | 61-113 |
| Endosulfan I | 26 | 61-113 |
| Endosulfan II | 30 | 62-122 |
| Endosulfan Sulfate | 46 | 56-148 |
| Endrin* | 26 | 62-114 |
| Endrin Aldehyde | 24 | 64-112 |
| BHC-alpha | 30 | 62-114 |
| BHC-beta | 20 | 75-115 |
| BHC-delta | 34 | 68-136 |
| BHC-gamma (Lindane)* | 29 | 60-118 |
| Heptachlor* | 35 | 63-133 |
| Heptachlor Epoxide | 26 | 61-113 |
| Hexachlorobenzene | 65 | 34-164 |
| Methoxychlor | 41 | 64-146 |
| Propachlor | 28 | 75-131 |
| Trifluralin | 16 | 87-119 |

Table 5-8. Analytes, Precision, and Accuracy Data For Organohalide Pesticides and Arochlors in Drinking Water, EPA 505 (Continued, Page 2 of 2)

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (%Recovery) |
|---|---|---|
| Toxaphene | 41 | 73-155 |
| PCB-1016 | 23 | 74-120 |
| PCB-1221 | 29 | 63-121 |
| PCB-1232 | 22 | 64-108 |
| PCB-1242 | 22 | 74-118 |
| PCB 1248 | 30 | 54-114 |
| PCB-1254 | 35 | 50-120 |
| PCB-1260 | 59 | 29-147 |

Reference: Accuracy: EPA Method 508--Supplement to "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water," EPA, Cincinnati, OH, September 1986. Precision: ESE, meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (EPA 508).

*Matrix spike and QC check sample compound.

Source: ESE.

Table 5-9. Reporting Limits Data for Organohalide Pesticides and Arochlors in Drinking Water, EPA 508

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| ALdrin | 0.10 |
| Chlordane, alpha | 0.5 |
| Chlordane, gamma | 0.5 |
| Chlordane | 0.5 |
| 4,4'-DDD | 0.05 |
| 4,4-DDE | 0.01 |
| 4,4'-DDT | 0.06 |
| Dieldrin | 0.10 |
| Endosulfan I | 0.2 |
| Endosulfan II | 0.2 |
| Endosulfan Sulfate | 0.5 |
| Endrin | 0.2 |
| Endrin Aldehyde | 0.2 |
| BHC-alpha | 0.1 |
| BHC-beta | 0.1 |
| BHC-delta | 0.1 |
| BHC-gamma | 0.1 |
| Heptachlor | 0.1 |
| Heptachlor Epoxide | 0.1 |
| Hexachlorobenzene | 0.05 |
| Methoxychlor | 0.05 |
| Propachlor | 0.5 |
| Trifluralin | 0.5 |
| Toxaphene | 10 |
| PCB-1016 | 2.0 |
| PCB-1221 | 2.0 |
| PCB-1232 | 2.0 |
| PCB-1242 | 2.0 |
| PCB 1248 | 2.0 |
| PCB-1254 | 2.0 |
| PCB-1260 | 2.0 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

†Method detection limits listed in EPA Method 508, Analysis of Organohalide Compounds in Drinking Water (supplement to "Methods for the Determination of Organic Compounds in Drinking Water," EPA/600/4-88/039, December 1988) times ten.

Source: ESE.

Table 5-10. Analytes, Precision, and Accuracy Data For Nitrogen and Phosphorous Containing Pesticides, EPA 507

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (%Recovery) |
|---|---|---|
| Alachlor | 33 | 62-128 |
| Ametryn | 30 | 61-121 |
| Atraton | 33 | 58-124 |
| Atrazine* | 24 | 68-116 |
| Bromacil | 27 | 64-118 |
| Butachlor | 12 | 84-108 |
| Butylate | 63 | 34-160 |
| Carboxin | 12 | 90-114 |
| Chlorpropham | 33 | 60-126 |
| Cycloate | 27 | 62-116 |
| Diazinon* | 21 | 94-136 |
| Dichlorvos | 18 | 79-115 |
| Diphenamid | 24 | 69-117 |
| Disulfoton | 30 | 59-119 |
| Disulfoton Sulfone | 30 | 68-128 |
| Disulfoton Sulfoxide | 33 | 54-120 |
| EPTC | 27 | 58-112 |

Table 5-10. Analytes, Precision, and Accuracy Data For Nitrogen and Phosphorous Containing Pesticides, EPA 507,
(Continued, Page 2 of 3)

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (%Recovery) |
|---|---|---|
| Ethoprop | 15 | 88-118 |
| Fenamiphos | 24 | 66-114 |
| Fenarimol | 15 | 84-114 |
| Fluridone | 27 | 60-114 |
| Hexazinone | 21 | 69-111 |
| Merphos | 24 | 72-120 |
| Methyl Parathion | 30 | 68-128 |
| Metolachlor | 12 | 81-105 |
| Metribuzin | 15 | 86-116 |
| Mevinphos | 33 | 62-128 |
| Molinate | 54 | 44-152 |
| Napropamide | 18 | 83-119 |
| Norflurazon | 15 | 79-109 |
| Pebulate | 27 | 67-121 |
| Prometon | 27 | 51-105 |
| Prometryn | 24 | 69-117 |
| Pronamide | 30 | 61-121 |

Table 5-10. Analytes, Precision, and Accuracy Data For Nitrogen and Phosphorous Containing Pesticides, EPA 507,
(Continued, Page 3 of 3)

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (%Recovery) |
|---|---|---|
| Propazine | 24 | 68-116 |
| Simazine* | 21 | 79-121 |
| Simetryn | 15 | 84-114 |
| Stirofos | 18 | 80-116 |
| Tebuthiuron | 27 | 57-111 |
| Terbacil | 18 | 79-115 |
| Terbufos | 12 | 85-109 |
| Terbutryn | 27 | 67-121 |
| Triademefon | 24 | 69-117 |
| Tricyclazole | 21 | 65-107 |
| Vernolate | 18 | 75-111 |

Reference: Accuracy: EPA Method 507--Methods for the Determination of Organic Compounds in Drinking Water, EPA 600/4-88/039, December 1988.
Precision: ESE, meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (EPA 507).

*Matrix spike and QC check sample compound.

Source: ESE.

Table 5-11. Reporting Limit Data for Nitrogen and Phosphorus Containing Pesticides, EPA 507

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| Alachlor | 3.8 |
| Ametryn | 20 |
| Ametraton | 6.0 |
| Atrazine | 0.6+ |
| Bromacil | 25 |
| Butachlor | 3.8 |
| Butylate | 0.3+ |
| Carboxin | 6.0 |
| Chlorpropham | 5.0 |
| Cycloate | 2.5 |
| Diazinon | 0.3+ |
| Dichlorvos | 0.3+ |
| Diphenamid | 6 |
| Disulfoton | 0.3+ |
| Disulfoton Sulfone | 38 |
| Disulfoton Sulfoxide | 3.8 |
| EPTC | 0.3 |
| Ethoprop | 1.9 |
| Fenamiphos | 10 |
| Fenarimol | 3.8 |

Table 5-11. Reporting Limit Data for Nitrogen and Phosphorus Containing Pesticides, EPA 507 (Continued, Page 2 of 3)

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| Fluridone | 38 |
| Hexazinone | 1.2+ |
| Merphos | 0.3+ |
| Methyl Parathion | 25 |
| Metolachlor | 7.5 |
| Metribuzin | 1.5 |
| Mevinphos | 2.9 |
| Molinate | 1.5 |
| Napropamide | 2.5 |
| Norflurazon | 5 |
| Pebulate | 0.3+ |
| Prometon | 3 |
| Prometryn | 1.9 |
| Pronamide | 7.6 |
| Propazine | 1.3 |
| Simazine | 0.75 |
| Simetryn | 2.5 |
| Stirofos | 0.6+ |
| Tebuthiuron | 13 |
| Terbacil | 45 |

Table 5-11. Reporting Limit Data for Nitrogen and Phosphorus Containing Pesticides, EPA 507 (Continued, Page 3 of 3)

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| Terbufos | 0.3+ |
| Terbutryn | 2.5 |
| Triademefon | 6.5 |
| Tricyclazole | 10 |
| Vernolate | 0.3 |

*Estimated detection limits listed in EPA Method 507, (Methods for the Determination of Organic Compounds in Drinking Water, EPA 600/4-88/039, December 1988) times ten.
+Based on the lowest standard that ESE routinely uses, taking into account sample volume and final extract volume. The lowest standard is chosen to be 5 to 10 times the background noise of the instrument.

Source: ESE.

Table 5-12. Analytes, Precision, and Accuracy Data For Chlorinated Herbicides, EPA 515

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (%Recovery) |
|---|---|---|
| 2,4-D* | 30 | 54-120 |
| 2,4,5-TP/Silvex+der.* | 30 | 48-126 |
| Dalapon | 30 | 64-118 |
| Picloram | 30 | 20-104 |
| Dinoseb | 30 | 0-113 |
| Dicamba (banvel)* | 30 | 54-120 |
| Pentachlorophenol | 30 | 30-96 |
| 2,4-DB | 30 | 0-159 |
| 2,4,5-T | 30 | 46-124 |

Reference: Accuracy: EPA Method 515--Supplement to "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water," EPA, Cincinnati, OH, September 1986.
Precision: ESE, meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the EPA 515 method.

*Matrix spike and QC check sample compound.

Source: ESE.

Table 5-13. Reporting Limit Data for Chlorinated Herbicides, EPA 515.1

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| 2,4-D | 0.029 |
| 2,4,5-TP/Silvex+der. | 0.029 |
| Dalapon | 0.029 |
| Picloram | 0.029 |
| Dinoseb | 0.029 |
| Dicamba (banvel) | 0.029 |
| Pentachlorophenol | 0.029 |
| 2,4-DB | 0.029 |
| 2,4,5-T | 0.029 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be 5 to 10 times the background noise of the instrument.

Source: ESE.

Table 5-14. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA 524.2

| Parameter | Aqueous Precision (RPD% Recovery) | Accuracy |
|---|---|---|
| Dichlorobenzene, total | 21 | 82-124 |
| 1,1-Dichloroethane | 16 | 80-112 |
| 1,2-Dichloroethane | 16 | 79-111 |
| 1,1-Dichloroethylene* | 14 | 61-145 |
| cis-1,2-Dichloroethene | 20 | 81-121 |
| trans-1,2-Dichloroethene | 17 | 76-110 |
| 1,2-Dichloropropane | 18 | 79-115 |
| 1,3-Dichloropropane | 18 | 78-114 |
| 2,2-Dichloropropane | 51 | 35-107 |
| 1,1-Dichloropropene | 27 | 71-125 |
| Ethylbenzene | 26 | 73-125 |
| Hexachlorobutadiene | 20 | 80-120 |
| Isopropylbenzene | 23 | 78-124 |
| cis-1,3-Dichloropropene | 20 | 0-227 |
| trans-1,3-Dichloropropene | 20 | 17-183 |
| p-Cymene (4-Isopropyltoluene | 15 | 81-111 |
| Naphthalene | 25 | 79-129 |
| Methylene chloride | 16 | 79-111 |
| n-Propylbenzene | 12 | 85-109 |
| Styrene | 21 | 81-123 |
| 1,1,1,2-Tetrachloroethane | 20 | 70-110 |
| 1,1,2,2-Tetrachloroethane | 19 | 72-110 |
| Tetrachloroethene | 20 | 69-109 |
| Toluene* | 13 | 76-125 |
| 1,2,3-Trichlorobenzene | 26 | 83-135 |
| 1,2,4-Trichlorobenzene | 25 | 83-135 |
| Benzene* | 11 | 76-127 |
| Bromobenzene | 17 | 83-117 |
| Bromochloromethane | 19 | 71-109 |

Table 5-14. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA 524.2 (Continued, Page 2 of 3)

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (% Recovery) |
|---|---|---|
| Bromodichloromethane | 18 | 77-113 |
| Bromoform | 19 | 82-120 |
| Bromomethane | 25 | 70-120 |
| n-Butylbenzene | 23 | 77-123 |
| sec-Butylbenzene | 23 | 77-123 |
| tert-Butylbenzene | 22 | 80-124 |
| Carbon tetrachloride | 26 | 58-110 |
| Chlorobenzene* | 13 | 75-130 |
| Chloroform | 18 | 72-108 |
| Chloromethane | 27 | 66-120 |
| Chloroethane | 27 | 62-116 |
| 2-Chlorotoluene | 19 | 71-109 |
| 4-Chlorotoluene | 25 | 74-124 |
| Dibromochloromethane | 21 | 71-113 |
| 1,2-Dibromo-3-chloropropane | 60 | 23-143 |
| 1,2-Dibromoethane | 12 | 90-102 |
| Dibromomethane | 17 | 83-117 |
| 1,2-Dichlorobenzene | 19 | 74-112 |
| 1,3-Dichlorobenzene | 21 | 78-120 |
| 1,4-Dichlorobenzene | 19 | 84-122 |
| Dichlorodifluoromethane | 23 | 67-113 |
| 1,1,1-Trichloroethane | 24 | 74-122 |
| 1,1,2-Trichloroethane | 22 | 82-126 |
| Trichloroethene* | 14 | 71-120 |
| Trichlorofluoromethane | 24 | 65-113 |
| 1,2,3-Trichloropropane | 43 | 65-151 |
| 1,2,4-Trimethylbenzene | 24 | 75-123 |
| 1,3,5-Trimethylbenzene | 22 | 70-114 |

Table 5-14. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA 524.2 (Continued, Page 3 of 3)

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (% Recovery) |
|---|---|---|
| Vinyl chloride | 20 | 78-118 |
| Xylene, total | 23 | 81-127 |
| Dichlorobenzene-D4† | NA | 87-107 |
| 4-Bromofluorobenzene† | NA | 86-115 |

Reference: Accuracy: EPA Method 524.2--Methods for the Determination of Organic Compounds in Drinking Water, EPA 600/4-88/039, December 1988 and CLP SOW 7/87 for the controlling analytes.
Precision: ESE (meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the EPA method 524.2) and CLP SOW 7/87 for controlling analytes.

Note: N/A = spiking and recovery information is not available.
NA = not applicable.

*Matrix spike and QC check sample compound.
†Surrogate; the surrogate is added to all environmental samples and quality control samples.

Source: ESE.

Table 5-15. Reporting Limit Data for Volatile Organic Compounds, EPA 524.2

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| Dichlorobenzene, total | 1.0 |
| 1,1-Dichloroethane | 1.0 |
| 1,2-Dichloroethane | 1.0 |
| 1,1-Dichloroethylene | 1.0 |
| cis-1,2-Dichloroethene | 1.0 |
| trans-1,2-Dichloroethene | 1.0 |
| 1,2-Dichloropropane | 1.0 |
| 1,3-Dichloropropane | 1.0 |
| 2,2-Dichloropropane | 1.0 |
| 1,1-Dichloropropene | 1.0 |
| Ethylbenzene | 1.0 |
| Hexachlorobutadiene | 1.0 |
| Isopropylbenzene | 1.0 |
| cis-1,3-Dichloropropene | 1.0 |
| trans-1,3-Dichloropropene | 1.0 |
| p-Cymene | 1.0 |
| Naphthalene | 1.0 |
| Methylene chloride | 1.0 |
| Pentachloroethane | 1.0 |
| Styrene | 1.0 |
| 1,1,1,2-Tetrachloroethane | 1.0 |
| 1,1,2,2-Tetrachloroethane | 1.0 |
| Tetrachloroethene | 1.0 |
| Toluene | 1.0 |
| 1,2,3-Trichlorobenzene | 1.0 |
| 1,2,4-Trichlorobenzene | 1.0 |
| Benzene | 1.0 |
| Bromobenzene | 1.0 |
| Bromochloromethane | 1.0 |
| Bromodichloromethane | 1.0 |
| Bromoform | 1.0 |

Table 5-15. Reporting Limit Data for Volatile Organic Compounds, EPA 524.2 (Continued, Page 2 of 3)

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| Bromomethane | 1.0 |
| n-Butylbenzene | 1.0 |
| sec-Butylbenzene | 1.0 |
| tert-Butylbenzene | 1.0 |
| Carbon tetrachloride | 1.0 |
| Chlorobenzene | 1.0 |
| Chloroform | 1.0 |
| bis-2-Chloroisopropyl ether | 1.0 |
| Chloromethane | 1.0 |
| Chloroethane | 1.0 |
| 2-Chlorotoluene | 1.0 |
| 4-Chlorotoluene | 1.0 |
| Dibromochloromethane | 1.0 |
| 1,2-Dibromo-3-chloropropane | 3.0 |
| 1,2-Dibromoethane | 3.0 |
| Dibromomethane | 1.0 |
| 1,2-Dichlorobenzene | 1.0 |
| 1,3-Dichlorobenzene | 1.0 |
| 1,4-Dichlorobenzene | 1.0 |
| Dichlorodifluoromethane | 1.0 |
| 1,1,1-Trichloroethane | 1.0 |
| 1,1,2-Trichloroethane | 1.0 |
| Trichloroethene | 1.0 |
| Trichlorofluoromethane | 1.0 |
| 1,2,3-Trichloropropane | 1.0 |
| 1,2,4-Trimethylbenzene | 1.0 |
| 1,3,5-Trimethylbenzene | 1.0 |
| Vinyl chloride | 1.0 |
| Xylene, total | 1.0 |

Table 5-15. Reporting Limit Data for Volatile Organic Compounds, EPA 524.2
(Continued, Page 3 of 3)

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*The reporting limits are based on the concentration that can be detected reliably according to ESE's past database and analytical experience performing
volatile organic analyses by gas chromatography/mass spectrometry.

Source: ESE.

Table 5-16. Analytes, Precision, and Accuracy Data For N-Methyl Carbamoxyloximes and N-Methyl Carbamates, EPA 531.1

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (%Recovery) |
|---|---|---|
| Aldicarb* | 17† | 83-117† |
| Aldicarb sulfone | 20 | 84-120 |
| Aldicarb sulfoxide | 20 | 72-128 |
| Carbaryl* | 26† | 63-115† |
| Carbofuran* | 18† | 81-117† |
| 3-Hydroxycarbofuran | 20 | 36-162 |
| Methomyl | 20 | 64-115 |
| Oxamyl | 20 | 34-148 |

Reference: Accuracy: EPA Method 531.1--Supplement to "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water," EPA, Cincinnati, OH, September 1986.
Precision: ESE, meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (EPA 531.1).

*Matrix spike and QC check sample compound.
†Accuracy and precision criteria are based on ESE historical data.

Source: ESE.

Table 5-17. Reporting Limit Data for N-Methyl Carbamoxyloximes and N-Methyl Carbamates, EPA 531.1

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| Aldicarb | 2.0 |
| Aldicarb sulfone | 2.0 |
| Aldicarb sulfoxide | 2.0 |
| Carbaryl | 2.0 |
| Carbofuran | 2.0 |
| 3-Hydroxycarbofuran | 2.0 |
| Methomyl | 2.0 |
| Oxamyl | 2.0 |

*Based on the lowest standard that ESE routinely uses. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

Source: ESE.

Table 5-18. Analytes, Precision, and Accuracy Data for Purgeable Halocarbons, EPA 601 and SW 5030/8010

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Bromodichloromethane | 20 | 42-172 | 30 | 42-172 |
| Bromoform | 20 | 13-159 | 30 | 13-159 |
| Bromomethane | 20 | 0-144 | 30 | 0-144 |
| Carbon tetrachloride | 20 | 43-143 | 30 | 43-143 |
| Chlorobenzene* | 43† | 51-137† | 50 | 38-150 |
| Chloroethane | 20 | 46-137 | 30 | 46-137 |
| 2-Chloroethylvinylether | 20 | 14-186 | 30 | 14-186 |
| Chloroform | 20 | 49-133 | 30 | 49-133 |
| Chloromethane | 20 | 0-193 | 30 | 0-193 |
| Dibromochloromethane | 20 | 24-191 | 30 | 24-191 |
| Dichlorobenzene,tot. | 20 | 42-143 | 30 | 42-143 |
| 1,1-Dichloroethane | 20 | 47-132 | 30 | 47-132 |
| 1,2-Dichloroethane | 20 | 51-147 | 30 | 51-147 |
| 1,1-Dichloroethylene* | 38† | 51-127† | 30 | 28-167 |
| Trans-1,2-dichloroethene | 20 | 38-155 | 30 | 38-155 |
| 1,2-Dichloropropane | 20 | 44-156 | 30 | 44-156 |
| cis-1,3-Dichloropropene | 20 | 22-178 | 30 | 22-178 |

Table 5-18. Analytes, Precision, and Accuracy Data for Purgeable Halocarbons, EPA 601 and SW 5030/8010 (Continued, Page 2 of 2)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Trans-1,3-dichloropropene | 20 | 22-178 | 30 | 22-178 |
| Methylene chloride | 20 | 25-162 | 30 | 25-162 |
| 1,1,2,2-Tetrachloroethane | 20 | 8-184 | 30 | 8-184 |
| Tetrachloroethene | 20 | 26-162 | 30 | 26-162 |
| 1,1,1-Trichloroethane | 20 | 41-138 | 30 | 41-138 |
| 1,1,2-Trichloroethane | 20 | 39-136 | 30 | 39-136 |
| Trichloroethene* | 40† | 54-134†† | 30 | 35-146 |
| Trichlorofluoromethane | 20 | 21-156 | 30 | 21-156 |
| Vinyl chloride | 20 | 28-163 | 30 | 28-163 |
| Freon 113** | 33 | 73-139 | N/A | N/A |
| Bromofluorobenzene (surrogate) | NA | 43-125 | NA | 69-113 |

Reference: Accuracy: EPA Method SW 8010--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986. Precision: ESE, meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (SW 8010).

Note: N/A - spiking and recovery information are not available.
NA - Not applicable

*Matrix spike and QC check sample compound.
†Accuracy and precision criteria are based on ESE historical data.
**Accuracy and precision criteria are based on ESE validation study (see Appendix U).
Source: ESE.

Table 5-19. Reporting Limit Data for Purgeable Halocarbons, EPA 601 and SW 5030/8010

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid* (µg/kg) |
|---|---|---|
| Bromodichloromethane** | 1.0 | 100 |
| Bromoform** | 1.0 | 100 |
| Bromomethane** | 1.0 | 100 |
| Carbon tetrachloride** | 1.0 | 100 |
| Chlorobenzene** | 1.0 | 100 |
| Chloroethane** | 1.0 | 100 |
| 2-Chloroethylvinylether** | 1.0 | 100 |
| Chloroform** | 1.0 | 100 |
| Chloromethane** | 1.0 | 100 |
| Dibromochloromethane** | 1.0 | 100 |
| Dichlorobenzene,tot.** | 1.0 | 100 |
| 1,1-Dichloroethane** | 1.0 | 100 |
| 1,2-Dichloroethane** | 1.0 | 100 |
| 1,1-Dichloroethylene** | 1.0 | 100 |
| Trans-1,2-dichloroethene** | 1.0 | 100 |
| 1,2-Dichloropropane** | 1.0 | 100 |
| cis-1,3-Dichloropropene | 1.0 | 100 |
| Trans-1,3-dichloropropene | 1.0 | 100 |
| Methylene chloride** | 1.0 | 100 |
| 1,1,2,2-Tetrachloroethane** | 1.0 | 100 |
| Dichlorodifluoromethane | 1.0 | 100 |

Table 5-19. Reporting Limit Data for Purgeable Halocarbons, EPA 601 and SW 5030/8010 (Continued, Page 2 of 2)

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid+ (µg/kg) |
|---|---|---|
| Tetrachloroethene** | 1.0 | 100 |
| 1,1,1-Trichloroethane** | 1.0 | 100 |
| 1,1,2-Trichloroethane** | 1.0 | 100 |
| Trichloroethene** | 1.0 | 100 |
| Trichlorofluoromethane** | 1.0 | 100 |
| Vinyl chloride** | 1.0 | 100 |
| Freon 113 | 1.0 | N/A |

Note: N/A = Reporting limit information not available.

*Based on the lowest standard that ESE routinely uses.
+Based on the lowest standard that ESE routinely uses times a factor of 100. The solid reporting limits are expressed on a wet weight basis.
**Appendix IX compounds.

Source: ESE.

Table 5-20. Analytes, Precision, and Accuracy Data for Purgeable Aromatics, EPA 602 and SW 5030/8020

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Benzene*,† | 44† | 44-132† | 28† | 74-130† |
| Chlorobenzene† | 20 | 55-135 | 30 | 55-135 |
| Dichlorobenzene,total† | 20 | 42-143 | 30 | 42-143 |
| Ethylbenzene† | 20 | 32-160 | 30 | 32-160 |
| Toluene*,** | 40† | 47-127† | 26† | 75-127† |
| Xylenes, total** | 23† | 80-126† | 27† | 74-128† |
| MTBE | 17 | 13-147 | 47 | 90-184 |
| Total VOA (BTEX) | 42† | 46-130† | 27† | 75-129† |
| Bromofluorobenzene (surrogate) | NA | 76-124 | NA | 82-116 |
| Fluorobenzene (surrogate) | NA | 67-127 | NA | 67-127 |

Reference: Accuracy: EPA Method SW 8020--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986.
Precision: ESE, meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (SW 8020).

Note: Total VOA (BTEX) is calculated and defined as the arithmetic sum of the concentrations of benzene, toluene, ethylbenzene, and total xylenes.
MTBE = methyl tert-butyl ether.
N/A = spiking and recovery information are not available.
NA = not applicable
* Matrix spike and QC check sample compound.
† Accuracy and precision criteria are based on ESE historical data.
** Appendix IX compounds.

Source: ESE.

Table 5-21. Reporting Limit for Purgeable Aromatics, EPA 602 and SW 5030/8020

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid† (µg/kg) |
|---|---|---|
| Benzene | 1.0 | 100 |
| Chlorobenzene | 1.0 | 100 |
| Dichlorobenzene, total | 1.0 | 100 |
| Ethylbenzene | 1.0 | 100 |
| Toluene | 1.0 | 100 |
| Xylenes, total | 1.0 | 100 |
| MTBE | 1.0 | 100 |
| Total VOA (BTEX) | 5.0 | 500 |

Note: N/A = Reporting limit information not available.

*Based on the lowest standard that ESE routinely uses.
†Based on the lowest standard that ESE routinely uses times a factor of 100. The solid reporting limits are expressed on a wet weight basis.

Source: ESE.

Table 5-22. Analytes, Precision, and Accuracy Data for Phenols, EPA 604 and SW 3510/3520/3540/3550/8040

| Parameter | Aqueous | | Solid | |
|---|---|---|---|---|
| | Precision (RPD | Accuracy (%Recovery) | Precision (RPD) | Accuracy (%Recovery) |
| 4-Chloro-3-methylphenol*,† | 30 | 39-130 | 50 | 39-130 |
| 2-Chlorophenol*,† | 30 | 38-126 | 50 | 38-126 |
| 2,4-Dichlorophenol† | 30 | 44-119 | 50 | 44-119 |
| 2,4-Dimethylphenol† | 30 | 24-118 | 50 | 24-118 |
| 2,4-Dinitrophenol† | 30 | 12-145 | 50 | 12-145 |
| 2-Methyl-4,6-dinitrophenol† | 30 | 30-136 | 50 | 30-136 |
| 2-Nitrophenol† | 30 | 43-117 | 50 | 43-117 |
| 4-Nitrophenol† | 30 | 13-110 | 50 | 13-110 |
| Pentachlorophenol*,† | 30 | 36-134 | 50 | 36-134 |
| Phenol*,† | 30 | 23-108 | 50 | 23-108 |
| 2,4,6-Trichlorophenol† | 30 | 53-119 | 50 | 53-119 |

Reference: Accuracy: EPA Method SW 8040--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986.
Precision: ESE; meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (SW 8040).

*Matrix spike and QC check sample compound.
†Appendix IX compounds.

Source: ESE.

Table 5-23. Reporting Limit Data for Phenols, EPA 604 and SW 3510/3520/3540/3550/8040

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid† (µg/kg) |
|---|---|---|
| 4-Chloro-3-methylphenol | 5.0 | 500 |
| 2-Chlorophenol | 5.0 | 500 |
| 2,4-Dichlorophenol | 5.0 | 500 |
| 2,4-Dimethylphenol | 5.0 | 500 |
| 2,4-Dinitrophenol | 20.0 | 2,000 |
| 2-Methyl-4,6-dinitrophenol | 5.0 | 500 |
| 2-Nitrophenol | 5.0 | 500 |
| 4-Nitrophenol | 25.0 | 2,500 |
| Pentachlorophenol | 10.0 | 1,000 |
| Phenol | 5.0 | 500 |
| 2,4,6-Trichlorophenol | 6.0 | 600 |

*Based on the lowest standard that ESE routinely uses taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

†Based on the lowest standard that ESE routinely uses, taking into account sample weight and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. The solid detection limits are expressed on a wet weight basis.

Source: ESE.

Table 5-24. Analytes, Precision, and Accuracy Data for Benzidines, EPA 605

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (%Recovery) |
|---|---|---|
| Benzidine* | 30 | 31-92 |
| 3,3'-Dichlorobenzidine | 30 | 35-93 |

Reference: Accuracy: EPA Method 605--Test Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA 600/4-82-057, July 1982.
Precision: ESE; meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (EPA 605).

*Matrix spike and QC check sample compound.

Source: ESE.

Table 5-25. Reporting Limit Data for Benzidines, EPA 605

| Parameter | Reporting Limit* Aqueous (µg/L) |
|---|---|
| Benzidine | 1.0 |
| 3,3'-Dichlorobenzidine | 1.5 |

*Ten times the method detection limit listed in Table 1 of EPA Method 605.

Source: ESE.

Table 5-26. Analytes, Precision, and Accuracy Data for Phthalate Esters, EPA 606 and SW 35010/3520/3540/3550/8060

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| bis(2-Ethylhexyl)phthlate | 30 | 0-158 | 50 | 0-158 |
| Butyl benzyl phthalate | 30 | 30-136 | 50 | 30-136 |
| di-n-Butylphthalate* | 30 | 23-136 | 50 | 23-136 |
| Diethylphthalate* | 30 | 0-149 | 50 | 0-149 |
| Dimethylpthalate | 30 | 0-156 | 50 | 0-156 |
| di-n-Octylphthalate* | 30 | 0-114 | 50 | 0-114 |

Reference: Accuracy: EPA Method SW 8060--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986.
Precision: ESE; meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (SW 8060).

*Matrix spike and QC check sample compound.

Source: ESE.

Table 5-27. Reporting Limit Data for Phthalate Esters, EPA 606 and SW 3510/3520/3540/3550/8060

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid† (µg/kg) |
|---|---|---|
| bis(2-Ethylhexyl)phthlate | 0.15 | 25 |
| Butyl benzylphthalate | 0.15 | 25 |
| di-n-Butylphthalate | 0.15 | 25 |
| Diethylphthalate | 0.15 | 25 |
| Dimethylpthalate | 0.15 | 25 |
| di-n-Octylphthalate | 0.30 | 50 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

†Based on the lowest standard that ESE routinely uses, taking into account the sample weight and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. the solid reporting limits are expressed on a wet weight basis.

Source: ESE.

Table 5-28. Analytes, Precision, and Accuracy Data for Organochlorine Pesticides and PCBs, EPA 608/617 and SW 3510/3520/3540/3550/8080

| | Aqueous | | Solid | |
|---|---|---|---|---|
| Parameter | Precision (RPD | Accuracy (%Recovery) | Precision (RPD) | Accuracy (%Recovery) |
| Aldrin[a,g] | 45[b] | 37-127[b] | 40[b] | 53-133[b] |
| BHC,A[g] | 30 | 37-134 | 50 | 37-134 |
| BHC,B[g] | 30 | 17-147 | 50 | 17-147 |
| BHC,D[g] | 30 | 19-140 | 50 | 19-140 |
| BHC,G(lindane)[a,g] | 51[b] | 43-145[b] | 42[b] | 45-129[b] |
| Chlordane[g] | 30 | 45-119 | 50 | 45-119 |
| DDD,PP'[g] | 30 | 31-141 | 50 | 31-141 |
| DDE,PP'[g] | 30 | 30-145 | 50 | 30-145 |
| DDT,PP'[a,g] | 53[b] | 46-152[b] | 59[b] | 37-155[b] |
| Dieldrin[a,g] | 43[b] | 56-142[b] | 47[b] | 46-140[b] |
| Endosulfan,A[g] | 30 | 45-153 | 50 | 45-153 |
| Endosulfan,B[g] | 30 | 0-202 | 50 | 0-202 |
| Endosulfan sulfate[g] | 30 | 26-144 | 50 | 26-144 |
| Endrin[a,g] | 60[b] | 35-155[b] | 37[b] | 52-126[b] |
| Endrin aldehyde[g] | 40[e] | 58-138[e] | 53[e] | 56-162[e] |
| Heptachlor[a,g] | 38[b] | 48-124[b] | 59[b] | 30-148[b] |
| Heptachlor epoxide[g] | 30 | 37-142 | 50 | 37-142 |

Table 5-28. Analytes, Precision, and Accuracy Data for Organochlorine Pesticides and PCBs, EPA 608/617 and SW 3510/3520/3540/3550/8080 (Continued, Page 2 of 3)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Methoxychlor[g] | 44[e] | 78-162[e] | 53[e] | 61-167[e] |
| Toxaphene[g] | 30 | 41-126 | 50 | 41-126 |
| Isodrin[g,i] | 27[b] | 74-128[b] | 10[b] | 97-117[b] |
| Kepone[g,h] | 44[b] | 26-114[b] | 30[b] | 98-158[b] |
| Metolachlor | 28[f] | 74-130[f] | 24[f] | 62-110[f] |
| Kelthane (Dicofol) | 20[f] | 47-87[f] | 19[f] | 40-78[f] |
| PCB-1016[d,g] | 30 | 50-114 | 50 | 50-114 |
| PCB-1221[g] | 30 | 15-178 | 50 | 15-178 |
| PCB-1232[g] | 30 | 10-215 | 50 | 10-215 |
| PCB-1242[g] | 30 | 39-150 | 50 | 39-150 |
| PCB 1248[g] | 30 | 38-158 | 50 | 38-158 |
| PCB-1254[g] | 30 | 29-131 | 50 | 29-131 |
| PCB-1260[d,g] | 30 | 8-127 | 50 | 8-127 |
| Dibutylchlorendate[c] (surrogate) | NA | 46-146[b] | NA | 32-156[b] |
| Tetrachloro-m-xylene (surrogate) | NA | 60-150 | NA | 60-150 |
| Decachlorobiphenyl (surrogate) | NA | 60-150 | NA | 60-150 |

Table 5-28. Analytes, Precision, and Accuracy Data for Organochlorine Pesticides and PCBs, EPA 608/617 and SW 3510/3520/3540/3550/8080 (Continued, Page 3 of 3)

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Reference: Accuracy: EPA Method SW 8080 and CLP SOW 7/87 for the controlling analytes.
Precision: ESE and CLP SOW 7/87 for the controlling analytes.

Note: NA = not applicable.

[a]Matrix spike and QC check sample compound. For Los Alamos project CLP SOW 12/90 precision and accuracy acceptance criteria will be used.
[b]Accuracy and precision criteria are based on ESE historical data and method detection limit data.
[c]Surrogate; the surrogate is added to all environmental samples and quality control samples.
[d]PCB 1016 and PCB 1260 are only used as matrix spike and QCC samples compounds when using EPA 608/8080 to evaluate PCBs only.
[e]Accuracy and precision data are from ESE method certification.
[f]Based on validation studies performed by ESE (see Appendices D and E).
[g]Appendix IX compounds.
[h]This compound is not included in EPA's parameter lists for Methods 608, 617, and 8080; however, it can be analyzed by EPA method 8080 and is reported if specifically requested by the client (see Appendices L and M for method validation data).
[i]See Appendices L and M for method validation data of isodrin by EPA Method 8050.

Source: ESE.

Table 5-29. Reporting Limit Data for Organochlorine Pesticides and PCBs, EPA 608 and SW 3510/3520/3540/3550/8080

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid† (µg/kg) |
|---|---|---|
| Aldrin | 0.006 | 3 |
| BHC,A | 0.006 | 3 |
| BHC,B | 0.006 | 3 |
| BHC,D | 0.006 | 3 |
| BHC,G(lindane) | 0.006 | 3 |
| Chlordane | 0.030 | 20 |
| DDD,PP | 0.006 | 3 |
| DDE,PP' | 0.006 | 3 |
| DDT,PP' | 0.006 | 3 |
| Dieldrin | 0.006 | 3 |
| Endosulfan,A | 0.006 | 3 |
| Endosulfan,B | 0.006 | 3 |
| Endosulfan sulfate | 0.006 | 3 |
| Endrin | 0.006 | 3 |
| Endrin aldehyde | 0.006 | 3 |
| Heptachlor | 0.006 | 3 |
| Heptachlor epoxide | 0.006 | 3 |
| Methoxychlor | 0.006 | 3 |
| Toxaphene | 0.6 | 300 |
| PCB-1016 | 0.12 | 60 |
| Mirex | 0.2 | 100 |
| Trifluralin | 0.1 | 50 |
| PCNB | 0.02 | 1 |

Table 5-29. Reporting Limit Data for Organochlorine Pesticides and PCBs, EPA 608 and SW 3510/3520/3540/3550/8080
(Continued, Page 2 of 2)

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid† (µg/kg) |
|---|---|---|
| Isodrin | 0.05 | 8 |
| Kepone | 0.10 | 50 |
| Metolachlor | 0.06 | 10 |
| Kelthane (Dicofol) | 0.06 | 10 |
| PCB-1221 | 0.12 | 60 |
| PCB-1232 | 0.12 | 60 |
| PCB-1242 | 0.12 | 60 |
| PCB-1248 | 0.12 | 60 |
| PCB-1254 | 0.12 | 60 |
| PCB-1260 | 0.12 | 60 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

†Based on the lowest standard that ESE routinely uses, taking into account sample weight and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. The solid reporting limits are expressed on a wet weight basis.

Source: ESE.

Table 5-30. Analytes, Precision, and Accuracy Data for Polynuclear Aromatic Hydrocarbons, EPA 610 and SW 3510/3520/3540/3550/8310

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Acenaphthene[*,**] | 30[†] | 49-109[†] | 50 | 0-124 |
| Acenaphthylene[*,**] | 25[†] | 53-103[†] | 50 | 0-139 |
| Anthracene[*,**] | 40[†] | 44-124[†] | 50 | 0-126 |
| Benzo(a)anthracene[**] | 30 | 12-135 | 50 | 12-135 |
| Benzo(a)pyrene[*,**] | 38[†] | 45-121[†] | 62[†] | 27-151[†] |
| Benzo(b)fluoranthene[**] | 30 | 6-150 | 50 | 6-150 |
| Benzo(ghi)perylene[**] | 30 | 0-116 | 50 | 0-116 |
| Benzo(k)fluoranthene[*,**] | 41[†] | 41-123[†] | 55[†] | 22-132[†] |
| Chrysene[**] | 30 | 0-199 | 50 | 0-199 |
| Dibenyl(a,h)anthracene[**] | 30 | 0-110[†] | 50 | 0-110 |
| Fluoranthene[**] | 30 | 14-123 | 50 | 14-123 |
| Fluorene[*,**] | 35[†] | 40-110[†] | 49[†] | 25-123[†] |
| Indeno(1,2,3-cd)pyrene[**] | 30 | 0-116 | 50 | 0-116 |
| Naphthalene[*,**] | 48[†] | 21-117[†] | 50 | 0-122 |
| Phenanthrene[*,**] | 32[†] | 52-116[†] | 50 | 0-155 |
| Pyrene[**] | 30 | 0-140 | 50 | 0-140 |
| 1-Methylnaphthalene[**] | 37[†] | 23-97[†] | 37[†] | 23-97[†] |

Table 5-30. Analytes, Precision, and Accuracy Data for Polynuclear Aromatic Hydrocarbons, EPA 610 and SW 3510/3520/3540/3550/8310 (Continued, Page 2 of 2)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| 2-Methylnaphthalene** | 37† | 23-97† | 37† | 23-97† |
| Methylnaphthalene, total | 37† | 23-97† | 75† | 10-160† |
| Triphenylene (surrogate) | NA | 60-124† | NA | 30-124† |

Reference: Accuracy: EPA Method SW 8310--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986.
Precision: ESE; meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (SW 8310).

*Matrix spike and QC check sample compound.
†Accuracy and precision criteria are based on ESE historical data.
**Appendix IX compounds.

Source: ESE.

Table 5-31. Reporting Limit Data for Polynuclear Aromatic Hydrocarbons, EPA 610 and SW 3510/3520/3540/3550/8310

| Parameter | Reporting Limits Aqueous* (µg/L) | Reporting Limits Solid† (µg/kg) |
|---|---|---|
| Acenaphthene | 2.5 | 84 |
| Acenaphthylene | 1.5 | 44 |
| Anthracene | 0.095 | 3.5 |
| Benzo(a)anthracene | 0.002 | 0.05 |
| Benzo(a)pyrene | 0.004 | 0.4 |
| Benzo(b)fluoranthene | 0.001 | 0.02 |
| Benzo(ghi)perylene | 0.006 | 0.20 |
| Benzo(k)fluoranthene | 0.001 | 0.01 |
| Chrysene | 0.03 | 0.80 |
| Dibenzo(a,h)anthracene | 0.004 | 0.07 |
| Fluoranthene | 0.003 | 0.08 |
| Fluorene | 0.25 | 10 |
| Indeno(1,2,3-cd)pyrene | 0.004 | 0.15 |
| Naphthalene | 0.90 | 23 |
| Phenanthrene | 0.07 | 4.0 |
| Pyrene | 0.03 | 0.6 |
| 1-Methylnaphthalene | 1.5 | 45 |
| 2-Methylnaphthalene | 1.2 | 36 |
| Methylnaphthalene, total | 3.0 | 63 |

Table 5-31. Reporting Limit Data for Polynuclear Aromatic Hydrocarbons, EPA 610 and SW 3510/3520/3540/3550/8310
(Continued, Page 2 of 2)

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*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

†Based on the lowest standard that ESE routinely uses, taking into account sample weight and final extract volume. The solid reporting limits are expressed on a wet weight basis. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

Source: ESE.

Table 5-32. Analytes, Precision, and Accuracy Data for Chlorinated Herbicides, EPA 615 and SW 8150.

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| 2,4-D*,** | 55† | 9-119† | 48† | 35-131† |
| 2,4-DB | 30 | 84-102 | 50 | 84-102 |
| 2,4,5-T** | 30 | 67-103 | 50 | 67-103 |
| 2,4,5-TP/Silvex†der.*,** | 51† | 33-135† | 41† | 61-143† |
| Dicamba (banvel)* | 47† | 21-115† | 32† | 57-121† |
| Dalapon | 30 | 42-90 | 50 | 42-90 |
| Dichlorprop | 30 | 91-103 | 50 | 91-103 |
| Dinoseb** | 30 | 74-100 | 50 | 74-100 |
| MCPA | 30 | 86-110 | 50 | 86-110 |
| MCPP | 30 | 82-106 | 50 | 82-106 |

Reference: Accuracy: EPA Method SW 8150--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986.
Precision: ESE; meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (SW 8150).

*Matrix spike and QC check sample compound.
†Accuracy and precision criteria are based on ESE historical data.
**Appendix IX compounds.

Source: ESE.

Table 5-33. Reporting Limit Data for Chlorinated Herbicides, EPA 615 and SW 8150

| Parameter | Reporting Limits Aqueous* (µg/L) | Reporting Limits Solid† (µg/kg) |
|---|---|---|
| 2,4-D | 0.03 | 3 |
| 2,4-DB | 0.03 | 3 |
| 2,4,5-T | 0.03 | 3 |
| 2,4,5-TP/Silvex+der. | 0.03 | 3 |
| Dicamba (banvel) | 0.03 | 3 |
| Dalapon | 0.03 | 3 |
| Dichlorprop | 0.03 | 3 |
| Dinoseb | 0.03 | 3 |
| MCPA | 0.60 | 50 |
| MCPP | 0.60 | 50 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

†Based on the lowest standard that ESE routinely uses, taking into account sample weight and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. The solid reporting limits are expressed on a wet weight basis.

Source: ESE.

Table 5-34. Analytes, Precision, and Accuracy Data for Organophosphorous Pesticides, EPA 622/614 and SW 3510/3520/3540/3550/8140

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Bolstar | 30 | 46-84 | 50 | 46-84 |
| Chlorpyrifos | 30 | 82-115 | 50 | 82-115 |
| Coumaphos | 30 | 71-147 | 50 | 71-147 |
| Demeton | 30 | 36-99 | 50 | 36-99 |
| Diazinon* | 47** | 61-155** | 294** | 75-133** |
| Dichlorvos | 30 | 49-95 | 50 | 49-95 |
| Disulfoton†† | 30 | 55-109 | 50 | 55-109 |
| Ethoprop | 30 | 88-113 | 50 | 88-113 |
| Fenthion | 30 | 9-128 | 50 | 9-128 |
| Fensulfothion | 30 | 43-145 | 50 | 43-145 |
| Guthion (methylazinphos)* | 51** | 44-146** | 51** | 59-161** |
| Malathion* | 35** | 64-134** | 31** | 66-128** |
| Merphos | 30 | 97-144 | 50 | 97-144 |
| Mevinphos | 30 | 33-80 | 50 | 33-80 |
| Naled | 30 | 54-102 | 50 | 54-102 |
| Ethylparathion*,†† | 43** | 65-151** | 49** | 61-159** |
| Methylparathion†† | 30 | 80-112 | 50 | 80-112 |

Table 5-34. Analytes, Precision, and Accuracy Data for Organophosphorous Pesticides, EPA 622/614 and SW 3510/3520/3540/3550/8140 (Continued, Page 2 of 3)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Phorate[††] | 30 | 36-89 | 50 | 36-89 |
| Ronnel | 30 | 82-116 | 50 | 82-116 |
| Stirofos | 30 | 48-84 | 50 | 48-84 |
| Tokuthion | 30 | 44-85 | 50 | 44-85 |
| Trichloronate | 30 | 49-161 | 50 | 49-161 |
| Alachlor[***] | N/A | N/A | 19 | 112-150 |
| Metribuzin[***] | N/A | N/A | 31 | 62-124 |
| EPTC[-] | 25 | 70-120 | 6 | 97-109 |
| Butylate[+] | 23 | 61-107 | 7 | 95-114 |
| Pebulate[+] | 22 | 69-113 | 11 | 89-111 |
| Vernolate[+] | 23 | 69-115 | 8 | 94-110 |
| Atrazine[+] | 32 | 79-143 | 32 | 61-125 |
| Terbufos[+] | 16 | 79-111 | 15 | 88-118 |
| Hexazinone[+] | 50 | 56-150 | 50 | 40-140 |
| Famphur[††] | 61 | 52-174 | 40 | 69-149 |
| 0,0,0-Triethyl Phosphorothioate[††,***,†††] | 44 | 41-129 | 14 | 107-135 |
| Sulfotepp[††,***,†††] | 28 | 50-106 | 13 | 99-125 |

Table 5-34. Analytes, Precision, and Accuracy Data for Organophosphorous Pesticides, EPA 622/614 and SW 3510/3520/3540/3550/8140 (Continued, Page 3 of 3)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Thionazin[††,***,†††] | 22 | 64-108 | 13 | 92-118 |

Reference: Accuracy: EPA Method SW 8140--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986.
Precision: ESE; meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (SW 8140).

Note: N/A = spiking and recovery information not available.

[*]Matrix spike and QC check sample compound.
[+]Precision and accuracy criteria are based on validation studies performed by ESE (see Appendices F and G).
[**]Accuracy and precision criteria are based on ESE historical data.
[††]Appendix IX compounds.
[***]Precision and accuracy criteria are based on validation studies performed by ESE (see Appendices J and K).
[†††]This compound is not included in EPA's parameter list for Method 614, 622, and 8140; however, it can be analyzed by EPA Method 8140 and is reported if specifically requested by the client.

Source: ESE.

Table 5-35. Reporting Limit Data for Organophosphorous Pesticides, EPA 614/622 and SW 3510/3520/3540/3550/8140

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid† (µg/kg) |
|---|---|---|
| Bolstar | 0.3 | 50 |
| Chlorpyrifos | 0.3 | 50 |
| Coumaphos | 3.0 | 500 |
| Demeton | 0.3 | 50 |
| Diazinon | 0.3 | 50 |
| Dichlorvos | 0.3 | 50 |
| Disulfoton | 0.3 | 50 |
| Ethoprop | 0.3 | 50 |
| Fenthion | 0.3 | 50 |
| Fensulfothion | 1.5 | 250 |
| Guthion (methylazinphos) | 3.0 | 500 |
| Malathion | 0.3 | 50 |
| Merphos | 0.3 | 50 |
| Mevinphos | 0.3 | 50 |
| Naled | 1.5 | 250 |
| Ethylparathion | 0.3 | 50 |
| Methylparathion | 0.3 | 50 |
| Phorate | 0.3 | 50 |
| Ronnel | 0.3 | 50 |
| Stirofos | 0.6 | 100 |

Table 5-35. Reporting Limit Data for Organophosphorous Pesticides, EPA 614/622 and SW 3510/3520/3540/3550/8140 (Continued, Page 2 of 2)

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid† (µg/kg) |
|---|---|---|
| Tokuthion | 0.3 | 50 |
| Trichloronate | 0.3 | 50 |
| Alachlor | N/A | 100 |
| Metribuzin | N/A | 250 |
| EPTC | 0.3 | 50 |
| Butylate | 0.3 | 50 |
| Pebulate | 0.3 | 50 |
| Vernolate | 0.3 | 50 |
| Atrazine | 0.6 | 100 |
| Terbufos | 0.3 | 50 |
| Hexazinone | 1.5 | 250 |
| Famphur | 0.5 | 70 |
| 0,0,0-Triethyl Phosphorothioate | 0.5 | 70 |
| Sulfotepp | 0.5 | 70 |
| Thionazin | 0.5 | 70 |

Note: N/A = reporting limit not available.

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

†Based on the lowest standard that ESE routinely uses, taking into account sample weight and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. The solid reporting limits are expressed on a wet weight basis.

Source: ESE.

Table 5-36. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA 624 and SW 5030/8240/8260

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Acetone[d] | 53[c] | 56-162[c] | 53[c] | 52-158[c] |
| Benzene[a,d] | 11 | 76-127 | 21 | 66-142 |
| Bromodichloromethane[d] | 20 | 35-155 | 30 | 35-155 |
| Bromoform[d] | 20 | 45-169 | 30 | 45-169 |
| Bromomethane[d] | 20 | 0-242 | 30 | 0-242 |
| Carbon tetrachloride[d] | 20 | 70-140 | 30 | 70-140 |
| Chlorobenzene[a,d] | 13 | 75-130 | 21 | 60-133 |
| Chlorobenzene[e] | 9 | 89-107 | 37 | 76-150 |
| 2-Chloroethylvinyl ether | 20 | 0-305 | 30 | 0-305 |
| Chloroform[d] | 20 | 51-138 | 30 | 51-138 |
| Chloromethane[d] | 20 | 0-273 | 30 | 0-273 |
| Dibromochloromethane[d] | 20 | 53-149 | 30 | 53-149 |
| Dichlorobenzene,tot.[d] | 20 | 18-190 | 30 | 18-190 |
| 1,1-Dichloroethane[d] | 20 | 59-155 | 30 | 59-155 |
| 1,2-Dichloroethane[d] | 20 | 49-155 | 30 | 49-155 |
| 1,1-Dichloroethylene[a,d] | 14 | 61-145 | 22 | 59-172 |
| trans-1,2-Dichloroethene[d] | 20 | 54-156 | 30 | 54-156 |

Table 5-36. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA 624 and SW 5030/8240/8260 (Continued, Page 2 of 4)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| 1,2-Dichloropropane[d] | 20 | 0-210 | 30 | 0-210 |
| cis-1,3-Dichloropropene[d] | 20 | 0-227 | 30 | 0-227 |
| trans-1,3-Dichloropropene[d] | 20 | 17-183 | 30 | 17-183 |
| Methylene chloride[d] | 20 | 0-221 | 30 | 0-221 |
| Methyl ethyl ketone[d] (MEK) | 42[e] | 61-145[e] | 79[e] | 12-172[e] |
| Methyl isobutyl ketone[d] (MIBK) | 46[e] | 50-146[e] | 41[e] | 78-160[e] |
| Styrene[d] | 13[e] | 91-117[e] | 13[e] | 89-115[e] |
| 1,1,2,2-Tetrachloroethane[d] | 20 | 46-157 | 30 | 46-157 |
| Tetrachloroethene[d] | 20 | 64-148 | 30 | 64-148 |
| Toluene[a,d] | 13 | 76-125 | 21 | 59-139 |
| 1,1,1-Trichloroethane[d] | 20 | 52-162 | 30 | 52-162 |
| 1,1,2-Trichloroethane[d] | 20 | 52-150 | 30 | 52-150 |
| Trichloroethene[a,d] | 14 | 71-120 | 24 | 62-137 |
| Trichlorofluoromethane[d] | 20 | 17-181 | 30 | 17-181 |
| Vinyl chloride[d] | 20 | 0-251 | 30 | 0-251 |
| Xylene, total[d] | 26[e] | 83-135[e] | 46[e] | 52-144[e] |
| Toluene-D8[f] | NA | 88-110 | NA | 81-117 |

Table 5-36. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA 624 and SW 5030/8240/8260 (Continued, Page 3 of 4)

| Parameter | Aqueous | | Solid | |
|---|---|---|---|---|
| | Precision (RPD | Accuracy (%Recovery) | Precision (RPD) | Accuracy (%Recovery) |
| 4-Bromofluorobenzene[†] | NA | 86-115 | NA | 74-121 |
| 1,2-Dichloroethane-D4[†] | NA | 76-114 | NA | 70-121 |
| Dibromofluoromethane [g] | NA | 86-118 | NA | 80-120 |
| Acetonitrile[d,f] | 48[e] | 120-216[e] | 49[e] | 91-188[e] |
| Acrolein[d] | 21[e] | 75-117[e] | 55[e] | 6-116[e] |
| Acrylonitrile[d] | 52[e] | 25-129[e] | 10[e] | 72-92[e] |
| Carbon Disulfide[d] | 14[e] | 81-109[e] | 47[e] | 97-191[e] |
| Chloroprene[d,f] | 8[e] | 93-109[e] | 8[e] | 89-105[e] |
| 3-Chloropropene[d,f] | 8[e] | 87-103[e] | 21[e] | 116-158[e] |
| Dichlorodifluoromethane[d] | 32[e] | 67-131[e] | 50[e] | 37-137[e] |
| trans- 1,4-Dichloro-2-butene[d,f] | 20[e] | 69-109[e] | 63[e] | 0-121[e] |
| 1,4-Dioxane[d,f] | 8[e] | 95-111[e] | 31[e] | 83-145[e] |
| Ethyl Methacrylate[d] | 12[e] | 112-136[e] | 19[e] | 100-138[e] |
| 2-Hexanone[d] | 41[e] | 100-182[e] | 98[e] | 45-241[e] |
| Iodomethane[d] | 15[e] | 84-114[e] | 53[e] | 61-167[e] |
| Isobutanol[d,f] | 31[e] | 71-133[e] | 37[e] | 74-148[e] |
| Methacrylonitrile[d,f] | 19[e] | 52-90[e] | 11[e] | 87-109[e] |

Table 5-36. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA 624 and SW 5030/8240/8260 (Continued, Page 4 of 4)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Methyl Methacrylate[d,f] | 16[e] | 66-98[e] | 33[e] | 56-122[e] |
| Pentachloroethane[d,f] | 36[e] | 48-120[e] | 59[e] | 20-138[e] |
| Propionitrile[d,f] | 53[e] | 114-220[e] | 60[e] | 25-145[e] |
| 1,1,1,2-Tetrachloroethane[d,f] | 6[e] | 88-100[e] | 23[e] | 75-121[e] |
| 1,2,3-Trichloropropane[d] | 8[e] | 121-137[e] | 27[e] | 89-143[e] |
| Vinyl Acetate[d] | 37[e] | 57-131[e] | 33[e] | 46-110[e] |

Reference: Accuracy: EPA Method SW 8240--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986 and CLP SOW 7/87 for the controlling analytes. Precision: ESE (meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (SW 8240) and CLP SOW 7/87 for controlling analytes.

Note: NA = not applicable.

[a]Matrix spike and QC check sample compound.
[b]Surrogate; the surrogate is added to all environmental samples and quality control samples.
[c]Accuracy and precision data are from ESE method certification.
[d]Appendix IX compounds.
[e]Accuracy and precision data are from ESE method detection limit study.
[f]This compound is not included in EPA's lists of compounds (EPA 624, 8240, and 8260) methods; however, it can be analyzed by this method and is reported if specifically requested by the client (see Appendix N for method validation data).
[g]This surrogate will be used only for Los Alamos project.
Source: ESE.

Table 5-37. Reporting Limit Data for Volatile Organic Compounds, EPA 624 and SW 5030/8240/8260

| Parameter | Reporting Limits | | |
|---|---|---|---|
| | Aqueous* (µg/L) | Solid (µg/kg)** | |
| | | Low Level | Medium Level |
| Acetone | 9.0 | 10 | 5500† |
| Benzene | 2.2 | 5 | 220† |
| Bromodichloromethane | 2.2 | 5 | 110† |
| Bromoform | 2.6 | 5 | 235† |
| Bromomethane | 3.5 | 10 | 290† |
| Carbon tetrachloride | 2.6 | 5 | 220 |
| Chlorobenzene | 1.4 | 5 | 300† |
| Chloroethane | 8.2 | 10 | 410 |
| 2-Chloroethylvinyl ether | 3.1 | 5 | 500† |
| Chloroform | 2.5 | 5 | 110 |
| Chloromethane | 4.4 | 10 | 310 |
| Dibromochloromethane | 2.3 | 5 | 155† |
| Dichlorobenzene, total | 4.0 | 10 | 350† |
| 1,1-Dichloroethane | 2.5 | 5 | 235† |
| 1,2-Dichloroethane | 2.5 | 5 | 170 |
| 1,1-Dichloroethylene | 3.2 | 5 | 200 |
| trans-1,2-Dichloroethene | 2.4 | 5 | 120 |
| 1,2-Dichloropropane | 2.0 | 5 | 300† |
| cis-1,3-Dichloropropene | 2.0 | 5 | 250† |
| trans-1,3-Dichloropropene | 1.6 | 5 | 320† |
| Ethylbenzene | 1.3 | 5 | 360† |

Table 5-37. Reporting Limit Data for Volatile Organic Compounds, EPA 624 and SW 5030/8240/8260 (Continued, Page 2 of 3)

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid (µg/kg)** Low Level | Solid (µg/kg)** Medium Level |
|---|---|---|---|
| Methylene chloride | 6.4 | 5.0 | 1000† |
| Methyl ethyl ketone | 10 | 10 | 2400† |
| Methyl isobutyl ketone | 12 | 10 | 600† |
| 2-Nitropropane | 50 | 50† | NA |
| Styrene | 0.5 | 5.0 | 355† |
| 1,1,2,2-Tetrachloroethane | 1.5 | 5.0 | 205† |
| Tetrachloroethene | 1.9 | 5.0 | 205† |
| Toluene | 1.7 | 5.0 | 300† |
| 1,1,1-Trichloroethane | 2.5 | 5.0 | 190† |
| 1,1,2-Trichloroethane | 2.8 | 5.0 | 250† |
| Trichloroethene | 3.0 | 5.0 | 120 |
| Trichlorofluoromethane | 4.6 | 5.0 | 300 |
| Vinyl chloride | 4.6 | 10.0 | 360 |
| Xylene, total | 3.72 | 5.0 | 770 |
| Acetonitrile | 200 | 50 | NA |
| Acrolein | 100 | 100 | NA |
| Acrylonitrile | 100† | 100† | NA |
| Carbon Disulfide | 5† | 5† | NA |
| Chloroprene | 10† | 10† | NA |
| 3-Chloropropene | 50† | 50† | NA |
| Dichlorodifluoromethane | 200† | 200† | NA |
| trans-1,4-Dichloro-2-butene | 50† | 5† | NA |
| 1,4-Dioxane | 200† | 50 | 200† |

Table 5-37. Reporting Limit Data for Volatile Organic Compounds, EPA 624 and SW 5030/8240/8260 (Continued, Page 3 of 3)

| Parameter | Reporting Limits | | |
|---|---|---|---|
| | Aqueous* (µg/L) | Solid (µg/kg)** | |
| | | Low Level | Medium Level |
| Ethyl Methacrylate | 5† | 5† | NA |
| 2-Hexanone | 21† | 10† | NA |
| Iodomethane | 5† | 5† | NA |
| Isobutanol | 1000† | 1000† | NA |
| Methacrylonitrile | 5† | 5† | NA |
| Methyl Methacrylate | 5† | 5† | NA |
| Pentachloroethane | 5† | 5† | NA |
| Propionitrile | 5† | 5† | NA |
| 1,1,1,2-Tetrachloroethane | 5† | 5† | NA |
| 1,2,3-Trichloropropane | 5† | 5† | NA |
| Vinyl Acetate | 10† | 10† | NA |

Note: NA = Not available.

*Based on ESE's MDL studies conducted according to 40 CFR 136 Appendix B protocols, except for total dichlorobenzene, methyl ethyl ketone, and methyl isobutyl ketone. These compounds are difficult to analyze and do not respond well, therefore, the reporting limits have been adjusted to a concentration that is detected more reliably.

†Based on ESE's MDL studies but the reporting limits have been adjusted to a concentration that is detected more reliably.

**Based on ESE's MDL studies conducted according to 40 CFR 136 Appendix B protocols.

Source: ESE.

Table 5-38. Analytes, Precision, and Accuracy Data for Semivolatile Organic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Acenaphthene[a,f] | 31 | 46-118 | 19 | 31-137 |
| Acenaphthylene[f] | 30 | 33-146 | 50 | 33-146 |
| Anthracene[f] | 30 | 27-133 | 50 | 27-133 |
| Benzidine | 27[e] | 4-58[e] | 27[e] | 4-58[e] |
| Benzo(a)anthracene[f] | 30 | 33-143 | 30 | 33-143 |
| Benzo(b)fluoranthene[f] | 30 | 24-159 | 50 | 24-159 |
| Benzo(k)fluoranthene[f] | 30 | 11-162 | 50 | 11-162 |
| Benzo(a)pyrene[f] | 30 | 17-163 | 50 | 17-163 |
| Benzo(ghi)perylene[f] | 30 | 0-219 | 50 | 0-219 |
| Benzyl alcohol[f] | 14 | 65-93 | 43 | 17-103 |
| Butylbenzylphthalate[f] | 30 | 0-152 | 50 | 0-152 |
| bis(2-Chloroethyl)ether[f] | 30 | 12-158 | 50 | 12-158 |
| bis(2-Chloroethoxy)-methane[f] | 30 | 33-184 | 50 | 33-184 |
| bis(2-Ethylhexyl)-phthalate[f] | 30 | 8-158 | 50 | 8-158 |
| bis(2-Chloroisopropyl)-ether[f] | 30 | 36-166 | 50 | 36-166 |

Table 5-38. Analytes, Precision, and Accuracy Data for Semivolatile Orlganic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270 (Continued, Page 2 of 9)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| 4-Bromophenylphenyl-ether[f] | 30 | 53-127 | 50 | 53-127 |
| Chloronaphthalene[f] | 30 | 60-118 | 50 | 60-118 |
| 2-Chlorophenol[a,f] | 40 | 27-123 | 50 | 25-102 |
| 4-Chloro-3-methylphenol[a,f] | 42 | 23-97 | 33 | 26-103 |
| 4-Chlorophenylphenylether[f] | 30 | 25-158 | 50 | 25-158 |
| Chrysene[f] | 30 | 17-168 | 50 | 17-168 |
| Dibenzo(a,h)anthracene[f] | 30 | 0-227 | 50 | 0-227 |
| di-n-Butylphthalate[f] | 30 | 1-118 | 50 | 1-118 |
| 1,3-Dichlorobenzene[f] | 30 | 0-172 | 50 | 0-172 |
| 1,2-Dichlorobenzene[f] | 30 | 32-129 | 50 | 32-129 |
| 1,4-Dichlorobenzene[a,f] | 28 | 36-97 | 27 | 28-104 |
| 3,3'-Dichlorobenzidine[f] | 30 | 0-262 | 50 | 0-262 |
| 2,4-Dichlorophenol[f] | 30 | 39-135 | 50 | 39-135 |
| Diethylphthalate[f] | 30 | 0-114 | 50 | 0-114 |
| 2,4-Dimethylphenol[f] | 30 | 32-119 | 50 | 32-119 |
| Dimethylpthalate[f] | 30 | 0-112 | 50 | 0-112 |

Table 5-38. Analytes, Precision, and Accuracy Data for Semivolatile Orlganic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270 (Continued, Page 3 of 9)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| 2,4-Dinitrophenol[f] | 30 | 0-191 | 50 | 0-191 |
| 2,4-Dinitrotoluene[a,f] | 38 | 24-96 | 47 | 28-89 |
| 2,6-Dinitrotoluene[f] | 30 | 50-158 | 50 | 50-158 |
| di-n-Octylphthalate[f] | 30 | 4-146 | 50 | 4-146 |
| Fluoranthene[f] | 30 | 26-137 | 50 | 26-137 |
| Fluorene[f] | 30 | 59-121 | 50 | 59-121 |
| Hexachlorobenzene[f] | 30 | 0-152 | 50 | 0-152 |
| Hexachlorobutadiene[f] | 30 | 24-116 | 50 | 24-116 |
| Hexachlorocyclopentadiene[f] | 36[c] | 9-81[c] | 18[e] | 33-69[e] |
| Hexachloroethane[f] | 30 | 40-113 | 50 | 40-113 |
| Indeno(1,2,3-cd)pyrene[f] | 30 | 0-171 | 50 | 0-171 |
| Isophorone[f] | 30 | 21-196 | 50 | 21-196 |
| 2-Methyl-4,6-dinitrophenol[f] | 30 | 0-181 | 50 | 0-181 |
| Naphthalene[f] | 30 | 21-133 | 50 | 21-133 |
| Nitrobenzene [f] | 30 | 30-180 | 50 | 35-180 |
| 2-Nitrophenol[f] | 30 | 29-182 | 50 | 29-182 |

Table 5-38. Analytes, Precision, and Accuracy Data for Semivolatile Orlganic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270 (Continued, Page 4 of 9)

| Parameter | Aqueous | | Solid | |
|---|---|---|---|---|
| | Precision (RPD | Accuracy (%Recovery) | Precision (RPD) | Accuracy (%Recovery) |
| 4-Nitrophenol[a,f] | 50 | 10-80 | 50 | 11-114 |
| n-Nitrosodimethylamine[f] | 16[e] | 55-87[e] | 16[e] | 55-87[e] |
| n-Nitrosodi-n-propylamine[a,f] | 38 | 41-116 | 38 | 41-126 |
| n-Nitrosodiphenylamine[f] | 30 | 85-115 | 50 | 85-115 |
| Pentachlorophenol[a,f] | 50 | 9-103 | 47 | 17-109 |
| Phenanthrene[f] | 30 | 54-120 | 50 | 54-120 |
| Phenol[a,f] | 42 | 12-89 | 35 | 26-90 |
| Pyrene[a,f] | 31 | 26-127 | 36 | 35-142 |
| 1,2,4-Trichlorobenzene[a,f] | 28 | 39-98 | 23 | 38-107 |
| 2,4,6-Trichlorophenol[f] | 30 | 37-144 | 50 | 37-144 |
| Acetophenone[f] | 8[e] | 73-89[e] | 12[e] | 70-94[e] |
| 2-Acetylaminofluorene[f,g] | 10[e] | 23-43[e] | 11[e] | 15-37[e] |
| 4-Aminobiphenyl[f] | 14[e] | 44-72[e] | 48[e] | 5-101[e] |
| Aniline[f] | 34[e] | 51-119[e] | 74[e] | 6-154[e] |

Table 5-38. Analytes, Precision, and Accuracy Data for Semivolatile Orlganic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270 (Continued, Page 5 of 9)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Aramite[f,g] | 11[e] | 14-36[e] | 16[e] | 10-42[e] |
| 1,4-Benzenediamine[f,g] | 24[e] | 51-99[e] | 19 | 0-28 |
| p-Benzoquinone[f,g] | 29[e] | 19-77[e] | 49[e] | 64-162[e] |
| 4-Chloroaniline[f] | 20[e] | 48-87[e] | 89[e] | 0-149[e] |
| Chlorobenzilate[f,g] | 12[e] | 66-90[e] | 14[e] | 63-91[e] |
| 1-Chloronaphthalene[f] | 8[e] | 70-86[e] | 12[e] | 75-99[e] |
| Dibenz(a,j)acridine[f] | 19[e] | 69-107[e] | 40[e] | 0-58[e] |
| Diallate[f,g] | 8[e] | 41-57[e] | 8[e] | 43-59[e] |
| Dibenzofuran[f] | 14[e] | 71-99[e] | 42[e] | 40-124[e] |
| 2,6-Dichlorophenol[f] | 10[e] | 69-89[e] | 14[e] | 62-90[e] |
| Dimethoate[f,g] | 22[e] | 48-92[e] | 13[e] | 59-85[e] |
| p-(Dimethylamino)azo-benzene[f] | 8[e] | 57-73[e] | 15[e] | 46-76[e] |
| 7,12-Dimethylbenz(a) anthracene[f] | 12[e] | 43-67[e] | 11[e] | 12-34[e] |
| 3,3-Dimethylbenzidine[f,g] | 24[e] | 11-59[e] | 15[e] | 3-33[e] |
| m-Dinitrobenzene[f,g] | 8[e] | 32-48[e] | 15[e] | 38-68[e] |

Table 5-38. Analytes, Precision, and Accuracy Data for Semivolatile Orlganic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270 (Continued, Page 6 of 9)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Diphenylamine[f] | 7[e] | 68-82[e] | 14[e] | 56-85[e] |
| Diphenylhydrazine[f] | 8[e] | 67-83[e] | 16[e] | 65-97[e] |
| Ethylmethanesulfonate[f] | 7[e] | 72-86[e] | 16[e] | 64-96[e] |
| a,a-Dimethylphenylamine[f] | 93[e] | 0-149[e] | 31 | 0-41 |
| Hexachlorophene[f,g] | 51 | 138-240 | 73 | 0-71 |
| Hexachloropropene[f,g] | 17[e] | 45-79[e] | 14[e] | 54-82[e] |
| Isosafrole[f,g] | 12[e] | 64-88[e] | 28[e] | 50-106[e] |
| Methapyrilene[f,g] | 66[e] | 15-147[e] | 53 | 0-71 |
| 3-Methylcholanthrene[f] | 14[e] | 41-69[e] | 42[e] | 9-93[e] |
| Methylmethanesulfonate[f,g] | 36[e] | 35-107[e] | 24[e] | 52-100[e] |
| 2-Methylnaphthalene[f] | 17[e] | 55-89[e] | 28[e] | 49-105[e] |
| 2-Methylphenol(o-Cresol)[f] | 20[e] | 58-98[e] | 43[e] | 17-103[e] |
| 3-Methylphenol(m-Cresol)[f,g] | 8[e] | 64-80[e] | 10[e] | 59-79[e] |
| 4-Methylphenol(p-Cresol)[f] | 15[e] | 72-102[e] | 36[e] | 28-100[e] |
| 1-Naphthylamine[f] | 23[e] | 26-72[e] | 7[e] | 6-20[e] |
| 2-Naphthylamine[f] | 13[e] | 35-61[e] | 15[e] | 22-52[e] |

Table 5-38. Analytes, Precision, and Accuracy Data for Semivolatile Orlganic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270 (Continued, Page 7 of 9)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| 2-Nitroaniline[f] | 13[e] | 45-71[e] | 18[e] | 48-84[e] |
| 3-Nitroaniline[f] | 25[e] | 28-78[e] | 22[e] | 40-84[e] |
| 4-Nitroaniline[f] | 33[e] | 63-91[e] | 45[e] | 75-165[e] |
| N-Nitrosodiethylamine[f,g] | 13[e] | 63-91[e] | 14[e] | 67-95[e] |
| N-Nitroso-di-n-butylamine[f] | 20[e] | 66-106[e] | 17[e] | 71-105[e] |
| N-Nitrosomethyl-ethylamine[f,g] | 79[e] | 13-171[e] | 23[e] | 29-75[e] |
| N-Nitrosomorpholine[f,g] | 18[e] | 54-90[e] | 22[e] | 49-93[e] |
| N-Nitrosopiperidine[f] | 15[e] | 64-94[e] | 17[e] | 57-91[e] |
| Nitroquinoline-1-oxide[f,g] | 57[e] | 0-113[e] | 53[e] | 11-117[e] |
| Nitrosopyrrolidine[f,g] | 25[e] | 52-102[e] | 16[e] | 53-85[e] |
| 1,4-Naphthoquinone[f,g] | 5[e] | 44-54[e] | 16[e] | 45-77[e] |
| 5-Nitro-o-toluidine[f,g] | 23[e] | 25-71[e] | 10[e] | 41-61[e] |
| Pentachlorobenzene[f] | 7[e] | 70-84[e] | 10[e] | 77-97[e] |
| Pentachloronitrobenzene[f] | 44[e] | 0-81[e] | 36[e] | 15-87[e] |
| Phenacetin[f] | 10[e] | 65-85[e] | 16[e] | 56-88[e] |

Table 5-38. Analytes, Precision, and Accuracy Data for Semivolatile Orlganic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270 (Continued, Page 8 of 9)

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| 2-Picoline[f] | 53[e] | 0-98[e] | 44[e] | 0-70[e] |
| Pronamide[f] | 15[e] | 51-81[e] | 13[e] | 57-83[e] |
| Pyridine[f,g] | 79[e] | 5-163[e] | 40[e] | 0-45[e] |
| Resorcinol[f,g] | 15[e] | 11-41[e] | 55[e] | 17-127[e] |
| 1,2,4,5-Tetrachloro-benzene[f] | 13[e] | 61-87[e] | 10[e] | 77-97[e] |
| 2,3,4,6-Tetrachlorophenol[f] | 16[e] | 48-80[e] | 12[e] | 48-72[e] |
| 2,4,5-Trichlorophenol[f] | 17[e] | 58-92[e] | 44[e] | 11-99[e] |
| 1,3,5-Trinitrobenzene[f,g] | 18[e] | 39-75[e] | 38[e] | 0-75[e] |
| o-Toluidine[f,g] | 8[e] | 71-87[e] | 13[e] | 60-86[e] |
| Safrole[f,g] | 25[e] | 50-100[e] | 23[e] | 58-104[e] |
| Nitrobenzene-D5[b] | NA | 35-114 | NA | 23-120[e] |
| 2-Fluorobiphenyl[b] | NA | 43-116 | NA | 30-115[e] |
| p-Terphenyl-D4[b] | NA | 33-141 | NA | 18-137 |
| Phenol-D6[b] | NA | 10-94 | NA | 24-113 |
| 2-Fluorophenol[b] | NA | 21-100 | NA | 25-121 |
| 2,4,6-Tribromophenol[b] | NA | 10-123 | NA | 19-122 |

Table 5-38. Analytes, Precision, and Accuracy Data for Semivolatile Orlganic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270 (Continued, Page 9 of 9)

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Reference: Accuracy: EPA Method SW 8270--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986 and CLP SOW 7/87 for the controlling analytes. Precision: ESE (meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method (SW 8270) and CLP SOW7/87 for controlling analytes.

Note: N/A = spiking and recovery information is not available.
NA = not applicable.

[a]Matrix spike and QC check sample compound.
[b]Surrogate; the surrogate is added to all environmental samples and quality control samples.
[c]Accuracy and precision criteria taken from Methods for the Determination of Organic Compounds in Drinking Water, EPA/600/4-88/039, December, 1988.
[d]Accuracy and precision data are from ESE method certification.
[e]Accuracy and precision data are from ESE method detection limit study.
[f]Appendix IX compounds.
[g]This compound is not included in EPA's list of compounds (EPA 625, 8270) for these methods; however, it can be analyzed by this method and is reported if specifically requested by the client (see Appendix O for method validation data).

Source: ESE.

Table 5-39. Reporting Limit Data for Semivolatile Organic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270

| Parameter | Reporting Limits Aqueous* (µg/L) | Reporting Limits Solid* (µg/kg) |
|---|---|---|
| Acenaphthene | 1.0 | 70 |
| Acenaphthylene | 1.0 | 70 |
| Anthracene | 1.0 | 70 |
| Benzidine | 20 | 2,000 |
| Benzo(a)anthracene | 1.5 | 100 |
| Benzo(b)fluoranthene | 1.5 | 100 |
| Benzo(k)fluoranthene | 1.5 | 100 |
| Benzo(a)pyrene | 2.0 | 140 |
| Benzo(ghi)perylene | 2.5 | 160 |
| Benzyl alcohol | 2.0 | 140 |
| Butylbenzylphthalate | 1.5 | 100 |
| bis(2-Chloroethyl)ether | 1.5 | 70 |
| bis(2-Chloroethoxy)methane | 1.0 | 70 |
| bis(2-Ethylhexyl)phthalate | 2.0 | 100 |
| bis(2-Chloroisopropyl)ether | 1.0 | 70 |
| 4-Bromophenylphenylether | 1.0 | 140 |
| 2-Chloronaphthalene | 1.0 | 70 |
| 2-Chlorophenol | 2.0 | 140 |
| 4-Chloro-3-methylphenol | 1.5 | 140 |
| 4-Chlorophenylphenylether | 1.0 | 100 |
| Chrysene | 1.5 | 100 |
| Dibenzo(a,h)anthracene | 2.5 | 160 |

Table 5-39. Reporting Limit Data for Semivolatile Organic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270
(Continued, Page 2 of 7)

| Parameter | Reporting Limits Aqueous* (µg/L) | Reporting Limits Solid* (µg/kg) |
|---|---|---|
| Dioxin (scan) | 2.0 | 140 |
| di-n-Butylphthalate | 1.0 | 70 |
| 1,3-Dichlorobenzene | 1.0 | 70 |
| 1,2-Dichlorobenzene | 1.0 | 70 |
| 1,4-Dichlorobenzene | 1.0 | 70 |
| 3,3'-Dichlorobenzidine | 5.0 | 500 |
| 2,4-Dichlorophenol | 2.0 | 140 |
| Diethylphthalate | 1.0 | 70 |
| 2,4-Dimethylphenol | 2.0 | 140 |
| Dimethylpthalate | 2.0 | 100 |
| 2,4-Dinitrophenol | 30.0 | 1,300 |
| 2,4-Dinitrotoluene | 2.0 | 140 |
| 2,6-Dinitrotoluene | 2.0 | 140 |
| di-n-Octylphthalate | 2.4 | 140 |
| Fluoranthene | 1.0 | 70 |
| Fluorene | 1.0 | 70 |
| Hexachlorobenzene | 2.0 | 100 |
| Hexachlorobutadiene | 2.0 | 140 |
| Hexachlorocyclopentadiene | 10 | 1000 |
| Hexachloroethane | 1.5 | 100 |
| Indeno(1,2,3-cd)pyrene | 2.5 | 160 |

Table 5-39. Reporting Limit Data for Semivolatile Organic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270
(Continued, Page 3 of 7)

| Parameter | Reporting Limits Aqueous* (µg/L) | Reporting Limits Solid* (µg/kg) |
|---|---|---|
| Isophorone | 1.0 | 140 |
| 2-Methyl-4,6-dinitrophenol | 20.0 | 1,000 |
| Naphthalene | 1.0 | 70 |
| Nitrobenzene | 1.0 | 70 |
| 2-Nitrophenol | 2.0 | 140 |
| 4-Nitrophenol | 10.0 | 500 |
| n-Nitrosodimethylamine | 1.0 | 100 |
| n-Nitrosodi-n-propylamine | 1.0 | 100 |
| n-Nitrosodiphenylamine | 1.0 | 70 |
| Pentachlorophenol | 10.0 | 500 |
| Phenanthrene | 1.0 | 70 |
| Phenol | 2.0 | 140 |
| Pyrene | 1.0 | 70 |
| 1,2,4-Trichlorobenzene | 1.0 | 100 |
| 2,4,6-Trichlorophenol | 4.5 | 300 |
| 2-Methylnaphthalene | 1.0 | 100 |
| 2,3,7,8-TCDD | 2.0 | 140 |

Table 5-39. Reporting Limit Data for Semivolatile Organic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270
(Continued, Page 4 of 7)

| Parameter | Reporting Limits Aqueous* (µg/L) | Reporting Limits Solid* (µg/kg) |
|---|---|---|
| Acetophenone | 1.0 | 70 |
| 2-Acetylaminofluorene | 2.0 | 140 |
| 4-Aminobiphenyl | 1.0 | 70 |
| Aniline | 2.0 | 140 |
| Aramite | 5.0 | 360 |
| 1,4-Benzenediamine | 30.0 | 2,000 |
| p-Benzoquinone | 10 | 300 |
| 4-Chloroaniline | 4.0 | 300 |
| Chlorobenzilate | 2.0 | 140 |
| 1-Chloronaphthalene | 1.0 | 70 |
| Dibenz(a,j)acridine | 2.0 | 140 |
| Diallate | 1.0 | 70 |
| Dibenzofuran | 1.0 | 70 |
| 2,6-Dichlorophenol | 1.0 | 70 |
| Dimethoate | 2.0 | 70 |
| p-Dimethylaminoazobenzene | 2.0 | 140 |

Table 5-39. Reporting Limit Data for Semivolatile Organic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270
(Continued, Page 5 of 7)

| Parameter | Reporting Limits Aqueous* (µg/L) | Reporting Limits Solid* (µg/kg) |
|---|---|---|
| 7,12-Dimethylbenz(a)anthracene | 2.0 | 140 |
| 3,3-Dimethylbenzidine | 2.0 | 140 |
| m-Dinitrobenzene | 2.5 | 200 |
| Diphenylamine | 1.0 | 70 |
| Diphenylhydrazine | 1.0 | 70 |
| Ethylmethanesulfonate | 1.0 | 70 |
| a,a-Dimethylphenethylamine | 11.0 | 500 |
| Hexachlorophene | 140 | 16,000 |
| Hexachloropropene | 4.0 | 140 |
| Isosafrole | 1.0 | 70 |
| Methapyrilene | 10 | 500 |
| 3-Methylcholanthrene | 2.0 | 140 |
| Methylmethanesulfonate | 1.0 | 70 |
| 2-Methynaphthalene | 1.0 | 100 |
| 2-Methylphenol (o-Cresol) | 2.0 | 140 |
| 3-Methylphenol (m-Cresol) | 2.0 | 140 |
| 4-Methylphenol (p-Cresol) | 2.0 | 140 |

Table 5-39. Reporting Limit Data for Semivolatile Organic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270
(Continued, Page 6 of 7)

| Parameter | Reporting Limits Aqueous* (µg/L) | Reporting Limits Solid* (µg/kg) |
|---|---|---|
| 1-Naphthylamine | 1.0 | 140 |
| 2-Naphthylamine | 1.0 | 140 |
| 2-Nitroaniline | 5.0 | 300 |
| 3-Nitroaniline | 5.0 | 300 |
| 4-Nitroaniline | 5.0 | 300 |
| N-Nitrosodiethylamine | 1.0 | 70 |
| N-Nitrosomethylethylamine | 2.0 | 70 |
| N-Nitroso-di-n-butylamine | 1.0 | 70 |
| N-Nitrosomorpholine | 1.0 | 70 |
| N-Nitrosopiperidine | 1.0 | 70 |
| 4-Nitroquinoline-1-oxide | 26.0 | 300 |
| Nitrosopyrrolidine | 1.0 | 70 |
| 1,4-Naphthoquinone | 2.0 | 140 |
| 5-Nitro-o-toluidine | 2.0 | 140 |
| Pentachlorobenzene | 1.0 | 70 |
| Pentachloronitrobenzene | 5.0 | 350 |

Table 5-39. Reporting Limit Data for Semivolatile Organic Compounds, EPA 625 and SW 3510/3520/3540/3550/8270
(Continued, Page 7 of 7)

| Parameter | Reporting Limits Aqueous* (µg/L) | Reporting Limits Solid* (µg/kg) |
|---|---|---|
| Phenacetin | 2.0 | 70 |
| 2-Picoline | 2.0 | 140 |
| Pronamide | 2.0 | 70 |
| Pyridine | 2.0 | 140 |
| Resorcinol | 20.0 | 700 |
| 1,2,4,5-Tetrachlorobenzene | 1.0 | 70 |
| 2,4,5-Trichlorophenol | 4.0 | 300 |
| 2,3,4,6-Tetrachlorophenol | 2.0 | 140 |
| 1,3,5-Trinitrobenzene | 2.0 | 700 |
| o-Toluidine | 1.0 | 70 |
| Safrole | 1.0 | 70 |

Note: ND = not detected.

*Based on ESE's MDL studies; however, the reporting limits of compounds that are difficult to analyze; were adjusted to a concentration that is detected more reliably. The MDL studies were conducted according to the 40 CFR 136 Appendix B protocols.

Source: ESE.

Table 5-40. Analytes, Precision, and Accuracy Data for Carbamates and Urea Pesticides, EPA 632 and Modified 632*

| Parameter | Aqueous Precision (RPD | Aqueous Accuracy (%Recovery) | Solid Precision (RPD) | Solid Accuracy (%Recovery) |
|---|---|---|---|---|
| Aldicarb | NA | NA | 5 | 92-102 |
| Aldicarb sulfone | NA | NA | 4 | 64-72 |
| Aldicarb sulfoxide | NA | NA | 4 | 13-22 |
| Carbaryl (sevin)† | 55†† | 34-144†† | 43†† | 35-124†† |
| Carbofuran† | 37†† | 53-127†† | 34†† | 43-111†† |
| Diuron† | 29†† | 60-118†† | 19†† | 58-96†† |
| Linuron† | 26†† | 66-118†† | 37†† | 42-116†† |
| Methiocarb | 35 | 87-103 | 29 | 71-129 |
| Methomyl | 35 | 67-82 | 4 | 66-74 |
| Monuron | 35 | 92-102 | 23 | 82-128 |
| Oxamyl | 35 | 62-112 | 5 | 55-65 |
| Fluorometron† | 35 | 64-143 | 35 | 64-134 |
| Propoxur | 22 | 65-109 | 22 | 65-109 |
| Barban† | 12 | 86-110 | 12 | 86-110 |
| Chloropham | 12 | 83-107 | 12 | 83-107 |
| Neburon | 20 | 76-116 | 20 | 76-116 |
| Propham† | 18 | 70-106 | 18 | 70-106 |

Reference: Accuracy: EPA Method 632--Test Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA, January 1982.
Precision: ESE, meets or exceeds the RPD criteria that was calculated from the spiking and recovery information presented in the method (EPA 632).

Note: NA = method is not applicable.

* See Appendix A for Modified Method 632.
† Matrix spike and QC check sample compound.
** Based on the data validation study.
†† Accuracy and precision criteria are based on ESE historical data.

Source: ESE.

Table 5-41. Reporting Limit Data for Carbamates and Urea Pesticides, EPA 632 and Modified 632

| Parameter | Reporting Limits Aqueous* (µg/L) | Solid** (µg/kg) |
|---|---|---|
| Aldicarb | NA | 250 |
| Aldicarb sulfone | NA | 250 |
| Aldicarb sulfoxide | NA | 250 |
| Carbaryl (sevin) | 1.5 | 550 |
| Carbofuran | 2.5 | 1,000 |
| Diuron | 0.6 | 260 |
| Linuron | 0.65 | 270 |
| Methiocarb | 5.0 | 2,000 |
| Methomyl | 3.0 | 1,500 |
| Monuron | 0.65 | 260 |
| Oxamyl | 1.5 | 510 |
| Fluorometron | 0.5 | 200 |
| Propoxur | 4.0 | 1,700 |
| Barban | 2.0 | 940 |
| Chlorpropham | 1.5 | 700 |
| Neburon | 0.5 | 47 |
| Propham | 2.5 | 1,100 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

**Based on the lowest standard that ESE routinely uses, taking into account the sample weight and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. The solid reporting limits are expressed on a weight basis.

Source: ESE.

Table 5-42. Analytes, Precision, and Accuracy Data for Chlorinated Hydrocarbons, EPA 612 and SW 3510/3520/3540/3550/8120

| | Aqueous | | Solid | |
|---|---|---|---|---|
| | Precision (RPD) | Accuracy (% Recovery) | Precision (RPD) | Accuracy (% Recovery) |
| 2-Chloronaphthalene | 30 | 9-148 | 50 | 9-148 |
| 1,2-Dichlorobenzene* | 30 | 9-160 | 50 | 9-160 |
| 1,3-Dichlorobenzene | 30 | 0-150 | 50 | 0-150 |
| 1,4-Dichlorobenzene | 30 | 13-157 | 50 | 13-157 |
| Hexachlorobenzene* | 30 | 15-159 | 50 | 15-159 |
| Hexachlorobutadiene* | 30 | 0-139 | 50 | 0-139 |
| Hexachlorocyclopentadiene | 30 | 0-111 | 50 | 0-111 |
| Hexachloroethane* | 30 | 8-139 | 50 | 8-139 |
| 1,2,4-Trichlorobenzene* | 30 | 5-149 | 50 | 5-149 |

Reference: Accuracy: EPA Method SW8120--Test Methods for Evaluating Solid Wastes, EPA-SW-846 3rd Edition, September 1986.
Precision: ESE, meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the method SW 8120.

*Matrix spike and QC check sample compound.

Source: ESE.

Table 5-43. Reporting Limit Data for Chlorinated Hydrocarbons, EPA 612 and SW 3510/3520/3540/3550/8120

| Parameter | Reporting Limits Aqueous* (μg/L) | Reporting Limits Solid† (μg/kg) |
|---|---|---|
| 2-Chloronaphthalene | 0.200 | 40.0 |
| 1,2-Dichlorobenzene | 0.100 | 20.0 |
| 1,3-Dichlorobenzene | 0.100 | 20.0 |
| 1,4-Dichlorobenzene | 0.100 | 20.0 |
| Hexachlorobenzene | 0.012 | 2.00 |
| Hexachlorobutadiene | 0.012 | 2.10 |
| Hexachlorocyclopentadiene | 0.012 | 2.40 |
| Hexachlorethane | 0.012 | 2.40 |
| 1,2,4-Trichlorobenzene | 0.15 | 2.60 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

†Based on the lowest standard that ESE routinely uses, taking into account the sample weight and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. The solid reporting limits are expressed on a wet weight basis.

Source: ESE.

Table 5-44. Analytes, Precision, and Accuracy Data for Triazines, EPA 619

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (% Recovery) |
|---|---|---|
| Ametryne* | 30 | 74-134 |
| Atrazine | 30 | 78-138 |
| Prometon* | 17 | 50-84 |
| Prometryne | 51 | 59-161 |
| Propazine | 24 | 92-140 |
| Simatryn | 36 | 147-200 |
| Simazine* | 24 | 75-123 |
| Terbutylazine | 45 | 69-159 |
| Terbutryn | 36 | 47-119 |

Reference: Accuracy and Precision: EPA Method 619 -- Test Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA 600/4-82-057, July 1982.

*Matrix spike and QC check sample compound.

Source: ESE.

Table 5-45. Reporting Limit Data for Triazines, EPA 619

| Parameter | Reporting Limits Aqueous* (µg/L) |
|---|---|
| Ametryn | 0.3 |
| Atrazine | 0.3 |
| Prometon | 1.2 |
| Prometryne | 0.6** |
| Propazine | 0.3** |
| Simatryn | 0.7** |
| Simazine | 0.6** |
| Terbuthylazine | 0.3** |
| Terbutryn | 0.6** |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.
**Ten times the detection limits specified in the Method EPA 619.

Source: ESE.

Table 5-46. Analytes, Precision, and Accuracy Data for Organonitrogen Pesticides, EPA 633

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (% Recovery) |
|---|---|---|
| Bromacil* | 40 | 82-162 |
| Deet | 6 | 99-111 |
| Hexazinone* | 23 | 78-124 |
| Metrabuzin* | 29 | 83-141 |
| Terbacil | 25 | 61-111 |
| Triadimefon | 13 | 84-110 |
| Tricyclazole | 22 | 56-100 |

Reference: Accuracy and Precision: EPA Method 633--Test Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA 600/4-82-057, July 1982.

*Matrix spike and QC check sample compound.

Source: ESE.

Table 5-47. Reporting Limit Data for Organonitrogen Pesticides, EPA 633

| Parameter | Reporting Limits Aqueous* (µg/L) |
|---|---|
| Bromacil | 2.5 |
| Deet | 1.0** |
| Hexazinone | 2.5 |
| Metribuzin | 1.5 |
| Terbacil | 2.0** |
| Triadimefon | 7.0** |
| Tricyclazole | 1.0** |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.
**Ten times the detection limits listed in the Method EPA 633.

Source: ESE.

Table 5-48. Analytes, Precision, and Accuracy Data for Certain Amine Pesticides and Lethane, EPA 645

| Parameter | Aqueous | |
|---|---|---|
| | Precision (RPD) | Accuracy (% Recovery) |
| Alachlor* | 40 | 64-144 |
| Butachlor | 25 | 68-118 |
| Diphenamid | 43 | 57-143 |
| Fluridone* | 35 | 57-127 |
| Lethane* | 60 | 33-153 |
| Norflurazon | 22 | 68-112 |

Reference: Accuracy and Precision: EPA Method 645 -- Test Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA 600/4-82-057, July 1982.

*Matrix spike and QC check sample compound.

Source: ESE.

Table 5-49. Reporting Limit Data for Certain Amine Pesticides and Lethane, EPA 645

| Parameter | Reporting Limits Aqueous* (µg/L) |
|---|---|
| Alachlor | 2.0 |
| Butachlor | 3.0 |
| Diphenamid | 2.0 |
| Fluridone | 5.0 |
| Lethane | 1.0 |
| Norflurazon | 0.2 |

*Ten times the detection limits listed in the method, EPA 645.

Table 5-50. Analytes, Precision, and Accuracy Data for Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC), SW 8330

| | Aqueous† | | Solid† | |
|---|---|---|---|---|
| | Precision (RPD) | Accuracy (% Recovery) | Precision (RPD) | Accuracy (% Recovery) |
| HMX†† | 13 | 84-111 | 18 | 80-116 |
| RDX* | 30 | 51-111 | 18 | 71-107 |
| 1,3,5-Trinitrobenzene* | 28 | 46-102 | 25 | 65-115 |
| 1,3-Dinitrobenzene†† | 37 | 58-132 | 30 | 70-130 |
| Methyl-2,4,6-Trinitro-phenylnitramine (Tetryl)†† | 21 | 67-109 | 46 | 65-157 |
| Nitrobenzene* | 32 | 44-108 | 24 | 72-120 |
| 2,4,6-Trinitrotoluene* | 38 | 48-124 | 23 | 72-118 |
| 4-Amino-2,6-Dinitrotoluene†† | 26 | 66-118 | 21 | 87-126 |
| 2-Amino-4,6-Dinitrotoluene†† | 26 | 66-118 | 65 | 33-163 |
| 2,4-Dinitrotoluene* | 21 | 60-102 | 19 | 68-106 |
| 2,6-Dinitrotoluene†† | 26 | 67-119 | 44 | 58-146 |
| o-Nitrotoluene†† | 28 | 53-109 | 22 | 70-114 |
| m-Nitrotoluene†† | 48 | 40-136 | 48 | 40-136 |
| p-Nitrotoluene†† | 26 | 60-112 | 26 | 60-112 |
| 3,4-Dinitrotoluene (surrogate) | NA | 30-126 | NA | 71-143 |

*Matrix spike and QC check sample compound
†Accuracy and precision criteria based on ESE historical data, unless specified differently.
††Accuracy and precision criteria based on ESE method validation studies.

Source: ESE.

Table 5-51. Reporting Limit Data for Nitroaromatics and Nitroamines by High Performance Liquid Chromatography, SW 8330

| Parameter | Reporting Limit Aqueous* (µg/L) | Reporting Limit Solid† (µg/kg) |
|---|---|---|
| HMX | 0.25 | 500 |
| RDX | 0.25 | 500 |
| 1,3,5-Trinitrobenzene | 0.20 | 250 |
| 1,3-Dinitrobenzene | 0.10 | 200 |
| Methyl-2,4,6-Trinitro-phenylnitramine | 0.20 | 300 |
| Nitrobenzene | 0.20 | 300 |
| 4-Amino-2,6-Dinitrotoluene | 0.15 | 250 |
| 2,4,6-Trinitrotoluene | 0.15 | 250 |
| 2-Amino-4,6-Dinitrotoluene | 0.15 | 250 |
| 2,4-Dinitrotoluene | 0.15 | 150 |
| 2,6-Dinitrotoluene | 0.15 | 200 |
| o-Nitrotoluene | 0.25 | 500 |
| m-Nitrotoluene | 0.25 | 500 |
| p-Nitrotoluene | 0.30 | 600 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 50 to 10 times the background noise of the instrument.

†Based on the lowest standard that ESE routinely uses, taking into account the sample weight and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. The solid reporting limits are expressed on a wet weight basis.

Source: ESE.

Table 5-52. Analytes, Precision, and Accuracy Data for Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC), AEC QA Plan 11/92**

| | Aqueous† | | Solid† | |
|---|---|---|---|---|
| | Precision (RPD) | Accuracy (% Recovery) | Precision (RPD) | Accuracy (% Recovery) |
| HMX†† | 13 | 84-111 | 18 | 80-116 |
| RDX* | 30 | 51-111 | 18 | 71-107 |
| 1,3,5-Trinitrobenzene* | 28 | 46-102 | 25 | 65-115 |
| 1,3-Dinitrobenzene†† | 37 | 58-132 | 30 | 70-130 |
| Methyl-2,4,6-Trinitro-phenylnitramine (Tetryl)†† | 21 | 67-109 | 46 | 65-157 |
| Nitrobenzene* | 32 | 44-108 | 24 | 72-120 |
| 2,4,6-Trinitrotoluene* | 38 | 48-124 | 23 | 72-118 |
| 2,4-Dinitrotoluene* | 21 | 60-102 | 19 | 68-106 |
| 2,6-Dinitrotoluene | 26 | 67-119 | 44 | 58-146 |
| o-Nitrotoluene* | 28 | 53-109 | 22 | 70-114 |
| m-Nitrotoluene†† | 48 | 40-136 | 48 | 40-136 |
| p-Nitrotoluene†† | 26 | 60-112 | 26 | 60-112 |
| 3,4-Dinitrotoluene (surrogate) | NA | 30-136 | NA | 71-145 |

*Matrix spike and QC check sample compound
†Accuracy and precision criteria based on ESE historical data, unless specified differently.
**UW32 and LW12 are ESE's USATHAMA approved methods (see Appendices H and I).
††Accuracy and precision criteria based on ESE method validation studies for Methods LW12 and UW32.

Source: ESE.

Table 5-53. Reporting Limit Data for Nitroaromatics and Nitroamines by High Performance Liquid Chromatography, AEC QA Plan 11/92

| Parameter | Reporting Limit Aqueous* (µg/L) | Reporting Limit Solid† (µg/kg) |
|---|---|---|
| HMX | 0.25 | 500 |
| RDX | 0.25 | 500 |
| 1,3,5-Trinitrobenzene | 0.20 | 250 |
| 1,3-Dinitrobenzene | 0.10 | 200 |
| Methyl-2,4,6-Trinitro-phenylnitramine | 0.20 | 300 |
| Nitrobenzene | 0.20 | 300 |
| 4-Amino-2,6-Dinitrotoluene | 0.15 | 250 |
| 2,4,6-Trinitrotoluene | 0.15 | 250 |
| 2-Amino-4,6-Dinitrotoluene | 0.15 | 250 |
| 2,4-Dinitrotoluene | 0.060 | 150 |
| 2,6-Dinitrotoluene | 0.070 | 200 |
| o-Nitrotoluene | 0.25 | 500 |
| m-Nitrotoluene | 0.25 | 500 |
| p-Nitrotoluene | 0.30 | 600 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 50 to 10 times the background noise of the instrument.

†Based on the lowest standard that ESE routinely uses, taking into account the sample weight and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. The solid reporting limits are expressed on a wet weight basis.

Source: ESE.

Table 5-54. Analyte, Precision, and Accuracy Data for Glyphosate, EPA 547 (Modified)

| Parameter | Aqueous* Precision (RPD) | Aqueous* Accuracy (% Recovery) |
|---|---|---|
| Glyphosate | 18 | 90-126 |

*Precision and accuracy are based on method validation study performed by ESE (see Appendix V).

Source: ESE.

Table 5-55. Reporting Limit Data for Glyphosate, EPA 547 (Modified)

| Parameter | Reporting Limit Aqueous* (µg/L) |
|---|---|
| Glyphosate | 2.5 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

Source: ESE.

Table 5-56. Analyte, Precision, and Accuracy Data for Ethylene-Bis-Dithiocarbamates (EBDC), EPA 630.1 (Modified)

| | Aqueous* | | Solid* | |
|---|---|---|---|---|
| | Precision (RPD) | Accuracy (% Recovery) | Precision (RPD) | Accuracy (% Recovery) |
| EBDC | 9 | 92-100 | 12 | 67-91 |

*Precision and accuracy are based on method validation studies performed by ESE (see Appendix W).

Source: ESE.

Table 5-57. Reporting Limit Data for Ethylene-Bis-Dithiocarbamates (EBDC), EPA 630.1 (Modified)

| Parameter | Reporting Limit Aqueous* (µg/L) | Reporting Limit Solid† (µg/kg) |
|---|---|---|
| EBDC | 5.5 | 100 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

Source: ESE.

Table 5-58. Analytes, Precision, and Accuracy Data for Organochlorine Pesticides and PCBs in Water, EPA 617

| Parameter | Aqueous Precision (RPD) | Aqueous Accuracy (% Recovery) |
|---|---|---|
| Aldrin[a] | 45[b] | 37 - 127[b] |
| BHC, A | 30 | 37 - 134 |
| BHC, B | 30 | 17 - 147 |
| BHC, D | 27 | 68 - 122 |
| BHC, G (lindane)[a] | 51[b] | 43 - 145[b] |
| Chlordane | 30 | 45 - 119 |
| DDD, PP' | 15 | 79 - 109 |
| DDE, PP' | 11 | 79 - 101 |
| DDT, PP' | 14 | 77 - 105 |
| Dieldrin | 15 | 83 - 113 |
| Endosulfan, A | 23 | 80 - 124 |
| Endosulfan, B | 14 | 79 - 107 |
| Endosulfan sulfate | 30 | 26 - 144 |
| Endrin[a] | 60[b] | 35 - 155[b] |
| Endrin aldehyde | 40[e] | 58 - 138[e] |
| Heptachlor[a] | 38[b] | 48 - 124[b] |
| Heptachlor epoxide | 12 | 82 - 106 |
| Methoxychlor | 20 | 77 - 117 |
| Toxaphene | 30 | 41 - 126 |
| Mirex | 14 | 75 - 103 |
| Trifluralin | 32 | 62 - 126 |
| PCNB | 19 | 64 - 102 |
| PCB-1061[d] | 30 | 50 - 114 |
| PCB-1221 | 30 | 15 - 178 |
| PCB-1232 | 30 | 10 - 215 |
| PCB-1242 | 30 | 39 - 150 |
| PCB-1248 | 30 | 38 - 158 |
| PCB-1254 | 30 | 29 - 131 |
| PCB-1260[d] | 30 | 8 - 127 |
| Dibutylchlorendate[c] | NA | 46 - 146[b] |
| Decachlorobiphenyl (surrogate) | NA | 12-140 |
| Tetrachlorobiphenyl (surrogate) | NA | 33-119 |

Table 5-58. Analytes, Precision, and Accuracy Data for Organochlorine Pesticides and PCBs in Water, EPA 617 (Continued, Page 2 of 2)

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Reference: Accuracy and Precision: EPA Methods 617 and SW 8080.

Note: NA = not applicable.

[a]Matrix spike and QC check sample compound.
[b]Accuracy and precision criteria are based on ESE historical data.
[c]Surrogate; the surrogate is added to all environmental samples and quality control samples.
[d]PCB 1016 and PCB 1260 are only used as matrix spike and QCC samples compounds when using EPA 608/8080 to evaluate PCBs only.

Source: ESE.

Table 5-59. Reporting Limit Data for Organochlorine Pesticides and PCBs in Water, EPA 617

| Parameter | Reporting Limits Aqueous* (µg/L) |
|---|---|
| Aldrin | 0.006 |
| BHC,A | 0.006 |
| BHC,B | 0.006 |
| BHC,D | 0.006 |
| BHC,G(lindane) | 0.006 |
| Chlordane | 0.030 |
| DDD,PP | 0.006 |
| DDE,PP' | 0.006 |
| DDT,PP' | 0.006 |
| Dieldrin | 0.006 |
| Endosulfan,A | 0.006 |
| Endosulfan,B | 0.006 |
| Endosulfan sulfate | 0.006 |
| Endrin | 0.006 |
| Endrin aldehyde | 0.006 |
| Heptachlor | 0.006 |
| Heptachlor epoxide | 0.006 |
| Methoxychlor | 0.006 |
| Toxaphene | 0.6 |
| PCB-1016 | 0.12 |
| Mirex | 0.2 |
| Trifluralin | 0.1 |
| PCNB | 0.02 |

Table 5-59. Reporting Limit Data for Organochlorine Pesticides and PCBs in Water, EPA 617 (Continued, Page 2 of 2)

| Parameter | Reporting Limits Aqueous* (µg/L) |
|---|---|
| PCB-1221 | 0.12 |
| PCB-1232 | 0.12 |
| PCB-1242 | 0.12 |
| PCB-1248 | 0.12 |
| PCB-1254 | 0.12 |
| PCB-1260 | 0.12 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

Source: ESE.

Table 5-60. Analyte, Precision, and Accuracy Data for Tetrazene, EPA 8331

| Parameter | Aqueous* | | Solid* | |
|---|---|---|---|---|
| | Precision (RPD) | Accuracy (% Recovery) | Precision (RPD) | Accuracy (% Recovery) |
| Tetrazene | 10 | 94-114 | 25 | 35-85 |

*Precision and accuracy are based on EPA Method 8331--Test Methods for Evaluating Solid Waste, EPA SW-846, 3rd Edition, September 1986.

Source: ESE.

Table 5-61. Reporting Limit Data for Tetrazene, EPA 8331

| Parameter | Reporting Limit | |
|---|---|---|
| | Aqueous* (µg/L) | Solid (µg/kg) |
| Tetrazene | 7 | 1,000 |

Source: ESE.

Table 5-62. Analytes, Precision, and Accuracy Data for Non-Halogenated Volatile Organic Compounds, EPA 8015 Modified B

| | Aqueous | |
|---|---|---|
| Parameter | Precision (RPD) | Accuracy (% Recovery) |
| Isobutanol | 32 | 56-120 |
| 2-Ethoxyethanol | 17 | 85-109 |

*Accuracy and precision criteria are based on ESE historical data.

Source: ESE.

Table 5-63. Reporting Limit Data for Non-Halogenated Volatile Organic Compounds, EPA 8015 Modified B

| Parameter | Reporting Limits Aqueous* (µg/L) |
|---|---|
| Isobutanol | 500 |
| 2-Ethoxyethanol | 5,000 |

*Based on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument.

Source: ESE.

Table 5-64. Analytes, Precision, and Accuracy Data for Total Petroleum Hydrocarbons (TPH), EPA 8015 Modified A

| Parameter | Aqueous* | | Solid* | |
|---|---|---|---|---|
| | Precision (RPD) | Accuracy (% Recovery) | Precision (RPD) | Accuracy (% Recovery) |
| TPH as Gas | 22+ | 53-971+ | 8+ | 80-96+ |
| TPH as Diesel | 30 | 61-121 | 38 | 56-132 |
| Pentacosane (surrogate) | NA | 52-168 | NA | 54-158 |

Note: NA = not applicable.

*Accuracy and precision based on ESE historical data.
+Accuracy and precision criteria based on method validation data.

Source: ESE.

Table 5-65. Reporting Limit Data for Non-Halogenated Volatile Organic Compounds, EPA 8015 Modified A

| Parameter | Reporting Limit Aqueous* (µg/L) | Reporting Limit Solid† (µg/kg) |
|---|---|---|
| TPH as Gas | 400 | 8,000 |
| TPH as Diesel | 400 | 8,000 |

*Base on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standrd is chosen to be within 5 to 10 times the background noise of the instrument.
†Base on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standrd is chosen to be within 5 to 10 times the background noise of the instrument. The solid reporting limits are expressed on a wet weight basis.

Source: ESE.

Table 5-64. Precision and Accuracy Data for Nitrocelloluse by Autoanalyzer, UF03 and LF03*

| Parameter | Aqueous+ Precision (RPD) | Aqueous+ Accuracy (% Recovery) | Solid+ Precision (RPD) | Solid+ Accuracy (% Recovery) |
|---|---|---|---|---|
| Nitrocelllulose | 39 | 39-117 | 29 | 6-64 |

*UF03 and LF03 are ESE's USATHAMA-approved methods.
+Accuracy and precision criteria based on method validation data.

Source: ESE.

Table 5-65. Reporting Limit Data for Nitrocellulose, UF03 and LF03

| Parameter | Reporting Limit Aqueous* (µg/L) | Reporting Limit Solid† (µg/kg) |
|---|---|---|
| Nitrocellulose | 553 | 10,500 |

*Base on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standrd is chosen to be within 5 to 10 times the bachground noise of the instrument.
†Base on the lowest standard that ESE routinely uses, taking into account the sample volume and final extract volume. The lowest standrd is chosen to be within 5 to 10 times the bachground noise of the instrument. The solid reporting limits are expressed on a wet weight basis.

Source: ESE.

# 6.0 SAMPLE HANDLING PROCEDURES

## 6.1 INTRODUCTION

The validity of analytical data is dependent on the integrity of the field procedures employed in obtaining a sample. Environmental sampling has many variables which can affect analytical results. The properties of most contaminated materials warrant the analysis of a small aliquot of the bulk of the material. Proper sampling techniques must be employed to obtain a representative sample of the bulk material. For a sample to be representative, it must be collected and handled so as to keep its original physical form and chemical composition as much as possible and to protect against any loss or contamination. To achieve this sample's integrity, quality assurance procedures should be closely followed throughout the sampling effort.

Exhaustive and sometimes expensive actions are taken based on the analytical data generated from field sampling programs. Therefore, it is in the best interest of the investigation, as well as the public, to ensure the quality of the data by ensuring the quality of the samples being delivered to the analyst.

This section of the LCQAP details sample handling requirements in the laboratory.

## 6.2 SAMPLE CONTAINERS CLEANING PROCEDURES

### 6.2.1 CLEANING PROCEDURES

ESE uses commercially cleaned sample containers whenever practical. Only Type 300 series precleaned sample containers provided with certificate of cleanliness will be used. The certificates will be kept on file. Table 6-1 summarizes the application of these cleaning procedures. Cleaned sample containers are stored in a secured

Table 6-1. Sample Container Cleaning Procedures Within the Laboratory

| Analysis/Parameter | Container Type | Matrix | Fraction Code | Cleaning Protocol* |
|---|---|---|---|---|
| Organic extractables include GC, HPLC, GC/MS, and Total Phenols Analyses | Glass jar with Teflon®-lined cap | Water | MS, EC, HB, UP, NP, LC, W, Z | A |
| | Glass jar with Teflon®-lined cap | Soil/Sediment | SS | A |
| | Aluminum foil and plastic bags | Tissue+ | TS | NA |
| Organic purgeables including GC and GC/MS Analyses, TOX, Aldicarb | Glass septum vial with Teflon®-lined cup | Water | V, VP, ED, AL, XP | B |
| | Wide-mouth glass jar with Teflon®-lined cap | Soil | SV | B |
| | Aluminum foil and plastic bags | Tissue+ | TS | NA |
| Metals | Linear polyethylene cubitainer with polyethylene cap | Water | N | C |
| | Glass jar with Teflon®-lined cap (or new plastic) | Soil/Sediment | SS | A |
| | Plastic bags | Tissue+ | TS | NA |
| Inorganics include total cyanide, alkalinity, acidity, residues, BOD, color, MBAS, COD, TOC, chloride, turbidity, sulfate, bromide, sulfide, fluoride, nutrients, and radionuclides | Linear polyethylene cubitainer with polyethylene cap | Water | C, B, S, H, R | D* |
| | Glass jar with Teflon®-lined cap (or new plastic) | Soil | SS | A |
| | Aluminum foil and plastic bags | Tissue+ | TS | NA |
| Oil and grease (O&G), odor | Glass jar with Teflon®-lined cap | Water | O,OD | A |
| Oil and grease (O&G) | Glass jar with Teflon®-lined cap | Soil/ Sediment | SS | A |
| Toxicity tests | Linear polyethylene cubitainer with polyethylene cap | Effluent | None | D |

Table 6-1. Sample Container Cleaning Procedures Within the Laboratory (Continued, Page 2 of 2)

Note:
BOD = biochemical oxygen demand.
COD = chemical oxygen demand.
GC/MS = gas chromatography/mass spectrometry.
GC/HPLC = gas chromatography/high performance liquid chromatography.
Glass = amber for all organic water analyses.
MBAS = methylene blue active substance.
NA = not applicable.
TOC = total organic carbons.
TOX = total organic halide.

*Tissue samples for these parameters are first wrapped in aluminum foil and then put in plastic bags.

| *Cleaning Protocol A | B | C | D | Specifications |
|---|---|---|---|---|
| X | X | X | | Wash with hot tap water using laboratory-grade, interference free, nonphosphate detergent. |
| X | X | X | | Rinse 3 times with tap water. |
| X | | X | | Rinse with 1:1 nitric acid (reagent-grade nitric acid diluted with ASTM Type 1 deionized water). |
| X | X | X | | Rinse 3 times with ASTM Type 1 deionized water. |
| X | | | | Rinse with pesticide-grade methylene chloride using 20 mL per 64-oz bottle, 10 mL per 32- or 16-oz bottle, or 5 mL per 8- or 4-oz bottle. Methylene chloride is used as organics rinse. |
| X | X | | | Oven dry, using a forced-air oven, at 105° to 125°C for 1 hour. |
| | | X | | Invert and air-dry in contaminant-free environment. |
| X | X | X | | The containers are sealed with caps containing Teflon® liners or Teflon®-backed septa that had been cleaned the same way as the containers, packed in cartons, and stored until needed. |
| | | | X | No cleaning required; use new cubitainers (only). |

Note: Cleaning protocols A, B, and C are applied by commercial supplier.
Cleaning protocol D is applied by ESE.
Source: ESE.

storage building away from the analytical laboratory until needed. Activities and records associated with contaminant-free containers are maintained.

All sample containers are stored in a secured storage building located away from the laboratory. When containers are needed, they are moved to the sample kit preparation area that is also located away from the laboratory and packed for shipment to the project site. Upon receipt of precleaned sample containers, the purchase order form is dated with date of receipt by the laboratory purchasing personnel and the purchase order form is filed. Documentation associated with the sample containers such as lot numbers and certification statements for 300 series containers are maintained and filed in their department by the kit preparation personnel. These containers are labeled individually with lot numbers, hence, it is not necessary to maintain records of lot numbers used for a particular project.

### 6.2.2 TYPES OF WATER

DI water is defined as ESE water that has been treated by passing it through a standard resin column and an activated carbon unit. The water contains no detectable (i.e., ESE's routine detection limits) heavy metals or inorganic compounds of analytical interest and is relatively free of organic compounds. The water is acceptable for use in the initial rinsing of laboratory glassware and field equipment. Ultrapure water, used for equipment and field blanks, is defined as ESE DI water that has been additionally treated through a Milli-Q® treatment system and contains no organic compounds of analytical interest above ESE's routine detection limits. Organic-free water, used for trip blanks, is prepared by purging American Society for Testing and Materials (ASTM) Type 2 water at 60°C for 24 hours with Grade 6 helium.

Documentation is maintained to demonstrate reliability and "purity" of analyte free water source(s).

DI water other than ESE-treated water may be used if it is of documented equivalent quality. Use of commercially DI or distilled water is discouraged because it often contains phthalate esters.

## 6.3 SAMPLING CONTAINERS, VOLUMES, HOLDING TIMES AND PRESERVATION

### 6.3.1 CONTAINERS AND SAMPLE HOLDING TIMES

Table 6-2 identifies the proper containers, preservation techniques, and maximum holding times established by EPA (40 CFR Part 136). The maximum holding times in Table 6-1 apply to water and soils as noted. Samples that exceed the regulatory holding times will be flagged by the laboratory coordinator in the final deliverable.

### 6.3.2 SAMPLE PRESERVATION

Sample preservation is generally performed in the field. However, sample containers for volatile analysis (water only) are sent to the field with preservatives added to the containers. Sample preservation requirements are listed in Table 6-2.

Grades of the preservatives used are specified as a footnote in Table 6-2. Fresh preservatives are obtained from laboratory stocks prior to each sampling event.

## 6.4 SAMPLE SHIPPING FROM THE FIELD TO THE LABORATORY

A typical environmental sample consists of some type of soil or water matrix; however, other types of samples such as tissues or dust wipes are also collected. Whatever the field sample type, the field crew should package each sample container to ensure its integrity inside the shipping container. This packaging may include packing materials such as Bubble Wrap® or styrofoam fillers.

Table 6-2. Required Containers, Preservation Techniques, and Holding Times

| Measurement | Container[1] | Preservation | Maximum Holding Time[2] (Waters and Soils) |
|---|---|---|---|
| Metals | | | |
| Chromium VI | P, G | Cool, 4°C | 24 hours[3] |
| Mercury | P, G | $HNO_3$ to pH<2 | 28 days |
| Metals, except chromium VI and mercury (filtered and unfiltered) | P, G | $HNO_3$ to pH<2 | 6 months |
| Inorganic Tests | | | |
| Acidity | P, G | Cool, 4°C | 14 days[3] |
| Alkalinity | P, G | Cool, 4°C | 14 days[3] |
| Ammonia | P, G | Cool, 4°C, $H_2SO_4$ to pH<2 | 28 days[3] |
| BOD | P, G | Cool, 4°C | 48 hours[3] |
| Bromide | P, G | None required | 28 days[3] |
| BOD, carbonaceous | P, G | Cool, 4° | 48 hours[3] |
| COD | P, G | Cool, 4°C, $H_2SO_4$ to pH<2 | 28 days[3] |
| Chloride | P, G | None required | 28 days[3] |
| Chlorine, total | P, G | None required | Analyze immediately[3,7] |
| Color | P, G | Cool, 4°C | 48 hours[3] |
| Cyanide, total and amenable to chlorination | P, G | Cool, 4°C, NaOH to pH>12, 0.6 g ascorbic acid[8] | 14 days[3,8] |
| Fluoride | P | None required | 28 days[3] |
| Hardness | P, G | $HNO_3$ to pH<2, $H_2SO_4$ to pH<2 | 6 months[3] |
| Hydrogen ion (pH) | P, G | Cool, 4°C | Analyze immediately[3] |
| Kjeldahl and organic nitrogen | P,G | Cool, 4°C, $H_2SO_4$ to pH<2 | 28 days[3] |
| Nitrate | P, G | Cool, 4°C | 48 hours[3] |
| Nitrate (drinking water) | | | |
| Chlorinated | P, G | Cool, 4°C | 28 days |
| Unchlorinated[12] | P, G | $H_2SO_4$ to pH <2 | 14 days |
| Nitrate-nitrite | P, G | Cool, 4°C, $H_2SO_4$ to pH<2 | 28 days[3] |
| Nitrite | P, G | Cool, 4°C | 48 hours[3] |
| Oil and grease | G | Cool, 4°C, $H_2SO_4$ to pH<2 | 28 days[3] |
| Organic carbon | P, G | Cool, 4°C, HCl or $H_2SO_4$ to pH<2 | 28 days[3] |

Table 6-2. Required Containers, Preservation Techniques, and Holding Times (Continued, Page 2 of 5)

| Measurement | Container[1] | Preservation | Maximum Holding Time[2] (Waters and Soils) |
|---|---|---|---|
| Inorganics (cont) | | | |
| Orthophosphate | P, G | Filter immediately, cool, 4°C | 48 hours[3] |
| Oxygen, dissolved (DO) | | | |
| Probe | G Bottle and top | None required | Analyze immediately[3] |
| Winkler | G Bottle and top | Fix onsite and store in dark | 8 hours[3] Phenols |
| | G only | Cool, 4°C, $H_2SO_4$ to pH<2 | 28 days[3] |
| Phosphorus (elemental) | | G | Cool, 4°C48 hours[3] |
| Phosphorus, total | P, G | Cool, 4°C, $H_2SO_4$ to pH<2 | 28 days[3] |
| MBAS | P, G | Cool, 4°C | 48 hours[3] |
| Bromates (ion chromatography) | P, G | Cool, 4°C | 30 days[3] |
| Corrosivity (calculated) | P, G | Cool, 4°C | 7 days[9] |
| Odor | G | Cool, 4°C | 6 hours[3] |
| Unionized Ammonia (calculated) | P, G | Cool, 4°C | 8 hours[3] |
| | | $Na_2S_2O_3$ | 28 days[10] |
| Residue, total | P, G | Cool, 4°C | 7 days[3] |
| Residue, filterable | P, G | Cool, 4°C | 7 days[3] |
| Residue, nonfilterable (TSS) | P, G | Cool, 4°C | 7 days[3] |
| Residue, settleable | P, G | Cool, 4°C | 48 hours[3] |
| Residue, volatile | P, G | Cool, 4°C | 7 days[3] |
| Silica | P | Cool, 4°C | 28 days[3] |
| Specific conductance | P, G | Cool, 4°C | 28 days[3] |
| Sulfate | P, G | Cool, 4°C | 28 days[3] |
| Sulfide | P, G | Cool, 4°C, add zinc acetate plus NaOH to pH>9 | 7 days[3] |
| Sulfite | P, G | None required | Analyze immediately[3] |
| Surfactants | P, G | Cool, 4°C | 48 hours[3] |
| Temperature | P, G | None required | Analyze immediately[3] |
| Turbidity | P, G | Cool, 4°C | 48 hours[3] |
| Organic Tests | | | |
| Purgeable halocarbons | G, Teflon®-lined septum | Cool, 4°C, 0.008% $Na_2S_2O_3$[5,6] store in dark | 14 days |

Table 6-2. Required Containers, Preservation Techniques, and Holding Times (Continued, Page 3 of 5)

| Measurement | Container[1] | Preservation | Maximum Holding Time[2] (Waters and Soils) |
|---|---|---|---|
| Organics (cont) | | | |
| Purgeable aromatic hydrocarbons | G, Teflon®-lined septum | Cool, 4°C, 0.008% $Na_2S_2O_3$[5,6] HCl to pH2 | 14 days |
| Acrolein and acrylonitrile | G, Teflon®-lined septum | Cool, 4°C, 0.008% $Na_2S_2O_3$[5] Adjust pH to 4-5 | 14 days |
| Phenols | G, Teflon®-lined cap | Cool, 4°C, 0.008% $Na_2S_2O_3$[5] store in dark | 7/40 days for waters[4] 14/40 days for soils[4] |
| Benzidines | G, Teflon®-lined cap | Cool, 4°C, 0.008% $Na_2S_2O_3$[5] store in dark | 7/40 days for waters[4] |
| Phthalate esters | G, Teflon®-lined cap | Cool, 4°C, store in dark | 7/40 days for waters[4] 14/40 days for soils[4] |
| Nitrosamines | G, Teflon®-lined cap | Cool, 4°C, 0.008% $Na_2S_2O_3$[5] store in dark | 7/40 days for waters[4] 14/40 days for soils[4] |
| PCBs, pesticides, herbicides | G, Teflon®-lined cap | Cool, 4°C, 0.008% $NA_2S_2O3$[5] store in dark | 7/40 days for water[4] 14/40 days for soils[4] |
| Nitroaromatics and isophorone | G, Teflon®-lined cap | Cool, 4°C, 0.008% $Na_2S_2O_3$[5] store in dark | 7/40 days for water[4] 14/40 days for soils[4] |
| Polynuclear aromatic hydrocarbons | G, Teflon®-lined cap | Cool, 4°C, 0.008% $Na_2S_2O_3$[5] store in dark | 7/40 days for waters[4] 14/40 days for soils[4] |
| Haloethers | G, Teflon®-lined cap | Cool, 4°C, 0.008% $Na_2S_2O_3$[6] store in dark | 7/40 days for waters[4] 14/40 days for soils[4] |
| Volatile organics | G, Teflon®-lined septum | Cool, 4°C, 0.008% $Na_2SO_3$[6] HCL to pH 2 | 14 days |
| EDB, DBCP | G, Teflon®-lined septum | Cool, 4°C, 0.008% $Na_2S_2O_3$[6] | 28 days |
| Chlorinated hydro-carbons | G, Teflon®-lined cap | Cool, 4°C, store in dark | 7/40 days for waters[4] 14/40 days for soils[4] |
| TCDD | G, Teflon®-lined cap | Cool, 4°C, 0.008% $Na_2S_2O_3$[6] store in dark | 7/40 days for waters[4] 14/40 days for soils[4] |
| Total organic halogens pH <2 (TOX) | 28 days[3] cap | G, Teflon®-lined store in dark | Cool, 4°C, $H_2SO_4$ to |

Table 6-2. Required Containers, Preservation Techniques, and Holding Times (Continued, Page 4 of 5)

| Measurement | Container[1] | Preservation | Maximum Holding Time[2] (Waters and Soils) |
|---|---|---|---|
| Organics (cont) | | | |
| Acid and base/neutral | G, Teflon®-lined | | Cool, 4°C, 0.008% |
| $Na_2S_2O_3$[6] | 7/40 days for waters[4] | | |
| extractables | cap | store in dark | 14/40 days for soils[4] |
| Nitroaromatics and | G, Teflon®-lined | | Cool, 4°C7/40 days for |
| waters[4] | | | |
| Nitramines | cap | | 14/40 days for soils[4] |
| Radiological Tests | | | |
| Alpha, beta, Sr-90, Ra-226, Ra-228, Uranium, photon emitters | P, G | HCL, $HNO_3$ to pH<2 | 6 months |
| Cesium-134, Iodine-131, Titrium | P, G | None | 6 months |
| Tissues | | | |
| Organics, inorganics and radiological tests | Aluminum foil and plastic bag | Freeze, -20°C | 12 months or below |
| Metals tests | Plastic bag | Freeze, -20°C or below | 12 months |

Note: BOD = biochemical oxygen demand.
COD = chemical oxygen demand.
G = glass.
HCl = hydrochloric acid (metals grade).
$HNO_3$ = nitric acid (metals grade).
$H_2SO_4$ = sulfuric acid (metals grade).
NS = none specified by EPA.
$Na_2SO_3$ = sodium sulfite (ACS grade).
$Na_2S_2O_3$ = sodium thiosulfate (ACS grade).
P = polyethylene.
PCB = polychlorinated biphenyl.
NaOH = sodium hydroxide (ACS grade).
°C = degrees Celsius.

Table 6-2. Required Containers, Preservation Techniques, and Holding Times (Continued, Page 5 of 5)

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[1] For nonvolatile organics, containers for soil and sediment samples are glass with Teflon®-lined caps and for volatiles, containers are glass with Teflon®-lined septum.
Soil sample containers for inorganics are glass jars with Teflon®-lined caps, polyethylene (P), or glass (G).

[2] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the laboratory has data on file to show that the specific types of samples under study are stable for the longer time.

[3] Holding times provided are for waters. EPA does not have holding times for these parameters in soil. These water holding times will be used as goals for those methods where a soil analysis is applicable.

[4] 7/40 = 7 days until extraction; 40 days from extraction until analysis. 14/40 = 14 days until extraction; 40 days from extraction until analysis.

[5] Sample preservation should be performed immediately upon sample collection. The only preservation for soil samples is cooling at 4°C. For composite samples, each aliquot should be preserved at the time of collection. When use of an automatic sampler makes it impossible to preserve each aliquot, samples may be preserved by maintaining at 4°C until compositing and sample splitting are completed (maximum allowable time is 20 hours). $Na_2S_2O_3$ is used only in the presence of residual chlorine.

[6] If residual chlorine is present, sodium thiosulfate is added to the sample vial first, the vial is then filled to almost full volume with sample, acid is added, and finally the vial is filled. Note: It is not recommended to mix the two preservatives (and sample) together in an intermediate vessel.

[7] These parameters are best analyzed in the field. In consideration of shipping limitations, when these analyses are requested of our laboratory for confirmation purposes, ESE's policy is to analyze these constituents within 24 hours of receipt.

[8] The following test should be performed for cyanide samples:
(a) Oxidizing agents--Test the sample using KI-starch paper. If present, add a few crystals of ascorbic acid and test until negative. Add an additional 0.6 gram of ascorbic acid for each liter of sample to remove the chlorine.
(b) Sulfides--When sulfide is present as indicated by a positive test with lead acetate paper, the maximum holding time is 24 hours. Remove the sulfides by (1) filtration of sample if visible particulates are present, (2) precipitation with cadmium nitrate until a negative spot test is obtain, (3) filtration of the precipitate, and (4) addition of NaOH to pH $>12$ if sulfides are not removed with the previous procedure.

[9] Temperature and pH must be measured onsite at the time of sample collection. Seven days is the maximum time for laboratory analysis of total alkalinity, calcium ion, and total solids.

[10] The results of the measurements of pH, temperature, salinity (if applicable), and the ammonium ion concentration in the sample are used to calculate the concentration of ammonia in the un-ionized state. Temperature, pH, and salinity must be measured onsite at the time of sample collection. Laboratory analysis of the ammonium ion concentration should be conducted within 8 hours of sample collection. If prompt analysis of ammonia is impossible, preserve samples with $H_2SO_4$ to pH between 1.5 and 2. Acid-preserved samples, stored at 4°C, may be held up to 28 days for ammonia determination. Sodium thiosulfate should only be used if fresh samples contain residual chlorine.

[11] Chlorinated means that the source water has a detectable amount of residual chlorine, as will be indicated by the field test.

[12] Nonchlorinated means that the source water contains no detectable amount of residual chlorine (i.e., below the detection limit).

Source: ESE.

Sample containers are typically shipped by bonded courier to the laboratory. Samples are shipped by overnight delivery as soon as possible after collection (usually daily), with receiving signature required. Sample receipt and check-in at the laboratory is performed by the sample custodian, as described in Section 7.3.

Samples are usually organized by sample location in each shipping container with all of the fractions collected from a given station grouped together. A possible exception to this procedure would include the collection of large quantities of samples for VOC analyses.

If the samples require chilling/freezing, the sample containers will be isolated from the chilling/freezing materials using appropriate, waterproof materials such as plastic garbage bags. Typically, wet ice is used to chill the samples; reusable blue ice-type chilling products will not be used due to possible chemical interferences. If a sample must be kept frozen in a solid state, dry ice is used.

The chain-of-custody logsheet for the samples in each shipping container is sealed in a plastic Ziploc® bag and taped to the inside of the container. ESE's policy requires sealing all sample shipping containers with evidence tape prior to shipping.

## 6.5 REAGENT AND STANDARD STORAGE

Storage requirements of reagents and standards used are presented in Table 6-3.

Table 6-3. Reagent Storage

| Reagent | Method of Storage |
|---|---|
| Solvents | Stored in original containers in a vented storage room, or stored in double-walled flammable liquid storage cabinets. Stockroom personnel check the storage cabinets daily and tranfer solvents from the storage room to the storage cabinets as needed. Note: Methanol used for volatile organic analyses are stored in the GC-Volatiles and GC/MS-Volatiles analysis areas. |
| Inorganic acids | Stored in original containers in the ESE stockroom. Once issued from the stockroom to a department, the acids are kept in safety carriers and stored along with the carriers in the department's cabinet designated for acids only. |
| Organic acids | Stored in original containers in the ESE stockroom. Once issued from the stockroom to a deparment, the acids are kept in safety carriers and stored along with the carriers in the department's cabinet designated for acids only. Note: Organic acids are stored in separate cabinets from the inorganic acids. |
| Caustics | Stored in original containers in the ESE stockroom. Once issued from the stockroom to a department, the caustic reagents are kept in safety carriers and stored along with carriers in the department's cabinet designated for caustics only. Note: Caustic reagents are stored in separate cabinets from the acids. |
| Other reagents | Stored in the main chemical or standards storage room, or stored in the designated cabinets in each department. Liquids in quantities of one gallon or more must be kept in safety carriers. Standards that require storage at 4°C or at 0°C are stored in each department's refrigerators or freezers (respectively) designated for standards only. |

Source: ESE.

# 7.0 SAMPLE CUSTODY

## 7.1 SAMPLE CUSTODY OBJECTIVES

The primary objective of sample custody is to create an accurate written verified record that can be used to trace the possession and handling of the samples from the moment of collection until receipt by the laboratory. Adequate sample custody in the laboratory will be achieved by means of approved laboratory documentation.

### 7.1.1 DEFINITION OF LEGAL CHAIN OF CUSTODY

A sample for this project is defined to be in someone's custody if:

1. It is in one's actual physical possession;
2. It is in one's view, after being in one's physical possession;
3. It is in one's physical possession and then locked or otherwise sealed so that tampering will be evident; or
4. It is kept in a secure area, restricted to authorized personnel only.

### 7.1.2 LEGAL CUSTODY PROCEDURES

1. Formal chain of custody starts when the precleaned sample containers are dispatched to the field. The sample kit preparation personnel initiate custody of the sample containers by completing the first line under the "Relinquish By" of the chain-of-custody logsheet (Figure 7-5). Receipt of the sample containers are acknowledged by the field personnel by signing and dating the first line under the "Received By" of the logsheet.
2. The formal chain of custody is signed by the Laboratory Coordinator in the laboratory. At the field, the Field Team Leader or his designate, is responsible to ensure that the chain-of-custody form is maintained.
3. Copies of the chain-of-custody form and/or field sheets are maintained with project records.
4. Errors in all documents are corrected by drawing one line though the error, then signing, and dating the corrections.
5. All documentation/logs are signed/initialed by appropriate personnel.

Due to evidentiary nature of the samples collected, possession must be traceable from the time the precleaned containers leave the laboratory to the field. Field chain of custody actually begins at the laboratory. Sample kits, which refer to the coolers, sample containers, preservatives, and trip blanks, are requested from the kit preparation staff using the Sample Kit Request Form (Figure 7-1). This form is completed by the Laboratory Coordinator and accompanied by the field group logsheets, labels, and any other relevant information. Shipping labels and/or the ESE Shipping Request Form (87201.A) (Figure 7-2) are provided in accordance with current corporate policy on sample kit handling.

The preservatives are packed in fiberboard boxes filled with vermiculites (inert materials compatible with both acids and alkalis) and labeled showing type of preservatives used.

The sample containers, boxed preservatives, trip blanks, if needed, chain-of-custody field logsheet, and a copy of the sample fraction codes are packed in coolers, sealed and shipped to the field by bonded carrier (i.e., UPS or Federal Express). All kit request forms are signed and dated upon completion by kit preparation staff. The number of coolers shipped to the field is documented in the shipping receipts that are kept in a central file located in the Gainesville, Florida, ESE Accounting office. Coolers that are picked up by the field personnel are logged out from the sample kit preparation staff using the Kit Pick-up Log in Figure 7-3. An ESE cooler tracking report indicating the personnel who prepared the kits, cooler number(s), project name and number, contents of each cooler, and the time and date the cooler was released is generated. This report is attached to the kit request form, a copy is packed in the cooler along with the other documentation, and the original filed by the kit preparation staff for future reference. An example of the cooler tracking report is shown in Figure 7-4.

FROM: _____ Date Submitted: _____

PROJECT NAME: _____ Time Submitted: _____

FIELD GROUP(s) / SAMPLE #(s): _____

TRIP BLANKS? Y / N : TYPE: __ GCV __ GCMS # OF: VP ____ V ____ ED ____ Other: _____

QC LABELS REQUIRED? Y / N : IF SO, SAMPLE #'s TO BE MARKED: _____

IF VP FRACTIONS ARE INCLUDED, SHOULD THEY BE PREPRESERVED? Y / N (IF NO, REMEMBER HCL)

TYPE AND # OF REQUIRED PRESERVATIVE BOTTLES (25 mL PER BOTTLE):

____Sulfuric ____Nitric (18%) ____Hydrochloric ____Zinc Acetate ____Sodium Hydroxide

____Sodium Thiosulfate ____Sodium Sulfite ____Cadmium Nitrate ____Lead Acetate strips

OTHER SUPPLIES: __Y__ Logsheets __Y__ Trash Bags (for ice) ___Gloves ___Evidence Tape ___Pipettes ___pH Strips

(# of) ____Gals of Barnstead water ___Coolers of Blue Ice Other: _____

FOR PICKUP BY _____ ON __/__/__ OR

SHIP KITS ON: __/__/__ OR MAY SHIP BETWEEN __/__/__ AND __/__/__

TO: _____
Name

_____
Company

_____
Street Address for Delivery (NO P.O. Boxes)

_____
City State Zip

Telphone #(____) _____

Project # _____

SERVICE REQUIRED

Saturday Delivery Required? ____

___ Florida Overnight

___ Fed-X: ___ Next AM ___ Next PM ___ 2-Day/Std

___ UPS: ___ Next Day ___ 2-Day ___ 3-Day

___ Ground (1-2 Day in Fla.)

___ Bus: type service? _____

___ Other: _____

Kits Completed By _____ on __/__/__

_____ # of Coolers

_____ # of Separate Cartons

Transferred to ____ Mailroom ____ Facilities

By _____

On __/__/__

To Arrive on __/__/__ ___ AM ___ PM

Notes: _____

| | | | |
|---|---|---|---|
| 1)____ | 11)____ | 21)____ | 31)____ |
| 2)____ | 12)____ | 22)____ | 32)____ |
| 3)____ | 13)____ | 23)____ | 33)____ |
| 4)____ | 14)____ | 24)____ | 34)____ |
| 5)____ | 15)____ | 25)____ | 35)____ |
| 6)____ | 16)____ | 26)____ | 36)____ |
| 7)____ | 17)____ | 27)____ | 37)____ |
| 8)____ | 18)____ | 28)____ | 38)____ |
| 9)____ | 19)____ | 29)____ | 39)____ |
| 10)____ | 20)____ | 30)____ | 40)____ |

**Figure 7-1**
**SAMPLE KIT PREP & SHIPPING REQUEST FORM**

SOURCE: ESE

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

# ESE SHIPPING REQUEST

DATE: _____

FROM: _____ EXT: _____

PROJECT/PROPOSAL/CHARGE NO.: _____

TO: _____
Name

_____
Company

_____
Street Address for UPS, Federal Express-(NO P.O. Boxes)

_____
City State Zip

( )
Telephone

DELIVERY TIME-PACKAGE MUST REACH DESTINATION BY:

_____ _____
Date Time

SATURDAY SERVICE REQUIRED ☐

DECLARED VALUE $_____

WEIGHT (for more than one package, see other side)_____

TYPE OF SERVICE REQUIRED:

- ☐ 1st CLASS MAIL
- ☐ UPS GROUND
- ☐ UPS 2-DAY
- ☐ UPS NEXT DAY
- ☐ FEDERAL EXPRESS 2-DAY
- ☐ FEDERAL EXPRESS NEXT DAY
- ☐ DHL
- ☐ OTHER_____

FORM 87201.A

**Figure 7-2**
ESE SHIPPING REQUEST FORM

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

## KIT PICK-UP LOG

**This log must be filled out whenever kits are not shipped by UPS or FED-X.**

| Project Name | Field Group | # of Coolers | Relinquished By/Date | Received By/Date |
|---|---|---|---|---|
| | | | | |
| | | | | |
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| | | | | |
| | | | | |
| | | | | |

Figure 7-3
KIT PICK-UP LOG

SOURCE: ESE.

ENVIRONMENTAL SCIENCE
& ENGINEERING, INC.

```
                    ESE SAMPLE_TRACKING-- ICE CHEST CHECK OUT (A100)
                        PRINTED ON 17:02:17  03 DEC 1992 PAGE 1

LMP    COOLER   TO                      TIME  COMMENT
E03289 COOL0287 3904076-0214-3200-      11:25 SITE ID 1,- 11 GLOVES; LOGSHEETS; PIPETTES; TRASH BAGS; 1 GALLON BARNSTEAD WATER
-----------------------------------------------------------------------------------------------------------------------------
E01421 COOL0471 3924031G-0202-3200      16:31 SITE ID 1 - 5 ; LOGSHEETS; TRASH BAGS;
E03291 COOL0553 3924031G-0202-3200      11:25 SITE ID 1 - 19 TRASH BAGS; GLOVES; LOGSHEETS;
-----------------------------------------------------------------------------------------------------------------------------
E03180 COOL0167 3924062-0800-3200       13:29 2 BOX(ES); 500 ML; 1 BOX(ES); 60 ML; BUBBLE WRAP
E03180 COOL0499 3924062-0800-3200       16:27 2 BOX(ES); 500 ML; 1 BOX(ES); 60 ML; BUBBLE WRAP;
E03180 COOL0217 3924062-0800-3200       16:29 1 BOX(ES)500 ML; 3 BOXES 60 ML;BUBBLE WRAP
E03180 COOL0592 3924062-0800-3200       16:30 1 BOX(ES); 1 LITER; BUBBLE WRAP;
E03180 COOL0060 3924062-0800-3200       16:30 1 BOX(ES); 1 LITER; BUBBLE WRAP;
E03180 COOL0655 3924062-0800-3200       16:30 1 BOX(ES); 1 LITER; BUBBLE WRAP;
E03180 COOL0668 3924062-0800-3200       16:30 1 BOX(ES); 1 LITER; BUBBLE WRAP;
E03180 COOL0664 3924062-0800-3200       16:30 1 BOX(ES); 1 LITER; BUBBLE WRAP;
E03180 COOL0653 3924062-0800-3200       16:30 1 BOX(ES); 1 LITER; BUBBLE WRAP;
E03180 COOL0629 3924062-0800-3200       16:30 1 BOX(ES); 1 LITER; BUBBLE WRAP;
E03180 COOL0550 3924062-0800-3200       16:31 1 BOX(ES); 1 LITER; BUBBLE WRAP;
E03180 COOL0472 3924062-0800-3200       16:31 1 BOX(ES); 1 LITER; BUBBLE WRAP;
E03180 COOL0267 3924062-0800-3200       16:31 1 BOX(ES); 1 LITER; BUBBLE WRAP;
-----------------------------------------------------------------------------------------------------------------------------
E01421 COOL0344 3924079G-0201-3200      16:48 6 SODIUM HYDROXIDE; TRASH BAGS; GLOVES; LOGSHEETS; PH STRIPS; PIPETTES; EVIDENCE TAPE;SITE IDS
                                                 :
E01421 COOL0484 3924079G-0201-3200      16:48 SITE ID 14 ; LOGSHEETS; TRASH BAGS;
E01421 COOL0151 3924079G-0201-3200      16:49 SITE ID 15 ; TRASH BAGS; LOGSHEETS; LOGSHEETS;
E01421 COOL0155 3924079G-0201-3200      16:51 SITE 16 ; TRASH BAGS; LOGSHEETS;L0001
E01421 COOL0117 3924079G-0201-3200      16:51 SITE ID 17 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0613 3924079G-0201-3200      16:52 SITE ID 18; TRASH BAGS; LOGSHEETS;
E01421 COOL0174 3924079G-0201-3200      16:52 SITE ID 19 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0669 3924079G-0201-3200      16:53 SITE ID 20 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0434 3924079G-0201-3200      16:54 SITE ID 21 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0457 3924079G-0201-3200      16:54 SITE ID 22 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0676 3924079G-0201-3200      16:55 SITE ID 23 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0675 3924079G-0201-3200      16:55 SITE ID 24 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0168 3924079G-0201-3200      16:56 SITE ID 25 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0672 3924079G-0201-3200      16:57 SITE ID 26 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0096 3924079G-0201-3200      16:57 SITE ID 27 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0674 3924079G-0201-3200      16:58 SITE ID 28 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0149 3924079G-0201-3200      16:58 SITE ID 29 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0678 3924079G-0201-3200      16:59 SITE ID 30 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0456 3924079G-0201-3200      16:59 SITE ID 31 ; TRASH BAGS; LOGSHEETS;
E01421 COOL0480 3924079G-0201-3200      16:59 SITE ID 32 ; TRASH BAGS; LOGSHEETS;

-----------------------------------------------------------------------------------------------------------------------------
E03289                    : VYLRIE MCWILLIAMS
E01421                    : ALFREDA MOORE
E03291                    : DONNA CREWS
E03180                    : DELORES DARLING
3904076-0214-3200         : -
3924031G-0202-3200        : 3924031G-0202-3200-  , MARK SKROBACZ, ESE INC, 250-A EXCHANGE PLACE, HERDON, VA.  VA.
3924062-0800-3200         : 3924062-0800-3200- ATTN: UMATILLA D & M, DAMES & MOORE (KEVIN PERRETTE ), UMATILLA ARMY DEPOT, BLDG 11, HERMI
3924079G-0201-3200        : 3924079G-0201-3200- ATTN: RARITAN, KEITH WARD, HOLIDAY INN, 125 RARITAN CENTER PARKWAY, EDISON  NJ
```

**Figure 7-4**
**EXAMPLE OF COOLER TRACKING REPORT**

SOURCE: ESE

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

Environmental Science & Engineering, Inc. 12-23-92 *** FIELD LOGSHEET *** FIELD GROUP: EXAMPLE
PROJECT NUMBER 3924000V 0000 PROJECT NAME: COMPANY XXX LAB COORD. PORTIA PISIGAN

| ESE # | SITE/STA | HAZ? | FRACTIONS(CIRCLE) | DATE | TIME | PARAMETER LIST |
|---|---|---|---|---|---|---|
| *1 | MW-1 | | EC EC VP VP VP | | | W610LC |
| *2 | MW-2 | | EC EC VP VP VP | | | W610LC |
| *3 | MW-3 | | EC EC VP VP VP | | | W610LC |
| *4 | MW-4 | | EC EC VP VP VP | | | W610LC |
| *5 | MW-5 | | EC EC VP VP VP | | | W610LC |
| *6 | MW-6 | | EC EC VP VP VP | | | W610LC |
| *7 | MW-7 | | EC EC VP VP VP | | | W610LC |
| *8 | MW-8 | | EC EC VP VP VP | | | W610LC |
| *9 | MW-9 | | EC EC VP VP VP | | | W610LC |
| *10 | MW-10 | | EC EC VP VP VP | | | W610LC |

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE,TIME,FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN COMPLETED LOGSHEETS WITH SAMPLES TO Environmental Science & Engineering, Inc.

| RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME) | VIA: | REC'D BY (NAME/ORGANIZATION/DATE/TIME) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

SAMPLER: Shipped on Ice? Yes/No; I anticipate shipping ____(#) more samples on ___/___
SAMPLE CUSTODIAN: Custody Seals Used? Yes/No; If Yes, Seals Intact? Yes/No Interior Temp? ___Deg C
Preservatives Audited? Yes/No Any Problems? Yes/No; If Yes, describe:

**Figure 7-5**
**CHAIN-OF-CUSTODY FIELD LOGSHEET**

SOURCE: ESE.

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

### 7.1.3 DOCUMENTATION

The records for laboratory sample custody include:

1. Laboratory Forms:

   Sample Kit Request Form (Figure 7-1),
   ESE Shipping Request Form (Figure 7-2),
   Kit Pick-Up Log (Figure 7-3),
   Example of Cooler Tracking Report (Figure 7-4),
   Sample Label (Figure 7-6),
   Standardized Sample Preservation Codes (Figure 7-7),
   Sample Chest Custody Form (Figure 7-8),
   Cold Room Sample Arrival Logbook (Figure 7-9),
   Sample Check In/Out Log (Figure 7-10),
   VOA GC Sample Thru-Log (Figure 7-11),
   VOA GC/MS Sample Thru-Log (Figure 7-12),
   Radiochemistry Sample Storage and Custody Logsheet (Figure 7-13),
   Conductivity Meter Calibration Form (Section 9.0), and
   pH Meter Calibration Form (Section 9.0).

2. Sample Extraction Log (Organic Laboratory/Extraction Logsheet, Figure 7-14).

Errors in all documents are corrected by following the procedure in Section 7.1.2.

## 7.2 LABORATORY CUSTODY

Sample chests (packages/coolers) are transported to the laboratory. The deliverer will sign, date, and indicate the time of delivery, the number of packages, the Laboratory Coordinator or addressee, and any comments including visible or suspected physical condition of the packages into the Sample Chest Custody Logbook (Figure 7-8). The chests are then recorded as having been received by the laboratory in the Sample Chest Custody Logbook by the Sample Custodian.

PRJ# 3924000V 0000 MW-10
COMPANY XXX
EXAMPLE*10-VP
SAMPLER DATE TIME
COND PH
G000000

Figure 7-6
SAMPLE LABEL

SOURCE: ESE.

ENVIRONMENTAL SCIENCE
& ENGINEERING, INC.

## ESE KEY TO FRACTION CODES 05/94

| | CODE | PRESERVATIVE | CONTAINER | ANALYSIS TYPE | HOLDING TIMES |
|---|---|---|---|---|---|
| AIR: | AA | 4° C | Various | Various | Various |
| | AO | Exclude Light | Sorbent | Organic | 14 Days |
| | AV | Exclude Light | Charcoal | Volatiles | 14 Days |
| | AT | 4° C | Tedlar | Volatiles | 72 Hrs |
| | FL | Exclude Light | Cassette | Various | Various |
| | HV | | Hi-Vol Filter | TSP/PM10/Metals | |
| SOILS: | SS | 4° C | G, 250 mL | All excl. Vol. | 7-28 Days |
| | SV | 4° C | G, 120 mL | Volatiles | 7-14 Days |
| WATER: | AL | 4° C# | G, 2x40 mL* | Carbamates, EPA531 | 14 Days |
| | B | 4° C; NaOH, pH>12 | P, 1-4 L** | Cyanides | 14 Days |
| | C | 4° C | P, 1-4 L | Various Inorganics | 1-28 Days |
| | CF | 4° C | P, 1-4 L | Filtered Inorganics | 1-28 Days |
| | CL | 4° C | P, 1 L, opaque | Chlorophyll | 14 Days |
| | EC | 4° C, # | G, 1 L | Chlorinated Pests | 7 Days |
| | ED | 4° C, # | G, 2x40 mL* | EDB, DBCP | 14 Days |
| | F | – | P, 1-4 L | Collection prior to Field Filtering | |
| | FI | 4° C, # | G, 40-125 mL | GC/FI Organic | 7 Days |
| | FM | Formaldehyde | P/G, 500 mL | "Quats" | 28 Days |
| | FP | 4° C, # | G, 3x40 mL* | GC/FP Organic | 14 Days |
| | H | Zn Acetate;NaOH,pH>10 | P, 1 L | Sulfides | 7 Days |
| | HB | 4° C, # | G, 1 L | Chlorinated Herbs | 7 Days |
| | IC | 4° C | G, 250mL-1L | IMPA | 40 Days |
| | LC | 4° C | G, 1 L | HPLC Organics | 7 Days |
| | M | 4° C, #, Exclude Light | P, 250 mL | Bacteriologic | 6 Hours |
| | MS | 4° C, # | G, 1 L | GCMS - SVOCs | 7 Days |
| | N | $HNO_3$, pH<2 | P, 1 L | Metals (Total) | 180 Days |
| | NF | $HNO_3$, pH<2 | P, 1 L | Metals (Dissolved) | 180 Days |
| | NC | 4° C | G, 1 L | Nitrocellulose | 7 Days |
| | NG | 4° C | G, 1 L | Nitroglycerin/PETN | 7 Days |
| | NP | 4° C | G, 1 L | GC/NP Organic | 7 Days |
| | NQ | 4° C | G, 1 L | Nitroguanidine | 7 Days |
| | O | 4° C; $H_2SO_4$, pH<2 | G, 1 L | Oil & Grease, TRPH | 28 Days |
| | OC | 4° C; $H_2SO_4$, pH<2 | G, 1 L | TOC (USAEC) | 28 Days |
| | OD | 4° C | G, 1 L | Odor | 2 Days |
| | R | $HNO_3$, pH<2 | P, 1-4 L | Radionuclides | 180 Days |
| | S | 4° C; $H_2SO_4$,pH<2 | P, 1 L | Nutrients; TOC | 28 Days |
| | SF | 4° C; $H_2SO_4$,pH<2 | P, 1 L | Filt'd Nutrients;TOC | 28 Days |
| | V | 4° C, # | G, 4x40 mL | VOCs, ex. Aromatics | 14 Days |
| | VP | 4° C; HCL, pH<2, # | G, 4x40 mL* | VOCs, w/ Aromatics | 14 Days |
| | W | 4° C, # | G, 1 L | Var. Organics | 7 Days |
| | X | 4° C | G, 250 mL | Various | Various |
| | XP | 4° C; $H_2SO_4$, pH<2, @ | G, 2x250 mL* | TOX | 28 Days |
| | Z | 4° C; $H_2SO_4$, pH<2 | G, 1 L | Total Phenols | 28 Days |
| OTHER: | OL | None | G, 10-100 mL | Organic - Oil | 14 Days |
| | TS | Frozen, <-20° C | Various | Frozen Tissue | Various |

FOOTNOTES:
- # - Add Sodium Thiosulfate ($Na_2S_2O_3$) If Residual Chlorine Present (0.25g/L).
- @ - Add Sodium Sulfite ($Na_2SO_3$) if residual chlorine present (0.1M, 1 mL/L).
- * - These fractions are prepreserved unless noted otherwise.
- ** - Test for presence of sulfide and follow EPA procedures (below) as necessary.

### INSTRUCTIONS FOR SAMPLING AND SHIPPING

- Plastic (P) containers may be rinsed with sample; Do not rinse Glass (G).
- Fill completely, especially for volatiles (fill these slowly; achieve positive meniscus; cap; invert; check for air bubbles; top off if needed).
- Preserve with reagents provided as instructed above (unless pre-preserved).
- Special cyanide preservations: When the presence of sulfide is indicated by a positive spot test with lead acetate paper, preservation consists of: 1) precipitation with cadmium nitrate until a negative test is obtained; 2) filtration of the precipitate; and 3) addition of NaOH to pH > 12.
- Fill-out logsheet/chain-of-custody. Indicate: Sample Number (*) and fractions collected; dates/times of collection & shipment; appropriate field notes. Be sure to sign and date the bottom of each page where indicated.
- Ship with bagged ice in ice-chest by express carrier to lab coordinator's attention.

Source: ESE, 1994

**Figure 7-7**
**STANDARDIZED SAMPLE PRESERVATION CODES**

SOURCE: ESE.

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

SAMPLE CHEST CUSTODY FORM

**DO NOT REMOVE FROM CHECK-IN AREA**

| Relinquished By: | | | | |
|---|---|---|---|---|
| Time | Date | Signature | No. of Chests | Coordinator |
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| Received By: | | | | | | |
|---|---|---|---|---|---|---|
| Date | Time | Project Name | Signature | Comments * | Rads>Background | |
| | | | | | Chest? | Sample? |
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* No comment means that the container was relinquished/received in good condition, properly sealed and that there was no evidence of tampering.

**Figure 7-8**
**SAMPLE CHEST CUSTODY FORM**

SOURCE: ESE.

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

COLD ROOM SAMPLE ARRIVAL LOGBOOK

**DO NOT REMOVE FROM COLDROOM**

| Date | Time | Project Name or Field Group | No. Containers or Sample Nos. | Coordinator or Fractions | Signature | Comments |
|---|---|---|---|---|---|---|
| | | | | | | |

**Figure 7-9**
**COLD ROOM SAMPLE ARRIVAL LOGBOOK**

**SOURCE: ESE.**

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

ESE SAMPLE CHECK IN/OUT LOG

| FIELD GROUP | SAMPLE SEQUENCE # | FRACTION | INITIALS | DEPT. # | DATE OUT | DATE IN |
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**Figure 7-10**
**SAMPLE CHECK IN/OUT LOG**

**SOURCE: ESE.**

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

## ESE VOA GC SAMPLE THRU - LOG WEEK ENDING_____

| Project Coordinator | Samples & Description | Arrival Date | Checked in by | Screen Date | Analysis Date | Complaints | Comments VOA Screen Requested |
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**Figure 7-11**
**VOA GC SAMPLE THRU LOG**

SOURCE: ESE.

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

# ESE VOA GC/MS SAMPLE THRU - LOG

| Sample & Description | Sample Date | Arrival Date | Screen Date | Date Placed in Analyst Fridge | Checked in By | Trip Blank | Comments |
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GCMSVOA.LOG
11/30/93

**Figure 7-12**
**VOA GC/MS SAMPLE THRU LOG**

SOURCE: ESE.

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

## Radiochemistry Sample Receipt Log

| PROJECT COORDINATOR | PROJECT NAME | FIELD GROUP | SAMPLE SEQUENCE | ARRIVAL DATE | DELIVERED BY: | RECEIVED BY: | NOTES |
|---|---|---|---|---|---|---|---|
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RADCHEM/SAMRCT/APR93

Figure 7-13
RADIOCHEMISTRY SAMPLE STORAGE
AND CUSTODY LOG SHEET

SOURCE: ESE.

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& ENGINEERING, INC.

660

**ESE** ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

## ORGANIC LABORATORY/EXTRACTION LOG SHEET

PROJECT: _____ EXTRACTION METHOD: _____
PROJECT NO.: _____ CASE NO.: _____ SAMPLE FRACTION: _____
EXTRACTOR(S): _____ CLEAN-UP: _____ CHECKED BY: _____
DATE: _____ TIME: _____ BALANCE USED: _____

| SAMPLE NO. | VOLUME-ml MASS-gr. | INITIAL/ FINAL pH | TYPE/DATE OF CLEAN-UP | FINAL VOL. SOLVENT | SURRO-GATE ADDED Y/N | COMMENTS |
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| CHAIN-OF-CUSTODY RECORD | |
|---|---|

FORM 87287

**Figure 7-14**
**ORGANIC EXTRACTION LOG SHEET**

SOURCE: ESE.

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The samples are checked in by the Sample Custodian for proper preservation (e.g., pH, temperature), integrity (e.g., leaking, broken bottles), and proper and complete sample documentation and ID. Sample chests or coolers that are not within the 4 $\pm$ 2 degrees Celsius (°C) requirement are reported immediately to the Laboratory Coordinator to determine if resampling will be required. All samples contained in the shipment are compared to the logsheet(s) to ensure that all samples designated on the logsheet have been received. Any changes in station ID from the originally established station ID are noted. The Sample Custodian will note any special remarks concerning the shipment. The Sample Custodian reviews the integrity of all sample fraction containers, checks the accuracy and clarity of all documentation received, and scans all the samples for radioactivity level. The Sample Custodian audits all fractions requiring field preservation to ensure that they have been properly preserved. The Sample Custodian will preserve unpreserved fractions or add additional preservative, if needed, on receipt. Deficiencies in sample preservation, additional preservative added, and all other inadequacies are recorded on the logsheet and reported to the Laboratory Coordinator.

All insufficiencies and/or discrepancies are recorded on the logsheet and immediately reported to the appropriate Laboratory Coordinator. The Laboratory Coordinator will inform the Project Manager and field team. The Project Manager, upon consultation with the Project QA Coordinator, may decide if resampling is required.

After all samples and documentation have been reviewed and appropriately annotated, the Sample Custodian signs the logsheet and submits it to Information Services for processing. Any marks or notes made on the chain-of-custody document by the Sample Custodian should be clearly distinguished from original field notations.

Shipping receipts are stapled on chain-of-custody logsheets and stored in the project file.

Samples are placed in appropriate storage areas in the laboratory depending on storage requirements. The Department Managers or their designee are notified that the samples

have arrived through the distribution of arrival notices. The majority of the samples are stored in the main coldroom with the temperature maintained at 4 $\pm$ 2°C. The Sample Custodian will log the samples delivered into the coldroom in the Cold Room Sample Arrival Logbook (Figure 7-9). The coldroom is kept locked when not in use. The water samples for metals analysis (fractions N and NF) are stored in a separate air-conditioned storage room located near the metals sample preparation area. This room is also kept locked if not being used by the analyst. The samples in these storage areas are assigned to labeled shelves by field group. A sample location list is posted at the door of each storage room. Access to samples is limited to authorized personnel, and a Sample Check In/Out Log is maintained (Figure 7-10). ESE has started to institute the bar code system to track samples that were taken in and out of the main coldroom.

The samples for volatile organics are delivered directly to the gas chromatography (GC)-Volatiles or gas chromatography/mass spectrometry (GC/MS) Department by the Sample Custodian and are stored in the department's refrigerators designated for sample storage only. The samples delivered to these departments by the Sample Custodian are logged in the department's Sample Thru-Log (Figures 7-11 and 7-12). Sample fractions for volatiles are stored separate from standards or semivolatile fractions in order to minimize cross-contamination. Samples remain in storage until it is unnecessary to retain them, at which time their disposition (in accordance with Section 8.0) is noted.

The samples for radiochemistry analyses are delivered directly to the Radiochemistry Department and logged into the Sample Storage and Custody Logsheet (Figure 7-13). Samples checked out and checked in from this storage room are also documented in the Sample Storage and Custody Logsheet.

When it is necessary to use another laboratory for sample analysis, the Laboratory Coordinator is responsible for arrangements with the second laboratory. The samples will only be subcontracted to a NEESA, HAZWRAP, FDER, state and federal government agency, or client-approved laboratory (as appropriate). Specific NEESA/HAZWRAP

approval is required prior to subcontracting. Documentation to transfer to another laboratory must include: collection data and time, field ID, laboratory ID, date of sample preparation, and requested analyses.

The samples should be chilled prior to and during shipment. A logsheet indicating samples and fractions sent must accompany the samples to the subcontractor. The subcontractor should sign and date the logsheet upon receipt of the samples. A copy of the signed logsheet will be returned to ESE and placed in the project file.

## 7.3 LABORATORY INFORMATION MANAGEMENT SYSTEM (LIMS)

CLASS™ is an automated, inhouse-developed LIMS that integrates information from sample collection, laboratory analyses, and QC requirements; and calculates, checks, stores, and reports data in a variety of formats. CLASS™ resides on a Novell Arcnet (using Novell SFT, version 2.11) IBM-PC-compatible network with 1,600 megabytes of storage and is connected to more than 80 personal computers (PCs) throughout the Gainesville chemistry laboratories and offices. CLASS™ is managed by the Laboratory Information Services Department within the Gainesville laboratory. All data from analyses performed by the laboratory are managed and stored using CLASS™.

The database is stored, processed, and retrieved using the database manager Advanced Revelation© (copyright Revelation Technologies). The file structure and indexing provided by Advanced Revelation© allow easy retrieval, grouping, and formatting of data. Incorporated into the system is the ability to combine field data, analytical results, and QC data and produce specially formatted project-specific reports, statistical analyses, plots, and electronic files.

CLASS™ manages the flow of samples and data through the laboratory. Prior to sampling, the Laboratory Coordinator provides information on the number of samples, site IDs, parameters to be analyzed, and estimated collection dates. This information is

entered into CLASS™ and used to produce sample labels and chain-of-custody logsheets (Figure 7-5). A unique ESE number is assigned to each sample, and labels with that number and the site ID are placed on each container for that sample. At each site, samples are collected and placed in the appropriate prelabeled containers. Sampling information is recorded on the field logsheet. Samples accompanied by the field logsheet are sent to the laboratory where they are checked and processed by the Sample Custodian. Samples are stored in the coldroom at 4 $\pm$ 2°C. The logsheet is submitted to the Laboratory Information Services Department, where the samples, along with the date of collection and site ID, are logged into CLASS™. Logsheets are placed in the project file and maintained by Information Services.

ESE uses a combination of EPA Storage and Retrieval (STORET) numbers and company-assigned Method Codes to designate parameters required for analysis. Each STORET-method combination has its own laboratory QC requirements specific to that analytical method stored in CLASS™. A list of all required parameters is logged into the computer with each sample. This list is identified on the field logsheet for each sample.

The sampling information is entered into the computer to activate the parameter list for the samples collected and received by the laboratory. A report (Available Numbers) of samples available for each analysis indicates the number of days left before the holding time is exceeded for each method for each sample. This report is distributed daily to each analytical department, and the information also can be accessed readily from CLASS™ by the Laboratory Coordinator or any analyst in the laboratory.

CLASS™ uses a batch method for analyzing, checking QC, and calculating final results of samples. Prior to analyzing a sample batch, the analyst will designate a specified group of samples in the computer and the sample-parameter status will be updated to "IL" ("In Laboratory"). The analytical batch is assigned a unique batch control number, which is stored with all final data, to facilitate data review, QC reporting, and retrieval of original documentation.

The production of each laboratory batch usually requires several distinct activities. Instrument calibrations are entered first and includes several QC checks by CLASS™. The linear (or quadratic or logarithmic) regression equation and correlation coefficient are calculated from the calibration curve data, and the correlation coefficient is tested to determine whether it is within an acceptable range specific to the analysis. Method blank and control spike information are then entered, and results are calculated and checked against control limits for that method. Sample responses are entered into the batch, and final concentrations are calculated for each sample. Responses are checked to ensure that they are bracketed by the standard curve. The batch printout includes a QC summary showing the automated QC checks, such as holding times, the presence of spikes, and acceptable spike recoveries. Any discrepancies are flagged by the computer for the analyst.

The batch printout also documents that the analyst has checked data entries and provided all required documentation for the analysis. The batch printout is completed, signed, and dated by the analyst, and reviewed and signed by the Department Manager or a designated reviewer.

Analysts use the PC to reserve samples for analysis, calculate final concentrations, and interactively check calibration curves and QC results. By allowing the analyst to enter data directly and check QC and sample results, the analyst is made aware of QC problems. When the analyst has entered the curve and QC and sample data, the batch printout (including checklists), worksheets, copies of notebook pages and any other pertinent documentation (e.g., chromatograms), are placed in a file folder with the assigned batch number and submitted to Information Services. Information Services personnel process the batch in the computer to verify QC and to update the sample records and final calculated concentrations.

Each employee is assigned an individual access code for entry into CLASS™. Laboratory personnel and Laboratory Coordinators are not permitted to update sample records; this is done exclusively by Information Services. All personnel with an access code may retrieve information from the system.

Once a batch has been finalized by Information Services, the batch is locked, and data cannot be changed by the analyst. If a data change is necessary, a Batch Update Request Form (Figure 7-15) must be completed. This form requires the reason for the change,the approval of the Laboratory Department Manager, and the approval of the Laboratory Coordinator. The form is then submitted to Information Services, where the original batch folder is retrieved. Information Services personnel make the change, the form is stapled to the new batch printout, and the updated batch is reviewed and approved by the Laboratory Department Manager and Laboratory Coordinator.

The batch folders, with all supporting documentation, are filed chronologically by department in a secured Information Services storage room; file cabinets with project files are stored similarly. These may be signed out for review by the analysts, Laboratory Coordinators, or QA personnel. A program in CLASS™ is used to track folders that have been checked out. Batch folders and project files are kept a minimum of 5 years.

Laboratory personnel and Laboratory Coordinators use the computer to monitor the flow of data through the system. Data are accessed and reported by sampling event, project, or any subset of samples and parameters. A log of electronic transfers is kept by Information Services. CLASS™ enables the Laboratory Coordinator to:

1. Produce a variety of summary reports of analytical data;
2. Calculate parameters from analytical data (e.g., cation/anion balance);
3. Calculate statistics such as mean, maximum, minimum, and standard deviation;
4. Calculate atmospheric concentrations;

BATCH UPDATE

Batch # _____ Analysis _____ Dept.# _____

Request to (circle one): DEFINALIZE or CHANGE

Initiated by: _____ In Order to:

APPROVED/ACKNOWLEDGED BY:

Dept. Manager _____ Date _____

Lab Coordinator(s) _____ _____

_____ _____

_____ _____

Changes Processed by: _____ _____

UPDATED Batch Reviewed & Approved by: _____ _____

Batch Refinalized by: _____ _____

**Figure 7-15**
**BATCH UPDATE REQUEST FORM**

SOURCE: ESE.

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

5. Produce a data file to be read into the Statistical Analysis System (SAS) for in-depth statistical analysis;
6. Summarize QC in various formats; and
7. Produce a project-specific export-data file.

Data are stored in the CLASS™ database and can be exported electronically into Lotus and DBASE files. Many client-requested formats have been developed in CLASS™ for electronic data transfer. When a client requests an electronic data transfer, a regularhardcopy data report is usually sent in addition to the electronic file. Copies of both electronic and hard copies are maintained in project files.

Information Services has a staff of computer programmers to maintain and modify CLASS™. Requests for new programs or changes are kept in both electronic and hardcopy files; the names of the person making the request and the programmer are included. Every change made to a program is documented electronically at the end of the program with the date, employee number of the programmer, and a brief description of the change. A summary of these changes is maintained in CLASS™ listing the programs, changes, requestors, and programmers. All program revisions are documented in a revisions file and can be reviewed anytime. Completed requests are tested by the programmer staff and then verified by the requestor.

The Laboratory QC Coordinator validates a portion of the data quarterly by recalculations from the raw values and verification that the computer is performing calculations correctly.

The database is backed up daily except Saturday using optical disks or equivalent high-density storage media. These disks are stored in the Information Services air-conditioned locked storage room located in a separate building. Archived electronic data are stored in special files accessible by Information Services personnel. Laboratory Coordinators can access the status of all data (including archived samples in CLASS™) and may request that sample data be restored for more thorough review.

# 8.0 ANALYTICAL PROCEDURES

## 8.1 STANDARD PROCEDURES

Standard analytical procedures to be used for any project for chemical analysis of water and soil are referenced in Section 5.0. Laboratory Department Managers will ensure that only these standard analytical methods are employed by the staff. Standard analytical methods manuals are required for all departments, and development of the documents are ultimately the responsibility of the department managers. The methods cited in these documents will be the methods normally used. Any deviation from the standard method must be documented in the analyst notebook and approved by the department manager.

For parameters not listed, nonstandard methods may be specified by the client or developed by the laboratory. Nonstandard methods must be validated as described in Section 8.3.

## 8.2 NONSTANDARD METHODS VALIDATION

If other than standard analytical methods become necessary due to a change in work scope, it is necessary to validate the analytical method. The responsible department manager must establish thorough method validation so that the method selected measures the reported parameter with the necessary precision, accuracy, and detection limit and without severe interference by other constituents in the sample. Major modifications of standard methods such as extraction, preparation, and cleanup procedures and/or the application of a standard method to new analytes or matrices will require method validation. Nonstandard methods will be submitted to the appropriate agency (i.e. NEESA, HAZWRAP, FDEP, USAEC, etc) for review and approval prior to use on samples for analyses.

The following subsections constitute the minimum requirements for initial establishment of the accuracy, precision, and detection limit of nonstandard methods.

For each parameter of interest, seven replicate spike samples will be prepared from laboratory blank water (for water methods) or an uncontaminated "standard" appropriate matrix (for soil or tissue methods) at one appropriate analyte concentration. Spiked samples will be analyzed according to the method. An unspiked "standard" matrix blank or unspiked laboratory blank water will be analyzed. The spiking concentration should be selected such that the final extract or aliquot can be analyzed with less than tenfold dilution in the midrange of the calibration curve.

The detection limit of each parameter of interest will be determined according to the protocols described in 40 CFR Part 136 Appendix B.

Accuracy (Recovery)--The minimum requirements for initial establishment of accuracy for nonstandard methods are as follows:

1. Calculate the found concentration for each spiked sample as follows:
   R = measured concentration = measured concentration in spiked sample minus the measured concentration in unspiked (blank) sample.
2. Calculate the percent recovery for each spiked sample as follows:

$$P = \frac{R}{S} \times 100\%$$

where: R = measured concentration for each spiked sample, and
S = target concentration for each spiked sample.

3. Calculate the average percent recovery and relative standard deviation of the percent recovery for the spiked "standard" samples as follows:

$$\overline{P} = \frac{P_1 + P_2 + P_3}{3} = \begin{matrix}\textit{(standard samples)} \\ \textit{average percent recovery}\end{matrix}$$

where: $S_r$ = standard deviation of P

$$S_r = \sqrt{\frac{1}{n-1}\left[\left(\sum_{i=1}^{n} R_i^{\,2}\right) - \frac{1}{n}\left(\sum_{i=1}^{n} R_i\right)^2\right]}$$

where: n = number of recovery values, and

$RS_r$ = relative standard deviation of P.

$$RS_r = \frac{S_r}{P} \; x \; 100\%$$

Precision--The minimum requirements for initial establishment of precision for nonstandard methods are as follows:

1. Calculate the RPD between each pair of replicate sample matrix spike samples.

$$RPD_1 = \frac{|\ R_1 - R_2\ |}{(R_1 + R_2)/2} x 100$$

$$RPD_1 = \frac{|\ R_1 - R_3\ |}{(R_1 + R_3)/2} x\ 100$$

$$RPD_3 = \frac{|\ R_2 - R_3\ |}{(R_2 + R_3)/2} x 100$$

2. Calculate the average RPD for the sample matrix spikes.

$$RPD = \frac{RPD_1 + RPD_2 + RPD_3}{3}$$

Detection Limit--The detection limit of the method is the lowest sample concentration that can be reliably recovered and measured in the sample matrix with a low background level. Statistically based procedures to determine absolute method detection limits (MDLs) as described in 40 CFR Part 136 Appendix B will be used. The reported detection limit for a method will be subject to the judgment of the analyst and the department manager and should take into account background levels, instrument baseline noise, spiking recoveries, and the lowest calibration standards analyzed. In general (except for those methods where the detection limit is derived from instrument considerations), the reported detection limit for a method is determined by the lowest standard concentration analyzed, taking into consideration the sample volume or weight of sample used and the final extract volume (where applicable).

Method validation and method detection limits determination results should be recorded and submitted to the Department Manager and Laboratory QA/QC Manager prior to the initiation of analysis. Before analysis begins, the department manager will assure that the method meets the performance criteria required by the project.

Once the method is validated, these initial validation data (precision and accuracy) are periodically revised, updated, and improved using the data acquired during the laboratory's routine analytical QC program.

## 8.3 LABORATORY GLASSWARE

Dirty glasswares are drained of solvents and rinsed with tap water, if soils or other residues are still remaining, before they are submitted to the ESE washroom for cleaning. Glasswares from the Metals and Radiochemistry Departments are always rinsed with tap water prior to submittal to the washroom.

A completed Glassware Washing Request Form (Figure 8-1) must accompany each box of glasswares brought to the ESE washroom. All laboratory glasswares (i.e., volumetric flasks, separatory funnels, extraction tubes, beakers, graduated cylinders, and others) are cleaned according to the analysis/parameter group listed in Table 8-1. These cleaning procedures are subject to change depending on the requirements of the projects. The washroom personnel perform cleaning procedures 1 through 4 listed in the table, unless otherwise directed in writing by the analyst via the Glassware Washing Request Form. Cleaned glassware for organic analyses are placed in boxes lined with fresh aluminum foil. The form is then initialled, dated, and the type of cleaning procedures performed specified by the washroom personnel. The remaining cleaning procedures are performed by the analyst.

GLASSWARE WASHING REQUEST FORM

**TO BE DONE**

☐ Normal Wash 1) Hot soapy tap water wash
2) Tap water rinse
3) DI rinse

☐ Rinse with DI only!

☐ Other _____ (be specific)
_____
_____
_____

SOLVENT RINSE

☐ Acetone

☐ Other _____
_____
_____

NEEDED BY: _____
Date and Time

SPECIAL INSTRUCTIONS: _____
_____
_____
_____

REQUESTED BY: _____

THE FOLLOWING HAS BEEN COMPLETED

☐ Normal Wash

☐ Rinse with DI only!

☐ Other _____
_____
_____
_____

SOLVENT RINSE

☐ Acetone

☐ Other _____
_____
_____

COMPLETED BY _____

DATE _____

Figure 8-1
GLASSWARE WASHING
REQUEST FORM

SOURCE: ESE.

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Table 8-1. Glassware Cleaning Procedures

| Analysis/Parameter | Cleaning Protocol* |
|---|---|
| Extractable Organics | 1,2,3,4,5,6 |
| Purgeable Organics (Volatiles) | 1,2,3,4,7,13 |
| HPLC Analyses | 1,2,3,4,5,10 |
| EDB, DBCP, THMS | 1,2,3,4,5,8,13 |
| Trace Metals | 1,2,3,4,12 |
| Nutrients | 1,2,3,4,11 |
| Minerals | 1,2,3,4 |
| Residues | 1,2,3,4,14 |
| Cyanide, Oil and Grease, Phenols | 1,2,3,4 |
| Petroleum Hydrocarbons | 1,2,3,4,5,9 |
| COD, BOD | 1,2,3,4 |
| Radiochemistry | 1,2,3,4 |

Note: DBCP = 1,2-Dibromo-3-chloropropane
EDB = 1,2-Dibromoethane
HCL = Hydrochloric acid
HNO3 = Nitric acid
HPLC = High Pressure Liquid Chromatography
THMS = Trihalomethanes

*Cleaning Procedures

1. Remove all labels using sponge or acetone.
2. Wash with hot soapy water (use Liquinox soap only) using brushes to scrub inside of glasswares, stopcocks, and other small pieces if possible.
3. Rinse three times with hot tap water.
4. Rinse three times with deionized water.
5. Rinse thoroughly with pesticide grade acetone.
6. Rinse with pesticide grade Methylene Chloride.
7. Rinse with pesticide grade methanol.
8. Rinse with pesticide grade hexane.
9. Rinse with appropriate extraction solvent prior to use .
10. Rinse with pesticide grade acetonitrile and pesticide grade methanol prior to use, if needed.
11. Acid rinse with 1:1 HCL, using only metals grade HCL.
12. Acid rinse with dilute HNO3 and then with deionized water prior to use.
13. Bake at 80°C for 3-4 hours.*
14. Bake at 180°C for 3-4 hours.*

*Class A volumetric glassware should not be baked.

Source: ESE.

## 8.4 LABORATORY METHOD MODIFICATIONS

Laboratory method modifications are done either to improve the method efficiency, apply a water method with the addition of appropriate sample preparation/digestion method to soils or add new compounds to an approved method. ESE has several method modifications involving the addition of new compounds to a specific EPA method(s) or applying a water method with the addition of appropriate sample digestion/extraction method to soils. These compounds are listed in Table 8-2 and their QA targets are found in Section 5.0. Method validation have been performed and the method validation packages were submitted to FDEP for approval. These method validation studies were referenced in the appendices of this LCQAP. The method validation packages include precision and accuracy data, method detection limit studies, copy of the method used, and raw data. Method validation were performed on the following compounds listing the method and matrix used:

Table 8-2. Laboratory Method Modification Compounds

| Compound/Parameter | EPA Method | Matrix |
|---|---|---|
| Cyanide | EPA 9010 | Soil |
| Total Organic Carbon | EPA 9060 | Soil |
| Hexavalent Chromium | EPA 3060/7196 | Soil |
| Total Petroleum Hydrocarbons (TRPH) | EPA 3550, 418.1 | Soil |
| TOX | EPA 9020 | Soil |
| Gross Alpha | EPA 3050, 9310 | Soil |
| Gross Beta | EPA 3050, 9310 | Soil |
| Radium 226 | EPA 3050, 9320 | Soil |
| Radium 226, alpha emitters | EPA 3050, 9315 | Soil |
| Radium 228 | EPA 3050, 9320 | Soil |
| Freon 113 | EPA 8010 | Water |
| MTBE | EPA 8010 | Water |
| Isodrin | EPA 8080 | Water & Soil |
| Kepone | EPA 8080 | Water & Soil |
| Metolachlor | EPA 8080 | Water & Soil |
| Kelthane (Dicofol) | EPA 8080 | Water & Soil |
| Alachlor | EPA 8140 | Soil |
| Metribuzin | EPA 8140 | Soil |
| EPTC | EPA 8140 | Water & Soil |
| Butylate | EPA 8140 | Water & Soil |
| Pebulate | EPA 8140 | Water & Soil |
| Vernolate | EPA 8140 | Water & Soil |
| Atrazine | EPA 8140 | Water & Soil |
| Terbufos | EPA 8140 | Water & Soil |
| Haxazinone | EPA 8140 | Water & Soil |
| Famphur | EPA 8140 | Water & Soil |
| O,O,O-Triethyl Phosphorothioate | EPA 8140 | Water & Soil |
| Sulfotepp | EPA 8140 | Water & Soil |
| Thionazin | EPA 8140 | Water & Soil |
| Methylethyl ketone (MEK) | EPA 8240 | Water & Soil |
| Methylisobutyl ketone (MIBK) | EPA 8240 | Water & Soil |
| Acrolein | EPA 8240 | Water & Soil |
| Acrylonitrile | EPA 8240 | Water & Soil |

Table 8-2. Laboratory Method Modification Compounds
(Continued, Page 2 of 2)

| Compound/Parameter | EPA Method | Matrix |
|---|---|---|
| Carbon disulfide | EPA 8240 | Water & Soil |
| Acetophenone | EPA 8270 | Water & Soil |
| 4-Aminobyphenyl | EPA 8270 | Water & Soil |
| 4-Chloroaniline | EPA 8270 | Water & Soil |
| 2,6-Dichlorophenol | EPA 8270 | Water & Soil |
| p-(Dimethylamino)azobenzene | EPA 8270 | Water & Soil |
| 7,12-Dimethylbenz(a)anthracene | EPA 8270 | Water & Soil |
| Ethyl methanesulfonate | EPA 8270 | Water & Soil |
| o-Cresol | EPA 8270 | Water & Soil |
| p-Cresol | EPA 8270 | Water & Soil |
| 1-Napthylamine | EPA 8270 | Water & Soil |
| 2-Nitroaniline | EPA 8270 | Water & Soil |
| 3-Nitroaniline | EPA 8270 | Water & Soil |
| 4-Nitroaniline | EPA 8270 | Water & Soil |
| N-Nitroso-di-n-butylamine | EPA 8270 | Water & Soil |
| N-Nitrosomethylethylamine | EPA 8270 | Water & Soil |
| N-Nitrosopiperidine | EPA 8270 | Water & Soil |
| Pentachlorobenzene | EPA 8270 | Water & Soil |
| Pentachloronitrobenzene | EPA 8270 | Water & Soil |
| Phenacetin | EPA 8270 | Water & Soil |
| 2-Picoline | EPA 8270 | Water & Soil |
| Pronamide | EPA 8270 | Water & soil |
| 1,2,4,5-Tetrachlorobenzene | EPA 8270 | Water & Soil |
| 2,3,4,6-Tetrachlorophenol | EPA 8270 | Water & Soil |
| 2,4,5-Trichlorophenol | EPA 8270 | Water & Soil |
| 1,3,5-Trichlorobenzene | EPA 8270 | Water & Soil |

## 8.5 REAGENT STORAGE

The procedures for storing reagents in the laboratory are presented in (Section 6.0). All reagents are marked with date received and date opened.

## 8.6 LABORATORY WASTE DISPOSAL

It is important that all waste materials generated in the laboratory be disposed of promptly and properly. The following subsections describe the procedures for handling laboratory wastes.

### 8.6.1 LIQUID WASTES

1. In general, no chemical wastes may be disposed of in the sinks.
2. Only certain dilute acid wastes can be disposed of in the sinks.
3. Disposal of Standards and Solutions--As standards and solutions are made, the solvent, constituents, date, and initials must be put on the container. This information must be on the container before it is offered for disposal. Standards containing any amount of organic solvents must not be poured down the sink. Aqueous standards of organic or inorganic (metals, etc.) compounds must either be disposed of in the appropriate waste drum, or picked up by the waste technician.
4. Disposal of Solvent Wastes--All waste solvents should be disposed of in the red waste-solvent containers located throughout the different departments in the laboratory. Solvents should be segregated according to the designated chemical types and placed only in the appropriate waste-solvent container. The waste containers will be emptied on a regular basis. If the containers become full before then, the hazardous materials technician should be called so the containers can be emptied.

Solvents will be segregated as follows:

| Freon - Waste | Chlorinated Solvents | Flammable Solvents | | HPLC Solvents |
|---|---|---|---|---|
| Freon-112 | Methylene chloride | Hexane | Benzene | Methanol |
| | | Acetone | Toluene | Acetonitrile |
| | Chloroform | Pentane | Xylene | Water |
| | Carbon tetrachloride | Ethyl ether | Petroleum ether | Tetrahydro-furan |
| | | Isopro-panol | Cyclohexane | Isopropanol |

*Note: Isopropanol may be disposed of in either the flammable or HPLC container.

Specially marked waste cans are available in the water quality laboratory for waste Freon-112. Freon should never be disposed of with other chlorinated solvents.

Glass jugs will not be accepted for solvent waste. Solvents must be segregated as shown and put into the red waste containers. The hazardous waste technician should be called if the solvent cans should fill during the day, and they will be emptied as soon as possible.

5. Disposal of Extracted Water Samples--Water samples which have been solvent extracted should be disposed in the extracted water waste disposal drum located in each department.

### 8.6.2 SOLID WASTES

1. Solvent saturated solids, such as sodium sulfate saturated with methylene chloride, should be disposed of in the red solid waste cans.

2. Soil samples which have been extracted with a solvent should be disposed of in the red solid waste cans in the laboratory. These containers have a closed lid to prevent solvent fumes from entering the laboratory air. Full containers will be collected by the hazardous waste technician on a regular basis. The contents of this container will be allowed to air dry and disposed of in the trash by the hazardous waste technician.
3. Disposal of Old or Contaminated Chemicals--Commercial chemicals that are out of date or contaminated should be left in their original containers. The label should be secured and the date and initials should be marked on the container. The hazardous materials technician should then be called to pick up the material.
4. Disposal of 1-milliliter (mL) and 5-mL Autosample Vials Containing Extracts--These are to be collected in the vial collection containers in each laboratory. The containers will be emptied on a regular basis by the hazardous waste technician. If the container should become full, call the technician to have it emptied.
5. Disposal of Additional Hazardous Material--The contents will be clearly marked on the container or on an accompanying analysis report. Again, clearly date and initial the container. Contact the hazardous materials technician for pickup and disposal.
6. Disposal of Unmarked Containers, or Unknowns--These are brought to the attention of the department manager. Unknowns should not be allowed to accumulate or be misplaced. Unknowns cannot be taken for disposal until they are identified.

### 8.6.3 SAMPLE WASTES

The following procedures are employed in the disposal of excess samples that have completed all necessary testing:

1. Samples stored in the coldroom will be handled as follows:
   a. Samples will be disposed of six weeks after the sampling date unless a longer storage time is authorized by the Laboratory Coordinator.
   b. Prior to disposal, a sample throw-out report will be generated by the coldroom technician and taken to the Laboratory Coordinator/Project Manager for disposal authorization on each project.

c. The Laboratory Coordinator must use the guidelines for sample disposal to determine if the sample is hazardous.

d. Nonhazardous soil samples will be disposed of by bulking them into a drum for offsite disposal. All labels on containers must be removed prior to disposal.

e. Nonhazardous water samples will be disposed by the coldroom technician in the following manner:

   1) Water samples will be bulked into the nonhazardous water waste tanks for offsite disposal.

   2) Empty sample containers should be disposed of by breaking them in the dumpster or recycle containers. Appropriate personal protective equipment (safety glasses, gloves, etc.) must be worn when breaking empty sample containers. All labels must be removed prior to disposal.

f. If samples are deemed hazardous, the Laboratory Coordinator will generate an analysis report for the involved samples. The Laboratory Coordinator's signature on this report will be the authorization for disposal of these samples. The specific compounds for which the sample is deemed hazardous should be marked. Any additional information (i.e., known contamination which was not tested for) should also be marked on the analysis report.

g. The coldroom technician will turn the samples and the analysis reports over to the hazardous waste technician.

h. The hazardous waste technician will store the samples with their report in the hazardous waste storage building until the next hazardous waste pickup.

i. During the storage time, the hazardous waste technician will combine all compatible samples to achieve the smallest overall volume.

2. Samples not stored in the coldroom will be handled as follows:

   a. The same criteria for disposal into the waste treatment system or dumpster apply to all samples.

   b. The responsible Department Manager will give a list of samples to be disposed to the appropriate Laboratory Coordinator.

c. The Laboratory Coordinator uses the guidelines for sample disposal and his knowledge of the sample to determine if the sample should be classified as hazardous.

d. The Laboratory Coordinator will generate analysis reports for those samples deemed to be hazardous. The Laboratory Coordinator will mark the specific compounds for which the sample is hazardous on the report. The Laboratory Coordinator's signature will authorize disposal. The Laboratory Coordinator will give the throw-out list and analysis reports back to the Department Manager.

e. For those samples deemed hazardous, the Department Manager will turn the samples and a signed analysis report over to the coldroom technician for disposal.

# 9.0 CALIBRATION PROCEDURES AND FREQUENCY

Calibration procedures establish the relationship between a calibration standard(s) and the measurement of that standard by an instrument or analytical procedure. At a minimum, calibration is required: (1) when an analytical method is first set up, (2) prior to the analysis of any lot or batch of samples, (3) when the instrument detector has been subject to major maintenance, or (4) when the instrument fails the calibration QC checks.

All analytical instruments are calibrated with each use. A series of standard solutions is prepared from stock standards. These standards are either purchased from various vendors in premixed solutions or prepared directly from the stock compound. The preparation of all standard solutions is documented in a standard preparation logbook. All stock standards are dated when received, opened, and prepared (laboratory). These standards are stored in designated areas and checked for expiration dates. Specific calibration requirements for major classes of analytical procedures are described in the following sections.

## 9.1 STANDARD RECEIPT AND TRACEABILITY

Before any standard is purchased from a supplier, traceability and safety must be considered. This includes a consideration of the standards purity. The purity of the analyte of interest must be known at least to the accuracy requirements for its measurement. The manufacturer ensures this through certification and traceability statements. All laboratory standards must be traceable to a NIST (or EPA equivalent) source. Other chemicals must have a purity specification mentioned on their labels. The safety requirements are checked with the material safety data sheets (MSDS) which are supplied by the manufacturer.

Upon receipt, the standard is cross referenced to its purchase order to confirm that what was received is what was ordered. The chemical is hand delivered (special carrying case if required) to the department manager or analyst. The standard receipt date and initials

are noted on each standard. All standards are stored in designated areas for each department (Table 8-2).

## 9.2 STANDARD SOURCES AND PREPARATION

All standards used in the laboratory must be traceable to a reference source to meet the accuracy requirements as outlined in Section 5.0. The concentrations of the working solutions will depend on the calibration range of each analyte of interest. A standard is a solution of an analyte of interest with verifiable accuracy which is used to evaluate that constituent in a sample.

All new standard preparations are recorded in the appropriate standard preparation logbooks. The information recorded are the standard prepared, the source and concentration of the standard, the standard lot number, date prepared, and initials of the preparer.

The protocols for standard sources and preparation are in Table 9-1. All standards should not exceed the storage (use) life for both the stock and working solutions. Each working solution and stock solution should be labeled with date prepared, initials, concentration used, and expiration date.

Secondary dilutions made from stock standards are also recorded in the standard preparation logbook. The lot number of the stock standard used and the notebook number and/or page number will also be indicated in the logbook for traceability. Table 9-1 lists the frequency of standard preparation and storage of standards by instrument group.

## 9.3 LABORATORY INSTRUMENTS

Calibration criteria will be required for analytical operations. All the laboratory instrumentation is listed in Table 9-2. Each of these instruments will be calibrated in a manner consistent with EPA calibration protocols and/or ESE SOPs. Calibration will be documented in a parameter notebook or the analyst's notebook.

Table 9-1. Standard Sources and Preparation

| Instrument Group | Standard Source(s) | How Received | Source Storage | Preparation from Source | Lab Stock Storage | Prep Frequency |
|---|---|---|---|---|---|---|
| ICAP/MS<br>GFAA<br>CVAA<br>FLAA | Various | 1,000 ppm soln. | RT | Intermediate and/or<br>Working Stock | RT<br>RT | >5ppm Monthly<br><5ppm Daily |
| Autoanalyzer<br>($NO_2$, $PO_4$, o-Phos.,<br>CN-, TKN, $NH_4$+$NH_3$,<br>Phenol) | Various | Neat and/or<br>Solution | RT | Primary<br>Working | RT<br>RT | Monthly<br>Semiannually (CN-)<br>Daily (all others) |
| | | | | Intermediate<br>Working | RT<br>RT | Daily<br>Daily |
| IR | Various | Neat (oil) | RT | Combined primary<br>Intermediate<br>Working | RT<br>RT<br>RT | Quarterly<br>Monthly<br>Monthly |
| Visible<br>Spectrophotometer<br>UV/VIS (MBAS, $CR^{+6}$,<br>$S^{=}$, Silica) | Various | Neat | RT | Intermediate<br>Working | Refrigerator | Semiannually and<br>Monthly<br>Daily |
| TOC Analyzer (TOC, TIC) | Baxter | Neat | RT | Intermediate | RT | Monthly |
| COD Reactors | Baxter | Neat | RT | Intermediate | Refrigerator | Semiannually |
| pH Meter | Baxter | Various Buffer<br>Solutions | RT | Primary | RT | Monthly |
| Specific Ion Meter<br>(Fluoride) | Baxter | Neat | RT | Intermediate | RT | Semiannually |
| Amperiometric Titrator<br>(Acidity) | Baxter | Neat | RT | Intermediate | Refrigerator | Monthly |
| Turbimeter | Baxter | Formazin<br>Solution | RT | Working | Not stored | Daily |
| Conductivity Bridge<br>(Specific Conductance) | Baxter | Neat | RT | Primary<br>Working | Refrigerator | Monthly<br>Daily |

Table 9-1. Standard Sources and Preparation (Continued, Page 2 of 2)

| Instrument Group | Standard Source(s) | How Received | Source Storage | Preparation from Source | Lab Stock Storage | Prep Frequency |
|---|---|---|---|---|---|---|
| GC (non-VOA) | Various | Neat | Freezer | Primary | Freezer or Refrigerator | Annually |
| | | | | Intermediate | Refrigerator | Annually or Semiannually |
| | | | | Working | Refrigerator | Semiannually |
| GC (VOA) | Various (Mainly Aldrich) | Neat | Freezer | Mixed Primary | Freezer | Bimonthly |
| | | | | Working | Freezer | Bimonthly |
| | | Mixed Soln. (Early Gasses) | Freezer | Working | Freezer | Weekly |
| LC | Various | Neat | Freezer | Primary | Freezer | Annually |
| | | | | Intermediate | Freezer | Semiannually |
| | | | | Working | Freezer | Weekly |
| GC/MS (non-VOA) | Various (Mainly Suppleco) | Mixed Soln. | Freezer | Working | Freezer | Annually/Semiannually |
| GC/MS (VOA) | Various (Mainly Suppleco) | Mixed Soln. | Freezer | Working | Freezer | Semiannually |
| Radiochemistry (Counters) | Various | Soln. | RT lead-lined | Working | RT Unlined but monitored | >50% decrease in activity |

Note: RT = Room temperature.
IR = Infrared.

Source: ESE.

Table 9-2. List of Laboratory Instruments

| Analysis Type | Number | Instrument |
|---|---|---|
| Gas Chromatography/ Mass Spectrometry: | | |
| Semivolatiles | 2 | HP 5988 GC/MS/DS capillary direct with HP-7671 Autosampler[1] and HP 5987 GC/MS/DS capillary direct with HP-7671 autosampler[1]; both instruments share one HP RTE-6/VM HP 1000 computer system for data acquisition and reduction and have one HP 7959 304MB hard drive and one HP 7914 132MB hard drive for a total storage capacity of 463MB. |
| | 2 | HP 5970B GC/MS/DS capillary direct with HP 7673 Autosampler; both instruments share an HP RTE-A, HP 1000 computer system for data acquisition and reduction; and have two HP-7959 304MB hard drives for a total data storage capacity of 608MB. |
| | 1 | Finnigan INCOS50 GC/MS/DS capillary direct with HP 7673 Autosampler and HP 5890 gas chromatograph; uses a Data General DG-10 computer with 70MB hard drive; and has an IBM-PC/AT for second terminal. |
| Volatiles | 2 | HP 5995 GC/MS/DS[1] using packed column with jet separator interface and HP 5987 GC/MS/DS[1] using packed column with jet separator interface; attached to a Tekmar 2000 liquid sampler (LCS) and Tekmar 2016 sixteen position autosampler (ALS); both instruments share one HP RTE-6/VM, HP 1000 computer system for data acquisition and reduction with HP7920 50MB and HP 7914 132MB hard drives for a total data storage capacity of 314MB. |
| | 1 | HP 5970B GC/MS/DS with megabore column (DB-624, 30M x 0.53 mm ID with jet separator interface; attached to Tekmar 2000 LSC and Tekmar 2016 sixteen position ALS; uses a HP RTE-A, HP 1000 computer system for data acquisition and reduction with two HP 7959 304 MD hard drives for a total data storage capacity of 608MB. |
| | 1 | HP 5989 Engine GC/MS/DS with capillary direct megabore column, DB-624, 75M x 0.53 mm ID; attached to Tekmar 2000 LSC and Tekmar 2016 sixteen position ALS; uses a HP -425T Apollo workstation, HP-UX UNIX computer system for data acquisition and reduction utilizing the Target 2 and the Envisions software developed by THRU-PUT for HP; the compute system has to HP-6000 660MB hard drives for a total data storage capacity of 1.3GB. |

Table 9-2. List of Laboratory Instruments (Continued, Page 2 of 5)

| Analysis Type | Number | Instrument |
|---|---|---|
| | 1 | Finnigan INCOS500 XL/E GC/MS/DS with megabore column. DB-624, 75M x 0.53 mm ID with jet separator interface and Varian 3400 gas chromatograph; attached to Tekmar 2000 LCS and Tekmar 2016 sixteen position ALS; uses Data General Eclipse MV/1000 computer with 179MB hard drive and a Compaq Desk-Pro 386/20E for second terminal. |
| Gas Chromatography | 11 | HP 5890 GC configured for automatic sampling and equipped with dual Electron Capture Detectors. Three of the GCs are attached to a HP 3350 Laboratory Data System (LDS) and 7 to a PE Nelson Data Acquisition System. |
| | 2 | HP 5890 GC configured for automatic sampling and equipped with dual Nitrogen-Phosphorus Detector. The GC is attached to a PE Nelson Data Acquisition System. |
| | 2 | HP 5890 GC configured for automatic sampling and equipped with Flame Ionization and Flame Photometric Detectors. The GC is attached to a PE Nelson Data Acquisition System. |
| | 2 | HP 5890 GC configured for automatic sampling and equipped with Photoionization, Electron Capture, and Flame Ionization Detectors. The GC is attached to a PE Nelson data Acquisition System. |
| | 1 | HP 5880 GC configured for automatic sampling and equipped with dual Electron Capture Detectors. |
| | 2 | HP 5730 GC configured for automatic sampling and equipped with Electron Capture Detectors. The GCs are attached to a PE Nelson data Acquisition System. |
| | 1 | Shimadzu GC-14A configured for automatic sampling and equipped with dual Nitrogen-Phosphorus and Flame Ionization Detector. The GCs are attached to a PE Nelson Data Acquisition System. |
| | 2 | Varian 3400 GCs configured for automatic sampling. One GC is equipped with just a Flame-Photometric Detector and the other GC with dual Flame-Photometric and Flame Ionization Detectors. |

Table 9-2. List of Laboratory Instruments (Continued, Page 3 of 5)

| Analysis Type | Number | Instrument |
|---|---|---|
| | 4 | Tracor 540 GCs equipped with series mounted Photoionization and Electrolytic Conductivity Detectors. Two of the GCs are attached to a Tekmar Purge and Trap LCS 2000 sample concentrator and 16 position Tekmar ALS 2016 automatic sampler. And two of the other GCs are attached to a Tracor Purge and Trap LCS-2 sample concentrator and 10 position Tekmar ALS automatic sampler. The GCs are attached to a PE Nelson Data Acquisition System. |
| HPLC* | 1 | Schimadzu SCL-6A/SIL-6A (Controller/Injector) Gradient HPLC System with LC-6A pumps (2), ABI/Kratos 520 PCRS (post-column reactor), and Beckman 110B pumps(2); equipped with SPD-551 UV Detector and RF-551 Fluorescence Detector; and attached to a PE Nelson Data Acquisition System. |
| | 1 | Shimadzu SCL-6B/SIL-6B (Controller/Injector) Isocratic HPLC System with Beckman 110B pump; equipped with ABI/Kratos 757 UV Detector; and attached to a PE Nelson Data Acquisition System. |
| | 1 | Shimadzu SCL-6B/SIL-6B (Controller/Injector) Gradient HPLC System with LC-6A pumps (2); equipped with Kratos 757 UV Detector. |
| | 1 | Shimadzu SCL-6A/SIL-6A (Controller/Injector) Isocratic HPLC System with LC-6A pump; equipped with SPD-6AV UV/Visible Detector; and attached to a PE Nelson Data Acquisition System. |
| | 1 | Shimadzu SCL-6B/SIL-6B (Controller/Injector) Gradient HPLC System with LC-6A pumps (2); equipped with SPD-6A UV Detector; and attached to a PE Nelson Data Acquisition System. |
| | 1 | Hewlett Packard 1090 with ternary gradient solvent delivery, equipped with Diode Array Detector (DAD) and 2 UV/Visible channel outputs. |
| | 1 | Shimadzu SCL-6A/SIL-6A (Controller/Injector) Gradient HPLC System with LC-6A pumps (2); equipped with SPD-6AV UV/Visible Detector, RF-535 Fluorescence Detector and Haake DI contant temperature circulating batch; and attached to a PE Nelson Data Acquisition System. |

Table 9-2. List of Laboratory Instruments (Continued, Page 4 of 5)

| Analysis Type | Number | Instrument |
|---|---|---|
| | 1 | Shimadzu SCL-10A/SIL-10A (Controller/Injector) Gradient HPLC system with LC-10A pumps (2); equipped with SPD-10A UV Detector; and attached to a PE Nelson Data Acquisition System. |
| Metals | 1 | Perkin-Elmer Elan 5000 Inductively-Coupled Plasma/Mass Spectrometer System |
| | 1 | Jarrell-Ash 61E Inductively Coupled Plasma Emission Simultaneous Air Spectrometer System |
| | 1 | Jarrel-Ash 1100 Inductively Coupled Plasma Emission Simultaneous Air Spectrometer System. |
| | 1 | Perkin-Elmer Inductively Coupled Plasma Emission Sequential Spectrometer System. |
| | 2 | Perkin-Elmer Model 5100 Atomic Absoption Spectrophotometer System equipped with Flame and Graphite Furnace Model HGA 600 with Zeeman Backgound Correction. |
| | 1 | Perkin-Elmer 5100 Atomic Absorption Spectrophotometer System equipped with Graphite Furnace Model HGA 600 and Zeeman Background Correction. |
| | 1 | Perkin-Elmer Model 4100 ZL Atomic Absoption Spectrophotometer System equipped with Graphite Furnace and Zeeman background correction. |
| | 1 | Perkin-Elmer 3030 Atomic Absoption Spectrophotometer System equipped with Graphite Furnace and Zeeman Background Correction. |
| | 2 | Perkin-Elmer Models MHS 20 and 50B Cold Vapor Mercury Analyzer. |
| | 1 | Buck Scientific 400 Cold Vapor Mercury Analyzer. |
| | 1 | Perkin-Elmer Model 3100 Atomic Absoption Spectrophotometer equipped with Flame, Hydride Generator, and cold Vapor attachment and $D_2$ background correction. |
| | 1 | Merlin Hg-1000 Atomic Absorption/Fluorescence Mercury Analyzer System |
| | 1 | Perkin-Elmer FIAS-200 automatic flow injection Mercury/Hydride System with amalgamation attachment. |

Table 9-2. List of Laboratory Instruments (Continued, Page 5 of 5)

| Analysis Type | Number | Instrument |
|---|---|---|
| Inorganics | 1 | Dorhman DC-190 TOC Analyzer. |
| | 6 | Dionex 4000I (4) and 2000I (2) Ion Chromatographs with autosampler. |
| | 6 | Technicon II (5) and TRACCS 800 (1) Autoanalyzer. |
| | 3 | HACH 16500 COD Reactors. |
| | 6 | Corning 125 (3) pH meters. |
| | 2 | Orion 801 and 701 Specific Ion Meters with 6-position electrode switch. |
| | 1 | Perkin Elmer 1420 Scanning Infrared Spectrophotometer. |
| | 1 | Perkin-Elmer 552 UV-Visible Spectrophotometer. |
| | 1 | Baush & Lomb Spectronic 20 Visible Spectrophometer. |
| | 1 | Wallace-Tiernan Amperiometric Titrator. |
| | 3 | Hach 2100A Turbidimeter |
| | 1 | Hach Ratio Turbidimeter |
| | 8 | Metler H80 (1), Metler AE160 (5), and Metler PC2000 (2) Analytical Balances |
| | 1 | Ohaus Analytical Balance |
| | 2 | Sartorius Analytical Balance |
| Radiochemistry | 2 | EG&G Berthold LB770-2 10 Channel Simultaneous Low Background Gas Flow Proportional Counter with PC Interface-2. |
| | 1 | EG&G Ortec Multichannel Analysis (MCA) System linked with one 20% High Purity Germanuim Model GEM20180 Detector, one 35% High Purity Germanium Model GEM 35185 Detector, two EG&G Ortec Octete (16-Detector) PC Model 1000 Detectors Alpha Spectroscopy System, and a Bicron Model P-14-W Sodium Iodide Detector. |
| | 1 | Beckman LS1801 Liquid Scintillation Detector. |
| | 12 | Ludlum Model 312 Alpha Scintillation Detectors with Model 1000 Scalers. |
| | 1 | R.J. Harvey OX-600 Biological Oxidizer System. |

- The other HPLC equipments we have that can be attached to any of the five HPLC systems, if needed are: RF-535 Fluorescence Detector; Raytest Ramona 5-LS Radiochemistry Detector; Beckman 110A pump; Gilson FC-80K fraction collector; Shimadzu FCV-2AH column switching valve; Waters WISP 712 autosampler; Altex 210 manual injector; and Wescan Conductivity Detector.

Specific calibration requirements for major classes of analytical procedures are described in Sections 9.3.1 through 9.3.12. If the calibration requirements of the specified analytical method are more stringent than the procedures described in this LCQAP, the method procedures will be followed.

### 9.3.1 GAS CHROMATOGRAPH/HIGH PRESSURE LIQUID CHROMATOGRAPH (GC-NONVOLATILES/HPLC) CALIBRATION

Standard Curve Calibration--Initial calibration standard solutions will be prepared by sequential dilution of a single stock standard solution to cover the analytical working range of the method. These may be either composite standards of more than one analyte or single-analyte solutions. The concentrations will be adjusted to take into account the instrumental and method detection limit. A minimum of three initial calibration standard concentrations or the number of standards specified by the method covering the working range and a blank will be prepared and analyzed. The initial calibration standards and the blank will be analyzed in every analytical run. For EPA 608 and 8080 methods only, the required calibration standards and a blank are analyzed every analytical run for single-component pesticides. However, for multi-component pesticides (Methods 608 and 8080 only one calibration standard of each pesticides will be analyzed. This standard will be used qualitatively to determine if there are hits in the samples. If there are hits in the samples, initial calibration standards of the appropriate multi-component pesticides and samples are reanalyzed. At least one calibration standard at the middle or high range of the curve will be analyzed every 20 samples and repeated at the end of the run. A QC check standard is analyzed every time new calibration standards are prepared and analyzed to verify acceptability of the new calibration standards.

The initial calibration curve will be produced by plotting the standard response for each standard versus the concentration of each standard from the initial calibration run. The concentrations of the standards may be expressed in units of mass injected or in terms of the concentration of the standard solution, if the injection volume is constant for standards and samples. QC evaluation criteria for initial calibration, recalibration, and continuing calibrations are as follows:

1. The initial calibration curve and the subsequent recalibrations possess a minimum of three points and a blank or possess the number of calibration standards specified by the method,
2. The correlation coefficient of the curve is 0.995 or greater,
3. Continuing calibration standards are within 15 percent of the same initial calibration standard for GC (25 percent for NP detector) and within 10 percent of the same initial calibration standard for HPLC,
4. The QC check standard must be within the acceptance range provided by the vendor or within 25 percent of the standard's true if a standard from a different source or lot number is used, and
5. The calibration curve brackets the response for all samples.

Corrective actions taken if these calibration QC criteria are not met are listed in Section 13.0.

The concentration (or amount) of the injected sample will be obtained by entering the response for the sample into the initial calibration curve equation and determining the sample concentration after all appropriate extract and sample dilution factors have been applied.

For Los Alamos project, calibration requirements for organochlorine pesticides and PCBs specified in CLP SOW 12/90 will be followed.

### 9.3.2 GAS CHROMATOGRAPH (GC-VOLATILES) CALIBRATION

Standard Curve Calibration--Calibration standard solutions will be prepared as needed by sequential dilution of a single stock standard solution (prepared every 2 months) to cover the analytical working range of the method. These may be either composite standards of more than one analyte or single-analyte solutions. The concentrations will be adjusted to take into account the instrumental and method detection limit. A minimum of three calibration standard concentrations, or the number of standards specified by the method

covering the working range and a blank, will be prepared and analyzed. The calibration standards and the blank will be analyzed in every analytical run. At least one calibration standard at the middle to high range of the curve will be analyzed every 20 samples and repeated at the end of the run to ensure constant instrument response. A QC check standard is analyzed every time new calibration standards are prepared to verify acceptability of the new calibration standards. Calibration is as described in Section 9.3.1.

### 9.3.3 GAS CHROMATOGRAPH/MASS SPECTROMETER (GC/MS) TUNING AND CALIBRATION

GC/MS Tuning--Daily instrument tuning will be practiced to ensure the instrument is calibrated and in proper working condition. The GC/MS will be tuned daily with decafluorotriphenylphosphine (DFTPP) for semivolatiles analysis and bromofluorobenzene (BFB) for volatiles analysis. The mass intensity specifications for BFB and DFTPP are contained in Table 9-3. ESE performs mass calibration in conjunction with the daily instrument tuning.

Table 9-3. Mass Intensity Specifications for DFTPP and BFB

| Key Ions | Ion Abundance Criterion |
|---|---|
| For DFTPP* | |
| 51 | 30 to 60 percent of mass 198 |
| 68 | Less than 2 percent of mass 69 |
| 70 | Less than 2 percent of mass 69 |
| 127 | 40 to 60 percent of mass 198 |
| 197 | Less than 1 percent of mass 198 |
| 198 | Base peak, 100-percent relative abundance |
| 199 | 5 to 9 percent of mass 198 |
| 275 | 10 to 30 percent of mass 198 |
| 365 | Greater than 1 percent of mass 198 |
| 441 | Present but less than mass 443 |
| 442 | Greater than 40 percent of mass 198 |
| 443 | 17 to 23 percent of mass 442 |
| For BFB* | |
| 50 | 15 to 40 percent of mass 95 |
| 75 | 30 to 60 percent of mass 95 |
| 95 | Base peak, 100-percent relative abundance |
| 96 | 5 to 9 percent of mass 95 |
| 173 | Less than 2 percent of mass 174 |
| 174 | Greater than 50 percent of mass 95 |
| 175 | 5 to 9 percent of mass 174 |
| 176 | Greater than 95 percent but less than 101 percent of mass 174 |
| 177 | 5 to 9 percent of mass 176 |

*Reference: Test Methods for Evaluating Solid Waste, EPA-SW-846, 3rd Edition, November 1986.

Source: ESE.

GC/MS Calibration--Relative response factors for the individual compounds will be determined as follows:

$$RF = \frac{A_C \, Q_{IS}}{A_{IS} \, Q_C}$$

where: A = integrated area taken from the extracted ion current profile,
Q = quantity of material,
C = compound, and
IS = internal standard.

Initial calibration, using a minimum of five levels of the compound, will be used to determine the instrument linearity. The average response factor (RF) will be calculated for each compound. The response factors for the System Performance Check Compounds (SPCC) must be $\geq$0.30 (0.25 for bromoform) for EPA 8240 and $\geq$0.05 for EPA 8270. The percent relative standard deviation (% RSD) will be calculated for each calibration check compound (CCC). The percent RSD of the CCCs in the initial calibration must be $\leq$30 percent ($\leq$35 percent for EPA Method 625 only).

A 1-point calibration using a midlevel standard from the initial calibration will be used daily for all subsequent analysis. The RFs of the SPCC for EPA 8240 and 8270 in this continuing calibration standard must meet the minimum response factors specified for the initial calibration previously mentioned. The RFs of the calibration check compounds in this daily calibration standard should be $\leq$25 percent ($\leq$20 percent for EPA Method 625 only and $\leq$ 30 percent for EPA Method 8270) difference from the average RFs in the initial calibration. All other analytes should have a percent difference of 30 percent. Corrective actions taken if the QC criteria for calibrations are not met are listed in Section 13.0.

The minimum required internal standards (IS) are chlorobenzene-d5, 1,2-dichloroethane-d4, and 1,4-dichlorobenzene-d4. for volatiles and 1,4-dichlorobenzene-d4, napthalene-d8, acenapthene-d10, phenanthrene-d10, chrysene-d12, and peylene-d12 for semivolatiles. A retention time and response check will be performed on every internal standard for samples that will be analyzed. The retention time (RT) of the IS in the sample must be $\leq \pm$ 30 seconds from the previous daily calibration. The response area of the IS in the sample should not be > factor of 2 (-50% to +100%0 from the previous calibration.

### 9.3.4 GENERAL INORGANIC AND ORGANIC PARAMETERS CALIBRATION

Standard Curve Calibration--This section applies to those inorganic and organic analyses procedures [ion chromatography, colorimetric, spectrophotometric, potentiometric, infrared (IR) and ultraviolet (UV) absorption, turbidimetric] that use a standard curve for calibration [except total organic carbon (TOC) and chemical oxygen demand (COD)]. Working standard solutions will be prepared by sequential dilution of a single-stock standard to bracket the analytical working range of the method. Working standard solutions may be either composite standards of more than one analyte or single-analyte solutions. The standard concentrations will be adjusted to take into account the instrument and method, upper and lower limits of linearity, and the instrumental detection limit. A minimum of three standard concentrations, or the number of standards specified by the method, covering the working range and a blank will be prepared and analyzed. The working standards and the blank will be analyzed at the beginning of every analytical run, and at least one midlevel standard, which is the continuing calibration verification (CCV) standard, will be reanalyzed at minimum intervals of every 20 samples and at the end of the run to check for constant instrument response.

The preparation of calibration standards is verified by the analysis of the ICV solution. The initial calibration verification (ICV) is an independent standard prepared from different stock solutions than those used to prepare the calibration standards. Typically, an EPA or NIST reference is used as the ICV and is prepared according to the supplier's instructions.

The working curve will be produced by plotting the standard response for each standard versus the concentration of each standard from the initial calibration run. QC evaluation criteria for working curves are as follows:

1. The working curve possesses a minimum of three points, or the number of standards specified by the method, and a blank;
2. The correlation coefficient of the line is 0.995 or greater;
3. The response for the CCV analyzed at minimum intervals of every 20 samples (every 10 samples for cyanide for Los Alamos project) during the run and at the end of the run is within 20 percent of true value (15 percent of true value for cyanide for Los Alamos project);
4. The ICV is within 10 percent of the element's true value; and
5. The calibration curve brackets the response for all samples.

Corrective action procedures taken if these QC evaluation criteria are not met are provided in Section 13.0. The sample concentration will be obtained by entering the response for the sample into the working curve equation and determining the sample concentration after all appropriate extract and sample dilution factors have been applied.

### 9.3.5 TRACE METALS ANALYSIS CALIBRATION

Atomic Absorption Spectroscopy (AAS) Standard Curve Calibration--Working standard solutions will be prepared to include the analytical working range of the method; these solutions may be either composite standards of more than one metal or single-metal solutions. The standard concentrations will be adjusted to take into account the instrument and method, upper and lower limits of linearity, and the instrumental detection limit. A minimum of three standard concentrations, or the number of standards specified by the method, covering the working range and a blank will be prepared and analyzed. The working standards and the blank will be analyzed at the beginning of every analytical run, and at least one midlevel standard will be analyzed at minimum intervals of every 20 samples (every 10 samples for cyanide for Los Alamos project) during the run and at the end of the run to check for constant instrument response.

The calibration is verified by the analysis of the ICV solution. The ICV is an independent standard prepared from different stock solutions than those used to prepare the calibration standards. Typically an EPA or NIST reference is used as the ICV and is prepared according to the supplier's instructions. For Los Alamos project, the ICV for cynanide analysis should be distilled with the batch of samples analyzed.

The working curve will be produced by plotting the standard response for each standard versus the concentration of each standard from the initial calibration run. QC evaluation criteria for working curves are as follows:

1. The working curve possesses a minimum of three points, or the number of standards specified by the method, and a blank;
2. The correlation coefficient of the line is 0.995 or greater;
3. The response for the midlevel standard analyzed at minimum intervals of every 20 samples (every 10 samples for Los Alamos project) during the run and at the end of the run is within 20 percent of true value (10 percent of true value for GFAA for Los Alamos project);
4. The ICV is within 10 percent (20 percent for CVAA for Los Alamos project) of the element's true value; and
5. The calibration curve brackets the response for all samples.

Refer to Section 13.0 for the corrective action procedures taken if these QC evaluation criteria for calibration are not met.

The concentration of the sample is obtained by entering the response for the sample into the working curve equation and determining the sample concentration after all appropriate digestate and sample dilution factors have been applied.

Inductively Coupled Argon Plasma (ICAP) Single Point Calibration--This procedure uses a single standard concentration for each element to obtain an instrument response (emission counts) and is analyzed in every analytical run. A second single point, emission counts obtained when aspirating a blank solution (undigested, acidified DI

water), is used in conjunction with the standard to calibrate the instrument in concentration units.

The calibration is verified by the analysis of an ICV solution, which is an independent standard prepared from different stock solutions than those used to prepare the calibration standards. The elemental concentrations of the calibration verification solution must be within the calibration range of the instrument and at concentrations other than those used for instrument calibration.

A multi-element interference check solution (ICS) and a method blank (acidified DI water that is carried through the digestion process) are analyzed each day prior to analyzing the samples. For Los Alamos project, the ICS will be analyzed at the beginning and end of each analysis run or a minimum of twice per 8 hour working shift, whichever is more frequent. The ICS is used to verify the correction of spectroscopic interference caused by emissions adjacent to analyte emission lines.

The CCV solution is analyzed at minimum intervals of every 20 samples (10 samples for Los Alamos project) during the run and at the end of the run to document constant instrument response. This solution contains one-half the concentration of each element present in the calibration standards. This solution may be prepared by dilution of an aliquot of the calibration standard or prepared as a separate solution in a manner analogous to the calibration standard preparation procedure.

QC evaluation criteria for the instrument calibration standard are as follows:

1. A calibration standard and a calibration blank are used.
2. All the values for the ICV are within 10 percent of each element's true value.
3. Values for the ICS are 20 percent of each element's true value.
4. The measured concentrations of the elements in the CCV solution, for which calibration was performed, are within 10 percent of their respective true values.

Corrective action procedures if these QC evaluation criteria are not met are provided in Section 13.0.

Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) Single Point Calibration -- This procedure uses a single standard concentration for each element to obtain an instrument response (intensity counts) and is analyzed in every analytical run. A second single point, intensity counts obtained when aspirating a blank solution (undigested, acidified DI water), is used in conjunction with the standard to calibrate the instrument in concentration units.

The calibration is verified by the analysis of an ICV solution, which is an independent standard prepared from different stock solutions than those used to prepare the calibration standards. The elemental concentrations of the calibration verification solution must be within the linear range of the instrument and at concentrations other than those used for instrument calibration.

A multi-element interference check solution (ICS) and a method blank (acidified DI water that is carried through the digestion process) are analyzed each day prior to analyzing the samples. For Los Alamos project, the ICS will be analyzed at the beginning and end of each analysis run or a minimum of twice per 8 hour working shift, whichever is more frequent. The ICS is used to verify the adequate application of elemental interference equations.

The CCV solution is analyzed at minimum intervals of every 10 samples during the run and at the end of the run to document constant instrument response. This solution contains one-half the concentration of each element present in the calibration standards. This solution may be prepared by dilution of an aliquot of the calibration standard or prepared as a separate solution in a manner analogous to the calibration standard preparation procedure.

QC evaluation criteria for the instrument calibration standard are as follows:

1. A calibration standard and a calibration blank are used.
2. All the values for the ICV are within 10 percent of each element's true value.
3. Values for the ICS are adequately corrected for in the interference equations.
4. The measured concentrations of the elements in the CCV solution, for which calibration was performed, are within 10 percent of their respective true values.

Corrective action procedures if these QC evaluation criteria are not met are provided in Section 13.0.

### 9.3.6 GRAVIMETRIC METHODS CALIBRATION

Two general types of analytical balances are used at ESE: (1) the more sensitive microanalytical balance, and (2) the top-loading balance. The calibration of the microanalytical balances is verified daily by weighing the following Class S and NIST-certified weights [in grams (g)]:

| Weight (g) | Tolerance Limits |
|---|---|
| 0.2 | ± 0.0005 |
| 1.0 | ± 0.0005 |
| 3.0 | ± 0.0005 |
| 5.0 | ± 0.0005 |

The calibration of the top loading balances are verified daily by weighing the following Class S and NIST-certified weights:

| Weight (g) | Tolerance Limits |
|---|---|
| 5 | ± 0.02 |
| 20 | ± 0.05 |
| 50 | ± 0.05 |

The results are recorded in the instrument logbook. If these criteria are not met, the weight may be reweighed. If the criteria are not met for the second weighing, the balance is taken out of service and repaired. The Class S weights are sent to the

manufacturer yearly for calibration and recertification. Two sets of Class S weights are available in-house.

Qualified service personnel calibrate the analytical balances semiannually. The semiannual calibration is documented by a tag on the instrument. A set of NIST-certified weights is used to check the calibration daily. Results are recorded in the instrument notebook.

### 9.3.7 TITRIMETRIC METHODS CALIBRATION

In all cases, standard reference materials are used to calibrate the titrant and back titrant. Preparation of these materials is described in Standard Methods or other methods manuals. Known solutions of the parameter to be analyzed will be prepared and analyzed to verify titrant standardization and the analyst's ability to discern the endpoint.

### 9.3.8 TOC CALIBRATION

The Dohrman TOC analyzer is calibrated with a standard reference material using a single-point calibration. The standard is analyzed before beginning every analytical run. The linearity of the calibration is verified with a low-level and high-level standard to bracket the sample concentration. The linearity checks must be within 5 percent. The continuing calibration verification standard (using mid- to high-level standard) is analyzed every 10 samples and at the end of the run, and the response must be within $\pm 15$ percent of true value.

### 9.3.9 COD CALIBRATION

A reference material will be used to verify the 0- and 500-mg/L reading to the standard curve developed by Hach Chemical Company for COD on a spectrophotometer using the prepared sample vials. The 500-milligrams-per-liter (mg/L) standard must be within 5 percent.

### 9.3.10 BOD CALIBRATION

The oxygen probe is calibrated daily according to the manufacturer's air calibration procedure. The temperature of the incubator used for the BOD analysis will be read and recorded twice daily when in use.

### 9.3.11 TOTAL ORGANIC HALIDES (TOX) CALIBRATION

The TOX analyzer is calibrated with a standard reference material using a 3-point calibration. The linearity of the calibration is verified with a low-level and high-level standard to bracket the sample concentration. The linearity checks must be within 5 percent. The continuing calibration verification standard (using mid- to high-level standard) is analyzed every 10 samples, and the response must be within $\pm 15$ percent of true value.

### 9.3.12 RADIOCHEMISTRY CALIBRATION

In compliance with the State of Florida DHRS Radioactive Materials licensing regulations, control charts for efficiencies and backgrounds are kept for all instruments used in radiochemical counting. All standards used in calibrations and QC spiking are either from NIST or EPA. Count rates are calculated using computer software.

Alpha/Beta Proportional Counter--The 10-chamber, low-background alpha/beta proportional counting system is calibrated for counting efficiencies on a quarterly basis with Am-241 and Cs-137 standards. The alpha/beta self-absorption calibration curve for each counting chamber is determined biannually. Performance check standards are counted prior to each analytical run, and count rates must be within historical control limits. Background is also checked prior to each analytical run, and the count rate must be within historical control limits. Historical limits for the performance check standards and backgrounds are generated quarterly.

Liquid Scintillation Counter--The Beckman Liquid Scintillation Counting System is calibrated prior to each run of samples with a set of check sources and applicable standards (tritium, C-14, Pb-210, and Ra-226) provided by the manufacturer. The H

Number Quench Efficiency Correction Curve is derived from the standards and applied to the data to account for counting efficiencies.

Lucas Cell Readers for Ra-226 Counting--Each Lucas Cell and the 12 matching cell readers are calibrated with known Ra-226 standard annually. The performance check standard is analyzed prior to each instrument use, and count rates must be within historical control limits generated quarterly. A background check is also performed prior to each instrument use, and the reading must be $\leq$ 1 cpm.

Gamma Spectroscopy--Both the Na(l) and Ge(Li) detector systems are calibrated before each analysis with known source standards, depending on the matrix to be analyzed. Performance standards are counted prior to each instrument use, and count rates must be within historical limits generated quarterly. Background is also checked prior to each instrument use.

Alpha Spectrometers-- Alpha spectrometers are calibrated biannually for efficiency with known electroplated standard sources. Detectors are checked for performance daily by counting standard sources, and count rates must be within historical control limits generated quarterly. Background is checked weekly, and the count rate must be $\leq$ 0.02 cpm in any channel.

### 9.3.12.1 TRACER AND CARRIER RECOVERY ACCEPTANCE CRITERIA

All alpha activity measurements by alpha spectrometry require the use of another isotope of the same element as a tracer. A known activity of the tracer is added to the sample at the beginning of the analysis and subsequently measured by alpha spectrometry. Recovery of this tracer should be at least 40%. Samples with tracer recoveries less than 40% require reanalysis.

Analysis of the Radium-228, Strontium-89, Strontium-90, and Lead-210 require the addition of other elements as chemical carriers. The following is a list of the common chemical carriers used for these isotopes and their required minimum percent recoveries:

Radium-228

| | |
|---|---|
| Yttrium Carrier | 40% Recovery |
| Barium Carrier | 40% Recovery |

Strontium-89/90

| | |
|---|---|
| Yttrium Carrier | 40% Recovery |
| Barium Carrier | 40% Recovery |

Lead-210

| | |
|---|---|
| Lead Carrier | 40% Recovery |
| Bismuth Carrier | 40% Recovery |

Samples with carrier recoveries less than the above minimum recoveries require reanalysis.

### 9.3.13 pH CALIBRATION

Calibrate the pH meter with three buffer solutions at pH 4, 7, and 10 prior to use. Set the pH meter temperature selector to ambient temperature. Place the probe on the pH 7 buffer and adjust the calibration switch until it reads 7.00. Repeat the procedure with the pH 4 buffer solution. Read the pH of the pH 10 buffer solution. It should be 10 $\pm$ 0.05; if not, check the pH probe and internal solution and repeat the calibration procedure.

### 9.3.14 SPECIFIC CONDUCTIVITY CALIBRATION

Calibrate the instrument with 0.01 M and 0.10 M KCL solutions. The conductivity reading of the 0.01 M KCL must be 1,413 umhos ± 15% and the 0.10 M KCL 12,900 ± 15%. If the calibration standards are outside the acceptance criteria, prepare new standards and recalibrate the instrument.

### 9.3.15 PENSKY-MARTENS CLOSE-CUP TESTER CALIBRATION

Determine the ignitability of the p-xylene standard prior to use of the Pensky-Martens Close-Cup Tester. The standard should ignite at 27.2 ± 1°C. If not, check the condition and operation of the apparatus, especially the tightness of the lid, the action of the shutter, and the position of the test flame. After adjustment, repeat the test with the p-xylene standard. Read and record the barometric pressure at the time of analysis.

### 9.3.16 DISSOLVED OXYGEN CALIBRATION

The dissolved oxygen probe should be calibrated daily or prior to use in saturated air by moving the calibration knob such that the reading is at the appropriate saturation value indicated on the instrument. Read and record the temperature at the time of reading.

## 9.4 STANDARDIZATION OF TITRATION SOLUTIONS

All titrants used in the laboratory are standardized against a primary standard. This ensures that the normality of the standard being used is at the correct level. Table 9-6 lists the solutions that require standardization, the standards used, and the frequency of standardization.

Table 9-4. Standardization of Titrating Solutions

| Solutions Req. | Primary Standard Source | Frequency of Standardization |
|---|---|---|
| Chloride: | | |
| Silver nitrate | Sodium chloride | Every run |
| Alkalinity: | | |
| Sulfuric acid | Sodium carbonate | Every run |
| Sulfite: | | |
| Potassium iodide-iodate | Sulfamic acid | Every run |
| Hardness: | | |
| EDTA | Calcium carbonate | Every run |

Source: ESE.

# 10.0 PREVENTIVE MAINTENANCE

To minimize the occurrence of instrument failure and other system malfunctions, a preventive maintenance program for laboratory instruments is implemented. Routine maintenance is performed as needed depending on how often the instrument is used. There are some parts of the instrument that will wear out faster and therefore will require replacement more frequently than the others. These wearable or expendable parts are kept in supply and evaluated during analysis. The major instrumentation in the laboratory is covered by the manufacturer's service contracts or agreements.

## 10.1 DOCUMENTATION

All maintenance performed on the instruments are documented in each instrument's maintenance logbook which is kept with the instrument. The date, initials of the analyst performing the maintenance, and the type of maintenance performed are recorded in this maintenance logbook. Receipts from the routine maintenance performed by the manufacturer's representative are kept in folders and filed in the department's file cabinets. Preventive maintenance for each major piece of laboratory equipment is listed in Table 10-1.

## 10.2 CONTINGENCY PLAN

In the event of instrument failure, every effort will be made to analyze samples within holding times by alternate means. If the redundancy in equivalent instrumentation is insufficient to handle the affected samples, efforts will be made to secure the same or equivalent analyses by a NEESA, HAZWRAP, USACE or FDEP-approved laboratory, when required. The Project Manager will be advised of any required changes in methodology or location; the Project Manager should then notify the state or government agency or the client.

Table 10-1. Preventive Maintenance

| Instrument | Activity | Frequency |
|---|---|---|
| Gas Chromatographs | Change septums | Weekly or as needed |
| | Check carrier gas | Daily |
| | Change carrier gas | As needed (when pressure falls below 100 psi) |
| | Cut off edge of a capillary column | As needed |
| | Replace oxygen traps used in the gas lines | Annually or as needed |
| | Clean ECD | Annually or as needed |
| | Replenish Electrolytic Conductivity Detector | Monthly or as needed |
| | Clean detectors | Annually or as needed |
| | Check system for gas leaks | At each column change |
| High Performance Liquid Chromatographs | Replace piston seals | Quarterly |
| | Replace or rebuild the the check valves | As needed (when performance of the instrument decreases) |
| | Clean detector flow cell | As needed |
| | Check pumps | As needed |
| | Replace guard column frits | As needed (when the HPLC system pressure increases) |
| | Clean detectors | Annually or as needed |
| Gas Chromatograph/Mass Spectrometer | Clean source and system | As needed |
| | Cut off ends of capillary columns | As needed |
| | Change columns | As needed |
| | Change injection point lines | Monthly or as needed |
| | Routine maintenance performed by the manufacturer | Annually |
| Atomic Absorption Spectrophotometers (Furnace and Cold Vapor) | Clean furnace windows | Daily |
| | Check plumbing connections | Daily |
| | Change graphite tubes | Daily or as needed |
| | Clean sample cells | Daily |
| | Check gases | Daily |
| | Check optics | Annually (on contract) |
| | Change graphite contact rings | As needed |
| Inductively Coupled Plasma (ICAP) | Routine maintenance performed by the manufacturer | Annually (on contract) |
| | Clean the torch and nebulizer | Every six months or as needed |
| | Check tubing | Daily |

Table 10-1. Preventive Maintenance (Continued, Page 2 of 4)

| Instrument | Activity | Frequency |
|---|---|---|
| Inductively Coupled Plasma/ Mass Spectrometer | Routine maintenance performed by the manufacturer | Annually (on contract) |
| | Clean the torch and nebulizer | Every six months or as needed |
| | Check tubing | Daily |
| | Change oil in rotary vane | Quarterly or as needed |
| | Check interface cones | Daily |
| | Check gas pressure, gas flows, and vacuum pressure | Daily |
| Autoanalyzers | Clean tubing | As needed |
| | Check tubings | Daily |
| | Check optics | Daily |
| | Clean optics | As needed |
| | Replace the lamp | As needed (when darkening is evident) |
| Colorimeter/ Turbidimeters | Check optics | Daily |
| | Check light source | As needed |
| Spectrophotometer | Routine maintenance performed by the manufacturer | Quarterly (on contract) |
| TOX Analyzer | Clean electrodes | Daily |
| | Replace all solutions | Daily |
| | Clean absorber module and the furnace unit | Every six months or as needed |
| | Clean sampler boat | Monthly |
| | Check gases and tubing | Daily |
| TOC Analyzer | Check gases and tubing | Daily |
| | Change pump tubes | Prior to each use |
| | Flush digestion tubes | After each use |
| Ionanalyzers/Conductivity | Check probe | Daily |
| | Change probe solution | As needed |
| Ion Chromatograph | Routine maintenance performed by the manufacturer | Every six months (on contract) |
| | Check system for leaks | Daily prior to each run |
| | Check line pressure | Daily prior to each use |
| | Clean conductivity cells | Every six months |
| | Clean injection loops | Every six months |
| | Change columns | As needed |
| | Replace tubings in the sample path | Every six months |

Table 10-1. Preventive Maintenance (Continued, Page 3 of 4)

| Instrument | Activity | Frequency |
|---|---|---|
| Turbidimeter | Clean the instrument | Prior to each use |
| DO Meter and Probe | Check to make sure that the mechanical zero is set properly | Prior to each use |
| | Check DO probe membrane | Prior to each use |
| DO Meter and Probe (cont) | Replace membrane | As needed (when tears, wrinkles, or bubbles are observed) |
| | Replace probe | As needed |
| Analytical Balances | Clean the balance | Daily |
| | Check alignment and balance | Daily |
| | Routine maintenance and calibration performed by the manufacturer | Semiannually |
| Radiochemistry: | | |
| Alpha/Beta Proportional Counter | Check gas flow | Daily |
| | Check counting chambers | Monthly or as needed |
| Liquid Scintillation Counter | Check counting system | Prior to each use |
| Alpha Spectrometer | Clean detectors | As needed |
| | Clean sample chambers | As needed |
| | Check vacuum | Daily |
| | Check voltage | Daily |
| Radon Flask Counters | Clean the face of the photomultiplier tube | Daily |
| | Check microswitch | Daily |
| Gamma Spectroscopy | Refill liquid nitrogen in the dewar for the Ge(Li) detector | Weekly |
| | Check all cabling to the gamma detectors | Monthly |
| Biological Oxidizer | Clean ladel | Prior to each use |
| | Clean sample boats | Prior to each use |
| Ovens: TS, TSS, TDS | Check temperature | Prior to use |
| | Calibrate thermometer | Annually |

Table 10-1. Preventive Maintenance (Continued, Page 4 of 4)

| Instrument | Activity | Frequency |
|---|---|---|
| Refrigerators/Freezers | Check temperature | Daily |
| | Calibrate thermometer | Annually |
| BOD Incubator | Check temperature | Prior to use |
| | Calibrate thermometer | Annually |

Note: TDS = total dissolved solids. TS = total solids. TSS = total suspended solids.

# 11.0 QC CHECKS, ROUTINES TO ASSESS PRECISION AND ACCURACY, AND CALCULATION OF METHOD DETECTION LIMITS

## 11.1 INTERNAL QC CHECKS

Analytical QC procedures are those steps taken by the laboratory in day-to-day activities to achieve the desired accuracy, precision, reliability, and comparability of analytical data. Each Laboratory Department Manager and coordinator is responsible for performing the analysis in accordance with the defined quality control practices outlined in this LCQAP.

For all analyses performed by ESE, the QC checks described in this section are mandatory unless alternate procedures are given in the specific project QA Plan or otherwise agreed upon by the Laboratory Coordinator and ESE's client. Table 11-1 summarizes minimum QC sample requirements. If method QC requirements are more stringent than those listed in Table 11-1, the method requirements will be followed. Sections 3.0 and 5.0 contain QC evaluation criteria for laboratory methods and calibrations. Section 11.4 describes precision and accuracy calculations used to control samples. Laboratory Department Managers are responsible for reviewing QC criteria for each method performed by their department. Permanent changes to the acceptance criteria must be approved by the Laboratory Department and Division Managers and will be incorporated into this document in accordance with Section 3.4, Document Control. Project-specific revisions may be documented in the specific project QA Plan (DER Form 17-160.900 for FDEP projects only).

Table 11-1. Minimum QC Sample Requirements+

| Analysis | Standard Matrix (QC Check Standard) Blank | Standard Matrix (QC Check Standard) Spike* | Sample Matrix** Spike | Sample Matrix** Replicate Spike | Sample Replicate | Surrogate Spike | Filter Blank (as required) |
|---|---|---|---|---|---|---|---|
| INORGANIC | | | | | | | |
| [a]All analyses except b,c,d | 5% | 5% | 5% | 5%++++ | -- | -- | 5% |
| [b]pH, residues, specific conductivity, turbidity, dissolved oxygen | 5% | -- | -- | -- | 5% | -- | -- |
| [c]Radiochemistry only | 5% | 5% | 5% | 5%++++ | 10%+++ | -- | 5% |
| [d]TCLP | 5% | 5% | ++ | -- | -- | -- | 5% |
| ORGANIC | | | | | | | |
| [a]All analyses | 5% | 5% | 5%**** | 5%**** | -- | 100%*** | 5% |
| [b]TCLP | 5% | 5% | ++ | -- | -- | 100%*** | 5% |

Note: -- = not applicable for this analysis.

*Standard Matrix Spike (QC Check Standard) is a spike into a blank matrix which is carried through sample preparation, sample digestion or extraction to sample analysis. The blank matrix is a reagent blank for aqueous samples and a standard soil for solid matrix, if available; if standard soil is not available, spiking is done on a reagent blank. This spike is also called a QC Check Standard because the standards used to prepare the spiking solution are from a different source than those used for the calibration standards.

+Actual number rounded up to nearest whole number, i.e., 5% = 1QC for 1-20 samples; 2QC for 21-40, etc.

**Sample Matrix Spike is a spike into a sample matrix which is carried through sample preparation, sample digestion, or extraction to sample analysis.

++5%, or 1 per waste type, whichever is greater.

***Surrogate(s) will only be spiked into all environmental and QC samples if specified by the method.

+++Required for drinking water analyses and Los Alamos project only.

****For Los Alamos project, sample matrix spike and sample matrix spike duplicate for organic analysis are not required, however, they will be analyzed if requested by the client.

++++For inorganic analysi, sample matrix duplicate is not required for Los Alamos project but will be analyzed upon request by the client.

Source: ESE.

For QC purposes, the number of samples extracted and/or prepared for instrumental analysis as one group in one 24-hour period will constitute a batch. The number and type of QC samples specified in Section 11.0 will apply to this sample batch. For example, a group of samples that is extracted on the same day and (if required) undergoes concentration and cleanup procedures on subsequent days would be considered one sample lot for QC purposes.

For analyses where no sample extraction or preparation is required, the number of samples that can be analyzed as one set during a 24-hour period will determine the number of samples per sample lot for QC purposes.

When required by the specific project QA Plan, the Project QA Coordinator may insert into a sample lot either a spiked sample or a duplicate of a previously analyzed sample for QC purposes. The Project QA Coordinator will monitor the results of this sample to ensure that the analysis meets QA criteria for the project.

Blind QC check samples are analyzed by the laboratory semiannually to evaluate the laboratory's overall system. If the blind QC check sample data are not acceptable, results will be reported in the QA report to FDEP.

Spikes will be placed into sample matrices for all analyses except pH, residues, specific conductivity, and turbidity. Samples will be split into duplicates, spiked, and analyzed. The relative-percent difference between the spike and the replicate spike will be used to assess analytical precision. Selection of the sample to be split and spiked may be made by the client or by the laboratory.

Control spikes (standard matrix spikes or QC check standards) will be placed into standard matrices for all analyses except pH, residues, specific conductivity, and turbidity. This spike will be used to control the method and verify the calibration

standards, if an ICV is not analyzed. A sample replicate will be prepared and analyzed for pH, residues, specific conductivity, and turbidity. The relative-percent difference between the sample and the replicate will be used to assess analytical precision.

It is ESE's policy to control sample analyses on those QC criteria that are actually under the control of the technicians and analysts performing the analytical procedure. Therefore, emphasis is placed on calibration, method blanks, and QC check standard (standard matrix spike) results. When these are within criteria, acceptable method performance is documented. Sample matrix spikes will be reported and evaluated for precision and accuracy but not necessarily used for method control. A sample matrix spike that has recoveries outside of criteria limits will be evaluated against other available QC data within a batch to determine if the method is in control and if sample flagging is warranted. Failure of a sample matrix spike to achieve the acceptance criteria when a QC check sample in the same batch has acceptable recoveries often documents only that the method employed is not applicable to that particular matrix, not that the method is out of control.

In the following subsections, those criteria marked with an asterisk (*) will be used to control the sample analysis. Precision and spike recovery checks are discussed in further detail in Section 11.4. In addition to the QC samples specified in the following subsections, field QC blanks must be prepared and analyzed as described in Section 11.1.

### 11.1.1 GC/MS MINIMUM QC

For GC/MS analyses, the following minimum QC checks will apply, except for CLP SOW:

1. All samples spiked with surrogates.
2. At least 5 percent spikes in sample matrix (MS) with selected analytes and surrogates will be analyzed (analyzed only if requested for Los Alamos project).

3. At least 5 percent duplicate spikes in sample matrix (MSD) with selected analytes and surrogates will be analyzed (analyzed only if requested for Los Alamos project).
4. At least 5 percent QC check spikes in blank matrix with selected analytes and surrogates will be analyzed.
5. At least 5 percent method blanks spiked with surrogates will be analyzed.
6. One calibration standard will be run daily. Response factors must be within 25 percent (20 percent for EPA 625) of initial calibration response factors for selected calibration check compounds. Response factors of the SPCC must be $\geq$0.05 for EPA 8270 and $\geq$0.30 for EPA 8240 (0.25 for bromoform)
7. Instrument tuning protocols will be performed and be within criteria prior to analysis.
8. Continuing calibration standard will be analyzed at a frequency of 5 percent.

### 11.1.2 GC AND HPLC MINIMUM QC

For GC-nonvolatiles, GC-volatiles, and HPLC analyses the following minimum requirements will apply, except for CLP SOW:

1. All samples spiked with surrogate, if specified by the method.
2. At least 5 percent spikes in sample matrix (MS) with selected analytes and surrogate(s) (if applicable) will be analyzed (analyzed only if requested for Los Alamos project).
3. At least 5 percent duplicate spikes in sample matrix (MSD) with selected analytes and surrogate(s) (if applicable) will be analyzed (analyzed only if requested for Los Alamos project).
4. At least 5 percent QC check spikes in blank matrix with selected analytes and surrogate (if applicable) will be analyzed.
5. At least 5 percent method blanks spiked with surrogates (if applicable) will be analyzed.
6. At least three standards or the number of standards specified by the method will be analyzed as a standard curve.

7. Correlation coefficient of the standard curve will be equal to or greater than 0.995.
8. Samples will be within concentration range of the standards.
9. Midlevel calibration standards will be repeated at minimum intervals of every 20 samples and at the end of a run, and response of the control analytes must be within 15 percent of initial response for GC (25 percent for NP detector) and 10 percent of initial response for HPLC.
10. Detection limits for each parameter will be determined and checked to ensure they meet limits specified for the field group.

### 11.1.3 TRACE METALS--ATOMIC ABSORPTION, ICAP SPECTROSCOPY, AND ICAP/MASS SPECTROMETRY MINIMUM QC

For each batch of samples analyzed by AAS, ICAP or ICP/MS, the following QC checks will apply, except for CLP SOW:

1. At least 5 percent spikes in sample matrix (MS) with selected elements will be analyzed.
2. At least 5 percent duplicate spikes in sample matrix (MSD) with selected elements will be analyzed (analyzed only if requested for Los Alamos project).
3. At least 5 percent QC check spikes in blank matrix with selected elements will be analyzed.
4. At least 5 percent method blanks will be analyzed.
5. At least three standards or the number of standards specified by the method will be analyzed as a standard curve.
6. Correlation coefficient of the standard curve will be equal to or greater than 0.995.
7. Samples will be within concentration range of the standards (or of the ICAP instrument).

8. Midlevel calibration standards will be repeated at minimum intervals of every 20 samples and at the end of a run, and response of the control elements must be within 20 percent (10 percent for ICAP and ICP/MS) of true value.
9. At least 5 percent filter blanks will be analyzed with all filtered samples.
10. Detection limits for each element will be determined and checked to ensure they meet limits specified for the field group.

### 11.1.4 MISCELLANEOUS METHODS MINIMUM QC

For each batch of samples analyzed by ion chromatographic, colorimetric, spectrophotometric, turbidimetric, IR, UV absorption, radiochemical, and titrimetric methods (except for pH, residues, specific conductivity, turbidity, and DO), the following QC checks will apply:

1. At least 5 percent QC check spikes in standard matrix will be analyzed.
2. At least 5 percent sample matrix spikes (MS) will be analyzed.
3. At least 5 percent duplicate control spikes in sample matrix (MSD) will be analyzed (analyzed only if requested for Los Alamos project).
4. For radiochemistry methods, at least 10 percent sample replicates will be analyzed for drinking water samples and Los Alamos project.
5. At least 5 percent method blanks will be analyzed.
6. At least three standards or the number of standards specified by the method will be analyzed as a standard curve.
7. Correlation coefficient of the standard curve will be equal to or greater than 0.995.
8. For radiochemistry methods, performance check standards will be analyzed and background checks performed at the required frequency.
9. Samples will be within concentration range of the standards.
10. Midlevel calibration standards will be repeated at minimum intervals of every 20 samples (10 samples for cyanide for Los Alamos project) and at the end of

a run, and responses must be within 20 percent (10 percent for cyanide for Los Alamos project) of true value.

11. At least 5 percent filter blanks will be analyzed with all filtered samples.
12. Detection limits for analytes will be determined and checked to ensure they meet limits specified for the field group.

For each batch of samples analyzed for pH, residues, specific conductivity, turbidity, and DO, the following QC checks will apply:

1. At least 5 percent sample replicates will be analyzed.
2. At least 5 percent method blanks will be analyzed.
3. At least 5 percent filter blanks will be analyzed with all filtered samples.
4. Detection limits for analytes will be determined and checked to ensure they meet limits specified for the field group.
5. Continuing calibration standards will be analyzed at a frequency of 5 percent.

## 11.2 ROUTINE METHODS USED TO ASSESS PRECISION AND ACCURACY

### 11.2.1 PRECISION

Precision is a measure of agreement among measurements performed using the same test procedure. Precision will be assessed for applicable parameters by calculating the RPD of two duplicate spike samples as follows:

$$RPD = \frac{|R_1 - R_2|}{(R_1 + R_2)/2} x\ 100$$

where: $R_1$ and $R_2$ = concentration of Replicate Spikes 1 and 2, respectively.

This calculated RPD value is compared to the criteria specified in this LCQAP. The procedures used to determine the precision targets are listed in Table 11-2.

### 11.2.2 ACCURACY

Accuracy is the degree of agreement between a sample's target value (known concentration) and the actual measured value. Accuracy for this project is measured by calculating the percent recovery (R) of known levels of spike compounds into appropriate sample matrices. Percent recovery is calculated as follows:

$$R = \frac{100x[(SpikeSampleConc.)(Sample+SpikeVol.) - (SampleVol.)(SampleConc.)]}{(SpikeConc.)(SpikeVolume)}$$

The following equation is an example of how this would be calculated:

1 mL of spike with concentration of 100 ppb

10 mL of sample with concentration of 10 ppb

spiked sample concentration of 20 ppb

$$=100x\frac{(20)(11)-(10)(10)}{(1)(10)}=100x\frac{120}{100}=120\,percent$$

Each calculated R value is compared to the accuracy criteria listed in Section 5.0. The accuracy ranges provided in Section 5.0 are based on the mean accuracy measured or expected (based on EPA data) for each parameter plus or minus three standard deviations of the mean. The procedures used to determine the accuracy targets are listed in Table 11-2. If RPD or R values for standard spikes or sample matrix spikes within a batch do not meet acceptance criteria for QC check samples as specified in Section 5.0, results reported for samples in this batch may require flagging and/or re-analysis. The Laboratory QC Manager or designee will be notified and the necessary corrective action implemented.

### 11.2.3 CONTROL CHARTS OF ACCURACY

Control charts will be maintained for standard laboratory spike samples for FDEP, NEESA, and other specified programs. Initial control charts are prepared using historical ESE data, or are derived from published EPA method data if sufficient inhouse data are

unavailable. Control chart limits are updated yearly or more often as needed using historical data.

Control charts are graphical "pictures" that demonstrate statistical control, monitor trends in a measurement process, and diagnose a measurement problem.

The formulas used to establish and maintain control charts for standard laboratory spike QC samples are as follows:

$$USL\text{-}_x = \bar{X} + 3SD$$
$$UWL\text{-}_x = \bar{X} + 2SD$$
$$LWL\text{-}_x = \bar{X} - 2SD$$
$$LCL\text{-}_x = \bar{X} - 3SD$$

where:
X = mean of the recoveries of the laboratory spikes,
SD = Standard deviation of the mean,
UCL = Upper control limit,
UWL = Upper warning limit,
LWL = Lower warning limit, and
LCL = Lower control limit.

All recoveries will be plotted on the appropriate matrix-specific control charts.

An out-of-control situation for accuracy control charts may be indicated by the following:

1. Any one point plots outside the control limits.
2. Any eight consecutive points plot on the same side of the mean.
3. Any six consecutive points trend in the same direction.
4. A cyclical pattern is evident.
5. Any three consecutive points plot within the control limits but outside the warning limits.

The occurrence of any of these events will be investigated; corrective actions will be taken as required to return the system to a state of statistical control. All corrective actions will be documented.

Table 11-2. Methods Used to Generate Precision and Accuracy Targets

| Method | Purpose | Concentration Level | Method References |
|---|---|---|---|
| Sample Duplicate | Precision | NA | STMD2216, ASTMD 32974, 110.2, 1110, SM 2330,360.1, 150.1, 9040, 9045, 160.1, 160.1, 160.3, 900.0, 903.1, 904, 905, 908 |
| Standard Matrix Spike (QC Check Standard) | Accuracy | Low Level | 7481, 270.2, 7740, 286.2, 7911, 8240 |
| | | Mid Level | 200.7, 202, 204.2, 206.2, 208.2, 210.2, 213.2, 218.1, 219.2, 220.1, 239.2, 243.2, 245.1, 249.2, 258.1, 272.2, 273.1, 279.2, 283.2, 286.2, 6010, 7020, 7041, 7060, 7091, 7131, 7191, 7201, 7200, 7210, 7421, 7460, 7470, 7471, 7480, 7610, 7770, 7841, 310.0, HACH 8000, 335.3, 9010, 300, 325.3 353.2, 9200, 350.1, 351.2, CE-81-1 P 3-201, 365.1, 370.1, 375.4, 376.2, 9030, 305.1, 405.1, 9060, 330.1, 7196, 340.2, 130.2, 413.1, 9071, 9073, 420.1, 9066, 425.1, 418.1, 9071, 9073, 9020, 900.0, 9310, 9315, 904.0, 905.0, 908.0,501.2, 504, 505, 507, 515.1, 524.2, 531.1, 601, 8010, 602, 8020, 604, 8040, 605, 606, 8060, 608, 617, 8080,610, 8310, 615, 8150, 622, 614, 8140, 624, 8240, 8260, 625, 8270, 632, 612, 8120, 619, 633, 645, 8330, UW32, LW12, 547, 630.1 (Mod) |
| | | High Level | 903.0, 9320 |
| Sample Matrix Spike | Accuracy | Low Level | 7481, 270.2, 7740, 286.2, 7911, 8240 |
| | | Mid Level | 200.7, 202, 204.2, 206.2, 208.2, 210.2, 213.2, 218.1, 219.2, 220.1, 239.2, 243.2, 245.1, 249.2, 258.1, 272.2, 273.1, 279.2, 283.2, 286.2, 6010, 7020, 7041, 7060, 7091, 7131, 7191, 7201,7200, 7210, 7421, 7460, 7470, 7471, 7480, 7610, 7770, 7841, 310.0, HACH 8000, 335.3, 9010, 300, 325.3, 353.2, 9200, 350.1, 351.2, CE-81-1 P 3-201, 365.1, 370.1, 375.4, 376.2, 9030, 305.1, 405.1, 9060, 330.1, 7196, 340.2, |

Table 11-2. Methods Used to Generate Precision and Accuracy Targets (Continued, Page 2 of 2)

| Method | Purpose | Concentration Level | Method References |
|---|---|---|---|
| | | | 130.2, 413.1, 9071, 9073, 420.1, 9066, 425.1, 418.1, 9071, 9073, 9020, 900.0, 9310, 9315, 904.0, 905.0, 908.0,501.2, 504, 505, 507, 515.1, 524.2, 531.1, 601, 8010, 602, 8020, 604, 8040, 605, 606, 8060, 608, 617, 8080,610, 8310, 615, 8150, 622, 614, 8140, 624, 8240, 8260, 625, 8270, 632, 612, 8120, 619, 633, 645, 8330, UW32, LW12, 547, 630.1 (Mod) |
| | | High Level | 903.0, 9320 |
| Sample Matrix Spike Duplicate | Precision | Low Level | 7481, 270.2, 7740, 286.2, 7911, 8240 |
| | | Mid Level | 200.7, 202, 204.2, 206.2, 208.2, 210.2,213.2, 218.1, 219.2, 220.1, 239.2, 243.2,245.1, 249.2, 258.1, 272.2, 273.1, 279.2,283.2, 286.2, 6010, 7020, 7041, 7060, 7091,7131, 7191, 7201, 7200, 7210, 7421, 7460,7470, 7471, 7480, 7610, 7770, 7841, 310.0,HACH 8000, 335.3, 9010, 300, 325.3 353.2,9200, 350.1, 351.2, CE-81-1 P 3-201, 365.1,370.1, 375.4, 376.2, 9030, 305.1, 405.1,9060, 330.1, 7196, 340.2, 130.2, 413.1,9071, 9073, 420.1, 9066, 425.1, 418.1,9071, 9073, 9020, 900.0, 9310, 9315, 904.0,905.0, 908.0,501.2, 504, 505, 507, 515.1,524.2, 531.1, 601, 8010, 602, 8020, 604,8040, 605, 606, 8060, 608, 617, 8080,610,8310, 615, 8150, 622, 614, 8140, 624, 8240,8260, 625, 8270, 632, 612, 8120, 619, 633,645, 8330, UW32, LW12, 547, 630.1 (Mod) |
| | | High Level | 903.0, 9320 |

Note: Low Level = Concentration from the reporting limit to 5 times the detection limit.
Mid Level = The mean level between the reporting limit and the upper end of the linear range.
High Level = Concentration at the upper end of the linear range.

## 11.3 METHOD DETECTION LIMITS AND PRACTICAL QUANTITATION LIMITS

### 11.3.1 METHOD DETECTION LIMITS (MDLS)

The detection limit of the method is the lowest sample concentration which can be reliably recovered and measured in the sample matrix with a low background level. To determine absolute MDL, statistically based procedures are available from EPA methods. The MDL studies will be performed annually.

The detection limit is defined as follows for all measurements:

$$MDL = t_{(n-1,\ 1-\alpha,\ =\ 0.99)} \times S$$

where:

MDL = method detection limit,

S = standard deviation of the replicate analyses, and

$t_{(n-1,\ 1-\alpha,\ =\ 0.99)}$ = Students t-value appropriate to a 99-percent confidence level and a standard deviation estimate with n-1 degrees of freedom.

The reporting limits in Section 5.0 are derived from MDLs.

### 11.3.2 PRACTICAL QUANTITATION LIMIT (PQL)

The PQL is defined as 12 times the standard deviation that is derived from the procedures used to determine MDL.

## 11.4 COMPLETENESS

Completeness is not an FDER requirement but is an ESE-required objective. Completeness is defined by EPA as "a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions" (EPA, 1980). A completeness of at least 90 percent for each

parameter is the objective for this project. Following completion of the analytical testing, percent completeness will be calculated as follows:

$$\text{Completeness (\%) for parameter y} = \frac{\text{\# of valid y values reported}}{\text{\# of samples collected for analysis of y}} \times 100$$

If completeness is less than 90 percent for any parameter(s), the Project Manager will be notified immediately. The Project Manager is responsible for determining if resampling will be necessary to meet project objectives and will inform the Project QA Officer and Laboratory Coordinator of the decision.

# 12.0 DATA REDUCTION, VALIDATION, AND REPORTING

## 12.1 DATA REDUCTION

Data transfer and reduction are essential functions in summarizing information to support conclusions. It is essential that these processes are performed accurately and, in the case of data reduction, that accepted statistical techniques are used. ESE will use its in-house-developed CLASS™ for data management.

If applicable, example calculations must be included with the analytical method to facilitate review. The entry of input data and calculations should be checked and the signature/initials of the analyst or individual entering the data and reviewer(s) should accompany all data transfers with and without reduction.

For routine analyses performed at the Gainesville Laboratory, sample response data will be entered into CLASS™ by the analyst or other designated individual(s). The computer calculates the following:

1. Linear, quadratic, or logarithmic regression line for standards,
2. Coefficients of variation for replicates,
3. Spiked recoveries,
4. Reference sample concentrations, and
5. Sample concentrations.

Linear or quadratic equations will be used to calculate final data for laboratory analyses requiring a calibration curve:

$$\text{Concentration} = \text{Intercept} + M\ (\text{Response}) + M2\ (\text{Response})^2$$

The equation used to calculate final data is dependent on the linearity of the standard curve and method of analysis.

Purgeable organics by GC/MS are calculated as follows:

$$\text{Concentration } (\mu g/L) = \frac{(A_{sa})(Q_{is})}{(RF)(A_{is})(PV)}$$

where: $A_{sa}$ = area from the extracted ion profile of the primary characteristic ion for the target analyte in the sample,

$Q_{is}$ = quantity of the internal standard [nanograms (ng)],

RF = response factor (see Section 8.0),

$A_{is}$ = area from the extracted ion profile of the primary characteristic ion of the internal standard in the sample, and

PV = purge volume (mL).

Semivolatile organics by GC/MS are calculated as follows:

$$\text{Concentration } (\mu g/L) = \frac{(A_{sa})(Q_{is})}{(A_{is})\ (RF)} \times \frac{1}{FE} \times \frac{1}{\text{volume}} \times DF$$

where: $A_{sa}$ = area from the extracted ion profile of the primary characteristic ion for the target analyte in the sample;

$A_{is}$ = area from the extracted ion profile of the primary characteristic ion of the internal standard in the sample;

$Q_{is}$ = quantity of the internal standard (ng);

RF = response factor (see Section 8.0);

$$FE = \text{fraction extract analyzed} = \frac{\text{Volume injected } (\mu L)}{\text{extract volume } (\mu L);}$$

volume = volume of extracted sample (mL); and

$$DF = \text{dilution factor} = \frac{\text{final extract volume for injection (mL)}}{\text{extract volume prior to dilution (mL).}}$$

The final data for GC/MS semivolatiles and volatiles analyses are calculated by the computer data acquisition system attached to each mass spectrometer.

QC acceptance criteria (Section 5.0) for the relative percent difference of replicate matrix spike recoveries and for the range of acceptable recoveries are electronically stored for each STORET number/method code combination. If the samples in a batch (sample lot) do not pass all the QC checks (Section 11.0), then the results reported in all samples processed in the same sample set may be considered as suspect and the analyses may need to be repeated.

Completed batch folders are stored in a secured central location arranged by departments and numerically by batch number. Strip charts, chromatograms, copies of parameter notebooks, and all other pertinent raw data and other documentation will be stored in the batch folders.

Once the data set is complete for each sampling effort, the Laboratory Coordinator organizes the information in final reports appropriate to project requirements. This Laboratory Coordinator is responsible for final QC review and release of the data.

### 12.1.1 THE DOCUMENTATION RECORDS

#### 12.1.1.1 GC/HPLC

Prior to analysis, the analyst must obtain a file folder and all applicable logsheets and data sheets.

Extraction Logsheet--An extraction logsheet (Figure 7-14), filled out by the analyst performing the sample extraction, will accompany each lot of samples throughout analysis. This sheet will include at least the following data:

1. Project name and number,
2. Extractor's initials,
3. Type of sample matrix,
4. Field group name,
5. Sample numbers,
6. Date extracted,
7. Analyte group [e.g., pentachlorophenol (PCP), PAHs, OCPs],
8. Initial volume or wet weight of sample extracted,
9. Initial/final pH (water sample),
10. Extracting solvent,
11. Final volume/solvent,
12. Lot number(s) of solvent(s) used,
13. Date of cleanup (if required),
14. Notes and comments affecting the extraction procedure, and
15. Appearance of each sample.

After extraction is complete, extraction logsheets will be filed in the batch folder and accompany the extracted samples to the instrumental analyst. Each extract vial will be properly labeled and include the following information:

1. Project name,
2. Field group name,

3. Sample number,
4. Extraction concentration factor,
5. Date extracted, and
6. Extractor's initials.

Instrument Logbooks--During analysis, the following information will be recorded in the instrument notebook:

1. A log of the types of analyses run on the instrument, to include:
   a. Column conditions and temperature zones,
   b. Sample numbers or other identification of samples,
   c. Reference to a method describing the analysis,
   d. Analysis date,
   e. Detector used [e.g., flame ionization detector (FID)], and
   f. Detector conditions.
2. Service records, which are kept in a separate maintenance log.

Chromatograms--At the time of analysis, the analyst will include on the chromatogram the following information:

1. Date and time of analysis,
2. Analyst's initials,
3. Instrument used,
4. Field group name,
5. Sample number and other identification for each chromatogram, and
6. Concentration/dilution factor for each sample.

The chromatograms, extraction logsheet, and copies of instrument logbooks will be placed in the batch file folder.

Chromatographic Logsheets--For each analysis, the analyst will record all pertinent information on a standard curve data sheet and chromatographic data logsheet. The standard curve data sheet lists the standards, their concentrations, and the respective responses. The chromatographic data sheet lists the samples in order of injection and the factors needed for calculating the concentrations. A sample calculation using calculated response factors will appear on the back of the chromatographic data sheet if responses are calculated manually.

After the analysis and data reduction are complete, the chromatograms and worksheets will be stored in the batch file folder and the data entered into CLASS™. The folder will be turned in to Laboratory Information Services for processing and storage in the secured central filing location.

Standards--Prior to analysis, stock standard solutions and working solutions covering the working range of the method will be prepared. Procedures used in preparing the standards will be recorded in the standards preparation notebook. The following information must be recorded:

1. Reference standard source,
2. Lot number,
3. Date of preparation,
4. Analyst's name or initials,
5. Actual weight measured,
6. Volumetric flask volume,
7. Calculated concentration,
8. Solvent name and lot number,
9. Dilutions, and
10. Expiration date.

Immediately after an analytical standard has been prepared, the standard will be transferred to an amber glass vial or bottle and properly labeled. Standards should be refrigerated when not in immediate use.

### 12.1.1.2 GC/MS

Prior to analysis, the extracting analyst must obtain a batch file folder and all applicable data sheets and logsheets.

Extraction Logsheet--Once a batch has been established, the sample extraction and analysis procedure begins. A GC/MS extraction logsheet (Figure 7-14), filled out by the analyst performing the sample extraction, will accompany the batch throughout analysis. This sheet will include at least the following data:

1. Project name and number,
2. Analyst's initials,
3. Type of sample matrix,
4. Field group name,
5. Sample numbers,
6. Date extracted,
7. Analyte group (i.e., acids, base/neutrals),
8. Initial volume or wet weight of sample extracted,
9. Initial/final pH,
10. Extract solvent,
11. Final volume/solvent,
12. Lot number(s) of solvent(s) used,
13. Date of cleanup, and
14. Notes and comments affecting the extraction procedure.

After extraction, extraction logsheets will be filed in the batch file folder and accompany the extracted samples to the instrument analyst. The extract vial will be properly labeled. The label will contain the following information:

1. Project name,
2. Field group,
3. Sample number,
4. Extraction concentration factor and solvent used,
5. Date extracted, and
6. Extractor's initials.

Sample Screening--Sample extracts may be screened by GC employing flame ionization detection (GC/FID) prior to GC/MS analysis to permit dilution of extracts (as required) to concentration levels compatible with the GC/MS instrument and column capabilities.

Spectral Data and GC/MS Computer Quantitation Report--The quantitative sample and standard data generated by the GC/MS data system and all mass spectral information will be labeled according to EPA-CLP 2/88 SOW and placed in the batch file folder. Manual data reduction sheets also will be placed in this folder.

Standards--Prior to analysis, stock standard solutions and working solutions covering the working range of the instrument are prepared. Procedures used in preparing the standards must be recorded in the preparer's laboratory notebook. The following information will be recorded:

1. Reference standard source,
2. Lot number,
3. Date of preparation,
4. Analyst's name or initials,
5. Actual weight (or volume) measured,
6. Volumetric flask volume,

7. Calculated concentration,
8. Solvent name and lot number, and
9. Dilutions.

The analytical standard will be transferred immediately to a properly labeled glass amber bottle or vial after preparation. Standards should be refrigerated when not in use.

GC/MS Instrument Logbooks--Whenever the GC/MS is used for sample analysis, the following information will be recorded in an instrument logbook:

1. Instrument conditions of the gas chromatograph,
2. Instrument conditions of the mass spectrometer,
3. Analyst's initials,
4. Date of analysis,
5. Sample number,
6. Dilution factor, and
7. Frame reference number (FRN).

Compound Identification--Compound identification will be made in terms of the full-scan mass spectrum obtained in the electron impact mode at 70 electronvolts (eV). Compound identification will require the presence of all significant major ions at the appropriate relative abundance as obtained with an authentic compound or reference spectrum from a reputable literature source. The selection of significant ions is strongly compound dependent, and because of this and other considerations, the identification of compounds will entail considerable professional judgment and experience.

The most convincing evidence for compound identification is comparison of spectrum with that of an authentic compound obtained under identical operation conditions. When this is not possible due to compound availability, computer identification or manual library search will be used.

When no tentative matches are found in the library, identification will be based on application of known fragmentation patterns, empirical correlations, and isotope abundance data. All data reported as a result of library searches will be reported as tentatively identified compounds (TICs).

Compound Quantification--The technique of extracted ion current profiles will be employed for the preliminary qualitative searching and for quantification of individual compounds. Appropriate internal standards will be employed to permit quantification in terms of the relative response to these internal standards. Concentration calculations and data reduction procedures are given in Section 10.1.

Spiking with Internal Standards--All samples will be spiked with quantitation standards just prior to the GC/MS analysis (Section 11.2). Appropriate internal standards will be selected for the remaining categories.

GC/MS Instrumental Detection Limits--The instrumental detection limit refers to the least quantity of material required to provide a total mass spectrum of sufficient quantity to permit compound identification. The mass spectrum must contain all major ions with the appropriate relative abundance within 20 percent of either an authentic compound analyzed under identical conditions or an appropriate reference spectrum from the literature.

Data Management--Output from the gas chromatography/mass spectrometry/ data system (GC/MS/DS) is variable, depending on the project. However, all raw data such as mass chromatograms will be stored on magnetic tape. The final results are transmitted to CLASS™ by project and sample number. Quantification reports present the calculation results. The FRN is obtained from the quantification reports. All magnetic tapes are kept in sequential order with respect to the FRN. By following this sequence, it is possible to obtain all raw data for a particular sample number. The GC/MS computer

generates a data file that is transmitted to CLASS™. Laboratory Information Services personnel process the transmitted data and generate a batch report. The batch is returned to the analyst for review. The batch folder, containing the quantification report, batch report, copies of logsheets, and other pertinent raw data is turned into Laboratory Information Services for processing and storage in the secured central filing location.

### 12.1.1.3 Trace Metals

Prior to analysis, the analyst must obtain a file folder and all applicable logsheets and data sheets.

Digestion or Sample Preparation Logsheet--A digestion or sample preparation logsheet, filled out by the analyst performing the sample digestion or sample preparation, will accompany each lot of samples throughout the analysis. This logsheet will include the following data:

1. Method used (GFAA, CVAA, ICAP, ICP/MS)
2. Analyst's initials,
3. Date sample digested,
4. Initial volume or weight,
5. Final volume,
6. Spiking solution used and date spiking solution prepared,
7. Field Group,
8. Sample numbers, and
9. Notes or comments affecting the digestion procedure.

Strip Charts--At the time of analysis (currently only applicable to mercury by cold vapor), the following information will be recorded on the strip chart:

1. Analyst's name, initials, or employee number;
2. Date of analysis;
3. Instrument/method used;

4. Element of interest;
5. Instrument conditions;
6. Sample matrix; and
7. Comments.

During analysis, the analyst will indicate on the strip chart sample numbers, QC samples, blanks, and standards.

After the data have been reduced and recorded in the instrument notebook, the strip charts are placed in a batch file folder together with the copies of the digestion logsheet, copies of the instrument logbook, and reduction sheets. These data are entered manually or automatically uploaded to CLASS™ to generate a uniquely numbered batch. The analyst reviews the data and validates the correct transcription of data into CLASS™. Then, the batch is signed and submitted to Laboratory Information Services to be stored in the secured central filing system.

For ICAP, ICP/MS and GFAA, the instrument computers produce data files that are evaluated and transmitted to CLASS™. The analyst then generates a batch for review. The batch folder containing the batch report, the data file, copies of logsheets, and all other pertinent raw data are turned in to Laboratory Information Services for processing and storage in the secured central filing location.

Laboratory Notebooks--Each instrument will have its own laboratory notebook. After each analysis, the analyst will record in the notebook the following information:

1. Problems encountered during the digestion/analysis,
2. Comments about the samples and/or analytical procedure,
3. Instrument used,
4. Method used (GFAA, CVAA, ICAP, ICP/MS),
5. Date of analysis,

6. Analyst(s),
7. Element,
8. Sample matrix,
9. Instrument conditions,
10. Field group,
11. Sample numbers,
12. QC data, and
13. Raw data.

Standards--Stock standard solutions are purchased from vendors. These stock solutions are certified by the vendor for purity and concentration.

Standard preparations are recorded in a logbook. The information recorded includes preparer's name, lot number, date of preparation, volumes used, calculated concentrations, and dilutions.

Volumetric dilutions are made from the stock solution to obtain working solutions. Serial dilutions are then made from the working solutions to obtain working standards to be used to generate standard curves. Working standard solutions are stored in volumetric flasks and properly labeled with the following information:

1. Preparer's name or initials,
2. Date of preparation,
3. Element(s),
4. Concentration, and
5. Expiration date (if not prepared daily).

### 12.1.1.4 Inorganics

Raw data for most inorganic analyses is documented through the use of parameter notebooks. The notebooks may vary slightly in format dependent upon the type of analysis, but, at a minimum will contain the following:

1. Analysis date,
2. Parameter,
3. STORET and method code,
4. Standard curve range and responses (where applicable),
5. Analytical batch number,
6. Instrument conditions (where applicable),
7. Method reference,
8. Sample, standard, QC sample and blank identification and responses or concentration as applicable, and
9. Analyst's signature.

Raw data for specialized instrumental analyses are documented in the following sections.

**Inorganic Analysis by Autoanalyzer**

Strip Charts--The following information will be recorded on the strip chart:

1. Analyst's name, initials, or employee number,
2. Date of analysis,
3. Instrument used,
4. Analytical parameter,
5. Analytical batch number,
6. Standard calibration setting,
7. Sample, standard, QC sample, and blank sample identification above appropriate peaks, with dilution factors when applicable.

After the data have been reduced and recorded in the parameter notebook, the strip charts are placed in a batch file folder with copies of the notebook pages and any additional related information. These data are entered manually or are electronically uploaded to CLASS™ to generate a uniquely numbered batch. The batch is reviewed for correctness and signed by the analyst and submitted for peer review. When peer review is complete, the reviewer signs and submits the batch to Laboratory Information Services to be finalized and stored in the secured central filing location.

Laboratory Notebooks--Each analytical parameter has its own laboratory notebook. During analysis, the following information is recorded:

1. Date of analysis,
2. Parameter,
3. STORET and method code,
4. Batch number,
5. Instrument conditions,
6. Calibration standard setting and response,
7. Standard curve range and date of preparation,
8. Sample and QC identification numbers, and
9. Analyst's signature.

**Inorganic Analysis by Ion Chromatography**

Chromatograms--All information on the chromatograms from each analytical run is electronically recorded from the input provided during run set up. This information includes the following:

1. Analyst's initials;
2. Analytes;
3. Analysis date and time;
4. Instrument identification;
5. Integration parameters;

6. Sample, standard, and QC sample identification with concentrations and responses; and
7. Dilution factors when appropriate.

These data are electronically uploaded to CLASS™ and a unique batch number is assigned. The data are reviewed by the analyst for correctness, signed and submitted for peer review. When peer review is complete, the reviewer signs and submits the batch to Laboratory Information Services to be finalized and stored in the secured central filing location.

Laboratory Notebooks-Each instrument has its own laboratory notebook. The following information is recorded in the notebook during the set up of the analytical run:

1. Analysis date,
2. Analyte,
3. STORET and method code,
4. Instrument identification and operating conditions,
5. Calibration standards and preparation dates,
6. Notes and comments as appropriate, and
7. Sample and QC sample identification numbers with dilution factors when applicable.

**12.1.1.5 Radiochemistry**

Instrument Logbooks--Each instrument will have its own laboratory notebook. After each analysis, the analyst will record in the notebook the following information:

1. Type of analysis being performed,
2. Name of person(s) doing the analysis,
3. Sample names and numbers,
4. Notes of GM surveys performed on samples prior to counting,
5. Background information on samples prior to counting,
5. Background information on each detector,

6. Analysis date,
7. Documentation concerning sample analysis (Did samples appear to have significant count rate?),
8. Physical appearance of samples,
9. Flow rate of gases, and
10. Detector conditions.

Service records are maintained in a separate logbook and contain all information pertinent to calibration, cleaning, and repair of instrumentation.

## 12.2 DATA VALIDATION

Unless otherwise specified by the client, the following procedures for review/validation of data are employed.

### 12.2.1 LABORATORY ACTIVITIES

Data review is initiated by the bench analyst upon conversion of raw data into reportable data. The bench analyst reviews preliminary data entries, calculations, holding times and precision, accuracy, and calibration checks. The analyst provides explanation and/or corrective action for any method control parameters which are outside criteria and signs the analytical batch when ready to release the data for further processing and review.

The analyst's supervisor or a designated reviewer also reviews the analytical batch documentation associated with the batch (such as sample preparation/ digestion/extraction logsheets, instrument logsheets, copy of sample preparation, etc.) and any explanations or corrective actions provided by the analyst. If the supervisor or designee is not satisfied with the explanations or corrective actions, an additional explanation or corrective action is provided in the batch. The supervisor or designee signs the analytical batch when satisfied with the data.

The Laboratory Coordinator reviews analytical data batches that have explanations and corrective actions and signs the analytical batch when satisfied with the data. The Laboratory Coordinator also reviews all final data reports for inconsistencies and completeness prior to releasing the reports to the client; qualification or flagging, if needed, of data and/or QC summaries are provided as appropriate.

The Laboratory QA/QC Coordinator performs quarterly audits to check that required QC procedures are being followed. This procedure entails random review of analytical batches to see that the QC designated for the analysis are being consistently performed. A record of this audit is maintained by the Laboratory QA/QC Coordinator. The Laboratory QA/QC Coordinator also initiates and follows up on corrective actions to resolve QC problems.

The minimum QA/QC data that should be included in the data batch are the following:

1. Sample data (matrix, date of extraction, and date of analysis);
2. Parameter, result, and test method identification;
3. Sample-specific detection limits for each parameter; and
4. Results of laboratory control data, method blanks, spikes, and replicates (as required).

## 12.3 DATA REPORTING

Data reporting is accomplished by the Laboratory Coordinator using CLASS™. The data flow scheme for CLASS™ is presented in Figure 12-1. All client data and pertinent field information are entered into CLASS™ directly from the chain of custody sheets. A copy of this information is given to the Laboratory Coordinators for verification to ensure that all pertinent information is available and correct. An example of a Results of Analysis Report is shown in Figure 12-2. CLASS™ sorts all available samples for analyses for each parameter by due date, client ID, field group, etc. Daily reports are generated by

Laboratory Information Services and sent to each analytical department to notify them of samples that are due for analysis.

Each analyst who enters their analytical information directly into CLASS™ as a batch report. The analysts enter standard curves (linear, quadratic, or logarithmic), method blank and control spike data into CLASS™ to create a batch. Sample responses are entered into the batch and the final results are then calculated according to the methods specified in Section 7.0 of the CompQAP and Section 12.1. The analysts check all their data to ensure that all information is available and correct before signing the batch report. The analyst's supervisor or Department Manager then reviews the final batch report and signs it to verify that all data are accurate as reported. The batch is then finalized by Laboratory Information Services. Once a batch is finalized, the analyst or analyst's supervisor cannot change the data. Any requests for corrections are sent to Laboratory Information Services where the changes are made. The Laboratory Coordinator generates and prepares from CLASS™ the final report to the client. The Laboratory Coordinator reviews the final reports for inconsistencies and completeness. Deliverables will comply with NEESA/HAZWRAP or project specific requirements for the DQOL (Data Quality Objective Level) specified for each project. Prior to the release to the client the final report is peer reviewed using the checklist in Figure 12-3.

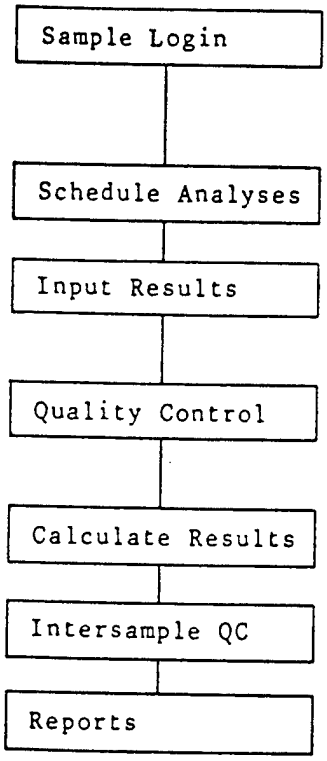
## 12.4 DATA STORAGE

A hard copy of all batch folders, supporting documents, and project files are filed chronologically by department in the secured centralized batch storage located in a separate building. The newer batch folders are also stored chronologically by department in locked file cabinets located in Information Services Department. The batch folders include copies of sample preparation/digestion/extraction logsheets, copies of instrument logsheets and standard preparation logbook pages, laboratory chain of custody, and raw data. The batch folders may be checked out for review by laboratory analysts, Laboratory Coordinators, or laboratory personnel. A program for tracking folder status and custody is available in CLASS™. This program is used to track folders that have

been checked out. In addition, any personnel checking out a batch folder from Laboratory Information Services is required to sign, date, indicate the batch numbers, and department numbers on the Document Control Logbook (Figure 12-4). When the laboratory or QA personnel are finished reviewing the batch folders, they are returned to Laboratory Information Services and the Document Control Logbook is signed and dated. At a minimum, all project files are kept for 5 years.

The original laboratory notebooks and analysts notebooks are used until they are filled, then sequentially numbered and archived by the supervisor within each department.

All data stored in the CLASS™ database are backed up every day except Saturday using electronic optical disks or equivalent high-density storage media. Disks are stored in special files and archived in a separate building in a secured air-conditioned location.




--activate samples
--set permanent station codes
--store collection time and date
--store field data

--list of samples available for each parameter sorted by due date

--reserve analysis
--input calibration, quality control and sample data

--calculate calibration curve, spike recovery, replicate and reference sample quality control

--calculate and store final sample concentrations

--check for data inconsistencies
--perform interparameter calculations

--produce reports of sample data, quality control, and statistical analyses

**Figure 12-1**
**FLOWCHART OF THE CLASS PROGRAM**

SOURCE: ESE.

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

Environmental Science and Engineering DATE 3/01/91 STATUS: FINAL

PROJECT NUMBER: 99999 0000 PROJECT NAME: EXAMPLE PROJECT
FIELD GROUP: XXXXXXX LAB COORDINATOR: ALAN CHEMY

RESULTS OF ANALYSIS

| PARAMETERS UNITS | STORET METHOD | MW5 XXXXXX 1 | MW6 XXXXXX 2 | MW7 XXXXXX 3 | MW10 XXXXXX 4 |
|---|---|---|---|---|---|
| DATE | | 04/13/90 | 04/13/90 | 04/12/90 | 04/13/90 |
| TIME | | 11:15 | 13:00 | 15:00 | 14:00 |
| LEAD,TOTAL UG/L | 1051 GFAA | 16.1 | 79.9 | 22.8 | 13.9 |
| 1,2-DIBROMOETHANE (EDB) UG/L | 77651 EC | <0.013 | 0.078 | <0.013 | <0.013 |
| CARBON TETRACHLORIDE UG/L | 32102 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| CHLOROBENZENE UG/L | 34301 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| CHLOROETHANE UG/L | 34311 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| CHLOROFORM UG/L | 32106 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| CHLOROMETHANE UG/L | 34418 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| 1,1-DICHLOROETHANE UG/L | 34496 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| 1,2-DICHLOROETHANE UG/L | 34531 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| 1,1-DICHLOROETHYLENE UG/L | 34501 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| TRANS-1,2-DICHLORO ETHENE UG/L | 34546 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| METHYLENE CHLORIDE UG/L | 34423 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| 1,1,2,2-TETRACHLORO ETHANE UG/L | 34516 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| TETRACHLOROETHENE UG/L | 34475 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| 1,1,1-TRICHL'ETHANE UG/L | 34506 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| 1,1,2-TRICHL'ETHANE UG/L | 34511 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| TRICHLOROETHENE UG/L | 39180 HA | <1.00 | <1.00 | <1.00 | <1.00 |
| BENZENE UG/L | 34030 PI | <1.00 | 25.0 | <1.00 | <1.00 |
| ETHYLBENZENE UG/L | 34371 PI | <1.00 | <1.00 | <1.00 | <1.00 |
| TOLUENE UG/L | 34010 PI | <1.00 | <1.00 | <1.00 | <1.00 |
| XYLENES,TOTAL UG/L | 81551 PI | <1.00 | 150 | <1.00 | <1.00 |
| METHYL-T-BUT'ETHER UG/L | 98676 PI | 2.90 | 5.50 | <1.00 | 5.42 |
| VOA,TOTAL(BTEX,T) UG/L | 97512 PI | <1.00 | 175 | <1.00 | <1.00 |

Figure 12-2
FINAL RESULTS OUTPUT FROM THE DATA PROGRAM

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

# ESE ANALYTICAL SERVICES
# DELIVERABLE CHECKLIST

Project #_____ Project Name_____

Field Group(s)_____

| | | | | Comment |
|---|---|---|---|---|
| Department's "excepted" batch checklist(s) reviewed? | Y | N | | |
| Corrective actions*/data flagging required? | Y | N | | |
| If yes, performed? | Y | N | | |
| Blank data (equipment, rinseate, field, trip) reviewed? | Y | N | NA | |
| Corrective actions*/data flagging required? | Y | N | | |
| If yes, performed? | Y | N | | |
| Field dupe data reviewed? | Y | N | NA | |
| Corrective actions*/data flagging required? | Y | N | | |
| If yes, performed? | Y | N | | |
| Data set reviewed against historical? | Y | N | NA | |
| Data set reviewed for reasonableness? | Y | N | | |
| If yes, by ____ self, or _____ | | | | |
| In general, were project QC requirements met? | Y | N | | |
| If no, add comments below. | | | | |
| QC deliverable prepared and reviewed? | Y | N | NA | |
| Deliverables in conformance with requirements? | Y | N | | |

* Attach a copy of any corrective action

Comments:

Completed by_____ Reviewed by_____

Date_____ Date_____

Distribution:

WHITE - Information Services YELLOW - Laboratory Coordinator PINK - Div. Administration

**Figure 12-3**
**DELIVERABLE CHECKLIST**

SOURCE: ESE.

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

## DOCUMENT CONTROL

**PLEASE USE SEPARATE LINE FOR EACH BATCH CHECKED-OUT!**

| INITIALS | DATE/TIME OUT | DOCUMENT TYPE (e.g. Batch #, F.G. Files, etc...) | DOCUMENT DEPT # | DATE/TIME RETURN | INITIALS | ✓ |
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(CONTROL 06/92)

Figure 12-4
DOCUMENT CONTROL LOGSHEET

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

# 13.0 CORRECTIVE ACTION

Corrective action is necessary when any measurement system fails to follow this LCQAP. Items that may need corrective action range from a minor problem of a field team member failing to sign a field form to a major problem of an analyst using an improper analytical method. For this reason, corrective action protocols must be flexible.

## 13.1 ANALYTICAL

In general, items needing corrective action fall into three "correction" categories: short-term, long-term, and QC; each item requires different action.

### 13.1.1 SHORT-TERM CORRECTIVE ACTIONS

These actions consist of minor and major problems that can be corrected immediately. Examples include failure to date or sign a standard form, incorrectly preserving sample, and errors in data entry. Corrective action is initiated by verbally calling attention to the problem followed by written notification.

### 13.1.2 LONG-TERM CORRECTIVE ACTIONS

The actions consist of minor and major problems that require a series of actions to resolve the problem. The actions to be taken are coordinated by the Laboratory QA/QC Manager or his designee, and a QA corrective action and routing form (Figure 13-1) is used to track the action. An example of this type of corrective action is as follows:

> Problem--A laboratory analyst fails to calibrate a pH meter prior to use.
> Corrective Action--The problem is identified by the person originating the corrective action, responsibility is assigned to an appropriate person (may be someone other than person failing to calibrate the instrument), re-training of the analysts in the use of the instrument is required, and the instrument is calibrated in prior to the next analysis. The QA/QC Coordinator audits this process to assure that it is completed in an expeditious manner.

# CORRECTIVE ACTION REQUEST AND ROUTING FORM

1. Identification of a problem: CA#_____

Originator: _____ Date: _____

Nature of Problem: _____

2. Determination of Required Action:

Responsibility Assigned to: _____ Due Date: _____

Recommended Action: _____

3. Implementation of Required Action:

Responsibility Assigned to: _____ Due Date: _____

4. Assuring Effectiveness of Action:

Responsibility Assigned to: _____ Due Date: _____

Procedure to Assure Effectiveness: _____

Corrective action status: _____ Acceptable _____ Unacceptable

Signature: _____ Date _____

Figure 13-1
QUALITY ASSURANCE CORRECTIVE ACTION REQUEST AND ROUTING FORM

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

### 13.1.3 QUALITY CONTROL CORRECTIVE ACTION

Consists of corrective action following a failure to meet QC criteria specified in this LCQAP and the analytical methods. Actions taken consist of two types: those resolved within each analytical department and those resolved outside the department. Examples outlining the differences between these two types of corrective action are as follows:

**WITHIN DEPARTMENT ACTION**

| QC Failure | Department Action |
|---|---|
| Tuning results for GC/MS fail criteria in Methods 624 and 625 | Analyst retunes instrument |
| Standard curve correlation coefficient is less than 0.995 | Analyst investigates problem and reruns curve and samples |
| Sample response falls outside calibration curve | Analyst dilutes sample into range of curve |

**OUTSIDE DEPARTMENT ACTION**

| QC Failure | Department Action |
|---|---|
| Holding times are exceeded | Notify Project Manager, Laboratory Coordinator, and Project QA Coordinator; resampling may be necessary |

The corrective action procedures that will be taken by the Gainesville Laboratory following a failure to meet QC criteria specified in this LCQAP and the analytical methods are summarized in Tables 13-1 through 13-6.

Corrective actions in the laboratory are documented and tracked using the Corrective Action Form (Figure 13-1).

Corrective actions may be initiated for each measurement system (individual disciplines) by subproject managers or other responsible individuals such as the Laboratory QA/QC Manager, Department Manager, or Division Manager. The Laboratory QA/QC Manager,

Table 13-1. Summary of Corrective Action Procedures for Metals Analyzed by Graphite Furnace and Cold Vapor Atomic Absorption Spectroscopy

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Initial calibration verification standard (ICV) | +/- 10% of true value | Rerun standard, if still out of control, recalibrate instrument. |
| Calibration blank (ICB) out | $\leq$ two times DL (listed in Table 5-3) | Rerun the blank, if still of control, reprocess and reanalyze the blank. |
| Calibration curve correlation coefficient | $\geq$ 0.995 | Rerun calibration standards, if still out of control, prepare new calibration standards and recalibrate the instrument or document why data are acceptable. |
| Calibration curve | Brackets all sample responses | Dilute and reanalyze within the calibration curve range or document why data are acceptable if reanalysis is not possible. |
| Continuing calibration verification standard (CCV) | +/- 20% of true value | Rerun standard, if still out of control, recalibrate instrument and reanalyze samples run since last acceptable CCV. |
| Method blank (MB) | $\leq$ two times DL (listed in Table 5-3) | Determine the cause of the blank problem, redigest set, if necessary, or document why data are acceptable. |

Table 13-1. Summary of Corrective Action Procedures for Metals Analyzed by Graphite Furnace and Cold Vapor Atomic Absorption Spectroscopy (Continued, Page 2 of 2)

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Standard matrix spike (QC check standard) | See Table 5-2 for percent recovery control limits | Determine and correct problem, redigest and reanalyze samples, if necessary, or document why data are acceptable. |
| Sample matrix spike | See Table 5-2 for percent recovery control limits | If standard matrix spike analytes are within control limits, qualify the data. If not, determine and correct the problem, redigest and reanalyze samples, if necessary, or document why data are acceptable. |
| Sample matrix spike | See Table 5-2 for RPD control limits | If standard matrix spike analytes are within control limits, qualify the data. If not, determine and correct the problem, redigest and reanalyze samples, if necessary, or document why data are acceptable. |

Note: DL = detection limit.
RPD = relative percent difference.

Source: ESE.

Table 13-2. Summary of Corrective Action Procedures for Metals Analyzed by Inductively Coupled Plasma Emission Spectroscopy and Inductively Coupled Plasma/Mass Spectrometry

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Initial calibration verification standard (ICV) | +/- 10% of true value | Rerun standard, if still out of control, recalibrate instrument. |
| Calibration blank (ICB) | ≤ two times DL (listed in Table 5-2) | Rerun the blank, if still out of control, reprocess and reanalyze the blank. |
| Interference check standard (ICS) | +/- 20% of true value (for ICAP only) | Rerun standard, if still out of control, recalibrate instrument and reverify calibration. |
| Continuing calibration verification standard (CCV) | +/- 10% of true value | Rerun standard, if still out of control, recalibrate instrument and reanalyze all samples run since last acceptable CCV or document why data are acceptable. |
| Method blank (MB) | ≤ two times DL (listed in Table 5-2) | Determine the cause of the blank problem; redigest samples if necessary or document why data are acceptable. |

Table 13-2. Summary of Corrective Action Procedures for Metals Analyzed by Inductively Coupled Plasma Emission Spectroscopy and Inductively Coupled Plasma/Mass Spectrometry (Continued, Page 2 of 2)

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Standard matrix spike (QC check standard) | See Table 5-2 for percent recovery control limits | Determine and correct problem, redigest and reanalyze samples, if necessary, or document why data are acceptable. |
| Sample matrix spike | See Table 5-2 for percent recovery control limits | If standard matrix analytes are within control limits, qualify the data. If not, determine and correct problem, reanalyze samples, if necessary, or document why data are acceptable. |
| Sample matrix spike duplicate | See Table 5-2 for RPD control limits | If standard matrix analytes are within control limits, qualify the data. If not, determine and correct the problem, reanalyze the samples, if necessary, or document why data are acceptable. |

Note: DL = detection limit.
RPD = relative percent difference.

Source: ESE.

Table 13-3. Summary of Corrective Action Procedures for Inorganics, Oil and Grease, Petroleum Hydrocarbons, and TOX

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Calibration curve correlation coefficient | $\geq$ 0.995 | Rerun calibration standards if still out of control prepare new calibration standards and recalibrate the instrument, or document why data are acceptable. |
| Calibration curve | Brackets all sample responses | Dilute and reanalyze samples within the calibration curve range, or document why data are acceptable. |
| Calibration blank | $\leq$ two times the DL (listed in Table 5-3) | out of control, reprocess and reanalyze the blank. |
| Continuing calibration verification standard (CCV) | +/- 20% of true value | Rerun standard, if still out of control, recalibrate instrument and reanalyze samples run since last acceptable CCV or document why data are acceptable. |
| Method blank (MB) | $\leq$ two times the DL (listed in Table 5-3) | Determine the cause of the blank problem, reanalyze samples, if necessary, or document why data are acceptable. |
| Sample replicate (RP)* | See Table 5-2 for RPD | Determine and correct control limits problem, reanalyze sample, if necessary, or document why data are acceptable. |

Table 13-3. Summary of Corrective Action Procedures for Inorganics, Oil and Grease, Petroleum Hydrocarbons, and TOX (Continued, Page 2 of 2)

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Standard matrix spike (QC check standard) | See Table 5-2 for percent recovery control limits | Determine and correct problem, reanalyze samples if necessary or document why data are acceptable. |
| Sample matrix spike | See Table 5-2 for percent recovery control limits | If standard matrix analytes are within control limits, qualify the data. If not, determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable. |
| Sample matrix spike duplicate | See Table 5-2 for RPD control limits | If standard matrix analytes are within control limits, qualify the data. If not, determine and correct the problem, reanalyze the samples, if necessary, or document why the data are acceptable. |

Note: DL = detection limit.
RPD = replicate percent difference.

*Sample replicate is only required for residues, pH, specific conductivity, and turbidity analyses.

Source: ESE.

Table 13-4. Summary of Corrective Action Procedures for Radionuclides

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Background check | See Section 9.4.12 | Check and clean the instrument and repeat the background check. |
| Performance check standard | See Section 9.4.12 | Check the instrument and recount the standard, if still out of control, recalibrate the instrument and recount the standard or document why data are acceptable. |
| Method blank | $\leq$ two times the RL (listed in Table 5-3) | Determine the cause of the blank problem, reanalyze samples, if necessary, or document why data are acceptable. |
| Sample replicate (RP) | See Table 5-2 for RPD control limits | Determine and correct the problem, reanalyze sample, if necessary, or document why data are acceptable. |
| Standard matrix spike (QC check standard) | See Table 5-2 for percent recovery control limits | Determine and correct the problem, reanalyze standard samples, if necessary, or document why data are acceptable. |
| Sample matrix spike | See Table 5-2 for percent recovery control limits | Determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable. |

Table 13-4. Summary of Corrective Action Procedures for Radionuclides

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Sample matrix spike duplicate | See Table 5-2 for RPD control limits | Determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable. |

Note: RL = reporting limit
RPD = replicate percent difference

Source: ESE.

Table 13-5. Summary of Corrective Action Procedures for Organics Analyzed by Gas Chromatography and High Pressure Liquid Chromatography

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Calibration curve correlation coefficient | $\geq$ 0.995 | Rerun calibration standards, if still out of control, prepare new calibration standards and recalibrate the instrument, or document why the data are acceptable. |
| Calibration curve | Brackets all sample responses | Dilute and reanalyze samples within the calibration curve range, or document why data are acceptable. |
| Continuing calibration standard (CCS) | +/- 15% of standard initial response for GC (except for NPD which is +/-25%) and +/- 10% of standard initial response for HPLC | Rerun standard, if still out of control, recalibrate instrument and reanalyze samples when last CCS is acceptable, or document why data are acceptable. |
| Method blank (MB) | < than two times DL for nonvolatile organics (listed in Tables 5-9 to 5-13, 5-16 to 5-35, and 5-40 to 5-61) | Determine and correct cause of the blank problem, reanalyze the samples, if necessary, or document why data are acceptable. |
| Method blank (MB) | No greater than five times DL (listed in Tables 5-5 and 5-7) for methylene chloride, acetone, toluene, and xylene organics. All other analytes must be $\leq$ two times DL (listed in Tables 5-5 and 5-7) | Reanalyze another MB. If second MB exceeds criteria, clean and recalibrate analytical system or document why data are acceptable. |

Table 13-5. Summary of Corrective Action Procedures for Organics Analyzed by Gas Chromatography and High Pressure Liquid Chromatography (Continued, Page 2 of 3)

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Standard matrix spike (SP) | See Tables 5-4 to 5-13, 5-16 to 5-35, and 5-40 to 5-61 for percent recovery control limits | Determine and correct the problem, reanalyze samples if necessary, or document why data are acceptable. |
| Sample matrix spike | See Tables 5-4 to 5-13, 5-16 to 5-35, and 5-40 to 5-61 for percent recovery control limits | If standard matrix spike analytes are within control limits, qualify the data. If not, determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable. |
| Sample matrix spike duplicate | See Tables 5-4 to 5-13, 5-16 to 5-35, and 5-40 to 5-61 for RPD control limits | If standard matrix analytes are within control limits, qualify the data. If not, determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable. |
| Surrogates* (SUR) | See Tables 5-18, 5-20, and 5-28 for percent recovery control limits | If surrogates in the MB or SP are within control limits, qualify data. If not, reanalyze samples with surrogates outside criteria or document why data are acceptable. |

Table 13-5. Summary of Corrective Action Procedures for Organics Analyzed by Gas Chromatography and High Pressure Liquid Chromatography (Continued, Page 3 of 3)

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Note: DL = detection limit.
GC = gas chromatography.
HPLC = high pressure liquid chromatography.
NPD = nitrogen-phosphorus detector.
RPD = relative percent difference.

*Surrogate/surrogates will only be spiked in samples if specified by the method.

Source: ESE.

Table 13-6. Summary of Corrective Action Procedures for Organics by Gas Chromatography/Mass Spectrometry

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| DFTPP or BFB instrument tuning | See Table 8-1 for tuning criteria | Retune instrument until within criteria. |
| Initial calibration standards | Percent RSD of RF of the calibration check compounds (CCC) are $\leq$ 30 percent ($\leq$35 percent for Method 625) | Rerun calibration standards, if still out of criteria, prepare new calibration standards and rerun standards. |
| One-point daily calibration | RFs of CCCs are $\leq$25 percent ($\leq$20 percent for Method 625) from average RFs in the initial calibration | Rerun standard, if still out of control, rerun calibration curve, or document why data are acceptable. |
| Method blank (MB) | < two times the DL (listed in Table 5-39) for semivolatile organics | Evaluate the impact of the presence of any target analytes in the method blank, the presence of low concentrations of phthalate may be acceptable. Reextract and reanalyze samples if presence of target analytes are unacceptable or document why data are acceptable. Background substraction may be applied. |

Table 13-6. Summary of Corrective Action Procedures for Organics by Gas Chromatography/Mass Spectrometry (Continued, Page 2 of 3)

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Method blank (MB) | No greater than 5 times the DL (listed in Tables 5-15 and 5-37) for methylene chloride, acetone, toluene, and xylene for volatile organics. All other analytes must be ≤ two times DL (listed in Tables 5-15 and 5-37) | Reanalyze another MB. If second MB exceeds criteria, clean and recalibrate the analytical system or document why data are acceptable. |
| Surrogate (SUR) | See Tables 5-14, 5-36, and 5-38 for percent recovery control limits | If surrogates in the MB or SP are within limits, qualify the data. If not, reanalyze samples with surrogates outside criteria or document why data are acceptable. |
| Standard matrix spike (SP) | See Tables 5-14, 5-36, and 5-38 for percent recovery control limits | If surrogates in the MB are within control limits, qualify the data. If surrogates in the MB are not within control limits, determine and correct the problem, reextract and reanalyze the sample, if necessary or document why data are acceptable. |

Table 13-6. Summary of Corrective Action Procedures for Organics by Gas Chromatography/Mass Spectrometry (Continued, Page 3 of 3)

| Quality Control | Acceptance Criteria | Corrective Action |
|---|---|---|
| Sample matrix spike | See Tables 5-14, 5-36, and 5-38 for percent recovery control limits | If standard matrix spike compounds are within criteria, qualify the data. If not, check surrogates in the MB or SP, if within criteria, qualify the data. If both QCs are outside criteria, determine and correct the problem, reanalyze the samples or document why the data are acceptable. |
| Sample matrix spike duplicate | See Tables 5-14, 5-36, and 5-38 for RPD control limits | If standard matrix spike compounds are within criteria, qualify the data. If not, check surrogates in the MB or SP, if within criteria, qualify the data. If both QCs are outside criteria, determine and correct the problem, reanalyze the samples if necessary or document why data are acceptable. |

Note: DL = detection limit.
RPD = relative percent difference.

Source: ESE.

Laboratory Department Manager, or Laboratory Director will be responsible for approving the corrective action.

## 13.2 EXTERNAL SOURCES

Corrective action may also be initiated from external sources. This may include performance sample results, split samples, audits (onsite or field by EPA, HRS, FDEP, USATHAMA, HAZWRAP, NEESA, etc.), and data validation/review. Corrective actions recommended by agencies such as EPA, DEP, etc. are prioritized, promptly acted on, and overseen by the Project QA Coordinator or Laboratory QA/QC Manager. Actions taken to resolve the problem will be documented and kept by the Project QA Coordinator or Laboratory QA/QC Manager.

# 14.0 PERFORMANCE AND SYSTEM AUDITS AND PERSONNEL TRAINING

## 14.1 INTRODUCTION

Two types of audit procedures will be used to assess and document performance of laboratory staff: system audits and performance audits. These are performed at frequent intervals by the Laboratory QA/QC Coordinator and QA Coordinator. These audits form one of the bases for corrective action requirements and constitute a permanent record of the conformance of measurement systems to QA requirements.

## 14.2 SYSTEM AUDITS

System audits are inspections of training status, records, QC data, calibrations, and conformance to SOPs without the analysis of check samples. System audits are performed quarterly.

The system audit protocol for the laboratory is summarized as follows:
The QA Coordinator and Laboratory QA/QC Manager or designee will perform the laboratory system audit using the checklist in Figures 14-1 through 14-4. The documents to be reviewed are:

a. Parameter and/or laboratory notebooks;
b. Instrument logbooks;
c. Sample log-in, dispensing, and labeling for analysis;
d. QC criteria update for spike recoveries; and
e. Verify that deficiencies in the last audit were corrected.

COMP.QAPP 6/94 MH

Coldrooms, Freezers and Sample Storage Areas - Dept. 1213

AUDITOR_____
DATE_____

| No. | Item | Yes | No* | Comment(s) |
|---|---|---|---|---|
| 1 | Is the work area clean and organized? | | | |
| 2 | Are SOPs available for receipt, storage and tracking of samples? | | | |
| 3 | Are there findings in this department from last quarter's lab audit? If yes, list below (or attach a separate sheet) and verify that they have been corrected. | | | |
| 4 | Are documentation errors corrected properly (one line drawn through error, date, error code/explanation, and initials)? | | | |
| 5 | Are the Sample Tracking forms properly filled out? | | | |
| 6 | Is the Sample Location report updated on a regular basis and placed next to the door of each storage area? | | | |
| 7 | Are all storage areas secured at all times? | | | |
| 8 | Are the temperature logs for the coldrooms and freezers filled out completely and corrections made properly? Are appropriate corrective actions taken for all out-of-control readings? | | | |
| 9 | Is a condensed SOP for check-in/check-out posted next to each storage room door? | | | |
| 10 | Is the Sample Check-In/Check-out log filled out completely? | | | |
| 11 | Is proper documentation available for tracking the disposal of samples? | | | |

Additional Comments:

*For all "No" answers, include all information necessary to trace audit finding (e.g., Rm.#, logbook #, page #, instrument #, etc.)

Figure 14-1
AUDIT CHECKLIST FOR SAMPLE STORAGE AREAS

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

Sample Receiving - Dept. 1220

AUDITOR
DATE

| No. | Item | Yes | No* | Comment(s) |
|---|---|---|---|---|
| 1 | Is the work area clean and organized? | | | |
| 2 | Are SOPs available for receipt, log-in and transfer of samples to storage areas? | | | |
| 3 | Are there findings in this department from last quarter's lab audit? If yes, list below (or attach a separate sheet) and verify that they have been corrected. | | | |
| 4 | Are documentation errors corrected properly (one line drawn through error, date, error code/explanation, and initials)? | | | |
| 5 | Is the Sample Custodian filling out all required information on the chain of custody (COC) form (cooler temp., seals intact? etc.)? | | | |
| 6 | Are the Sample Chest Custody Forms filled out completely? | | | |
| 7 | Is the Sample Custodian completely filling out the Cold Room Sample Arrival logbook? | | | |
| 8 | Is the Sample Custodian auditing 10% of all samples (except VOA samples) to verify that samples are properly preserved? Is documentation available? | | | |
| 9 | Are samples labelled properly? | | | |

Additional Comments:

Hood Maintenance - Dept. 1213

| No. | Item | Yes | No* | Comment(s) |
|---|---|---|---|---|
| 1 | Have fume hoods been calibrated within the last year? Are they labelled as to when last tested? | | | |

*For all "No" answers, include all information necessary to trace audit finding (e.g., Rm.#, logbook #, page #, instrument #, etc.)

Figure 14-2
AUDIT CHECKLIST FOR SAMPLE RECEIVING AND GLASSWARE WASHROOM AREAS

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

Sample Preparation Areas
Department_____

AUDITOR_____
DATE_____

| No. | Item | Yes | No* | Comment(s) |
|---|---|---|---|---|
| 1 | Is the work area clean and organized? | | | |
| 2 | Are SOPs available for receipt, storage and tracking of samples? | | | |
| 3 | Are there findings in this department from last quarter's lab audit? If yes, list below (or attach a separate sheet) and verify that they have been corrected. | | | |
| 4 | Are documentation errors corrected properly (one line drawn through error, date, error code/explanation, and initials)? | | | |
| 5 | Are samples and standards stored separately to avoid contamination? | | | |
| 6 | Are spike solutions, surrogate solutions, (Org. only) and reagents labelled clearly and appropriately (including plastic squeeze bottles)? | | | |
| 7 | Are there expired standards/reagents in the laboratory? Are they clearly labelled as "expired" or "for qualitative use only"? | | | |
| 8 | Is glassware stored so as to avoid contamination? | | | |
| 9 | Do all log books have control numbers? | | | |
| 10 | Are sample preparation logs completely filled out, including preparer and reviewer signatures? | | | |
| 11 | Are automatic pipettes and syringes calibrated each day of use? (Inorganic Division only) Are all water bath thermometers in use calibrated against a NIST thermometer? (Organic Division) Are the calibrations documented in the appropriate logbooks? | | | |
| 12 | Are instrument run logs made properly (e.g., microwave, GPC)? | | | |
| 13 | Are instrument maintenance logs filled out completely and corrections made properly? | | | |
| 14 | Are extracts (sample vials) labelled properly? | | | |
| 15 | Are sample extract/digest chain of custody logs filled out completely and corrections made properly? | | | |
| 16 | Are properly labelled waste containers available? | | | |
| Additional comments: | | | | |

*For all "No" answers, include all information necessary to trace audit finding (e.g., Rm.#, logbook #, page #, instrument #, etc.)

Figure 14-3
AUDIT CHECKLIST FOR SAMPLE PREPARATION AREAS

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

**Sample Analysis Areas**

Department_____ AUDITOR_____ DATE_____

| No. | Item | Yes | No* | Comment(s) |
|---|---|---|---|---|
| 1 | Is the work area clean and organized? | | | |
| 2 | Are SOPs available? | | | |
| 3 | Are there findings in this department from last quarter's lab audit? If yes, list below (or attach a separate sheet) and verify that they have been corrected. | | | |
| 4 | Are documentation errors corrected properly (one line drawn through error, date, error code/explanation, and initials)? | | | |
| 5 | Are samples and standards stored separately to avoid contamination? | | | |
| 6 | Are spike solutions, surrogate solutions (Org. only), calibration standards and reagents labelled clearly and appropriately (including plastic squeeze bottles)? | | | |
| 7 | Is glassware stored so as to avoid contamination? | | | |
| 8 | Do all log books have control numbers? | | | |
| 9 | Are standard and reagent prep. logbooks filled out completely and corrections made properly? Are lot numbers of neat standards recorded? | | | |
| 10 | Are instrument calibration checks performed prior to analysis? (Mandatory for Radiochemistry, only) | | | |
| 11 | Are instrument run logs filled out completely and corrections made properly? | | | |
| 12 | Are instrument maintenance logs filled out completely and corrections made properly? | | | |
| 13 | Are samples (analysis vials) labelled properly? | | | |
| 14 | Are sample chain-of-custody (COC) logs (VOA samples) or sample extract/digest COC logs filled out completely and corrections made properly? | | | |
| 15 | Are properly labelled waste containers available? | | | |

Additional Comments:

*For all "No" answers, include all information necessary to trace audit finding (e.g., Rm.#, logbook #, page #, instrument #, etc.)

Figure 14-4
AUDIT CHECKLIST FOR SAMPLE ANALYSIS AREAS

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

In addition, the Laboratory QA/QC Coordinator or QA Coordinator may monitor analyses randomly to assure adherence to approved analytical methods.

3. Final Reports--The Project QA Coordinator may review all final reports and deliverables before they are sent to the client.

The Gainesville Laboratory is externally audited regularly by the following agencies:

1. State of Florida Department of Health and Rehabilitative Services,
2. State of New Jersey Department of Environmental Protection and Energy,
3. State of California Department of Health,
4. State of Utah Department of Health,
5. U.S. Army Corps of Engineers,
6. American Industrial Hygiene Association, and
7. Army Environmental Center (AEC) (formerly U.S. Army Toxic and Hazardous Materials Agency).

## 14.3 PERFORMANCE AUDITS

The results of interlaboratory studies may be evaluated by the Project QA Coordiantor as part of the performance audits. This evaluation is performed at least quarterly. ESE is participating in the following proficiency programs:

1. National Institute of Occupational Safety and Health (NIOSH) through its Proficiency Analytical Testing (PAT) and Environmental Lead Proficiency Analytical Testing (ELPAT) Programs,
2. EPA Water Pollution and Water Supply proficiency programs,
3. EPA Radiochemistry Intercomparison Study and Blind Performance Samples,
4. U.S. Army Corps of Engineers,
5. U.S. Department of Energy's Environmental Measurements Laboratory Quality Assessment Program, and
6. U.S. Department Of Energy's Hazardous Waste Remedial Actions Program (HAZWRAP).

The following licenses, accreditations, certifications and validations are held by the Gainesville Laboratory:

1. American Industrial Hygiene Association (AIHA),
2. State of Florida Department of Health and Rehabilitative Services for environmental and drinking water analyses,
3. New Jersey Department of Environmental Protection,
4. State of Maryland Department of Health and Mental Hygiene,
5. State of Florida Department of Health and Rehabilitative Services for Radiochemistry,
6. State of California Department of Health Services for hazardous waste testing analyses,
7. State of Tennessee Department of Health and Environment for drinking water and underground storage testing analyses,
8. State of Utah Department of Health,
9. U.S. Army Environmental Center,
10. U.S. Army Corps of Engineers,
11. U.S. Navy, and
12. U.S. Department of Energy's HAZWRAP.

Peer review of all deliverable reports and data will be performed by technically qualified individuals from each major discipline represented in the deliverable. Figure 14-5 is a sample Deliverable Review Sheet.

# ESE — DELIVERABLE REVIEW SHEET

SHORT TITLE: _____ CLIENT: _____

PROPOSAL/PROJECT NUMBER: _____ DATE/TIME TO LEAVE ESE: _____

PROPOSAL/PROJECT MANAGER: _____ CLIENT DUE DATE: _____

AUTHOR(S): _____ DOCUMENT COORDINATOR: _____

| REVIEW CHECKLIST<br>REVIEWER SHOULD PLACE CHECK UNDER APPROPRIATE REVIEW CATEGORY<br>D—DRAFT F—FINAL | | REQUIRED REVIEW | | | | | | | | OPTIONAL REVIEW<br>BY AUTHOR OR OTHER QUALIFIED INDIVIDUAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ① Organization/ Presentation Reviewed | | ① Technical Approach and Conclusions Reviewed | | ② Proposal Costs Reviewed (If Applicable) | | ③ Laboratory Data Checked (If Applicable) | | Tables, Figures, Text Data Checked | | Critical Calculations Checked | | Computer Models/ Programs Verified | | Field Measurements Checked | |
| REVIEWER'S INITIALS | DOCUMENT/SECTION | D | F | D | F | D | F | D | F | D | F | D | F | D | F | D | F |
| | Document | | | | | | | | | | | | | | | | |
| | SECTION(S) | | | | | | | | | | | | | | | | |
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APPROVALS _____ _____ _____ (as appropriate)

AUDITED BY _____ (QA Manager or designate)

REMARKS: _____

① Required review by at least one reviewer other than author in these categories.
② Required F & A review for proposals
③ Required check by laboratory coordinator or other individual for laboratory data reports.

ORIGINAL TO PROJECT MANAGER—COPY TO QA

FORM 83345

Figure 14-5
DELIVERABLE REVIEW SHEET

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

## 14.4 PERSONNEL TRAINING

The Gainesville Laboratory personnel are trained on health and safety, QA/QC procedures, analytical methods, and the laboratory data management system as specified in the laboratory's SOP on personnel training (SOP-AS3210-004). New personnel are trained prior to performing any actual laboratory work. Laboratory personnel are also required to attend the health and safety and laboratory QA/QC procedures refresher courses that will be offered yearly. The training that each laboratory personnel had attended are documented on the personnel's training records that are maintained by the Laboratory QA/QC Coordinator.

## 15.0 QUALITY ASSURANCE REPORTS

Activities and actions to be reported will include:

1. Results of ongoing performance, systems and analytical method audits, and

2. Data quality review and significant QA/QC problems with proposed corrective action procedures.

The Laboratory QA/QC Manager reports the results of these activities to the Gainesville Laboratory Management. The QA/QC report is done on a quarterly basis or immediately upon discovery of a problem requiring corrective action.

For NEESA and HAZWRAP projects a Quality Assurance progress report summarizing the QA/QC activity associated with the sample collection, receipt, analysis, and data reporting for NEESA or HAZWRAP samples is submitted monthly to these agencies.