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**Quality Assurance Project Plan for the Environmental Monitoring
Program in Waste Area Grouping 6 at Oak Ridge National
Laboratory, Oak Ridge, Tennessee**

Date Issued—December 1993

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Oak Ridge, Tennessee 37831-6285
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
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RP

**Quality Assurance Project Plan for the Environmental Monitoring Program
in Waste Area Grouping 6 at Oak Ridge National Laboratory,
Oak Ridge, Tennessee**

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ABBREVIATIONS

ANSI	American National Standards Institute
APO	Analytical Projects Office
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	chemicals of concern
C-Q	concentration relationship vs volumetric flow rate
CRF	Change Request Form
DA	Drainage at MS2—middle portion of WAG 6 and south end of French drain
DB	Drainage at MS1—eastern section of WAG 6
DMC	Document Management Center
DOE	Department of Energy
DOE QA	Department of Energy Quality Assurance
DQOs	data quality objectives
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
FA	Drainage at MS3—west end of French drain
FB	Drainage at MS3—entire western portion of WAG 6
FOP	Field Operations Procedure
LOM	Laboratory Operations Manual
MDLs	method detection limits
MS	Monitoring Stations
NPDES	National Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSWER	Office of Solid Waste and Environmental Response
PARCC	precision, accuracy, representativeness, completeness, and comparability
PO	Primary Objectives
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFI	Resource Conservation and Recovery Act Facility Investigation
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SOW	statement of work
SWSA	Solid Waste Storage Area
TAL	Target Analyte List
TDEC	Tennessee Department of Environment and Conservation
VOC	volatile organic compound

WAG	Waste Area Grouping
WOC	White Oak Creek
WOD	White Oak Dam
WOL	White Oak Lake
WST	West Seep Tributary
WSW	West Seep Weir

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EXECUTIVE SUMMARY

This Quality Assurance Project Plan (QAPjP) has been developed as part of the *Environmental Monitoring Plan for Waste Area Grouping 6 at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-1192&D1). Environmental monitoring will be conducted in two phases: the baseline monitoring phase and the routine annual monitoring phase. The baseline monitoring phase will be conducted to establish the baseline contaminant release conditions at the Waste Area Grouping (WAG), to confirm the site-related chemicals of concern (COC), and to gather data to confirm the site hydrologic model. The baseline monitoring phase is expected to begin in 1994 and continue for 12-18 months. The routine annual monitoring phase will consist of continued sampling and analyses of COC to determine off-WAG contaminant flux, to identify trends in releases, and to confirm the COC. The routine annual monitoring phase will continue for ~4 years after completion of the baseline monitoring phase.

This QAPjP presents the Quality Assurance (QA) procedures and requirements for environmental monitoring and data evaluation of the WAG 6 Project and outlines the QA objectives applicable to the environmental monitoring plan developed for WAG 6. It also meets the requirements outlined in the Quality Assurance Plan for Waste Area Grouping 6, ORNL/ER-164, and the Environmental Restoration Division Quality Assurance Program Plan, ES/ER/TM-4/R3.

1. INTRODUCTION

Waste Area Grouping (WAG) 6 is a hazardous and low-level radioactive waste disposal site at Oak Ridge National Laboratory (ORNL). Extensive site investigations have revealed contaminated surface water, sediments, groundwater, and soils. Based on the results of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) conducted from 1989–1991 and on recent interactions with the U.S. Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC), a decision was made to defer implementing source control remedial measures at the WAG. The information shows WAG 6 contributes <2 % of the total off-site contaminant risk released over White Oak Dam (WOD). The alternative selected to address hazards at WAG 6 involves maintenance of site access controls to prevent public exposure to on-site contaminants, continued monitoring of contaminant releases to determine if source control measures will be required in the future, and development of technologies to support final remediation of WAG 6.

The WAG 6 Environmental Monitoring Plan (EMP) is designed to address all applicable regulatory requirements. Current regulatory drivers at the site include a triparty letter of agreement between the U.S. Department of Energy (DOE), the EPA Region IV Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program, and TDEC and RCRA and National Pollutant Discharge Elimination System (NPDES) compliance permits.

The WAG 6 EMP is also designed

- to contribute to a better understanding of pathways and processes important for contaminant transport in the White Oak Creek (WOC) watershed;
- to provide information to support the ORNL remedial action prioritization effort;
- to provide information to support a final remedy for the groundwater operable units;
- to gain insight into the development and implementation of a focused and effective monitoring program;
- to detect changes in the total flux and risk contribution from WAG 6 to WOD;
- to support the Melton Valley groundwater model development; and
- to determine the accuracy and reliability of the existing site hydrologic (water balance) model as part of the broader site conceptual model.

Essentially, the EMP defines the entire monitoring strategy for WAG 6 and provides the necessary mechanisms for implementation of the program to accurately assess all media.

The baseline and routine annual sampling/monitoring activities will be conducted as two phases of the EMP. The following activities will support the previously stated goals: surface water monitoring at gaged sites and along the ungaged perimeter of the site; surface water monitoring to evaluate the concentration (C) vs volumetric flow rate (Q) relationship (C-Q); groundwater quality perimeter monitoring; interior well monitoring; groundwater level monitoring; seep and spring water quality monitoring; and 49 trench area French drain discharge monitoring. Data quality objectives (DQOs) have been established to ensure that a twofold increase in annual risk from contaminant flux from WAG 6 can be identified. A factor of 2 increase in risk from WAG 6 releases each year for a period of 4 years would increase WAG 6 contribution to risk at WOD to a level that would make it a priority site for source control measures. Identifying a twofold annual risk increase will help ensure that appropriate actions can be taken before off-site risks reach an unacceptable level.

WAG 6 is comprised of three solid waste management units: Solid Waste Storage Area (SWSA) 6, the Emergency Waste Basin, and the Explosives Detonation Trench. SWSA 6 is the main burial area of WAG 6; it contains a variety of radioactive and nonradioactive wastes. The Emergency Waste Basin, located in the northeast corner of WAG 6, is an emergency holding basin with a surface area of ~2 acres and a storage capacity of 15 million gallons. This area has never been used for waste disposal but does receive some runoff from the northern part of SWSA 6. The Explosives Detonation Trench was located in the southeast corner of SWSA 6, but it has been backfilled and its exact location is unknown.

WAG 6 is located on a hillside just north of the White Oak Lake (WOL) within the Oak Ridge Reservation (ORR). The local WAG 6 receiving waters are the Emergency Waste Basin, the West Seep Tributary (WST), WOL, and the WOL floodplain. These surface water features are just outside the SWSA 6 fence, surrounding the entire eastern and southern boundary. SWSA 6 runoff that is contained in the Emergency Waste Basin is eventually discharged through the Eastern Drainage Area to the WST. This tributary receives surface water runoff and groundwater seepage from both WAG 6 and WAG 7 (located east of WAG 6) and ultimately discharges into the WOL floodplain. In addition, the Southern Drainage Area carries runoff from a small sloped area on the extreme south end of SWSA 6 directly into WOL and the Eastern Drainage Area. Roughly 15% of the WAG 6 surface area is drained through the Southern and Eastern Drainage Areas.

Approximately 80% of the WAG 6 surface area drains directly to WOL or the WOL floodplain through three major surface water monitoring stations (MS) located inside the SWSA fence. The drainage at MS1 is transported from a large eastern section of WAG 6, designated as DB in the RFI. Drainage at MS2, designated as DA in the RFI, originates from the middle portion of WAG 6 and the south end of the French drain. The west end of the French drain, as well the entire western portion of WAG 6 (designated as FA and FB in the RFI) drains through MS3. Flumes are installed at each of these stations and are currently monitored for both water flow and water quality.

Planned upgrades will merge the DA and DB discharges (new MS1) and will merge the FA and FB discharges (new MS3) into stations fully equipped to handle all expected ranges of flow. Gaged MS4 will be established in the small tributary north of the WST in order to gather data on the discharge and contaminants that are released from the Emergency Waste

Basin area. The locations of the new stations were chosen to provide the most useful data for determining total off-WAG flux. Each of these stations will be located at the end of the most downstream reach of combined internal drainages, near the WAG perimeter, making them ideal for off-WAG contaminant release monitoring. Data gathered at MS4 will account for discharge from ~5% of WAG 6. These MS upgrades are described further in Sect. 3, Project Description.

2. DEFINITION, PURPOSE, AND SCOPE

2.1 DEFINITION

This Quality Assurance Project Plan (QAPjP) is written for the environmental monitoring and data evaluation portion of the WAG 6 Project. This plan presents, in specific terms, the policies, organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) requirements designed to achieve the DQOs of the project.

2.2 PURPOSE

This document presents specific requirements, guidelines, and specifications that describe the essential elements of this QAPjP.

2.3 SCOPE

2.3.1 WAG 6 Document Interface

This QAPjP is a controlled document, and the information is to be used in conjunction with the responsibilities and procedures described in the *Environmental Monitoring Plan for the Interim Remediation of WAG 6, Oak Ridge National Laboratory, Oak Ridge Tennessee* (DOE/OR/01-1992&D1). Other interface documents are the Sampling and Analysis Plans (SAPs), Data Management Plan and Functional System Design, Field Operations Procedures (FOP) Manual, and Site Health and Safety Plan. If conflicts occur, this QAPjP takes precedence.

2.3.2 Regulating Agencies

The WAG 6 QAPjP for environmental monitoring is designed to comply with the EPA guidance established in *Interim Guidelines and Specifications for Preparing Quality Assurance Plans* (EPA 1980); American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) guidelines described in *Quality Assurance Program Requirements for Nuclear Facilities* (ASME NQA-1) (ANSI/ASME 1989); *Environmental Restoration Quality Assurance Program Plan*, issued as ES/ER/TM-4/R3; and DOE Order 5700.6C, "Quality Assurance Requirements" (DOE 1991). EPA QAMS-005-80 (EPA 1980) contains EPA's guidance for project QA/QC plans and has been adopted as the main QA/QC standard. Because this plan falls under CERCLA regulation, the WAG 6 QAPjP is subject to Office of Solid Waste and Environmental Response (OSWER) Directive 9502.00-6C (EPA 1987a), OSWER Directive 9355.0-76 (EPA 1987b), and OSWER Directive 9355.3-01 (EPA 1988a).

2.3.3 Modular Profile

The modular profile for the WAG 6 Project (Table 1) shows the relationship between QAMS-005/80, NQA-1, DOE 5700.6C, and ORNL QA elements and the elements of this QAPjP. Many of the ORNL elements adequately describe WAG 6 project-specific procedures and have been adopted for WAG 6 use with referenced additions and/or clarifications.

Table 1. Modular profile for the WAG 6 project

EPA QAMS 005/80	NQA-1 Basic Element	DOE Order 5700.6C Criteria	ES/ER-TM-4/R3	ORNL QA Reference	Location in WAG 6 QA/P
5.1 Title Page	6. Document Control	4. Documents and Records	4. Documents and Records	QA-L-6-100	1. Introduction
5.2 Table of Contents	6. Document Control	4. Documents and Records	4. Documents and Records	QA-L-6-100	2. Definition, Purpose, and Scope
5.3 Project Description	2. Quality Assurance Program 6. Document Control	1. Program	1. Program	QA-L-2-100 QA-L-2-101 QA-L-2-104 QA-L-6-100	3. Project Description
5.4 Project Organization and Responsibility	1. Organization	1. Program 2. Personnel Training and Qualification	2. Personnel Training and Qualification	QA-L-1-100	4. Project Organization and Responsibilities
5.5 QA Objectives for Measuring Data	3. Design Control	6. Design	6. Design	QA-L-3-100	5. QA Objectives for Measurement Data in Terms of PARCC
5.6 Sampling Procedures	5. Instructions, Procedures, and Drawings 6. Document Control Technical and Peer Reviews	4. Documents and Records 5. Work Processes 6. Design	4. Documents and Records 5. Work Processes 6. Design	QA-L-5-100 QA-L-6-100	6. Sampling Procedures
5.7 Sample Custody	6. Document Control 8. Identification and Control of Items 13. Handling, Storage, and Shipping	4. Documents and Records 5. Work Processes	4. Documents and Records 5. Work Processes	QA-L-6-100 QA-L-13-100	7. Sample Custody
5.8 Calibration Controls and Frequency	12. Control of Measuring and Test Equipment	5. Work Processes	5. Work Processes	QA-L-12-100	8. Calibration and Frequency
5.9 Analytical Procedures	5. Instructions, Procedures, and Drawings 6. Document Control 9. Control of Processes	4. Documents and Records 5. Work Processes 6. Design	4. Documents and Records 5. Work Processes 6. Design	QA-L-5-100 QA-L-6-100 QA-L-9-100	9. Analytical Procedures
5.10 Data Reduction, Validation, and Reporting	4. Procurement Document Control 7. Control of Purchased Items and Services 11. Test Control	7. Procurement 8. Inspection and Acceptance Testing	7. Procurement 8. Inspection and Acceptance Testing	QA-L-4-100 QA-L-7-100 QA-L-11-100	10. Data Reduction, Validation, and Reporting
5.11 Internal QC Checks	10. Inspections 11. Test Control 19. Software Quality Assurance	6. Design 8. Inspection and Acceptance Testing	6. Design 8. Inspection and Acceptance Testing	QA-L-10-100 QA-L-11-100 QA-L-19-100	11. Internal Quality Control
5.12 Performance and System Auditing and Frequency	18. Audits	9. Management Assessments 10. Independent Assessments	9. Management Assessments 10. Independent Assessments	QA-L-18-100 QA-L-18-101 QA-L-18-102	12. Performance and System Audits
5.13 Preventive Maintenance Procedures and Scheduling	12. Control of Measuring and Test Equipment 14. Inspection, Test, and Operating Status	5. Work Processes	5. Work Processes	QA-L-12-100 QA-L-14-100	13. Preventive Maintenance
5.14 Specific Routine Procedures	5. Instructions, Procedures, and Drawings 6. Document Control 9. Control of Processes	6. Design	6. Design	QA-L-5-100 QA-L-6-100 QA-L-9-100	14. Specific Project Procedures
5.15 Corrective Action	16. Corrective Action	3. Quality Improvement 9. Management Assessment 10. Independent Assessment	3. Quality Improvement	QA-L-16-100 QA-L-16-102	15. Corrective Action
5.16 QA Reports to Management	15. Non-Conformance 16. Corrective Action 17. Quality Assurance Records	2. Personnel Training and Qualifications 3. Quality Improvement 9. Management Assessment 10. Independent Assessment	2. Personnel Training and Qualifications 3. Quality Improvement	QA-L-2-103	16. QA Reports to Management

3. PROJECT DESCRIPTION

3.1 BACKGROUND

Based on the RFI and on subsequent discussions with regulators, implementing source control remedial measures at WAG 6 were deferred and the alternative selected will address the risks associated with WAG 6 by maintaining site access control, monitoring contaminant releases to determine if source control measures are required in the future, and development of technologies to support final remediation of WAG 6.

As stated earlier, the decision to defer active control measures at WAG 6 is based primarily on the fact that WAG 6 currently contributes <2% of the total off-site contaminant flux and risk released over WOD.

This decision necessitates long-term monitoring of the WAG to ensure that any major increases in contaminant release from the WAG are identified early enough to take appropriate action. WAG 6 is early in its release history compared to other WAGs; thus, current releases may not be indicative of future releases. Monitoring at WAG 6 will ensure that changes in releases are tracked and identified before they reach a magnitude comparable to other sources.

In addition to tracking risk contribution at WOD, data will be collected and analyzed in a manner that provides information on the risk to a hypothetical person residing at the boundary of the waste unit. The boundary of the WAG is the conventional point of compliance for RCRA and CERCLA actions. RFI risk estimates for a future hypothetical person residing on-WAG showed that currently established access controls are necessary to prevent indicated on-WAG exposures. Changes or status quo in risk estimated for the WAG boundary will be evaluated to satisfy regulatory concerns and to reiterate the need for continued access controls of the WAG.

3.2 MONITORING ACTIVITIES

Because the focus of the monitoring is to track changes in risk and flux, the EMP is divided into two primary phases: baseline monitoring and routine annual monitoring.

The **baseline monitoring** phase is estimated to take 12–18 months to complete, beginning in the first quarter of FY 1994. The baseline characterization phase is intended to provide the data necessary to confirm the findings of the RFI with respect to off-site transport of COC, establish baseline flux and risk estimates to which routine annual monitoring results can be compared, provide input into directed study activities, and obtain information to assist in refining the EMP for the routine annual monitoring phase.

The **routine annual monitoring** will begin at the completion of the baseline monitoring phase and will continue for 4 years. Routine annual monitoring is intended to provide the information necessary to calculate annual changes in contamination releases and risk associated with WAG 6.

The sampling at WAG 6 can be separated into five major tasks:

- Sampling at *gaged surface water stations* to capture water from the site that moves through the major surface water drainages.
- Sampling along the *ungaged perimeter* of the site, which includes two major components: (1) storm water runoff sampling to capture overland flow during storms and (2) seeps, springs, and water table interval groundwater monitoring to capture subsurface flow.
- Sampling of *RCRA compliance wells* to meet the requirements of the RCRA permit.
- Sampling of *internal seeps, springs, and wells* for the purpose of tracking changes in releases from the waste sources.
- Sampling of various environmental media at various locations for the purpose of confirming the site hydrologic model and identifying site characterization techniques (e.g., defining the C-Q relationship). These tasks will be performed mainly during baseline monitoring.

It was determined that the quality and location of the existing gaged monitoring stations needed to be upgraded at the site prior to performing baseline sampling activities. Existing structures commonly become submerged during storm events, effectively reducing the discharge rate through the flume and causing the values to be in error. The planned upgrades will merge the DA and DB discharges (new MS1) and will merge the FA and FB discharges (new MS3) into stations fully equipped to handle all expected ranges of flow. Gaged monitoring station MS4 will be established in the small tributary north of the WST in order to gather data on the discharge and contaminants that are released from the Emergency Waste Basin area. The locations of the new stations were chosen to provide the most useful data for determining total off-WAG flux. The new gaged surface water monitoring stations will be equipped with hydraulic structures and electronic data logging and autosampling equipment.

Several surface water monitoring stations will be sampled infrequently as part of an effort to perform mass balance confirmation on the total flux estimates for the WAG. Locations upgradient [West Seep Weir (WSW) and WOC] and downgradient (WOD) of WAG 6 will provide data to help confirm flux estimates. Two stations in the 49 trench area French drain outlets, Western French drain and Southern French drain, are included in the surface water monitoring task to monitor changes in contaminant releases closer to the sources.

The WSW station is also included in the surface water monitoring task to provide additional data for the characterization of the contaminants released from the northeast perimeter of the WAG.

Several **ungaged monitoring stations** will be monitored as part of the surface water monitoring task. Ungaged monitoring stations include two interior perimeter drainages that discharge only during storm events and will be monitored to capture storm runoff along the ungaged perimeter.

Data gathered at drainages B and C will allow quantification of the contaminant release from the eastern perimeter of the WAG during storm events. Contaminant flux determination is less straightforward in these areas because there are no acceptable sites for flumes or weirs.

Seeps and springs represent the continuum between the surface water and groundwater systems. Seeps and springs are the points at which subsurface water discharges to the surface water system and thus mark the predominant groundwater discharge points. As with the ungaged surface water stations, monitoring perimeter seeps and springs will help quantify flux moving across the ungaged perimeter of the site. Internal seep and spring monitoring will help identify changes in releases from the sources.

Seeps and springs at WAG 6 tend to occur in low-lying areas near drainages. Because characterization and/or location of seeps and springs at WAG 6 has not been conducted in detail sufficient to support the needs of the EMP, a seep and spring survey has been planned and will be conducted prior to baseline monitoring. Field reconnaissances will be conducted to identify visible seeps and springs throughout WAG 6 and adjacent to the eastern and southern boundaries, where additional information will greatly aid the estimates of off-site contaminant flux.

Groundwater wells will be monitored for four primary purposes:

- perimeter wells will be monitored to help estimate flux leaving the ungaged perimeter via the subsurface flow path,
- selected interior wells will be monitored to track releases at the trench sources,
- all wells will be monitored for water level measurements to continually calibrate the groundwater model to estimate flow across the ungaged perimeter, and
- RCRA compliance wells will be monitored to address RCRA permit requirements.

In general, existing groundwater wells at WAG 6 will be used to conduct water quality, water level, and RCRA compliance monitoring. The exception to this is six proposed wells along the southern and eastern perimeters of the site and nine internal trench piezometers.

The groundwater monitoring network is divided into three functional groups: upgradient perimeter wells, downgradient perimeter wells, and interior wells.

In the RFI, groundwater quality monitoring data gaps were identified along the eastern portion of WAG 6. These data gaps will be rectified by the installation of groundwater monitoring wells along the eastern perimeter of WAG 6. All additional monitoring wells will be installed in such a manner as to conform to RCRA protocol (EPA 1986, 1992a).

All groundwater monitoring wells and piezometers will have periodic water level measurements taken. A subset will be instrumented for continuous measurement of water levels and/or temperature and conductivity.

The water level monitoring network is divided into two groups: trench piezometers and nontrench monitoring wells and piezometers.

The use of existing piezometers and wells was maximized; however, installation of new piezometers is required in areas that have insufficient spatial density or where the piezometers have been damaged, are poorly constructed, or are otherwise not suitable.

By selecting trench piezometers inside the Interim Corrective Measure caps for monitoring, it is possible to continue evaluation of the effectiveness of the Interim Corrective Measure caps. The trench piezometers in uncapped trenches provide the minimum network necessary for evaluation of the areal extent of water table inundation of the trenches.

The meteorological monitoring effort will use the existing tumulus meteorology station. The station is located ~100 ft south of the tumulus disposal facility. The location of the meteorological tower is such that it will provide representative measurements of the local air flow patterns in WAG 6. The tower's location meets EPA specifications of no surface obstruction located within a distance of 10 times the height of the instrument. This minimizes the probability of any air flow obstructions or artificially induced turbulence.

3.3 PRIMARY OBJECTIVES

A major objective of the ER Program at ORNL is to identify potential risks to human health and the environment presented by contaminants leaving the ORR via the WOC watershed. Contaminants from multiple sources are released via the WOC watershed, and it is the objective of the ER Program to address the most problematic sources first. Presently, WAG 6 is not a high-priority site because it contributes a small percentage of the off-site releases. However, as resources are shifted from WAG 6 to other sources, it is imperative to continue to monitor the changing role WAG 6 plays in contributing to off-site releases and to understand if and when priorities should shift back to WAG 6.

To address the ER programmatic objectives, it was determined that the monitoring at the site should be able to detect a tenfold change in risk at the dam that is attributable to contaminant releases from WAG 6. A tenfold increase would result in WAG 6 flux contributions at WOD equal to ~20% of the current total releases. It was also determined that an annual twofold increase in total flux could alert decision-makers to the increased relative contribution from WAG 6 early before the WAG becomes a higher priority for source control.

Three primary objectives (POs) have been identified for performing environmental monitoring at WAG 6. The three POs have been divided into subobjectives for further clarification. The objectives are listed in Table 2.

PO1 is to identify changes in risk at the site to determine if additional action (either site characterization or remediation) is necessary. Risk associated with the WAG will be measured at two points: the boundary of the waste unit where releases enter a surface water body (a common compliance point in CERCLA and RCRA actions) and at WOD. The evaluation of relative risk at WOD supports the ORNL ER Program objective of identifying the greatest contributors to off-site risk. Baseline risk estimates at these two points will be established with data gathered during the baseline monitoring effort. Measurements and data evaluation performed in subsequent years will identify changes in the baseline estimates.

As part of tracking changes in risk, it will be necessary to determine if the correct contaminants are being measured. PO1-2 requires that the existing list of COC be checked periodically by analyzing samples for an expanded list of contaminants.

The third component of PO1 is sampling that will allow risk estimation methods to be continually refined. Estimating relative risk at WOD requires that total contaminant flux from the site be understood. A conceptual site water balance model and a numerical groundwater model are required to estimate total contaminant flux. PO1-3 calls for samples that will help confirm the conceptual model and refine the groundwater model.

PO2 is to ensure that all regulatory requirements that apply to WAG 6 are addressed in the monitoring effort. Regulatory drivers identified at the site include a RCRA permit (PO2-1), an NPDES permit (PO2-2), and DOE Orders 5400.1 and 5400.5, which require DOE contractors to ensure public protection against undue risk from radiation (PO2-3).

PO3 ensures that data are collected that will support implementation of an interim or final action at the WAG if such an action is deemed necessary. A primary component of this objective is to be able to understand the source of off-WAG contaminants. The majority of the monitoring efforts under PO1 will be focused on contamination leaving the WAG at the boundary of the waste unit. These efforts will identify if action is necessary but will not provide the information necessary to identify the source of the problem. PO3-1 is designed to ensure that internal locations on the WAG near the trenches indicate changes in releases from the sources.

PO3-2 directs efforts toward developing technologies for future site characterization and remediation efforts at ORNL.

Table 2. Objective for WAG 6 EMP

PO identifier	Objective description
PO1	Identify changes in risk associated with WAG 6
PO1-1	Estimate risk at boundary of waste unit and relative risk at WOD
PO1-2	Verify primary COC that contribute to risk
PO1-3	Refine risk estimates
PO2	Meet regulatory requirements
PO2-1	Meet RCRA reporting requirements
PO2-2	Meet NPDES reporting requirements
PO2-3	Address DOE Order 5400.1 and 5400.5
PO3	Support implementation of interim or final actions
PO3-1	Identify major sources of off-WAG contaminant migration
PO3-2	Develop technologies to support site characterization and remediation activities

4. PROJECT ORGANIZATION AND RESPONSIBILITY

4.1 ORGANIZATION

The overall WAG 6 environmental monitoring project organizational structure is shown in Fig. 1, and the project specific organizational structure is shown in Fig. 2. The responsibilities defined below are those specific to the development, implementation, and assessment of the WAG 6 EMP QAPjP. Additional QA-related responsibilities are delineated in Table 3, Project Document Summary.

All organizations performing tasks associated with the WAG 6 Environmental Monitoring Program must have a corporate QA Plan that is consistent with the WAG 6 program level QA Plan. Each organization will follow the QAPjP at the project level and will have similar requirements for their activities. Review of the QA Plans of other organizations is the responsibility of the QA Specialist and the Project Manager. If there is no approved QA plan for the task, then the responsible organization will be required to develop an acceptable plan. It may be necessary to add project-specific attachments, such as organization charts, functional responsibility matrixes, and surveillance plans, to otherwise adequate plans.

4.2 RESPONSIBILITIES

This section lists the key individuals who are responsible for ensuring the collection of valid measurement data and the routine assessment of measurement systems for precision and accuracy. The key individuals will either accomplish the responsibilities listed or will manage the individuals responsible for the listed activities.

4.2.1 Project Responsibilities

4.2.1.1 Project Manager

The Project Manager

- provides program oversight;
- ensures that the appropriate QA requirements of this document are included in planning, investigating, analyzing, and reporting activities of the WAG 6 Project;
- ensures that the ORNL ER Program QA Specialist is included in the project activities and is consulted with on all quality-related matters;
- ensures that the project personnel are qualified and trained to perform the assigned project activities;
- ensures that project changes are reviewed to determine if the changes impact project cost, scope, or schedule or if the changes are technical and do not impact cost, scope, or schedule;

- ensures that project changes are properly documented in accordance with WAG 6 deviation request or field change request procedures;
- approves project change requests that impact cost, scope, or schedule and coordinates changes with procurement organization;
- approves resolutions for quality problems and concurs with root-cause analysis, proposed solutions, and corrective actions as determined by the project QA Specialist and the SAP Coordinator;
- submits the appropriate documents to the QA Specialist for comment and approval;
- reviews and approves the QAPjP, the Health and Safety Plan, and the EMP;
- reviews and approves the SAPs and FOP Manual;
- reviews and approves the Data Management Plan and Functional System Design; and
- reviews and approves project-specific procedures.

4.2.1.2 QA Specialist

The QA Specialist

- oversees project-specific procedures and training development, implementation, and tracking;
- approves change requests;
- assists in the preparation of and approves the QAPjP;
- reviews and approves the standard operating procedures (SOPs), SAPs, Health and Safety Plan, and instructions;
- provides guidance to resolve quality problems and ensures that corrective action is taken and is appropriately documented;
- provides QA coordination between the Project Manager and project participants to ensure implementation and assessment of this plan;
- conducts field and laboratory evaluations of sampling methods and analytical procedures to ensure adherence to this QAPjP, SOPs, and instructions;
- assures that SOPs are in place and that appropriate personnel have been trained in the procedures;
- evaluates the effectiveness of project QA activities through scheduled audits and surveillances; and
- conducts QAPjP orientations to all WAG 6 environmental monitoring program staff.

Fig. 1. Organization chart for WAG 6 environmental monitoring.

Fig. 2. Environmental monitoring project specific WAG 6 organization chart.

4.2.1.3 DOE QA Officer

The DOE QA Officer

- approves the QAPjP, Site Health and Safety Plan, and other project documents as appropriate; and
- evaluates the effectiveness of project QA activities through scheduled audits and surveillances.

4.2.1.4 Technical Coordinators

Technical coordinators are responsible for integrating available information and collected data to meet the objectives and requirements of their specific tasks. The technical coordinator

- assists the Project Manager in achieving the goals and objectives of the WAG 6 project;
- resolves any technical questions concerning the sampling, monitoring, and data management; and
- reviews and approves the SAPs and FOP Manual.

One of the technical coordinators will be designated as the field coordination manager, who will provide all technical direction and changes to the field task manager.

4.2.1.5 Information Management Coordinator

The Information Management Coordinator is responsible for the management, integration, and dissemination of data generated for, or using data from, the WAG 6 information management system. The Information Management Coordinator

- coordinates the development of data and activity models to ensure the information management system provides organization, integrity, security, traceability, and consistency across WAG 6 data;
- coordinates information management activities with WAG 6 project managers;
- ensures the WAG 6 information management system supports the project data lifecycle including project planning, field measurements, sample tracking, laboratory analyses of environmental samples, data verification, validation and assessment, data consolidation and storage, transfer to the Oak Ridge Environmental Information System, data analysis, spatial analysis and mapping, summarization and reduction of data, simulations and risk assessment calculations, data presentation, and data and document archival;
- ensures the Software Development Methodology has been used for the design, implementation, and maintenance of the Information Management System;
- ensures that field, sample, and analytical data are entered on a timely basis into the WAG 6 Information Management System; and

- ensures the computing platform, data bases, and programs are operational and protected from unauthorized access, deletion, and modification.

4.2.1.6 Health and Safety Officer

The Health and Safety Officer is responsible for ensuring that site personnel adhere to the site Health and Safety Plan requirements. The Health and Safety Officer

- develops, coordinates, approves, and implements the Health and Safety Plan;
- revises the Health and Safety Plan as warranted by changed site conditions;
- verifies that all WAG 6 personnel have fulfilled the appropriate site access requirements;
- maintains site access verification documentation records for all WAG 6 personnel in onsite files;
- ensures that all WAG 6 personnel adhere to health and safety requirements; and
- reviews the QAPjP.

The Project Manager, with the assistance of the Health and Safety Officer, handles the agency liaison matters relating to health and safety.

4.2.1.7 Generator Certification Officer

The Generator certification officer

- reviews and approves the Waste Management Plan.

4.2.1.8 SAP Coordinator

The SAP Coordinator

- coordinates activities of Field Task Manager and Laboratory/Data Validation Coordinator;
- verifies that all appropriate QA requirements, as specified in the QAPjP, are met in all monitoring field and laboratory activities;
- consults with the WAG 6 Project Manager and appropriate EMP QA authorities on all quality-related matters;
- investigates field- and laboratory-related quality problems (e.g., out-of-control events), determining their root causes, proposing solutions, implementing corrective actions, and obtaining the concurrence of the WAG 6 Project Manager and QA Specialist on the appropriateness of any corrective action;
- submits any proposed changes to the SAPs, on a Change Request Form (CRF), to the WAG 6 Project Manager for approval;

- maintains custody of all original and copied EMP monitoring documentation;
- coordinates the preparation of FOP Manual, SAPs, and chain of custody forms;
- coordinates the development of applicable SOWs to procure subcontract technical services to support the project and verifies that methods specified are appropriate for meeting DQOs;
- submits all field data, documentation, and laboratory data to the WAG 6 Project Manager for review;
- develops, gains approval, and implements any cost-effective quality improvements; and
- reviews all field data and documentation and laboratory data for completeness and adherence to QA protocols.

4.2.1.9 Field Task Manager

The Field Task Manager is responsible for the management and coordination of specific field sampling teams. The Field Task Manager

- coordinates and supervises field sampling activities and ensures that all sampling activities have been approved by the QA Specialist;
- coordinates activities with project management;
- provides orientation, hazard information, and training to technical staff, based on the requirements of the support plans;
- ensures that field-related activities are performed correctly and documented as required by the WAG 6 QAPjP;
- ensures that corrective actions and nonconformance reports are initiated if necessary;
- provides coordination between the Site Health and Safety Officer and field personnel, including communication of requirements to all personnel and field supervision, and ensures that site personnel have received required Occupational Safety and Health Administration and WAG 6 training and that they adhere to the site safety requirements;
- provides maintenance and inventory control for field monitoring equipment;
- informs the Site Health and Safety Officer of any changes in sampling plans so that they may be appropriately addressed; and
- reviews and signs field logbooks.

4.2.1.10 Laboratory/Data Validation Coordinator

The WAG 6 Laboratory/Data Validation Coordinator

- serves as the main contact for the laboratories concerning chain-of-custody and requests for services;
- serves as a receiving and review point for all laboratory data, ensures that laboratory supplemental QC data are placed in program files, and ensures that the laboratory data are properly validated and verified in accordance with the project requirements;
- performs reviews and screening for completeness of analytical data provided by analytical laboratories prior to validation and data entry into the WAG 6 data management system;
- responsible for assembling and organizing the validation personnel. Acts as the coordinator of the data validation program and any deviations or modifications to the program must be approved by him/her;
- coordinates the development of applicable SOWs to procure subcontract technical services to support the project and verifies that methods specified are appropriate for meeting DQOs; and
- coordinates the verification and validation of field and laboratory data and assignment of qualifiers to the data as part of the verification or validation process.

4.2.1.11 Field and Analytical Data Manager

The Field and Analytical Data Manager

- coordinates the incorporation of analytical data into the project data base. Specific activities include processing electronically submitted data, supervising computerization of raw data, and identifying, documenting, and whenever possible resolving problems in the data submissions;
- ensures project data will be controlled through defined data reviews based upon user needs and roles that are approved by the project manager;
- ensures data are backed up on a set schedule, and that a portion of the data backups are stored in a different building than the workstation; and
- transfers copies of field logs to the ER Document Management Center (DMC).

4.2.1.12 Environmental Evaluation Coordinator

The Environmental Evaluation Coordinator

- ensures data are evaluated to determine whether DQOs are met;
- performs data useability function;
- examines sampling design and methods;

- examines data quality assessments, validation reports, and/or the laboratory and field QC data to determine if the precision, accuracy and sensitivity of the measurements meets the DQOs;
- examines acceptable data for spatial and temporal consistency; and
- corrects or deletes data depending on problem identified during evaluation.

4.2.1.13 Laboratory Supervisor

The Laboratory Supervisor

- ensures laboratory equipment calibration records are kept;
- evaluates validity of laboratory equipment inspection results and acceptability of the equipment;
- ensures that a Laboratory Operations Manual (LOM) is developed, controlled, and maintained; and
- checks and approves analytical data.

4.2.1.14 Training Coordinator

The Training Coordinator

- plans and implements the WAG 6 training programs, including training for EMP activities;
- prepares and maintains the WAG 6 training program procedures;
- provides guidance to subcontractor training coordinators;
- verifies and tracks individuals procedural training;
- establishes and maintains hardcopy and computerized training record files;
- provides duplicate copies of the training records to the ER DMC;
- prepares routine and special request training status reports; and
- works with the QA Specialist to correct and improve the training program.

4.2.1.15 Records Manager

The Records manager

- implements and maintains the security, storage, indexing, arrangement, retrieval and transmittal of all records pertaining to the WAG 6 project; and

- reports problems and deviations in use of the system to the QA Specialist and/or the Project Manager.

4.2.2 QA Program Responsibilities

4.2.2.1 QA Program

The Project Document Summary (Table 3) identifies responsibilities for the development, review, approval, and control of the QAPjP.

4.2.2.2 QA Planning

The development, review, approval, revision, and distribution of this QAPjP will follow guidelines set forth in *Preparation, Development, Approval, and Clearance of Environmental Restoration Documents*, ER/C-P1103.

4.3 VARIANCE/CHANGE APPROVAL

A variance is defined as a project change that would not significantly affect the quality of the data generated. An example of a variance would be changing the size of the split spoon sampler.

A change is defined as a deviation from project requirements that will affect quality of the data generated, will cause a significant change (either increase or decrease) in the cost of the effort, can be defined as a major change in the scope, or will cause significant delays or improvements in the schedule.

The key elements for the control of changes include the following:

- major changes from approved operating procedures, project scope, cost, or schedule will be documented on an CRF and submitted to the Project Manager. Change requests will be coordinated through the appropriate technical coordinator;
- the Project Manager and/or the QA Specialist must approve each CRF before work proceeds. Weekly quality status reports serve as the mechanism for notifying the QA staff of changes. Approval can be initiated on a verbal basis via telephone with follow-up sign-off. Copies of the CRFs will be kept on-site until the work is complete and then will be sent to the ER DMC;
- variances or minor changes to operating procedures will be promptly documented on variance forms. The variances will also be entered into a variance logbook and reported to the Project Manager on a weekly basis;
- if deemed necessary, the SAP, QAPjP, Health and Safety Plan, or other relevant documents will be revised, reviewed, approved, and reissued with control measures commensurate with the original documents. The Project Manager must approve each CRF before work proceeds. Other procedures will be kept current with existing requirements, and a documented review of all current procedures is to be conducted at least annually; and

- all changes will be logged in a project wide change log.

An example of the CRF for documentation of change requests is shown in Fig. 3.

4.4 TRAINING

4.4.1 QA Training

All personnel will be trained in the requirements of the QAPjP. The QA Specialist will be responsible for distributing the plan document and conducting information sessions. Personnel will sign read-and-understand acknowledgements after distribution of the plan, and their attendance at an information session will be documented on a WAG 6 Training Attendance Sheet. The signature acknowledgements and the attendance sheets will be kept in the WAG 6 Training Coordinator's training records file, with duplicate copies being maintained in the ER DMC. The off-site laboratory will maintain a training file at their facility and will not be required to submit training records to the ER DMC. All personnel will undergo at least annual re-training in the QAPjP.

4.4.2 Health and Safety Training

All field personnel will have received the appropriate Health and Safety training prior to being allowed access to the site. Training requirements will be identified by the individual's supervisor with input by the Site Health and Safety Officer. As a minimum, General Employee Training and the 24-hour Superfund Amendments and Reauthorization Act/Occupational Safety and Health Act training are required in order to obtain Melton Valley access approval. All field access requirements are identified in the WAG 6 EMP Site Mobilization Plan and the WAG 6 Training Program Procedure. Other requirements, as needed, will be identified, and as they are fulfilled, verified by the Site Health and Safety Officer. Copies of the verification documentation will be maintained by the individual's employer, the ORNL Training Division, and onsite by the Site Health and Safety Officer.

Training in the individual Health and Safety Task Instructions will take place as part of the training for each SAP. This training will be documented on signature acknowledgement forms, training attendance forms, and, if required, the WAG 6 personnel training record form. These forms will be maintained in the WAG 6 training record files and duplicates will be sent to the ER DMC.

4.4.3 Procedural Training

All ORNL and subcontractor personnel performing WAG 6 EMP activities will be trained and qualified individuals. In addition to education and experience, specific training in certain procedures may be required. Training will be accomplished and verified prior to an individual performing the activity. Training requirements are identified for each individual by the supervisor, with input from the Training Coordinator. Training will be provided by pre-approved instructors with appropriate qualifications. Determination of proficiency will be performance based. The instructor's evaluation of each individual will be documented on the WAG 6 personnel individual training record form. Completed training will be verified by the Training Coordinator. Each individual's training needs assessment and record sheet and individual training record form will be maintained in the WAG 6 training record files and in

CHANGE REQUEST FORM

Project No. _____ Change No. _____ Page _____ of _____

Project _____

Applicable Document: _____

Description: _____

Reason for change: _____

Recommended disposition: _____

Impact on present and completed work: _____

Requested By: _____ (Field/Project Manager)

Approval:

Energy Systems Project Manager: _____

Environmental Restoration QAS: _____

Other: _____

Other: _____

NOTE: The Energy Systems Project Manager is notified of the need for changes in project cost, schedule, or scope.

Fig. 3. Example of a change request form.

the ER DMC, with the exception of the off-site laboratory training records. The off-site laboratory will maintain their own training records file.

The WAG 6 training program is described in detail in procedure X-OE-703, *WAG 6 Training Program*, which includes a complete listing of applicable administrative and technical procedures.

A copy of the following documents will be available to all field personnel while in the field:

- WAG 6 EMP.
- WAG 6 QAPjP.
- WAG 6 Site Health and Safety Plan.
- WAG 6 FOP Manual.
- WAG 6 SAPs.
- Energy Systems Procedures and SOPs.
- Waste Management Plan.
- CDM Federal *Quality Assurance Manual* (1993).
- CDM Federal *CDM Health and Safety Assurance Manual—Hazardous Waste Projects* (1988).
- CDM Federal *CDM Field Equipment Operations, Maintenance, and Calibration Manual* (1987).

4.5 TECHNICAL AND PEER REVIEWS

Technical and peer reviews shall be provided and properly documented for all new plans and procedures that direct environmental monitoring activities at WAG 6. Field and laboratory data, including logbooks and field records, shall receive technical and peer reviews.

4.6 INFORMATION MANAGEMENT

Information management for the WAG 6 environmental monitoring program comprises the WAG 6 Data Management Plan and Functional System Design, with procedures, and the WAG 6 Information Management System, with supporting documentation. Information management will

- support the WAG 6 DQOs;
- provide organization, integrity, security, traceability, and consistency of the data generated during the WAG 6 project; and
- support the project data lifecycle including project planning, field measurements, sample tracking, laboratory analyses of environmental samples, data verification, validation and assessment, data consolidation and storage, transfer to the Oak Ridge Environmental Information System, data analysis, spatial analysis and mapping, summarization and reduction of data, simulations and risk assessment calculations, data presentation, and data and document archival.

Information management implementation for WAG 6 consists of both manual and automated methods. Manual methods are implemented through the use of standard operating procedures and work instructions. The automated methods are implemented according to the Energy Systems Automated Data Processing Systems Development Methodology, Volume 1 (K/CSD/INF-86-3). The Automated Data Processing Systems Development Methodology incorporates the definition, analysis, design and implementation activities; automated data processing security requirements; QA standards; verification, validation, and acceptance procedures and documentation guidelines into a single development and implementation structure.

Table 3. WAG 6 EMP document summary

Document title	QA record	Controlled document	Prepare	Review					Approve		
QAPjP	YES	YES	QAS	PM	QAS	HSO		DOE QA	PM	QAS	DOE QA
Personnel training records	YES	NO	TC	PM	TC	QAS			PM	QAS	
FOP Manual	YES	YES	SAPC	QAS	PM	PR			PM	QAS	TECH
SAPs	YES	YES	SAPC	PR	PM	IMC	TECH	QAS	PM	QAS	TECH
EMP	YES	YES	PM, PS	PR	PS	QAS	TECH	DOE QA	PM	TECH	DOE PM
Chain-of-custody forms	YES	NO	SAPC,FTM,IMC	IMC	QAS						
QA audit/surveillance reports	YES	YES	AO	PM	QAS				QAS	PM	
Statements of work	YES	NO	PM,APO,SAPC	PM	QAS	SAPC	APO		PM	APO	SAPC
Standards traceability documents	YES	NO		SAPC	QAS						
Lab/field forms	YES	NO	PS	FTM	QAS	IMC			FTM		
Lab/field notebooks	YES	NO	PS	FTM	QAS	SAPC			FTM	PM	
Data: electronic/hard copy	YES	NO	IMC	QAS	DVC	IMC			LS		SAPC
Memoranda of agreement	YES	NO	PM	QAS	DD	PM			DD	PM	
Variance form	YES	NO	FTM	QAS	FTM	PM					
Change request forms	YES	YES	PS,FTM	SAPC	QAS	PM	FTM		PM	QAS	
Controlled software	NO	YES	IMC,SAPC	IMC							
QA summary reports	YES	NO	QAS	PM					PM	QAS	
Inspection reports	YES	NO	FTM,LS	LS	QAS	FTM	LC		PM		
Lab operations manual	NO	NO	LS	QAS	APO				APO		

Table 3. (continued)

Document title	QA record	Controlled document	Prepare	Review					Approve		
Corrective action plans	YES	NO	PM	PM	QAS	PS			AO	PM	QAS
Health and safety plan	YES	YES	HSO	SAPC	QAS	DOE QA	HSO	PM	HSO	PM	DOE QA
Waste management plan	YES	YES	PS	PM	HSO	DOE QA			GCO	PM	
Data management plan and function system design	YES	YES	IMC	PM	QAS	SAPC	DOE QA		IMC	PM	

AD = agency/organization director/manager
AL = analytical laboratory
AO = auditing organization
APO = Analytical Projects Office
DD = division director
DOE PM = Department of Energy Project
DOE QA = Department of Energy Quality

FTM = field task manager
HSO = health and safety officer
IMC = information management
LC = laboratory coordinator
LS = laboratory supervisor
PM = project manager
PR = peer reviewers

QAS = program quality assurance specialist
SAPC = sampling and analysis plan
TC = training coordinator
TECH = technical coordinator

5. QA OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS, AND COMPARABILITY

The overall quality assurance objective is to develop and ensure the implementation of procedures for field sampling, chain of custody, laboratory analysis, and reporting that will provide legally defensible data (where necessary) or data of known quality. Specific procedures to be used for sample collection are listed in Sect. 6. Other procedures (chain of custody, calibration, laboratory analysis, reporting, internal quality control, audits, preventative maintenance, and corrective actions) are described in other sections of this QAPjP. The purpose of this section is to define the goals for the level of QA effort and data requirements for precision, accuracy, representativeness, completeness, and comparability (PARCC).

5.1 DATA QUALITY OBJECTIVES

One of the most important steps in assuring the quality and usability of environmental monitoring data is the development of DQOs. DQOs are developed during project scoping and during development of monitoring plans to ensure that the data collected are sufficient and adequate for decision-making. In support of the DQOs, the Data Management Plan and Functional System Design will provide organization, integrity, security, traceability, and consistency of the data generated during the WAG 6 Environmental Monitoring Program.

A major requirement for identifying DQOs is a conceptual site model that describes what is known about the current situation at a site. A conceptual site model was developed for the WAG 6 EMP, which defines four distinct flow path groups: surface water discharge at gaged sites, overland runoff at ungaged sites, shallow subsurface water along the WAG perimeter, and intermediate-to-deep groundwater.

The gaged and ungaged surface water flow path groups consist of the main WAG 6 tributaries and two gullies located on the eastern perimeter. Currently, each of the four main tributaries on the southern perimeter of the WAG is gaged and will be monitored separately during the initial stage of the EMP. Overland flow in the two eastern perimeter gullies occurs only during storm events (DOE/OR/01-1992&D1, Sect. 2).

The shallow subsurface water discharge along the perimeter comprises the third flow path group. Areal subsurface drainage (i.e., seeps and springs) along the southern and eastern perimeter of the WAG are the main transport pathways. While these areas are highly sloped toward the West Seep and WOL, they are not expected to have appreciable overland flow except in the two ungaged surface water gullies. However, shallow groundwater drainage and subsurface storm flow drainage are expected to flow to the receiving surface waters. A set of assumptions that accompanies the conceptual model was defined, including

- Annual risk associated with the primary WAG 6 contaminant (e.g., ^3H) is directly proportional to annual contaminant flux and thus can be estimated by measuring annual contaminant flux;

- Annual contaminant flux (mg/year) = water volume (L/year) * average contaminant concentration (mg/L);
- Water volume leaving the WAG 6 perimeter flows via four major flow paths (Table 4);
- Flux via surface water at gaged sites can be measured with water volume and contaminant concentration samples taken by an automatic sampler at the gaged monitoring stations MS1, MS3, and MS4;
- Flux via the ungaged perimeter (“overland flow at ungaged perimeter sites” and “subsurface flow paths”) can be estimated separately for five primary subsurface drainages along the eastern and southern boundaries of the WAG;
- The majority of flux via “overland flow at ungaged perimeter sites” and “subsurface flow paths” can be estimated using the WAG 6 groundwater model to calculate water volumes for each of the five drainages and contaminant concentrations measured at the following locations:
 - overland flow at ungaged sites (during storms) at B and C sampling locations along the eastern site boundary and
 - release via the subsurface flow path at five primary perimeter seeps and springs and/or shallow (water table interval) groundwater wells.

Table 4. Water volume by flow path

Flow path	Primary location(s) for measuring flow	Percent contribution to total flow from WAG 6
Surface water at gaged sites	Gaged surface water monitoring stations	~ 85 %
Overland flow at ungaged perimeter sites	Locations B & C on eastern boundary	
Subsurface flow paths (includes storm flow zone and water table interval groundwater)	Perimeter seeps and springs and perimeter shallow groundwater wells	~ 15 % (combined)
Intermediate and deep groundwater	Intermediate and deep groundwater wells	< 1 %

- A single primary location for collecting a contaminant sample that represents each of the five subsurface flow path drainages can be identified during the baseline sampling effort.
- The contaminants contributing the majority of the off-WAG risk are those that were consistently detected at elevated levels in the surface water during RFI sampling and

estimated to be the greatest contributor to risk to a hypothetical receptor at WOD (DOE/OR/01-1992&D1, Appendix A). These contaminants are ^3H and ^{90}Sr .

- Based on RFI sampling, a list of COC for WAG 6 has been developed. Primary considerations in developing the list include comparison to background and maximum concentration limits. Most of these contaminants do not contribute significantly to elevated off-WAG risk (e.g., are not detected frequently at the gaged surface water stations). Most of the sampling effort will be directed toward the high-risk contributors (^3H and ^{90}Sr); however, the full list of RFI COC will be analyzed less frequently to ensure that ^3H and ^{90}Sr remain as the only high-risk contributors.
- Base flow grab samples taken at surface water gaged stations upstream of WAG 6 (WOC, WSW); at the perimeter of WAG 6 (MS1, MS3); and downstream of WAG 6 (at WOD) can provide information that will help validate contaminant flux estimates.
- The largest relative uncertainty is in the groundwater regime, where, it is assumed, the smallest fluxes occur.

Using the site conceptual model and assumptions, the DQO development process began. The seven primary stages of the DQO development process defined by EPA (1992a) are

- state the problem,
- identify decisions to be made,
- identify inputs to the decision (data uses and data needs),
- define the study boundaries,
- develop the decision rule (if/then),
- specify limits on uncertainty, and
- optimize design for obtaining data.

Environmental data collection inherently involves some error; therefore, some degree of uncertainty will exist in any decision based on environmental data. Conventional uncertainty constraints will be used to establish quantitative limits on total study error and corresponding measurement and sampling error measurement (EPA 1992a).

Any data derived from the sampling proposed in this monitoring plan will be collected and documented in such a manner as to be technically and legally defensible. Sampling will be performed according to a set of approved procedures (detailed in the SAP and FOP Manual), and, in general, laboratory procedures will be performed according to the EPA Contract Laboratory Program (CLP) statement of work (SOW) protocols. It is suggested that all samples be analyzed at DQO Level III, with an appropriate level of quality assurance. Because the data will be used to evaluate risk associated with WAG 6, 10% of the data packages will be validated to a Level IV validation level to help provide confidence in the quality of the analytical procedures. Appendix A provides recommended analytical methods and PARCC parameters. The PARCC parameters have been chosen to ensure that all data used for decision-making have a high degree of accuracy associated with them and can be used to assess risk associated with WAG 6.

The primary basis for all specific uncertainty considerations is the decision rule that states that a twofold increase in annual risk from WAG 6 could result in some action being taken. The decision rule mainly applies to ^3H and ^{90}Sr samples because virtually all of these samples

are used to estimate total flux from the WAG. However, in the design of the EMP, more emphasis has been placed on understanding the variability in concentrations at the gaged sampling station because it is assumed that 85% of water flowing from the site flows through the gaged stations. Samples taken from interior groundwater wells and interior seeps and springs are used to identify changes in source releases. For interior sampling locations, it has been determined that sampling should be able to identify a trend in mean concentrations at any sampling location at the 95% confidence interval.

To limit the uncertainty in the risk estimates, higher sampling frequencies are being recommended for ^3H and ^{90}Sr at gaged surface water stations because these samples will reflect the majority of the flux and risk leaving the site. A baseline sampling program with higher sampling frequencies for all sample locations is being recommended to establish a baseline against which statistical changes can be identified.

Based on the conceptual model and the questions that need to be addressed by the program (e.g., is the risk associated with flux from WAG 6 increasing?), it was determined that optimal use of monitoring resources during routine monitoring results in the following:

- a relatively large number of samples at the gaged surface water stations, because ~85% of flow from the site can be measured at these stations,
- fewer samples along the ungaged perimeter, because flux from the two ungaged flow paths contribute 15% of the total flow,
- a focus on ^3H and ^{90}Sr as the major analytes, because they contribute nearly all the off-site risk from the WAG, and
- the required number of samples to meet regulatory requirements.

The baseline monitoring effort includes additional sample types to confirm the site conceptual model and groundwater model, an increased number of sample locations to identify the best locations for sampling the ungaged perimeter in the subsequent years, and increased sample sizes to establish the statistical baseline (e.g., the means and variances of contaminant concentrations and flow volumes against which year-to-year changes can be compared). Final determination of the optimal sample locations and frequencies for the routine annual monitoring may be changed on the basis of results of the baseline sampling.

The routine annual monitoring will provide enough routinely collected samples to determine if releases from the WAG are changing. During the fifth year of routine annual monitoring, the RFI COC list will be reconfirmed by sampling for expanded analytes.

The seven steps used to develop the DQOs are discussed in detail in ORNL/ER-158, Sect. 2.

5.2 LEVEL OF QA EFFORT FOR PARCC

Acceptable precision and accuracy for standard equipment/method combinations are determined through statistical evaluation of historical data. Representativeness is achieved by procedure design and results are assured by the use of proper calibration procedures and

standards as specified in project procedures. Completeness of both field and laboratory data will be measured. Laboratory completeness is defined as the percentage of usable (valid) data derived from sample collection activities. For field activities, completeness is defined as the number of samples planned to be collected vs the actual number collected for which valid data exist.

Five general levels of analytical options to support data collection are specified by the EPA as QC levels. These are Levels I, II, III, IV, and V; and they are defined in *Data Quality Objectives for Remedial Response Activities, Development Process* (EPA 1987b). These QC levels directly correspond to the QC levels A, B, C, D, and E as described in ES/ER/TM-16, *Requirements for Quality Control of Analytical Data*. These levels are based on the type of site to be investigated, the level of accuracy and precision required, and the intended use of the data.

Level A QC is designated for field screening and field measurements and is the QC level applicable to stream flow discharge measurements. Level A is also used for screening samples that will be subject to further analysis. No data quality criteria are specified for Level A because this level is characterized by the use of monitoring instrumentation that is not conducive to the generation of quantitative data.

Level B QC is designed to provide real-time data for ongoing field activities or initial data that will be the basis for seeking laboratory analytical support. The data typically are confirmed by submitting some duplicate samples to a fixed-base or a local laboratory. Level B analysis is used for on-site, real-time screening, baseline data development, extent of contamination, and on-site remedial activities. Field analysis involves the use of portable or transportable instruments that are based at or near a sampling site and can provide data from the analysis of air, soil, and water samples for organic and inorganic compounds. Since Level B analyses are performed in the field, the amount and type of documentation available will vary with the type of analysis and SOPs used. Field and analysis logbooks also would be a source of additional documentation.

Level C QC applies to data produced by an off-site (fixed-base) laboratory that meets Energy Systems QA/QC requirements. Level C QC includes review and approval of the laboratory QA plan, SAP, and the field QA plan. The laboratory that performs Level C QC will successfully analyze a performance evaluation sample, undergo an audit, correct deficiencies found during the audit, and provide monthly progress reports on QC. Level C allows the use of non-CLP methods but requires that the methods be EPA-approved or EPA-equivalent methods. The laboratory is required to provide the summary CLP or CLP-equivalent package with the analytical results (not full package). Level C QC results in technically defensible data.

Level D QC field and laboratory requirements are similar to Level C for the basic laboratory QA/QC, SAP, and QA Plan development and approvals. However, for Level D QC, the laboratory is required to submit the full CLP data package (or equivalent) with analytical results. This QC level typically applies to sites on the National Priorities List and results in very defensible data.

Level E QC requires the use of EPA or EPA-equivalent analytical methods. It generally is method specific and applies to unique materials such as pure waste, biota, etc.

As stated earlier, QC Levels A, B, and C will apply to data collected during this investigation. Approximately 10% of QC Level C analyses from each sample matrix will include QC Level D deliverables from the laboratory. This will allow a more in-depth review of the data, resulting in a higher level of confidence in the ability of the data to fulfill the project DQOs. The intended use, intended users, and QC level for various field activities or types of data are identified in DOE/OR/01-1992&D1.

The PARCC parameters are tools by which data sets can be evaluated. Evaluation of PARCC parameters can help ensure that DQOs are met. Definitions of the parameters are provided below.

Precision refers to the level of agreement among repeated measurements of the same characteristic, usually under a given set of conditions. To determine the **precision** of the laboratory analysis, a routine program of replicate analyses is performed. Duplicate field samples will be collected to determine total measurement (sampling and analytical) precision.

The results of replicate analyses are used to calculate the relative percent difference, which is used to assess laboratory precision.

For replicate results C_1 and C_2 ,

$$\text{Relative percent difference} = \frac{|C_1 - C_2|}{\frac{C_1 + C_2}{2}} \times 100.$$

Precision objectives for the laboratory analyses are defined in Appendix A.

Precision of the total sampling and analytical measurement process will be assessed from field duplicates. Although a quantitative goal cannot be set because of field variability, The Data Validation Coordinator will review field duplicate relative percent difference values to estimate precision.

Accuracy refers to the nearness of a measurement to an accepted reference or true value. To determine the accuracy of an analytical method and/or the laboratory analysis, a periodic program of sample spiking is conducted (minimum 1 spike and 1 spike duplicate per 20 samples).

In addition, a laboratory control sample will be performed for each batch and plotted on control charts. Accuracy of the laboratory control sample will be evaluated in accordance with laboratory statistical guidelines.

To determine the accuracy of an analytical method and/or the laboratory analysis, a periodic program of sample spiking is conducted (minimum 1 spike and 1 spike duplicate per 20 samples). The results of sample spiking are used to calculate the QC parameter for accuracy evaluation, the percent recovery (% R).

For surrogate spikes and QC samples, where C_s is the measured spiked sample concentration (or amount) and C_t is the true spiked concentration (or amount).

$$\% R = \frac{C_s}{C_t} \times 100,$$

For matrix spikes,

$$\% R = \frac{|C_s - C_o|}{C_t} \times 100,$$

where C_s is the measured spiked sample concentration, C_o is the sample concentration (not spiked), and C_t is the true concentration of the spike.

Accuracy and precision of data collected in the investigation will depend on the measurement standards used and their meticulous, competent use by qualified personnel. Objectives for laboratory analyses will be defined in the contracting documents with the specified analytical laboratory. The compound-specific precision and accuracy objectives will be included in the laboratory QAPjP and will be reviewed for appropriateness. Accuracy of the total sampling and analytical measurement process will not be determined. This would require the addition of chemical spiking compounds to the samples in the field. Accuracy of field instruments will not be determined; however, frequent calibration and operational checks will be performed to ensure that instrument measurements are in control.

Representativeness is the degree to which discrete samples accurately and precisely reflect a characteristic of a population, variations at a sampling location, or an environmental condition. Representativeness is a qualitative parameter and will be achieved through careful, informed selection of sampling sites and analytical parameters and through the proper collection and handling of samples to avoid interferences and to minimize contamination and sample loss.

Completeness is a measure of the percentage of valid, viable data obtained from a measurement system compared to the amount expected under normal conditions. The goal of completeness is to generate a sufficient amount of valid data to satisfy project needs. For this project, the completeness objective for field and laboratory measurements is 90%.

Completeness (C) is calculated as follows:

$$\% C = \frac{\text{No. of valid measurements}}{\text{No. of total measurements}}.$$

Comparability is the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. Comparability will be assessed in terms of field SOPs, analytical methods, QC, and data reporting. In addition, data validation assesses processes used by the laboratory that affect data comparability.

6. SAMPLING PROCEDURES

6.1 SAMPLING PROCEDURES

All sampling procedures and instructions will be developed, documented, and maintained for accomplishing activities described in DOE/OR/01-1992&D1 and to meet ER objectives. Required documents are to be appropriately referenced as source documents to facilitate traceability of requirements.

Field documentation shall consist of one master site logbook, one or more job- or area-specific field logbooks, task-specific field forms, sample labels and chain-of-custody forms, and methods and variances/field change requests. All documentation must be completed in waterproof black or blue ink, and corrections must be marked with a single line, dated, and initialed. Handwritten documents must be legible. All field documentation must be peer reviewed.

6.1.1 Sample Identification and Labeling

Labeling of all samples shall be performed in accordance with SOP-1001, "Procedure for Labeling Sample Bottles." The following information must be recorded on the sample label:

- site name,
- unique sample identification,
- date and time of sample collection,
- type of sample (matrix),
- name of sampler,
- sample preservation, and
- type of analyses to be conducted.

All labels must be waterproof and completed in permanent ink.

6.1.2 Chain of Custody

Electronic bar code readers will be used to support the EMP field activities in addition to manual chain of custody. Specific chain-of-custody procedures for electronic custody and data management will be included in subsequent revisions to the SAP.

Sample possession must be traceable and shall be maintained in accordance with ESP-500, "Manual Chain-of-Custody Procedures." To track sample possession, an official documented chain-of-custody form shall be maintained for each sample. A sample is under custody if one or more of the following criteria is met:

- it is in the possession of a sampling team member,
- it is in a sampling team member's view after being in possession, or
- it is in a designated secure area.

The following information must be recorded on the completed chain-of-custody form:

- project name,
- signature of sampler,
- sampling station,
- unique sample number,
- date and time of collection,
- grab or composite designation,
- temperature of cooler prior to shipment,
- pH of samples requiring acidic/basic preservation,
- matrix,
- preservatives, and
- signatures of individuals involved in sample transfer.

Chain-of-custody forms initiated in the field will be placed in a plastic cover and taped inside the shipping container used for sample transport from the field to the laboratory. When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill/receipt will be recorded on the chain-of-custody form and in the field logbook. Individuals receiving samples will sign, date, and note the time of receipt on the chain-of-custody form. An example of a typical chain-of-custody form is provided in the FOP Manual.

The laboratory receiving custodian must also record the temperature of the cooler as received, pH of preserved samples (except VOCs), presence or absence of custody seals, and any unusual conditions. The laboratory receiving custodian must provide immediate written feedback by facsimile to the Laboratory Coordinator of any problems noted during sample log in or any major problems that transpire during analysis.

6.1.3 Decontamination

Decontamination of all field sampling equipment shall be performed in accordance with ESP-900, "Cleaning and Decontaminating Sample Containers and Sampling Devices," and ESP-901, "Equipment Decontamination." Decontamination activities shall be recorded in the site logbook.

6.1.4 Sample Containers

Appropriate sample containers will be supplied precleaned by the specified analytical laboratory. Sample containers shall be stored in an area where there is no risk of contamination. A list of the required sample containers for the analyses to be performed, along with the corresponding preservation methods and holding times, is provided in the SAP.

6.1.5 Sample Preservation

All samples will be preserved as specified in the SAP and in accordance with ESP-701, "Sample Preservation and Container Materials." In the field, samples will be immediately placed in a cooler and maintained at 4°C during packaging and shipment. Preservation should be checked and documented on the chain-of-custody forms (except for VOCs).

6.1.6 Sampling, Packaging, and Shipping

All samples will be packaged in accordance with ER/C-P2302, "Sample Classifying, Packaging, Marking, Labeling, and Shipping for Analysis Through the K-25 and Y-12 Environmental Restoration Programs." Sample coolers shall be prepared to include the appropriate trip blanks as described in Sect. 11.1.1. Samples shall be shipped to the appropriate analytical laboratory using an overnight carrier.

6.2 CONTROL OF TECHNICAL LOGBOOKS

Site and field logbooks provide a daily handwritten record of all field activities at an investigation site and shall be completed in accordance with CDM Federal SOP 4-1, "Field Logbook Completion and Control." The site logbook is a master record of all site activities, and entries are usually made at the end of each work day. Field logbooks must be waterproof, contain detailed daily records that are kept in real time, and assigned to specific activities, positions, or areas within the site. Each day a new page will be started, and each page of the logbook will be initialed and dated by a person other than the one entering the data.

The logbook and the Field Data Sheets will be copied at the end of each day even if the activity encompasses more than one day.

All logbooks must be permanently bound, have a hard cover, and be sequentially numbered. The individual responsible for a logbook must sign and date the logbook at the end of each page, and pages should not be removed from the book. All partially used pages must be lined out to prevent data entry at a later date. The front of the logbook must list the project name and number, name of the subcontractor, contract number, and dates of use. Copies (photocopy) shall be made of entries on a daily basis. These copies shall be secured in the CDM Federal main office as backup records in case of loss of the original. Backup records shall also be available to project personnel as references.

6.2.1 Site Logbooks

The site logbook chronicles all field investigation activities but does not have the same level of detail as the field logbook. It delineates conditions and activities occurring on a given day and references the appropriate field logbooks and forms for specific information. For example, to find specific information relative to the conditions under which a surface water sample was taken, one would look in the site logbook for the appropriate day and find the reference to the field logbook for detailed information regarding the sampling event. The site logbook is also used to record all field changes with the supporting rationale.

The Field Task Manager is responsible for completing the site logbook. The following items are to be included in the site logbook:

- a list of all field logbooks and a brief outline of their required contents;
- daily temperature, weather conditions, and names and titles of personnel present;
- name, title, organization, and purpose of each visitor to the WAG 6 EMP field activities during the day;

- a brief outline of activities for each day and references to the appropriate field logbooks and field forms;
- specific comments on problems that occurred during daily activities, their final resolution, and anticipated impact on the field investigation;
- field changes or variances with references to the appropriate documentation of these changes;
- a record of telephone calls (incoming or outgoing) pertaining directly to the decision-making process of the field implementation and a brief description of the content of these conversations;
- a record of samples collected and shipped, the name of the laboratory(ies) to which samples were shipped, the airbill numbers of samples shipped, chain-of-custody form details, and other pertinent information relative to sample status;
- a record of instrument calibration, including the names of organizations or personnel performing the calibrations, with reference to any specific calibration logs; and
- a record of equipment decontamination, with reference to any specific documentation information.

6.2.2 Field Logbooks

The cover of each field logbook must identify the specific area, function, or position to which it is assigned. Entries in the field logbook must be made in real time and must be signed by the responsible person at the end of each page. Field logbooks shall be sequentially numbered. The following are to be included in field logbooks:

- Date and time the task was started; weather conditions; and names, titles, and organizations of personnel performing the task;
- A description of site activities in specific detail or an indication of which forms were used to record such information. It is good practice to duplicate the most important information in the field logbook as well as on the data form;
- A description, in detail, of any field test(s) (and results) that have been conducted. Reference any field forms that were used;
- A description, in specific detail, of samples collected and any splits, duplicates, matrix spikes, or blanks that were prepared. A list of all samples, sample identification numbers, sample containers and volumes, preservation methods, packaging, chain-of-custody form numbers, and analytical request form numbers pertinent to each sample shall be included in the field logbook. The time and name of the person to whom the sample custody was transferred or a reference to the appropriate documentation should be noted;
- a list of equipment used, the equipment identification number, and the calibration data for the instruments;

- description of the samples, such as appearance, color, etc;
- A list of the time, equipment type, serial or identification number, and procedure followed for decontaminations carried out or a reference to the appropriate documentation;
- A list of equipment failures or breakdowns that occur and a brief description of repairs and/or replacements or a reference to the appropriate documentation; and
- any unusual conditions noted.

6.2.3 Field Documentation Forms

Field documentation forms will be the primary documentation of all EMP field activities. Field forms have been developed for the complete documentation of all major field activities (e.g., site inspections, sampling events, and sample selection). The information required in the logbooks or documentation forms varies, depending on the purpose of the field activity being documented. Use of these forms ensures that all field and other notes are documented in a structured, consistent format. Field documentation forms must be completed by field personnel while they are on-site performing the field activity. Copies of the field documentation forms are provided in the SAPs.

Any information pertinent to the current field activity or field condition that is not requested on the field documentation form should be entered in the comments section of the form and in the field logbook. The forms used at each site will be numbered sequentially. A barcode label containing a unique form number will be affixed to the form and the form number will also be entered into the field logbook. In addition, any charts, oversize pages, and other printed material (e.g., runoff hydrographs, sample times) pertinent to current field activities will be securely attached to the corresponding field documentation form. The form number of the corresponding field documentation form must be written somewhere on the attached material.

There will be one original notebook for each monitoring and/or sampling activities. The Field Task Manager will be custodian of the site notebooks and will review them weekly, specifically checking for adherence to QA protocols. The site notebooks will be kept in a location that is secure and protected. Copies of all material within the site notebooks will be kept in a location separate from the original forms. The Field Task Manager will forward the copies to the SAP Coordinator weekly.

7. SAMPLE CUSTODY

7.1 RESPONSIBILITIES

7.1.1 Field Task Manager

The Field Task Manager

- determines the method of identification of samples in conjunction with the QA Specialist and the Information Management Coordinator and ensures that the items are identified in accordance with project SOPs;
- ensures that physical identification of equipment is provided to the maximum extent possible;
- ensures, when identification markings are used, that the identification materials and methods provide a clear and legible identification; that they do not detrimentally affect the function, integrity, or service life of the item; and that this marking will last for the time required;
- ensures that identification markings are transferred to each part of an identified item when the item is subdivided and that the markings shall not be obliterated or hidden by surface treatments or coatings unless other means of identification are substituted; and
- ensures that chain-of-custody procedures are completely described through the issuance of and training in chain-of-custody procedures.

7.1.2 Quality Assurance Specialist

The QA Specialist

- determines that sponsor requirements for identification and traceability of samples are met;
- ensures that procedures for the collection, handling, storage, and identification of samples are included in the WAG 6 SOPs; and
- ensures that procedures for control, identification, and cleaning and maintenance of sampling equipment and instruments are developed and implemented.

7.2 PROCEDURES

Each environmental sample collected will have a unique identifier that will be physically associated with the sample and maintained from the time of sample collection to sample disposal.

Sample chain-of-custody procedures require documented sample possession from the time of collection to disposal, in accordance with Energy Systems Procedure ESP-500.

Shipping and handling procedures are further described in technical SOPs for each sample medium and analysis.

7.2.1 Sample Labeling

All samples collected will be labeled in accordance with SOP-1001, "Procedure for Labeling Sample Bottles," and as described earlier in Sect. 6.1.5.

7.2.2 Sample Tampering Detection

In accordance with ESP-500, "Manual Chain-of-Custody Procedures," waterproof evidence tape, with the collector's initials and the date and time, must be placed over the sample container (i.e., bottle cap) to allow detection of any tampering. The evidence tape will be attached in such a way that it is necessary to tear the tape in order to open the sample container.

7.2.3 Sample Custody

Sample custody shall be maintained in accordance with ESP-500, "Manual Chain-of-Custody Procedures," as described earlier in Sect. 6.1.6. The procedure for electronic custody has been developed in the SAP.

8. CALIBRATION AND FREQUENCY

8.1 MEASURING AND TEST EQUIPMENT CALIBRATION

8.1.1 Procedures

Specific schedules and SOPs for flow monitoring and automatic sampling equipment calibration are presented in detail in Sect. 2.0 of the SAPs. In general, flow monitoring and automatic sampling equipment shall be calibrated when initially installed on-site and on a regular basis thereafter to ensure that the data collected are accurate and consistent. Each calibration event (including calibration results) must be documented in the appropriate field documentation form, usually the Instrument Calibration Log Form (FOP Manual) and the field logbook. Calibration of in-situ measurement equipment is to be performed before installation and in accordance with the specific SAPs. Calibration of portable instruments will be checked periodically during use to ensure sustained accuracy, and at the end of each work day.

An inspection of all on-site equipment will be performed whenever field personnel visit the site and will be documented in the field logbook and field forms. Thorough inspections will be performed weekly by the Field Task Manager or designee, who is also responsible for the direction and documentation of any maintenance/servicing of site equipment. Preventive maintenance will be performed during the site inspection on an as-needed basis. All maintenance actions must be documented in the appropriate field documentation form or the field logbook.

The servicing of site equipment must be performed as soon as problems are found. To maintain the continuity of equipment used, servicing should be performed on-site if possible. If on-site repair is not possible, the equipment must be replaced with a calibrated alternate. If on-site repair is possible, the equipment must be calibrated following servicing. All serviced equipment must be checked on the day immediately following its repair (or return to the site) to ensure that the problem has been corrected. All equipment servicing or replacement must be completely documented in the Site Inspection Form, Record of Repair, and field logbook. Each equipment service entry into the documentation form must be initialed by the person performing the service.

The laboratory has a SOP that describes calibration frequencies and nonconformance requirements for all laboratory equipment.

Calibration methods for laboratory equipment, when calibration is performed by the operator, are located in SOPs referenced in the LOM calibration information table.

Calibration records shall be maintained for each laboratory. The laboratory supervisor ensures that calibration records are kept current through periodic reviews. Quarterly detection limit studies will be considered as part of the calibration record.

Calibrated equipment shall be uniquely identified by either the manufacturer's serial number or an instrumentation and control number.

All equipment shall be categorized according to measuring and test equipment categories described in DOE/OR/01-1992&D1. The laboratory shall place calibration category decals or tags on laboratory equipment.

Calibration failures can occur regardless of timely calibration checks. If an individual suspects an equipment malfunction, that person should

- remove the device from service,
- tag it to prevent inadvertent use, and
- notify the laboratory supervisor or Field Task Manager.

If equipment is found to be out of calibration, the Field Task Manager or laboratory supervisor shall evaluate and document (in the calibration records) the validity of previous inspection or test results and the acceptability of similar equipment previously inspected or tested. Measuring and test equipment that is out of calibration or does not meet accuracy/precision specifications, must be tagged as out of service and segregated from usable equipment. Devices that are out of calibration must be recalibrated prior to reuse. Any equipment found to be consistently out of calibration shall be repaired or replaced. Any such action shall be recorded in an auditable record, such as a maintenance logbook. A measuring and test equipment inventory shall be maintained.

8.2 LABORATORY CALIBRATION STANDARDS

Laboratory calibration standards, when commercially available, will be traceable to National Institute of Standards and Technology, EPA, or other certified laboratory's standards. Documents certifying traceability are considered QA records and shall be indexed and filed in the ER DMC.

8.3 EQUIPMENT

Equipment requiring calibration, the calibration schedules and equipment locations are identified in Sect. 2 of the SAPs.

9. ANALYTICAL PROCEDURES

9.1 ANALYTICAL PROCEDURES

All analytical procedures will be developed, documented, and maintained for accomplishing activities and to meet ER objectives. Required documents are to be appropriately referenced as source documents to facilitate traceability of requirements.

Procedures will be kept current with existing requirements, and a documented review of all current procedures is to be conducted in accordance with the laboratory QA procedures. Documented procedures will provide sufficient, concise, and clear information to enable qualified individuals to effectively and efficiently perform the activity described and will be used as a basis for activity-specific training.

All laboratories performing analyses for this task will be required to hold a current U.S. Nuclear Regulatory Commission license for handling radioactive materials. In addition, all laboratories will be audited and accepted by the Analytical Projects Office (APO) and CDM Federal before field mobilization.

All laboratories performing analyses will be required to document on the appropriate chain-of-custody form as to the final disposition of residuals of sample materials and their related analyses. In addition, all laboratories must maintain a Waste Management Plan that describes procedures for handling and disposal of residuals.

When available and appropriate for the sample matrix, EPA methods will be used. When not available, other nationally recognized methods such as DOE and ASTM methods will be used. When appropriate, the laboratories will be required to analyze and report the EPA Toxicity Characteristic Leaching and the Target Analyte List. The SAP summarizes the analytical methods and other sample requirements for all environmental sampling required during this investigation. A discussion of method detection limits (MDLs) follows.

MDLs are the extent to which the equipment or analytical process can provide accurate, minimum data measurements of a reliable quality for specific constituents. MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The actual quantitation limit for a given analysis will vary depending on instrument sensitivity and matrix effects. MDLs for this project will be specified in contracting documentation with the specified analytical laboratory. Detection limits will not be established or reported for analyses performed using field instruments. The detection limits established by the manufacturer will be used as guidelines.

9.2 LABORATORY OPERATIONS MANUAL

All WAG 6 laboratories shall develop, control, and maintain an LOM in accordance with ES/ER/TM-16, *Requirements for Quality Control of Analytical Data*.

9.3 STATEMENTS OF WORK

9.3.1 Responsibilities

Refer to the Project Document Summary (Table 3) for the identification of organizations and WAG 6 staff members responsible for the development, review, and approval of analytical laboratory SOWs.

9.3.2 Procedures

Laboratory SOWs will

- be developed in conjunction with the APO,
- specify QC requirements and QC sample deliverables, and
- be submitted to the laboratory for approval prior to sample shipment.

The analytical laboratory shall submit the results of requested control sample analyses and other QA/QC documentation to the WAG 6 SAP Coordinator to ensure conformance with established control limits and other QC requirements. The QC requirements will be based on project DQOs. The data validation process will impose sufficient controls over the quality of analytical laboratory data and services. The laboratory will not perform data validation; laboratory data will be validated by an organization independent of the laboratory. The data review process consists of data screening, checking, auditing, verification, and certification.

The format and content of hard copy and electronic data reports will adhere to project needs and will be specified in SOWs, which include contract requirements of DOE and regulatory agency reporting formats. The laboratory supervisors are responsible for the preparation of each technical report. The required hard copy report format will be specified in the laboratory SOW.

- Final data presentation shall be checked according to data validation requirements and approved by the SAP Coordinator and laboratory supervisor.
- Each page of data will be identified with the project number or project name, sample delivery group number, batch number, and date of issue.
- Electronic copies of the data must match the hard copy reports.

Electronic data contents in the report will include, as a minimum,

- sample identification number used by the laboratory and/or the sample identification provided to the laboratory if it is different from that used in the laboratory,
- sample delivery group number and batch number;
- chemical parameters analyzed, reported values, laboratory data qualifiers, and units of measurement;

- quantification limit of the analytical procedure;
- results of QC sample analysis;
- achieved accuracy, precision, and completeness of data;
- references to specific data if required to explain reported values; and
- analytical methods used.

Analytical methods will be specifically referenced on all laboratory reports. Any method modification will be included in the case narrative provided by the laboratory. Data for field QC samples will be reported in the same format as that used for actual samples.

9.3.3 Handling, Storage, and Shipping

Requirements for controlling the handling, storage, cleaning, packaging, shipping, and preservation of items and samples to prevent damage or loss and to minimize deterioration are described in SOPs for each sample medium and analysis.

10. DATA REDUCTION, VALIDATION, AND REPORTING

10.1 DATA SUMMARIZATION, VALIDATION, AND REPORTING

The performance of laboratory equipment will be tested through the analysis of QC samples and the verification and validation of QC sample data. In addition, the type and frequency of QC tests shall be specified for different media and analyses in SOPs.

The data validation process compares the objective with the actual through the evaluation of the PARCC parameters. The laboratory will not perform data validation; laboratory QA/QC data will be validated, independent of the laboratory, by a contract organization or by WAG 6 staff as appropriate. A SOW describing data editing, screening, checking, auditing, verification, and certification (EPA 1988b) will be implemented prior to the initiation of data validation. All data for this project will be evaluated by QA/QC methods and internal peer review. Data reduction, verification, and reporting will be in accordance with the *Requirements for Quality Control of Analytical Data for the Environmental Restoration Program*, ES/ER/TM-16. Data will be entered into common, standardized formats. In addition to following field sampling documentation and QA/QC procedures, data are verified using a variety of computerized checks for reasonableness. These procedures will ensure that data are entered, encoded, and manipulated consistently and are available to WAG 6 investigators in a usable format. The Data Management Plan and Functional System Design states that 100 percent of the data generated will be screened. The Laboratory Supervisor will track data validation for 10 percent of the data at Level IV, and validation software will screen all of the data for Level III validation. Every tenth data package will be selected for Level IV. If the 10 percent reveals systematic problems, another 10 percent will be validated for Level IV. If the problem is still prevalent, the team will decide how to resolve the problems.

All data validation procedures for WAG 6 will include the data flow/reporting scheme from collection of raw data through storage. A flowchart will be used to show this process.

10.2 DATA REDUCTION AND EVALUATION

10.2.1 Field Data Reduction and Evaluation

Data collected during field activities will be evaluated by checking the procedures used and comparing the data to previous measurements. The QA Specialist and SAP Coordinator will be responsible for checking field QC sample results to ensure that field measurement and sampling protocols have been observed. These reviews will check, as a minimum,

- date and time sampled,
- preservation,
- SOPs utilized,
- calibration method and frequency, and

- chain-of-custody documentation.

Reviewers are responsible for ensuring that data reduction calculations are documented and checked by qualified personnel. Reviews will be indicated by signature on the sample results. Written reports, including reduced and summarized data, will include the raw data in appendices. Specific calculations used for data reduction will also be included.

Data are evaluated to ensure that they meet the DQOs developed for the project. The evaluation includes several steps to ensure that each objective has been met. Before data are included in the project data base, the sampling design and methods are reviewed. The sampling design and methods should produce data representative of the media and area that need to be characterized. Methods should be examined to ensure that data are comparable. This includes specifying units of measure and the basis of measurement such as wet weight vs dry weight basis and filtered vs unfiltered samples. Data quality assessments, validation reports, and/or the laboratory and field QC data are examined to determine if the precision, accuracy, and sensitivity of the measurements meets the objectives of the project. Deficient data must be excluded from the data base, kept in a separate data base, or flagged appropriately for its valid uses.

If the data appear acceptable by all criteria described above, they are examined for spatial and temporal consistency. This examination consists of plotting concentrations of selected analytes in space or time or frequency distributions as appropriate for the data. Analytical results that appear out of place in the plots are examined for problems in sampling, analysis, or reporting. This type of analysis can identify incorrect measurement units, misplaced decimal points, or other transcription errors that might otherwise remain undetected. Data are corrected or deleted depending on the problem identified. If no problem is identified, the data are retained in the data base. Data that do not fit expected patterns may represent real conditions that are important in understanding the site.

Analytical data generated during the sampling and analysis phase will be evaluated for completeness as an ongoing and concurrent process. In general, the laboratory analyst will process the data, either manually or by inputting the data into a computer. All computerized programs used to reduce and analyze data should be in compliance with software QC procedures. For manually processed data, all the steps in the computation must be provided, including equations used and the source of input parameters such as response factors, dilution factors, and calibration constants. If calculations are not performed directly on the data sheet or chromatogram, the calculations must be provided on company letterhead paper and attached to the data sheets. All pages of the calculations must be signed and dated by the analyst performing the calculations.

For data input by an analyst and processed using a computer, a copy of the input must be kept and uniquely identified with the project number and other pertinent information as necessary. The samples to which the data processing refers must be clearly stated, and the input must be signed and dated by the analyst performing the input.

When processing data acquired from instrumentation, the analyst must verify that the correct project, sample numbers, calibrations constants, response factors, units, and numerical values used for detection limits are present.

10.2.2 Analytical Laboratory Data Reduction and Evaluation

Analytical data generated during the sampling and analysis phase will be evaluated for completeness as an ongoing and concurrent process. This will include, but is not limited to, review of completed custody logs, photocopied pages of laboratory notebooks and data forms completed by the technical staff, including sample weights, dilutions, concentrations, data reduction, instrument logs, and all raw data. Reviewers of materials will include the SAP Coordinator, QA Specialist, and the assigned laboratory supervisor. In the data review process, the data are compared to information such as the sample history, sample preparation, and QC sample data to evaluate the validity of the results. Data validation includes, as a minimum,

- dated and signed entries by technical staff and supervisors on the worksheets and logbooks used for samples;
- sample tracking and numbering systems to track the progress of samples through the laboratory;
- QC criteria to reject or accept specific data in accordance with EPA CLP protocols and laboratory data validation functional guidelines for evaluating organic and inorganic data (EPA 1984, 1988b) and field QC vs laboratory QC as mandated by this QAPjP and those requested by EPA procedures; and
- examination of all data for a sample and site by checking for consistency among replicate samples, sending split samples to other laboratories for analysis, and using frequency distributions and range checks to evaluate outliers.

When required, other checks for internal consistency, such as evaluating ion balances, will be used.

10.3 FIELD DATA REPORTING AND COMPUTER ENTRY

Field data (information obtained before the sample is delivered to the laboratory) will be recorded on various forms and in field logbooks and transferred to the Data Manager. The data will include field recording sheets, calibration logs, instrument outputs, worksheets for calculating results, any deviations from SOPs, and other relevant information.

The field logbook and forms will be copied daily and, along with electronic data, sent weekly to the Data Manager, who will ensure accurate entry of information into the Information Management System and will send the SAP Coordinator a copy of the entered data. The Data Validation Coordinator or designee will verify the data and notify the Information Management Coordinator of verifications and/or inaccuracies.

The Data Management Plan and Functional System Design describes the data transfer activities and the SAPs contain examples of the forms to be used.

11. INTERNAL QUALITY CONTROL CHECKS

11.1 QUALITY CONTROL SAMPLES

11.1.1 Field QC Samples

The field sampling operations are described in detail in the SAPs. SOPs will be used for all routine sampling operations. Field QC sampling will be conducted to check sampling and analytical accuracy and precision for both laboratory and field analyses of the original samples. If contaminants are found in the blanks, attempts will be made to identify the source of contamination, and corrective action will be initiated in accordance with Sect. 15. The laboratory analyzing the samples also will include QC samples in accordance with the analytical method and ES/ER/TM-16. These samples will be discussed in the laboratory's QA Plan.

Field QC samples for the EMP will consist of trip blanks, rinseate blanks, field blanks, field duplicates and matrix spike/matrix spike duplicate samples. The SAP lists the number of field QC samples.

All field QC samples will have discrete sample numbers and be submitted as "blind" samples to the laboratories. These samples will be collected as specified in Sect. 6 and labeled according to SOP-1001, "Procedure for Labeling Sample Bottles." QC samples will be documented in the appropriate field documentation form completed during sample collection. Results of these samples will be included in the analytical data report. Results for the QC samples will not be used to adjust the results obtained for the original samples.

Trip blanks. Trip blanks are used to detect contamination by volatile organic compounds (VOCs) during sample shipping and handling. Trip blanks are 40-mL VOC vials of ASTM Type II water that are filled in the laboratory. Trip blanks are not to be opened in the field, and one trip blank shall accompany each cooler containing VOC samples. Each trip blank shall be stored at the laboratory with the associated samples and analyzed with the samples.

Field blanks. Field blanks are samples collected from all source water used for decontamination, including tap water and ASTM Type II water. At a minimum, one sample for each source of water shall be collected monthly for analysis. Each lot of ASTM Type II water shall be considered a source.

Field duplicates. Field duplicates shall be collected at a frequency of 10% of the samples collected per matrix per day. Sediment sample duplicates, excluding samples for VOC analysis, shall be collected and homogenized before being containerized. Field duplicates for water samples shall be collected simultaneously.

Rinseate blanks. Rinseate blanks are collected by running deionized water (ASTM Type II) over and/or through sampling and monitoring equipment after the equipment has been decontaminated. A preservative is added to these samples. These samples will be collected at a frequency of 10% of the samples collected per matrix per day.

Matrix Spike/Matrix Spike Duplicates. Matrix Spikes/Matrix Spike Duplicates are samples (one sample and a duplicate) collected in the field, labeled as an MS or an MSD. MS/MSD shall be collected at a frequency of 5% (one for every 20) of the samples collected per matrix per day.

Duplicates shall be sent to the primary laboratory responsible for analyses. One-half of the field duplicates, or 10% of the field samples, shall be split for laboratory QC samples. Extra volumes of sample shall be collected to ensure that enough sample is available for analyses. QC samples shall normally be used as a duplicate/matrix spike combination or a matrix spike/matrix spike duplicate by the laboratory.

11.1.2 Laboratory QC Samples

Laboratory QC samples will be used to check sample preparation and analysis and to monitor laboratory performance. ER Program guidelines for laboratory QC samples and documentation have been established in the ER Program (ORNL 1991a). Specific data deliverables will be approved by APO. Specific requirements for groups of samples will be specified in SOWs for those samples. Analysis-specific control samples may be required as indicated by EPA-accepted procedures. QC samples will consist of blanks, duplicates, and spikes. Laboratory standards will also function as QC components. APO-audited laboratory's QC will be provided according to the laboratory's internal QA/QC requirements. The laboratory QC documentation requested for delivery will be specified in the SOW and will be dependent on the intended use of the data, as determined by DQOs, for a given sampling event. Laboratory QC samples will include the following:

Method blank. A method blank is a blank sample made up of a pure, noncontaminated substance (usually distilled or deionized water or silica sand) that is subjected to all of the sample preparation (e.g., digestion, distillation, and extraction) and analytical methodology applied to the samples. The method blank is used to check for contamination from within the laboratory which might be introduced during sample preparation and analysis.

Calibration blank. A calibration blank is the substance that is used to zero the instrument. The calibration blank comprises the solvent used for the preparation of the calibration standards and samples. The calibration blank accounts for any interferences from the solvent matrix.

Laboratory duplicates. The laboratory analyst prepares laboratory duplicates by homogenizing a sample as thoroughly as possible and taking two separate aliquots of that sample for analysis. The duplicate sample, however, should never be a trip blank or field blank. The purpose of laboratory duplicates is to check the precision of the analyst, the sample preparation methodology, and the analytical methodology.

Matrix spikes. A matrix spike is an aliquot of a sample to which a known concentration of the compounds of interest has been added. The matrix spike is subjected to the same sample preparation and analytical methodology as are applied to the samples. The sample to be spiked is selected prior to sample submittal by the Laboratory Coordinator; however, the spiked sample cannot be a method blank, trip blank, or field blank. The purpose of the matrix spike is to check for interferences or false readings caused by the sample matrix.

Blank spike/blank spike duplicates or laboratory control sample. The blank spike/blank spike duplicate or laboratory control sample, is a blank sample (usually distilled or deionized water or silica sand) to which a known concentration of the compounds of interest has been added. The blank spike/blank spike duplicate is subjected to the same sample preparation and analytical methodology as are applied to the samples. The purpose of the blank spike is to check the accuracy of the analyst, the sample preparation methodology, and the analytical methodology. The level of accuracy is measured by calculating the percent recovery (%R).

The laboratory is responsible for preparing QC standards for analysis. Statistical analyses will then be performed by using the results of QC sample analyses. Each laboratory will apply precision and accuracy criteria to each parameter that is analyzed. When analysis of a sample set is completed, the QC data are reviewed and evaluated through the use of control charts to validate the data set. Laboratory QC standards will include the following:

Calibration standards. Calibration standards comprise the compounds of interest at known concentrations. Calibration standards are prepared from EPA reference material or commercially available, certified reference materials traceable to the National Institute of Standards and Technology, using the same solvent used for sample preparation at the same concentration. Semivolatile and volatile organic analyses by gas chromatography/mass spectrometry require calibration using three or more concentration levels to develop a calibration curve, followed by daily calibration checks within the calibration range for verification. Calibration standards for other methods require at least three concentration levels plus a blank standard throughout the calibration range required for the analysis. Calibration standards are not subjected to all of the preparation (e.g., extraction, distillation, and digestion) that is applied to the sample; rather, they are used (1) to initially calibrate the instrument by providing reference points throughout the calibration range and (2) to establish linearity throughout the calibration and working ranges of the instrument. The instrument is checked continually throughout the analysis with the calibration standards to check for instrument drift.

Performance evaluation samples. Performance evaluation samples consist of known concentrations of the analytes submitted in a blind manner to the laboratory being audited. These samples may be obtained through various EPA-sponsored programs and private vendors to provide an objective evaluation of laboratory performance and comparison with other participating laboratories. The laboratory is responsible for participation in a performance evaluation program.

Control charts are statistical representations of the laboratory's performance and are used to monitor precision and accuracy results. The laboratory will create precision and accuracy control charts for representative analytes for each analysis type performed. Warning Limits of two standard deviations and control limits of three standard deviations will be calculated. Precision and accuracy data will be evaluated against the warning and control limits. The warning and control limits will be used in conjunction with method specified control limits to assess the useability of the data.

Once established, control limits are updated as additional precision and accuracy data become available. Any control sample data point that falls beyond the control limits or any data trend (indicated by seven or more consecutive points on either side of the mean) will require an internal investigation. Control limits and corrective actions will be created and

updated in accordance with EPA protocol. Additional statistics for organics work will be done in accordance with SW-846 (EPA 1986a) or CLP-SOW (EPA 1986b), as applicable.

11.2 INSPECTION

11.2.1 Responsibilities of the Project Manager

The Project Manager

- reviews reports from inspections performed by inspecting and calibrating organizations to verify and track inspections on items important to the success of the project, and
- indicates his/her review and approval by signature on the inspection report.

11.2.2 Responsibilities of the Quality Assurance Specialist

The QA Specialist

- maintains inspection report copies as QA records, and
- submits reports to the ER DMC for indexing and filing.

11.2.3 Responsibilities of the Laboratory Coordinator

The Laboratory Coordinator

- provides the Project Manager and the QA Specialist with inspection reports.

11.3 SOFTWARE QUALITY ASSURANCE

The Energy Systems Policy, Standard, and Procedures, Volume 4, "Software Quality Assurance" (ESS-QA-19.0) and the Energy Systems Automated Data Processing Systems Development Methodology, Volume 1 (K/CSD/INF-86-3) provide software QA guidance for the WAG 6 environmental monitoring program.

12. PERFORMANCE AND SYSTEM AUDITS

This section describes the methods and policies for planning, performing, and reporting audits to verify compliance with all aspects of the QA program and to determine program effectiveness. The requirements of this section apply to internal audits or surveillances.

Audits will be performed in accordance with ORNL QA Procedure, QA-L-18-100, "Quality Assurance Audits," and personnel performing these audits shall be qualified in accordance with ORNL QA Procedure, QA-L-18-101, "Quality Assurance Audit Personnel Qualification Requirements."

12.1 RESPONSIBILITIES OF THE QUALITY ASSURANCE SPECIALIST

The QA Specialist

- assigns, tracks, and ensures implementation of all corrective actions identified by formal audits and surveillances;
- together with the Project Manager, ensures that internal surveillances of field and WAG 6 laboratory operations are planned, executed, and documented;
- prepares a brief surveillance summary for review and follow-up determinations by the Project Manager; and
- designates, in conjunction with the Project Manager, which project activities, if any, require surveillance and develops a plan for implementing surveillances and self-assessments.

12.2 PROCEDURES

12.2.1 Surveillances

When deemed appropriate by the Project Manager or the QA Specialist, surveillances of WAG 6 field and laboratory operations will be conducted by the QA Specialist. The QA adequacy of these operations will be assessed against the WAG 6 SAP and FOP Manual requirements. Management will be informed of QA status through the receipt of surveillance reports.

Project documents will be regularly surveilled for completion and clarity. Surveillance frequency and schedule of project documents, field sampling, laboratory analysis, and data management activities for the WAG 6 Project will be issued in a WAG 6 Surveillance Plan.

12.2.2 Audits

Audits shall be performed utilizing project program documents, highlighting the items to be verified, and/or checklist questions. Audit results shall be documented in a report and

issued promptly, providing the status of items reviewed and verified. Copies of audit reports shall be provided to the Project Manager, ORNL ER Program Director, and QA Specialist for use in management assessment. Audits of WAG 6 field and laboratory activities will be conducted by the QA Specialist and the Central ER audit staff. External analytical laboratories' audits shall be conducted by the APO. The laboratory will provide equipment inspection reports when requested. Audits conducted by regulatory agencies shall also be performed at the discretion of the regulatory agencies.

12.2.2.1 Frequency of Audits

The QA Specialist will perform internal audits according to a schedule that coincides with appropriate activities on the project schedule and SAPs. These internal audits will be used in independent self-assessment. Such scheduled audits may be supplemented by additional audits for one or more of the following reasons:

- to verify that work is being performed in accordance to requirements (SOPs, DOE Orders, Project Plans, etc.);
- when significant changes are made in the QAPjP;
- when it is necessary to verify that corrective action has been taken on a nonconformance reported in a previous audit; or
- when requested by the Project Manager.

All other audits will be performed according to the discretion of the auditing organization.

13. PREVENTIVE MAINTENANCE

The inspection, test, and operating status determinations of monitoring stations and associated equipment used to collect data under the WAG 6 environmental monitoring program are the responsibility of the monitoring organization. All measurement and testing equipment, as appropriate, must be placed on a routine preventive maintenance schedule. Interface agreements between WAG 6 management and the monitoring organizations, as described in Sects. 4 and 9, ensure that the WAG 6 Project Manager will be notified when test failures or changes affecting data quality occur.

14. PROJECT-SPECIFIC PROCEDURES

Many of the ORNL procedures adequately describe the WAG 6 project-specific procedures and have been adopted for WAG 6 use with referenced additions and/or clarifications. Where minor additions and/or clarifications are sufficient, no project-specific procedures have been developed. However, some of the elements require extensive elaboration in order to describe the WAG 6 project-specific procedures. In these cases, project-specific SOPs have been developed. SOPs are compiled in the WAG 6 FOP Manual and are maintained by the SAP Coordinator and distributed through the ER DMC.

15. CORRECTIVE ACTION

Corrective actions are required for those situations or items that exceed predetermined acceptability limits, deviate from prescribed methods, fail to meet performance requirements or DQOs. Corrective actions shall be developed and reported together with root cause and contributing causes, and the status of corrective actions shall be periodically evaluated.

15.1 RESPONSIBILITIES OF THE QUALITY ASSURANCE SPECIALIST

The QA Specialist

- monitors corrective action plans,
- verifies and documents the effectiveness of corrective actions,
- ensures that corrective actions are entered into a corrective action data base, and
- activates the root cause analysis process.

15.2 RESPONSIBILITIES OF THE PROJECT MANAGER

The Project Manager

- prepares corrective action plans,
- assigns responsibility for implementing corrective actions,
- evaluates deviations and results of corrective actions to determine lessons learned, and
- distributes lessons learned.

15.3 RESPONSIBILITIES OF THE PROJECT PERSONNEL

WAG 6 project personnel

- assist in preparing corrective action plans, and
- implement corrective action plans.

15.3.1 Nonconformances

Nonconforming equipment, items, activities, and conditions and unusual incidents that could affect compliance with project requirements will be identified, controlled, and reported in a timely manner. The Field Task Manager or Project Manager initiates the nonconformance reporting and corrective action process by completing a Nonconformance

Report (FOP Manual). Nonconforming equipment will immediately be labeled or tagged and segregated, if possible. Nonconformances will be trended to identify recurring problems or systematic problems.

15.3.2 Corrective Action

Conditions adverse to quality when identified, will be documented and corrective action taken and verified to resolve the problem.

Immediate corrective actions will be noted in field notebooks and reported to the Project Manager. Problems not immediately corrected will require formal corrective action.

16. QA REPORTS TO MANAGEMENT

16.1 NONCONFORMANCE

16.1.1 Responsibilities

Refer to Table 3 for the identification of individuals responsible for the review and approval of nonconformance, variance, and occurrence documents.

16.1.2 Procedures

All variances from approved WAG 6 SOPs will be documented in the variance logbook. Only WAG 6 personnel may initiate a procedure variance. All variances must be reviewed by the senior technical coordinator and evaluated for possible impact on reportable data. The reviewer may

- allow the activities to resume, or
- proceed with nonconformance, occurrence, and corrective action procedures.

Upon review, any variances that would result in major changes to an approved operating procedure, project scope, cost or schedule or impact reportable data, are considered deviations and must be documented on a CRF, and submitted to the WAG 6 Project Manager and the QA Specialist for review and approval. If the issuance of a CRF indicates the need for a minor procedural change, the Project Manager, SAP Coordinator, or the Field Task Manager may initiate a Procedural Change Notice.

The required reports to management include

- **Audit, Surveillance, and Inspection Reports**—The results of each QA audit, surveillance, or inspection will be documented in a report that is distributed within 20 working days of the audit, surveillance, or inspection.
- **QA Sections in Project Reports**—All reports that present measurement data generated during the work assignment require a QA section addressing the quality of the data and its limitations. Each QA section will address, at a minimum,
 - precision, accuracy, and completeness achieved for reported measurement data in relation to goals for these indicators;
 - results of audits or surveillance of the measurement work;
 - quality problems found and corrective actions taken; and
 - deviations from SAP and QAPjP.

All reviews and document checks will be documented. Deliverables produced for this project will be subject to three reviews:

- **The technical review** will be performed by senior professionals who have not been involved in project management or data collection activities. This technical review will

focus on technical statements, conclusions, and recommendations to ensure that they are justifiable and defensible.

- **The QA review** will be conducted by the QA staff to ensure that QA/QC requirements have been addressed.
- **The final review** will be performed by the SAP Coordinator and Project Manager. This review will be conducted to ensure that the document addresses all contractual requirements.

16.2 QA PROGRAM STATUS REPORTING

The active participation of management in the WAG 6 Project is fundamental to the success of this QAPjP. Management will be aware of project activities and will participate in development, review, and operation of the project. Management will be informed of QA status and activities through the receipt, review, and approval of

- laboratory and project-specific QA/QC plans and procedures,
- postaudit reports and audit closures,
- surveillance reports,
- technical logbooks,
- field change request forms,
- deviation request forms,
- corrective action overdue notices, and
- nonconformance reports.

The individuals responsible for providing management with the above documentation are defined in Table 3. Copies of these reports will be distributed to appropriate Energy Systems and DOE Oak Ridge Operations Office management and regulatory agencies. In addition, biannual assessment of QA/QC activities and data PARCC will be conducted by the QA Specialist and reported to the WAG 6 Project Manager.

Project management will inform the QA Specialist, as appropriate, of the QA status of the project, especially any significant quality accomplishments. WAG 6 personnel are required to inform the Project Manager or project support staff of all nonconformances or quality failures. The Project Manager will document and immediately report any nonconformance or quality failure to the QA Specialist. It is the responsibility of the QA Specialist to report all quality-associated activities to the ORNL QA Manager.

16.3 QUALITY ASSURANCE RECORDS

All project records, including QA records, will be controlled by the ER DMC. The WAG 6 Procedure Coordinator is responsible for the processing, maintenance, reporting, and retrieving of all WAG 6 record materials and for forwarding copies to the ER DMC.

SOP ER/P-OS/ERP-DMC establishes general responsibilities and guidelines for use of the ER DMC.

WAG 6 QA documents include, but are not limited to, the following:

- data collection information (including electronic and paper forms);
- data verification and validation materials;
- surveillance and audit reports;
- deviation request forms, nonconformance reports, occurrence reports;
- corrective action documentation;
- project-specific training records;
- laboratory notebook, calibration notebook, and field notebook copies;
- chain-of-custody forms, QA sample forms;
- analytical laboratory SOWs;
- interface agreements;
- variance logbook copies;
- standards traceability documents;
- Memorandum of Agreements;
- SOPs;
- QA summary reports;
- inspection reports;
- calibration reports;
- training needs assessment and training records;
- SAPs;
- Waste Management Plan;
- Health and Safety Plan; and
- Data Management Plan and Functional System Design.

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APPENDIX A
REVISED WAG 6 ENVIRONMENTAL MONITORING PLAN
PARCC PARAMETER GOALS

Table A.1. Revised WAG 6 Environmental Monitoring Plan PARCC parameter goals (12/3/93)

Parameter	Method/ Prep	Accuracy (%Recovery)	Precision (% RPD)	Completeness (%)	Project Quantitation Limits ¹
<i>Metals by ICP</i>					
Aluminum	CLP	75-125	0-20	96-100	200µg/L
Barium ²	CLP	75-125	0-20	96-100	200µg/L
Beryllium	CLP	75-125	0-20	96-100	5µg/L
Boron ³	CLP	75-125	0-20	96-100	100µg/L
Cadmium ²	CLP	75-125	0-20	96-100	5µg/L
Calcium	CLP	75-125	0-20	96-100	5000µg/L
Chromium	CLP	75-125	0-20	96-100	10µg/L
Cobalt	CLP	75-125	0-20	96-100	50µg/L
Copper	CLP	75-125	0-20	96-100	25µg/L
Iron	CLP	75-125	0-20	96-100	100µg/L
Nickel	CLP	75-125	0-20	96-100	40µg/L
Sodium	CLP	75-125	0-20	96-100	5000µg/L
Silver ²	CLP	75-125	0-20	96-100	10µg/L
Silicon	CLP	75-125	0-30	96-100	500µg/L
Zinc	CLP	75-125	0-20	96-100	20µg/L
Calcium	CLP	75-125	0-20	96-100	5000µg/L
Magnesium	CLP	75-125	0-20	96-100	5000µg/L
Manganese	CLP	75-125	0-20	96-100	15µg/L
Molybdenum ³	CLP	75-125	0-20	96-100	200µg/L
Potassium	CLP	75-125	0-20	96-100	5000 ¹ µg/L
Antimony ³	CLP	75-125	0-20	96-100	30µg/L
Vanadium	CLP	75-125	0-20	96-100	50µg/L
<i>Metals by GFAA</i>					
Arsenic ²	CLP	75-125	0-20	96-100	10µg/L
Lead ²	CLP	75-125	0-20	96-100	3µg/L
Selenium	CLP	75-125	0-20	96-100	5µg/L
Thallium	CLP	75-125	0-20	96-100	10µg/L

Table A.1 (continued)

Parameter	Method/ Prep	Accuracy (%Recovery)	Precision (% RPD)	Completeness (%)	Project Quantitation Limits ¹
<i>Metals by CVAA</i>					
Mercury ²	CLP	75-125	0-20	96-100	0.2µg/L
<i>Miscellaneous</i>					
Bromide	300	75-125	0-20	96-100	1mg/L
Chloride	300	75-125	0-20	96-100	1mg/L
Iodide	300	75-125	0-20	96-100	10mg/L
Nitrate	300	75-125	0-30	96-100	0.5mg/L
Phosphate	300	75-125	0-20	96-100	0.5mg/L
Sulfate	300	75-125	0-30	96-100	5mg/L
Dissolved Organic Carbon	415.1	60-140	0-40	96-100	1mg/L
Dissolved Inorganic Carbon	415.1	60-140	0-40	96-100	1mg/L
Alkalinity	310.1	75-125	0-30	96-100	1mg/L
<i>Semi-Volatile Organic Compounds</i>					
1,3-Dichlorobenzene	CLP	10-172	0-41	96-100	10µg/L
1,4-Dichlorobenzene	CLP	36-97	0-28	96-100	10µg/L
Hexachloroethane	CLP	40-113	0-40	96-100	10µg/L
Bis (2-chloroethyl) ether	CLP	10-150	0-50	96-100	10µg/L
1,2-Dichlorobenzene	CLP	32-129	0-40	96-100	10µg/L
Bis (2-chloroisopropyl) ether	CLP	36-166	0-46	96-100	10µg/L
N-Nitrosodipropylamine	CLP	41-116	0-38	96-100	10µg/L
Nitrobenzene	CLP	35-180	0-40	96-100	10µg/L
Hexachloro-1,3-butadiene	CLP	24-116	0-40	96-100	10µg/L
1,2,4-Trichlorobenzene	CLP	44-142	0-28	96-100	10µg/L
Isophorone	CLP	21-196	0-60	96-100	10µg/L
Naphthalene	CLP	21-133	0-40	96-100	10µg/L
Bis (2-chloroethoxy) methane	CLP	33-184	0-43	96-100	10µg/L
Hexachlorocyclopentadiene	CLP	10-150	0-50	96-100	10µg/L
Acenaphthylene	CLP	33-145	0-40	96-100	10µg/L
Acenaphthene	CLP	46-118	0-31	96-100	10µg/L

Table A.1 (continued)

Parameter	Method/ Prep	Accuracy (%Recovery)	Precision (% RPD)	Completeness (%)	Project Quantitation Limits ¹
Dimethyl phthalate	CLP	10-112	0-40	96-100	10µg/L
2,6-Dinitrotoluene	CLP	39-139	0-40	96-100	10µg/L
Fluorene	CLP	54-121	0-40	96-100	10µg/L
2,4-Dinitrotoluene	CLP	24-96	0-38	96-100	10µg/L
Diethyl phthalate	CLP	10-114	0-40	96-100	10µg/L
N-Nitrosodiphenylamine	CLP	41-116	0-38	96-100	10µg/L
Hexachlorobenzene	CLP	10-152	0-40	96-100	10µg/L
4-Bromophenyl phenyl ether	CLP	53-127	0-40	96-100	10µg/L
Phenanthrene	CLP	54-120	0-40	96-100	10µg/L
Anthracene	CLP	27-133	0-40	96-100	10µg/L
Di-n-butyl phthalate	CLP	10-118	0-50	96-100	10µg/L
Fluoranthene	CLP	26-137	0-40	96-100	10µg/L
Pyrene	CLP	26-127	0-31	96-100	10µg/L
Butyl benzyl phthalate	CLP	10-152	0-40	96-100	10µg/L
Bis (2-ethylhexyl) phthalate	CLP	10-158	0-40	96-100	10µg/L
Chrysene	CLP	17-168	0-48	96-100	10µg/L
Benzo [a] anthracene	CLP	33-143	0-40	96-100	10µg/L
3,3'-Dichlorobenzidine	CLP	10-162	0-100	96-100	10µg/L
Di-n-octyl phthalate	CLP	10-146	0-50	96-100	10µg/L
Benzo [b] fluoranthene	CLP	24-159	0-40	96-100	10µg/L
Benzo [k] fluoranthene	CLP	11-162	0-42	96-100	10µg/L
Benzo [a] pyrene	CLP	17-163	0-40	96-100	10µg/L
Indeno [1,2,3-cd] pyrene	CLP	10-171	0-45	96-100	10µg/L
Dibenz [a,h] anthracene	CLP	10-227	0-70	96-100	10µg/L
Benzo [ghi] perylene	CLP	10-219	0-56	96-100	10µg/L
2-Chlorophenol	CLP	27-123	0-40	96-100	10µg/L
Phenol	CLP	5-112	0-42	96-100	10µg/L
2,4-Dimethylphenol	CLP	32-119	0-40	96-100	10µg/L
2,4-Dichlorophenol	CLP	39-135	0-40	96-100	10µg/L
2,4,6-Trichlorophenol	CLP	37-144	0-40	96-100	10µg/L

Table A.1 (continued)

Parameter	Method/ Prep	Accuracy (%Recovery)	Precision (% RPD)	Completeness (%)	Project Quantitation Limits ¹
2,4-Dinitrophenol	CLP	10-191	0-50	96-100	25µg/L
Pentachlorophenol	CLP	9-103	0-50	96-100	25µg/L
o-Cresol (2-Methylphenol)	CLP	10-150	0-50	96-100	10µg/L
p-Cresol (4-Methylphenol)	CLP	10-150	0-50	96-100	10µg/L
p-Chloroaniline (4-Chloroaniline)	CLP	10-150	0-50	96-100	10µg/L
2-Methylnaphthalene	CLP	10-150	0-50	96-100	10µg/L
2,4,5-Trichlorophenol	CLP	10-150	0-50	96-100	25µg/L
o-Nitroaniline (2-Nitroaniline)	CLP	10-150	0-50	96-100	25µg/L
m-Nitroaniline (3-Nitroaniline)	CLP	10-150	0-50	96-100	25µg/L
Dibenzofuran	CLP	10-150	0-50	96-100	10µg/L
p-Nitroaniline (4-Nitroaniline)	CLP	10-150	0-50	96-100	25µg/L
o-Nitrophenol (2-Nitrophenol)	CLP	29-182	0-40	96-100	10µg/L
p-Chloro-m-cresol	CLP	22-147	0-42	96-100	10µg/L
<i>Volatile Organic Compounds⁴</i>					
Acetone	CLP	47-143	0-40	96-100	2µg/L
Benzene	CLP	76-127	0-11	96-100	2µg/L
Methyl chloride (Chloromethane)	CLP	10-140	0-60	96-100	2µg/L
Methyl bromide (Bromomethane)	CLP	10-170	0-65	96-100	2µg/L
Vinyl chloride	CLP	10-181	0-87	96-100	2µg/L
Methylene chloride (Dichloromethane)	CLP	41-177	0-40	96-100	2µg/L
Carbon disulfide	CLP	53-148	0-40	96-100	2µg/L
1,1-Dichloroethylene	CLP			96-100	2µg/L
1,1-Dichloroethane	CLP	10-169	0-43	96-100	2µg/L
1,2-Dichloroethane	CLP	56-146	0-40	96-100	2µg/L
Chloroform	CLP	60-140	0-40	96-100	2µg/L
2-Butanone (Methyl ethyl ketone)	CLP	46-153	0-40	96-100	2µg/L

Table A.1 (continued)

Parameter	Method/ Prep	Accuracy (%Recovery)	Precision (% RPD)	Completeness (%)	Project Quantitation Limits ¹
1,1,1-Trichloroethane	CLP	55-150	0-40	96-100	2µg/L
Carbon tetrachloride	CLP	71-140	0-40	96-100	2µg/L
Bromodichloromethane	CLP	35-155	0-40	96-100	2µg/L
1,1,2,2-Tetrachloroethane	CLP	54-142	0-40	96-100	2µg/L
1,2-Dichloropropane	CLP	10-162	0-55	96-100	2µg/L
Trichloroethene	CLP	71-120	0-14	96-100	2µg/L
Dibromochloromethane	CLP	56-142	0-40	96-100	2µg/L
1,1,2-Trichloroethane	CLP	53-152	0-40	96-100	2µg/L
Bromoform	CLP	46-169	0-40	96-100	2µg/L
2-Hexanone	CLP	49-151	0-40	96-100	2µg/L
4-Methyl-2-pentanone	CLP	46-152	0-40	96-100	2µg/L
Tetrachloroethene	CLP	70-140	0-40	96-100	2µg/L
Toluene	CLP	76-125	0-13	96-100	2µg/L
Chlorobenzene	CLP	75-130	0-13	96-100	2µg/L
Ethylbenzene	CLP	38-152	0-40	96-100	2µg/L
Styrene	CLP	34-176	0-42	96-100	2µg/L
Total Xylenes	CLP	50-150	0-40	96-100	2µg/L
Chloroethane	CLP	10-160	0-80	96-100	2µg/L
1,2-Dichloroethene	CLP	56-146	0-40	96-100	2µg/L
trans-1,3-Dichloropropene	CLP	26-160	0-45	96-100	2µg/L
cis-1,3-Dichloropropene	CLP	10-162	0-62	96-100	2µg/L
<i>Pesticides/PCBs</i>					
Aldrin	CLP	40-130	0-20	96-100	0.05µg/L
α-BHC	CLP	40-130	0-20	96-100	0.05µg/L
β-BHC	CLP	40-130	0-20	96-100	0.05µg/L
σ-BHC	CLP	40-130	0-20	96-100	0.05µg/L
Lindane	CLP	40-130	0-20	96-100	0.05µg/L
Chlordane	CLP	40-130	0-20	96-100	0.05µg/L
4,4'-DDD	CLP	40-130	0-20	96-100	0.10µg/L

Table A.1 (continued)

Parameter	Method/ Prep	Accuracy (%Recovery)	Precision (% RPD)	Completeness (%)	Project Quantitation Limits ¹
4,4'-DDE	CLP	40-130	0-20	96-100	0.10µg/L
4,4'-DDT	CLP	40-130	0-20	96-100	0.10µg/L
Dieldrin	CLP	40-130	0-20	96-100	0.10µg/L
Endosulfan I	CLP	40-130	0-20	96-100	0.05µg/L
Endosulfan II	CLP	40-130	0-20	96-100	0.10µg/L
Endosulfan Sulfate	CLP	40-130	0-20	96-100	0.10µg/L
Endrin	CLP	40-130	0-20	96-100	0.10µg/L
Endrin Aldehyde	CLP	40-130	0-20	96-100	0.10µg/L
Heptachlor	CLP	40-130	0-20	96-100	0.05µg/L
Heptachlor Epoxide	CLP	40-130	0-20	96-100	0.05µg/L
Methoxychlor	CLP	40-130	0-20	96-100	0.5µg/L
Toxaphene	CLP	40-130	0-20	96-100	5.0µg/L
Aroclor-1016 (PCB)	CLP	40-130	0-20	96-100	1µg/L
Aroclor-1221 (PCB)	CLP	40-130	0-20	96-100	2µg/L
Aroclor-1232 (PCB)	CLP	40-130	0-20	96-100	1µg/L
Aroclor-1242 (PCB)	CLP	40-130	0-20	96-100	1µg/L
Aroclor-1248 (PCB)	CLP	40-130	0-20	96-100	1µg/L
Aroclor-1254 (PCB)	CLP	40-130	0-20	96-100	1µg/L
Aroclor-1260 (PCB)	CLP	40-130	0-20	96-100	1µg/L
<i>Radiochemistry</i>					
Tritium	906.0	± 5%	25%	96-100	500pCi/L
60-Cobalt	901.1	± 5%	8%	96-100	1pCi/L
90-Strontium	905.0	± 10%	15%	96-100	2pCi/L
137-Cesium	901.1	± 15%	4%	96-100	5pCi/L
238-Plutonium	HASL-300 ASTM D8635	± 8%	5%	96-100	1pCi/L
239/240-Plutonium	HASL-300 ASTM D8635	± 8%	5%	96-100	1pCi/L
244-Curium	907.0	± 8%	8%	96-100	1pCi/L

Table A.1 (continued)

Parameter	Method/ Prep	Accuracy (%Recovery)	Precision (% RPD)	Completeness (%)	Project Quantitation Limits ¹
242-Curium	907.0	± 8%	8%	96-100	1pCi/L
241-Americium	907.0	± 8%	8%	96-100	1pCi/L
Gross Alpha	900.0	± 5%	8%	96-100	4pCi/L
Gamma Spectroscopy	901.1	± 5%	8%	96-100	5pCi/L
Isotopic Uranium	907.0	± 5%	8%	96-100	1pCi/L
Isotopic Thorium	907.0	± 5%	8%	96-100	1pCi/L

¹CLP detection limits suffice for TAL/TCL chemicals that are not historical chemicals of concern at WAG 6.

²Goals for metals identified to be WAG 6 chemicals of concern are CLP quantitative limits unless the CLP limit does not address risk concerns. The CLP detection limits for all WAG 6 metal COCs was determined to be sufficient for WAG 6.

³Goals for hazardous metals that are not on the TAL are based on risk assessment considerations and instrument detection limits (e.g., molybdenum, antimony, boron).

⁴Analytical methods for the volatile organic compounds should be Superfund Analytical Method (SAM)-1092, from "Low Concentration for Volatile Organic Compounds in Water, Statement of Work". Goals for volatile organic compounds for WAG 6 were based on detection limits that have been used historically for the RCRA Groundwater Assessment Monitoring. SAM-1092 is capable of achieving these limits. these limits ensure that results from the RCRA wells can be used for compliance monitoring considerations.

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