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Quality Assurance Project Plan for the U.S. Department of Energy Laboratory for Energy-Related Health Research Federal Facility University of California, Davis

August 2021

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Quality Assurance Project Plan
for the
U.S. Department of Energy
Laboratory for Energy-Related Health Research
Federal Facility
University of California, Davis

August 2021

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Abbreviations

ANSI	American National Standards Institute
ASTM	ASTM International
CA	Corrective Action
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	chain of custody
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
EDD	electronic data deliverable
EH&S	Environmental Health and Safety
EPA	U.S. Environmental Protection Agency
EQuIS	Environmental Quality Information System
GIS	Geographic Information System
HASP	health and safety plan
HSU	hydrostratigraphic unit
ICP	inductively coupled plasma
LEHR	Laboratory for Energy-Related Health Research
LM	Office of Legacy Management
LMS	Legacy Management Support
OCL	Old Campus Landfill
OSHA	Occupational Safety and Health Administration
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
%R	percent recovery
RD/RAWP	Remedial Design/Remedial Action Work Plan
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SMP	Soil Management Plan
SOP	standard operating procedure
SQP	standard quality procedure
UC Davis	University of California, Davis

DISTRIBUTION LIST

The following key personnel will receive a copy of the approved Quality Assurance Project Plan (QAPP) and subsequent revisions:

- Kathleen Whysner, Site Manager, DOE Office of Legacy Management
- Michael Butherus, Project Manager, RSI EnTech, LLC
- Holly Hadlock, Superfund Project Manager, U.S. Environmental Protection Agency
- John Bystra, Project Manager, California Department of Toxic Substances Control
- Durin Linderholm, Engineering Geologist, Central Valley Regional Water Quality Control Board
- Chris Wright, Environmental Manager, University of California, Davis
- Rachel Lauesen, Environmental Specialist, University of California, Davis
- Robert O. Devany, Principal Hydrogeologist, Weiss Associates
- Tim Utterback, Project Chemist/Engineer, Weiss Associates

The contact information for these individuals is provided in Appendix A of this QAPP. The approved QAPP and any revisions will be distributed in electronic format to the people on this list, as well as a broader group of project personnel, unless a printed copy is requested.

Terms and Definitions

acceptance criteria: Specified limits placed on characteristics of an item, process, or service defined in codes, standards, or other requirement documents.

activities that affect quality: Activities that, if not performed properly, could compromise the validity of information or data reported, potentially resulting in an unacceptable risk to the environment, the health or safety of the public, or the health or safety of workers involved or a detrimental effect on the achievement of project objectives.

assessment: An all-inclusive term used to denote any of the following: audit, performance evaluation, management assessment, peer review, or surveillance performed by or for management.

audit: A planned and documented activity performed to determine by investigation, examination, or evaluation of objective evidence the adequacy of and compliance with established procedures, instructions, drawings, and other applicable documents and the effectiveness of implementation. An audit should not be confused with surveillance or inspection activities performed for the sole purpose of process control or product acceptance.

audit team: One or more people who are responsible for audit performance and reporting. The team may consist of, or is headed by, an individual designated the audit team leader.

audit team leader: The individual responsible for organizing and directing the audit, coordinating the preparation and issuance of the audit report, and evaluating the responses.

conditions adverse to quality: An all-inclusive term used in reference to any of the following: malfunctions, deficiencies, defective items, nonconformance, and failure to meet performance objectives. A significant condition adverse to quality is one that, if uncorrected, could have a serious effect on safety or operability.

contractor: An entity directed by DOE to perform specific project work by through a contract or grant. The contractor may perform project work directly or use subcontractors. For the purposes of this Quality Assurance Project Plan (QAPP), "contractors" refers to both the Legacy Management Support contractor and the University of California, Davis because both entities receive direction from the LM site manager and direct the work of subcontractors.

contractor task plan: The document prepared by the contractor in response to a U.S. Department of Energy (DOE) task assignment request for conducting a task, or group of tasks, in support of project activities.

Corrective Action: Measure taken to rectify conditions adverse to quality and, where necessary, to preclude repetition.

document: Any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures, or results. A document is not considered to be a quality assurance record until it satisfies the definition of a quality assurance record.

DOE task assignment: A request by DOE for the completion of a task, or group of tasks, in support of project activities at the Laboratory for Energy-Related Health Research project site.

external audit: An audit of those portions of another organization's quality assurance or quality control program not under the direct control or within the organizational structure of the auditing organization.

fieldwork variance: Documented authorization from the contracting authority to depart from specified requirements.

finding: A documented statement of fact concerning a noncompliance or deviation from established requirements.

health and safety procedure: A written document that details the health and safety requirements to accompany an operation, analysis, or action whose mechanisms are thoroughly prescribed and that is commonly accepted as the method for safely performing certain routine or repetitive tasks.

independent (personnel): An individual or group of individuals qualified to analyze, review, inspect, test, audit, or otherwise evaluate data and work results because he, she, or they had no direct responsibility for, or involvement in, performing the activity or work and are not accountable for the activity or work result.

indoctrination: To provide personnel with initial information that will familiarize them with the general criteria of the project, quality assurance elements that apply to the project, and job responsibilities.

inspection: Examination or measurement to verify whether an item or activity conforms to specified requirements.

inspector: A person who performs inspection activities to verify conformance to specific requirements.

internal audit: An audit of those portions of an organization's quality assurance or quality control program retained under its direct control and within its organizational structure.

item: An all-inclusive term used in place of any of the following: appurtenance, facility, sample, assembly, component, equipment, material, module, part, structure, subassembly, subsystem, system, unit, documented concept, or data.

item to inspect: An item that requires a level of inspection as required to meet the cost, schedule, or quality objectives of the project.

nonconformance: A deficiency in characteristic documentation or procedure that renders the quality of an item unacceptable or indeterminate with respect to project criteria. Examples of nonconformances include test failures; physical defects; incorrect or inadequate documentation; data losses; or deviations from prescribed processing, inspection, or procedure.

objective evidence: Any documented statement of fact, other information, or record, either quantitative or qualitative, pertaining to the quality of an item or activity that is based on observations, measurements, or tests that can be verified.

observation: A statement of fact regarding the potential for a noncompliance that could lead to a more serious problem if not identified and corrected but that does not constitute a lack of compliance with established requirements.

procedure: A document that specifies or describes how an activity is to be performed.

procurement document: Purchase requisitions, purchase orders, drawings, contracts, specifications, or instructions used to define requirements for purchase.

project task: A subset of the work to be conducted in support of the project.

qualification (personnel): The characteristics or abilities gained through education, training, or experience as measured against established requirements, such as standards, tests, and evaluations that qualify a person to perform a required function.

quality: The degree to which an item or process meets or exceeds the user's requirements and expectations.

quality assurance: All planned and systematic actions necessary to provide confidence that a structure, system, or component will perform satisfactorily in service. When the product is a report of a significant study or investigation, quality assurance also comprises the planned and systematic actions necessary to provide adequate confidence in the validity and integrity of the reported data, methods, and procedures and in the protection, retrievability, and replicability of the data. The quality management system includes a multidisciplinary system of management controls backed by quality verification and overview activities that demonstrate the completeness and appropriateness of achieved quality.

quality assurance documents: Documents that establish the contractor requirements and methods to implement DOE activities. These documents are identified as the work plan, the Sampling and Analysis Plan, standard quality procedures (SQPs), standard operating procedures (SOPs), the project health and safety plan, health and safety procedures, and a *Field Work Variance/Field Work Modification Form*.

quality assurance procedures: Procedures developed to ensure that the quality assurance objectives of task activities are met through the application of preapproved project procedures. These procedures are limited to SQPs and SOPs. Health and safety procedures are subject to a review process that includes the project quality assurance manager but are not generally classed as quality assurance procedures.

Quality Assurance Project Plan (QAPP): A document that describes the management system for planning, performing, and assessing work to ensure that the results demonstrate stated quality, technical, and performance objectives. The QAPP will describe the organizational structure, quality control policies and procedures, functional responsibilities, levels of accountability and authority, and necessary interfaces for organizations performing activities in support of the project management office.

quality control: The actions that control the attributes of a material, sample, process, component, system, or facility in accordance with predetermined quality requirements and the routine application of procedures for obtaining prescribed standards of performance in monitoring and measurement.

quality control program: The overall program established by an organization to implement the requirements of the contract document. The program assigns responsibilities and authorities, defines policies and requirements, and provides for the performance and assessment of work. The QAPP describes the quality control program.

quality control record: A completed document that furnishes evidence of the quality of items and activities affecting the quality of items.

preparatory inspection: A systematic, documented review of the readiness for startup or continued, extended use of a facility, process, or activity. Preparatory inspections are typically conducted before proceeding beyond project milestones and before instituting a major phase of work.

readiness-review inspection: An inspection as required for tasks and activities defined in the QAPP with notification and involvement of DOE.

receiving: Taking delivery of an item at a designated location.

repair: Restoring a nonconforming characteristic to a condition that enables an item to function reliably and safely, even though that item does not conform to the original requirement.

rework: The process by which an item is made to conform to original requirements by completion or correction.

senior management: The top organizational manager for each participant (e.g., the program manager).

significant condition adverse to quality: A condition that, if left uncorrected, could have a serious effect on safety or operability. This term includes environmental and project compliance.

standard operating procedure: A written document that details an operation, analysis, or action whose mechanisms are thoroughly prescribed and that is commonly accepted as the method for performing certain routine or repetitive tasks.

standard quality procedure: A set of implementing procedures that establishes the responsibilities for, and describes the methods of, performing quality-affecting activities in response to QAPP requirements.

stop-work order: The order issued to the management of a contractor department or contractor supplier to stop further processing, delivery, installation, or operation until the proper disposition of a nonconformance, deficiency, or unsatisfactory condition has occurred.

supplier: Any individual or organization that furnishes items or services in accordance with a procurement document; an all-inclusive term used for any of the following: vendor, seller, contractor, subcontractor, fabricator, consultant, and subtier levels of any such supplier.

surveillance: The act of monitoring or observing to verify whether an item or activity conforms to specified requirements.

training: To impart specific information about job functions to achieve initial proficiency, maintain proficiency, and adapt to changes in technology, methods, or job functions.

uncontrolled document: A document that is current when issued but not kept up to date with revisions. Uncontrolled documents may initially be numbered and issued to individuals but will not be maintained as controlled or current.

use as is: A disposition permitted for a nonconforming item when it can be established that the item is satisfactory for its intended use.

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1.0 Introduction

This Quality Assurance Project Plan (QAPP) was developed to support ongoing long-term environmental remediation activities being performed by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) at the federal facility portions (or DOE areas) of the former Laboratory for Energy-Related Health Research (LEHR)/Old Campus Landfill (OCL) Superfund Site (site or project) at the University of California, Davis (UC Davis) (Figure 1). This document supersedes the project QAPP dated January 30, 2012 (DOE 2012) and excludes portions of the site where UC Davis is responsible for cleanup (Figure 2).

LM is responsible for the environmental restoration and long-term surveillance and maintenance of the site until cleanup goals established in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) *Record of Decision for DOE Areas at the Laboratory for Energy-Related Health Research, University of California, Davis* (DOE 2009) (ROD) are achieved. LM will continue to conduct CERCLA-required reviews every 5 years to ensure that the selected remedy remains protective. This QAPP has been prepared to document the quality management system that DOE will implement to achieve these objectives; it will serve as the primary quality-controlling document for DOE areas at the site by defining:

- Organizational structure.
- Roles and responsibilities.
- Requirements for document review and recordkeeping.
- The process for developing data quality objectives (DQOs) for sampling and analysis activities.
- Requirements for ongoing and planned sampling and analysis, data verification and validation, and data management.
- Project and analytical laboratory audit requirements.

LM relies on its Legacy Management Support (LMS) contractor and UC Davis project managers to perform selected environmental restoration and long-term surveillance and maintenance activities at the site. For the purposes of this QAPP, "contractors" refers to both the LMS contractor and UC Davis project managers, because both entities receive direction from the LM site manager and direct the work of subcontractors. A reference in this QAPP to a "contractor project manager," for example, would apply to the LMS contractor and UC Davis project managers.

Activities performed by these entities and their subcontractors are subject to the requirements of this QAPP. In some cases, job titles defined in the LMS contract or UC Davis federal grant may deviate from the generic key personnel titles defined in Section 2.0 of this QAPP. To document these differences, a crosswalk of the QAPP generic key personnel titles and contract and grant titles is provided in Appendix A.

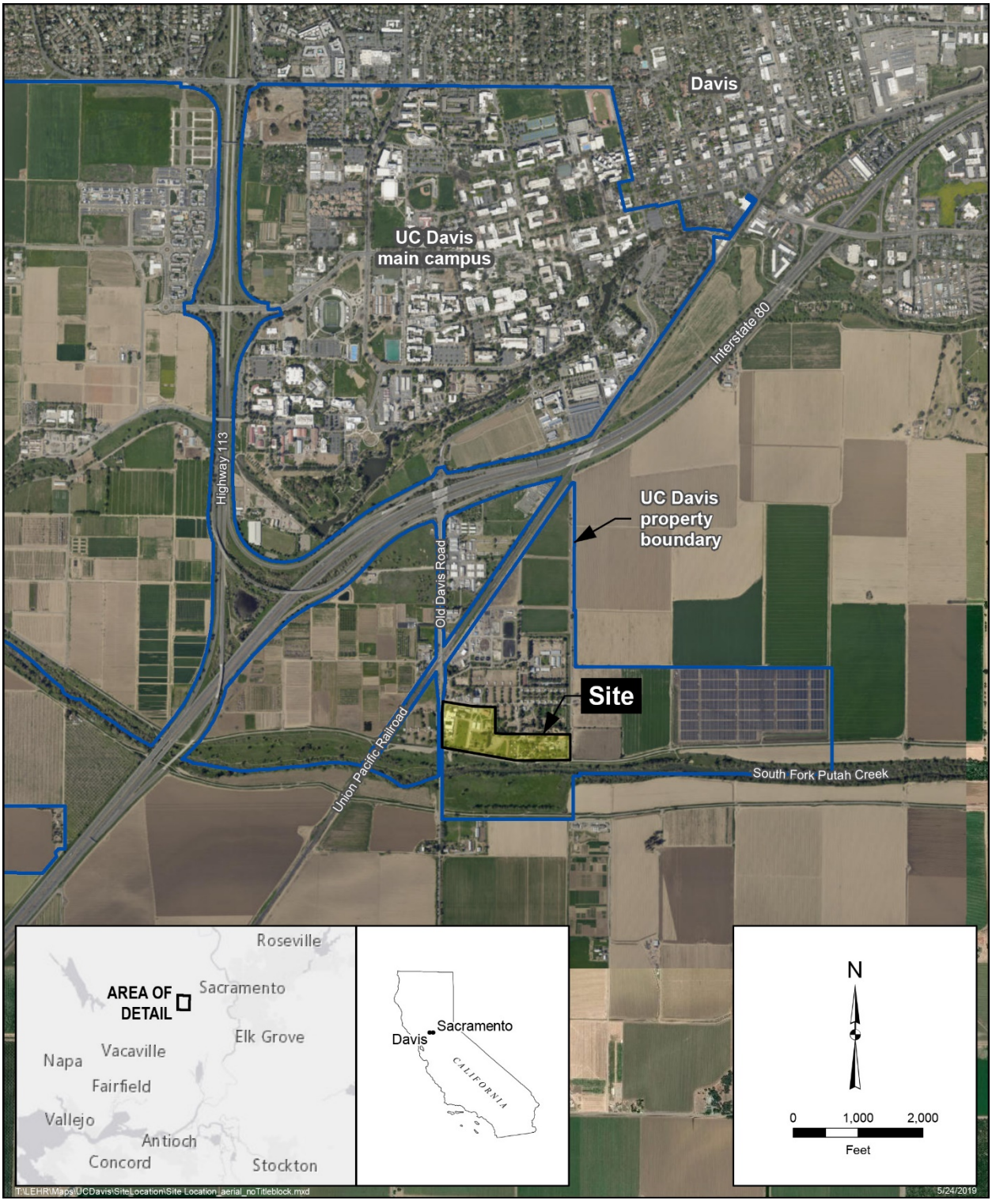

Figure 1. Location of the LEHR/OCL Superfund Site, UC Davis, Solano County, California

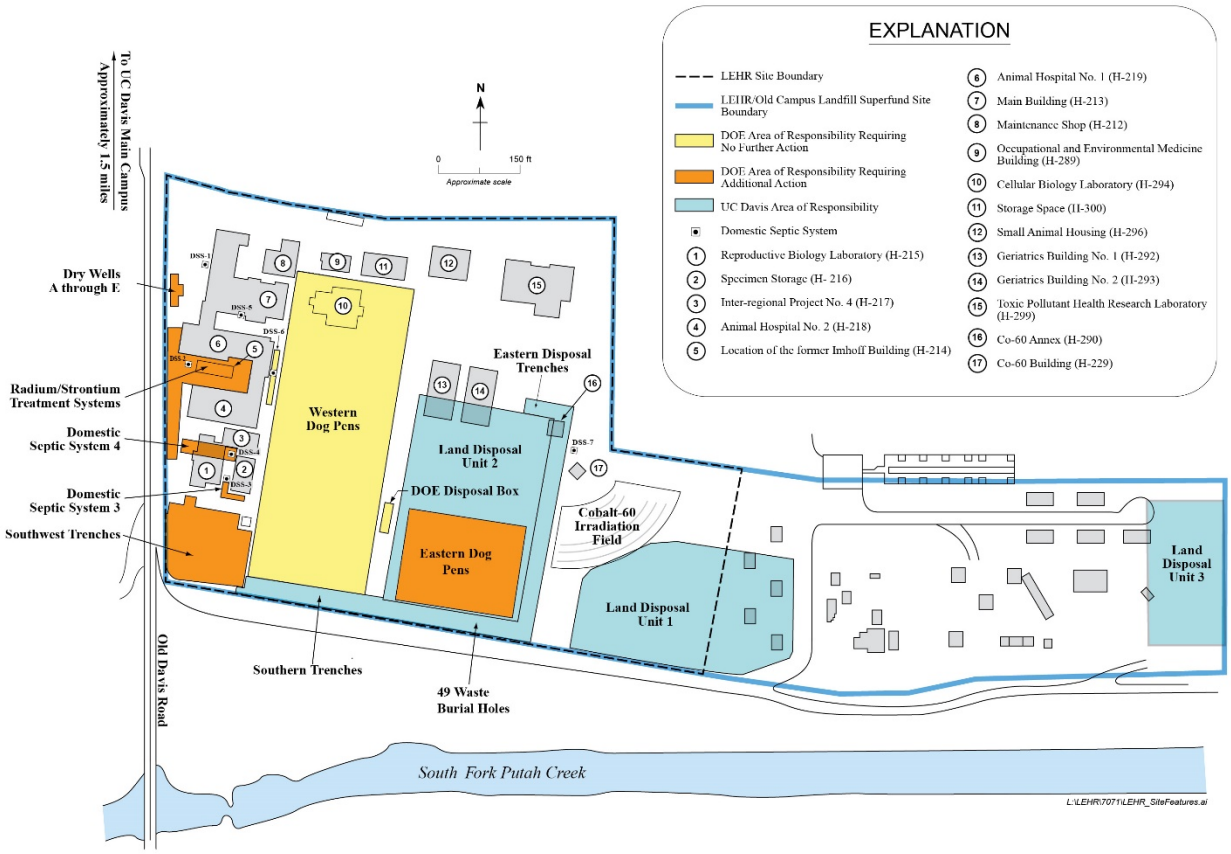

Figure 2. LEHR/OCL Site Features and Areas of Responsibility

This document has been developed using concepts from widely accepted quality management practices and requirements identified in applicable national and international standards, including DOE Order 414.4D, *Quality Assurance*; *Guidance for Quality Assurance Project Plans* (EPA 2002a); *EPA Requirements for Quality Assurance Project Plans* (EPA 2001); *Quality Management Systems for Environmental Information and Technology Programs–Requirements with Guidance for Use* (ASQ/ANSI 2014); *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006a); and the *Data Quality Assessment: A Reviewer's Guide* (EPA 2006b). These standards reflect the latest operational, technological, and engineering practices, thereby providing a sound quality assurance (QA) and quality control (QC) systems approach to the conduct of environmental activities at LEHR.

1.1 Project Definition and Background

The U.S. Atomic Energy Commission, predecessor agency to DOE, first sponsored radiological studies on laboratory animals at LEHR in the early 1950s. Research at LEHR through the late 1980s was focused on health effects from chronic exposure to radionuclides, primarily strontium-90 and radium-226, using beagles as research subjects. In 1988, DOE-funded research activities at LEHR ceased, and DOE began investigating contamination at the research site. The site was identified as a Superfund site under CERCLA in May 1994. DOE was designated as the lead agency for site cleanup under a Federal Facility Agreement established with the

U.S. Environmental Protection Agency (EPA) and state agencies in 1999 (EPA/DTSC/RWQCB/DHS/DOE 1999).

Under CERCLA, DOE successfully completed several non-time-critical removal actions to address elevated concentrations of pesticides, radionuclides, and metals in soil. However, residual contaminants remain in soil at concentrations that prevent unrestricted use of one area (Domestic Septic System No. 4) or have the potential to impact shallow groundwater above background concentrations in the future. In 2009, DOE completed a ROD (DOE 2009) that documented the final remedy, which required no additional physical cleanup of the site unless conditions change; the remedy also included long-term groundwater monitoring and land-use controls. The remedy was initiated in January 2011 with the installation of monitoring wells (Figure 3) in accordance with the *Remedial Design/Remedial Action Work Plan for the Former Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis* (DOE 2010), also called the Remedial Design/Remedial Action Work Plan (RD/RAWP). In 2014, Solano County recorded the *Covenant to Restrict Use of Property, Environmental Restriction (Re: Portions of County of Solano Assessor's Parcel No. 110-05-04 UC Davis, Laboratory for Energy-Related Health Research/Old Campus Landfill (LEHR/OCL) Superfund Site* (DTSC 2014), hereafter called the Land-Use Covenant. The protectiveness of the remedy was confirmed in the *Addendum to Laboratory for Energy-Related Health Research Federal Facility, University of California at Davis, Five-Year Review Report*, which was completed in July 2018 (DOE 2018).

Figure 3. DOE Areas of the LEHR Federal Facility Subject to Land-Use Controls and Locations of DOE Groundwater Monitoring Wells and Survey Monuments

1.2 Objective

This QAPP describes the management system and requirements to be used in the performance of anticipated work on the project to ensure that project goals, objectives, and EPA and DOE expectations are met. The system described herein is designed to ensure that work is planned, performed, and assessed in a controlled and specified manner and is adequately documented.

The objective of this document is to establish an effective and efficient quality management system to ensure that appropriate controls are implemented based on the relative importance and complexity of services to be provided for each project task. Qualified technical, QC, and management personnel working as a team will determine the QC to be applied.

Provisions of the QAPP apply to work performed by DOE's assigned contractors and their subcontractors, vendors, and suppliers in support of the project activities and tasks described in the contract. The federal entity responsible for the project is LM.

1.3 Project and Task Descriptions

Anticipated project activities include project management, groundwater monitoring, land-use control inspections and maintenance, soil management, Five-Year Reviews, and contingent remediation (if required). The associated key questions to be addressed by the project and descriptions of specific project tasks are summarized below.

1.3.1 Key Questions to Be Addressed by the Project

<u>Project Management</u>

- Are site conditions protective of human health and the environment?
- Is site work being conducted in a manner that protects workers, site occupants, animals, the public, and the environment?
- Are adequate funds available to support project activities required to meet local, state, and federal requirements?
- Are qualified staff available to perform the required work?
- Are staff properly trained to all project and contract requirements?
- Are all requirements of the DOE contract or grant being met?
- Is the work, including testing data, of sufficient quality to meet project objectives?
- Are corrective actions being taken to address identified deficiencies?
- Are project records and documents being properly managed and archived?

<u>Groundwater Monitoring</u>

- Are residual contaminants in soil impacting groundwater downgradient of DOE areas?
- Do the concentrations of monitored groundwater constituents have specific trends? If so, what is causing the trends if they potentially inform critical project decisions?

- Are concentrations of project-monitored constituents changing over time in upgradient or cross gradient groundwater background?
- Are there any monitoring well maintenance issues that could affect the integrity of groundwater samples collected from the monitoring wells?

Land-Use Control Inspection and Maintenance

- Are observed changes in land use consistent with the requirements of the Land-Use Covenant (DTSC 2014)?
- Have site excavation activities been conducted in compliance with the *Soil Management Plan, Former Laboratory for the Energy-Related Health Research Federal Facility, University of California, Davis* (DOE 2019), also called the Soil Management Plan (SMP)?
- Has vegetation been managed in compliance with the project SMP?
- Are the land-use control monuments undisturbed and accessible?

Five-Year Reviews

- Is the remedy protective?
- Are there changes in chemical toxicities or other factors that require a reevaluation of risks posed by the site?
- Are additional sampling and analysis required to confirm the remedy's protectiveness?
- Are any modifications to the existing remedy required to improve its performance?

Contingent Remediation

- Is contingent remedial action required?
- If contingent remediation is required, what are the appropriate remedial technologies and actions required to address the problem?

Specific categorical project functions required to address these questions are discussed below.

1.3.1.1 Project Management

Project management will be required for maintenance of ongoing programs and updates to project tasks and goals. Management tasks for the ongoing programs include:

- Development and approval of ongoing scope, schedule, and budget.
- Management and approval of program changes or corrections, if any.
- Review and approval of topical reports.

1.3.1.2 Stakeholder Interaction

Project team meetings are held regularly throughout each year to communicate project progress, results, and recommendations and to reach agreement between stakeholders on project decisions. Stakeholder interaction tasks include scheduling meetings, determining meeting agendas and issuing agendas to meeting participants, preparing meeting presentations, presenting at and

attending meetings, recording the meeting roster and meeting minutes, documenting stakeholder decisions, and storing meeting documentation. Interaction includes addressing any follow-up requests made by stakeholders, such as additional documentation of presented materials.

1.3.1.3 Long-Term Groundwater Monitoring

Long-term groundwater monitoring was implemented in 2011 and is ongoing to ensure that if contaminants begin to impact groundwater, contingent remedial action may be considered to prevent the degradation of water quality. Monitoring will continue until contaminants in soil no longer pose a threat to groundwater. Groundwater is sampled at nine hydrostratigraphic unit-1 (HSU-1) monitoring wells downgradient of DOE areas: UCD1-013, UCD1-021, UCD1-023, UCD1-054, UCD1-068, UCD1-069, UCD1-070, UCD1-071, and UCD1-072 (Figures 2 and 3). Groundwater monitoring and associated data evaluation is conducted in accordance with the RD/RAWP (DOE 2010) and the *First Five-Year Review for the Laboratory for Energy-Related Health Research Federal Facility* (DOE 2016), hereafter called the First Five-Year Review. Groundwater monitoring results are presented in an annual water monitoring report. Sample results generated by laboratory analysis and field measurement are stored in a relational database. Before database storage, laboratory results are verified and validated as described in Section 8.9; field measurements are verified as described in Section 8.8.1. Upon database import, the field and laboratory data output from the database are verified against the field forms and laboratory reports as described in Sections 8.8.1 and 8.8.7, respectively. Copies of the field measurement data sheets and laboratory reports are stored in the project files. The applicability of QAPP requirements to the groundwater monitoring program is discussed in Section 8.10.

1.3.1.4 Land-Use Control Inspections and Maintenance

Annual inspections are required for compliance with the Land-Use Covenant (DTSC 2014). Each groundwater monitoring well is inspected and its pump is operated to ensure proper function for groundwater sample collection. DOE areas subject to land-use restrictions are inspected along with the land survey monuments that define area boundaries. Delineators and bollards that serve to alert workers to the presence of wellheads and monuments are also inspected. The condition of wellheads, pumps, monuments, and delineators is assessed, and maintenance or repairs are performed as necessary. To confirm compliance with requirements in the SMP, inspections include verification of permits obtained for any soil-disturbing activities, site observation of soil and vegetation disturbances or changed conditions in DOE areas, and a review of disposal practices for waste generated during soil-disturbing activities. The land-use control inspection and maintenance activities are reported in annual Land-Use Covenant Inspection Reports. Land-use controls will continue until contaminants in soil no longer pose a threat to human health or groundwater.

1.3.1.5 Soil Management

Soil-disturbing activities (e.g., excavation, grading, trenching, utility installation or repair) and any other human activities that could potentially bring contaminated soil to the surface in DOE areas are subject to the requirements of the SMP (DOE 2019). Before commencing soil-disturbing activities, a permit application and work plan must be submitted to and approved by the UC Davis Environmental Health and Safety (EH&S) Unit, after which the UC Davis EH&S Unit will regularly inspect approved activities. Samples are collected to characterize any

waste soil and soil for potential reuse at the Site, and determine its disposition. The approval of the California Department of Toxic Substances Control (DTSC) is obtained for soil that will be reused onsite. Upon offsite disposal or onsite reuse of waste soil, the disposition is documented in a Soil Disturbance Report that is submitted to the UC Davis EH&S Unit. The process is completed when a Permit Close-Out is issued by the UC Davis EH&S Unit, and the soil management activities are reported in the annual Land-Use Covenant Inspection Report.

The UC Davis EH&S Unit conducts annual training to communicate soil management requirements to applicable units that may perform, manage, or contract for work at and near DOE areas. Personnel working in departments on or near DOE areas also receive annual training. Soil management activities will continue until contaminants in soil no longer pose a threat to human health.

1.3.1.6 Five-Year Reviews

Five-Year Reviews are conducted to assess whether the implemented remedy at the DOE areas is protective of human health and the environment. The First Five-Year Review was issued in 2016 (DOE 2016), and the next Five-Year Review is planned for completion in 2021. Five-Year Reviews involve community notification, project document review, data review, inspection of DOE areas, and interviews with involved parties. The Five-Year Reviews include assessments to determine if:

- The remedy is functioning as intended.
- Any changes in toxicity standards or risk assessment methodology have occurred since risks were determined for the Remedial Investigation/Feasibility Study that would significantly change the estimated levels of risk.
- Any other information that could call into question the protectiveness of the remedy.

Issues identified in the Five-Year Review, if any, are summarized, and follow-up actions to address the issues are proposed. Finally, a statement is made about the remedy's level of protectiveness.

1.3.1.7 Contingent Remediation

The results of the long-term groundwater monitoring program described above may indicate that the constituents of concern being monitored are migrating to groundwater and are impacting or may impact groundwater quality. In such a case, remedial cleanup technologies may be evaluated in accordance with CERCLA. At the time the remedy is selected, the adequacy of this QAPP to provide QA/QC measures for the planned activities will need to be evaluated.

1.4 Graded Approach

Quality assurance will be implemented on the project using a graded approach—a process by which the level of analysis, documentation, and actions necessary to comply with a QA/QC requirement is commensurate with the relative importance of quality assurance to a task or activity. The complete set of activities necessary to meet the QA requirements, as well as the level of depth, rigor, and thoroughness in applying them to the project, are determined by

applying a graded approach. This approach permits tailoring the QA/QC activities to each task to ensure that resources are not unnecessarily expended.

1.5 Plan Approval, Review, and Revisions

This QAPP shall be reviewed at least every 5 years as part of the CERCLA Five-Year Review, and any recommendations to revise the QAPP shall be documented in the Five-Year Review report. Revisions may also be required if significant changes to the project scope result in quality assurance elements that are not addressed by this QAPP. If revisions to the QAPP are necessary, the QAPP shall be revised and resubmitted to EPA, DTSC, and the RWQCB for review and approval in accordance with a schedule presented in the Five-Year Review report or under a schedule that DOE, EPA, DTSC, and the RWQCB agree to.

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2.0 Responsibilities and Organization

2.1 Project Responsibilities and Organization

DOE is responsible for all aspects of remedial action program implementation in DOE areas of the site. LM relies on its contractor (the LMS contractor and UC Davis project managers) to implement certain aspects of the remedial action program. Specifically, the LMS contractor is responsible for annual inspection of land-use controls, conducting Five-Year Reviews, as-needed sampling and analysis, stakeholder interaction, and compliance support. UC Davis is responsible for implementing an SMP and for groundwater monitoring and reporting for DOE areas. With the objective of maintaining consistent QA/QC practices across the project, all parties supporting project implementation are subject to the requirements of this QAPP.

The project organizational structure is shown on Figure 4. All entities performing work on the project are required to conform functionally to this organizational structure.

2.2 Project Roles and Responsibilities

The roles and responsibilities for key personnel assigned to the project are discussed in detail below. The key position titles used in this QAPP are generic and may not correspond to position titles described in the LMS contract and UC Davis contract and grant, respectively. To ensure that QAPP-defined roles and responsibilities are properly assigned, Appendix A provides a crosswalk of the QAPP-defined roles and the corresponding contract and grant or operational titles, as well as the specific key personnel assigned to the roles. Appendix A will be amended by LM when applicable contract or grant conditions or key personnel assignments change.

Key personnel may delegate the execution of, but not the responsibility for, these defined roles. Key personnel may delegate a substantial subset of their functions to a deputy who will assume full responsibility for the delegated duties when the delegated duties and responsibilities shall be clearly defined and documented in writing. When appropriate or necessary, a single individual may occupy more than one of the roles defined in this section, thereby assuming the responsibilities of each role to which he or she is assigned.

2.2.1 LM Roles and Responsibilities

2.2.1.1 LM Site Manager

The LM site manager is responsible and accountable for all project activities and is the focal point and main channel of communication between DOE and the contractor. The LM site manager will establish and interpret project policies, ensure that necessary resources are made available, prepare long-range program plans, identify and resolve potential problems or conflicts, and provide for the safe performance and high quality of the work. Other duties, as appropriate, include:

- Receiving, negotiating, and tracking project performance.
- Assigning the scope for the contractor project manager to direct his or her project responsibilities and providing the necessary funding.

- Approving and consistently implementing the project planning documents (e.g., the QAPP, project health and safety plan [HASP]).
- Assessing the overall project for compliance with federal, state, and local regulations and laws and with specific DOE orders and directives.
- Interacting with regulatory and public agency clients.
- Disseminating project-related information from DOE and others.
- Providing project change order control.
- Reporting any significant conditions adverse to quality and obtaining concurrence on proposed resolutions.
- Providing overall project technical, quality, and performance consistency.
- Attending meetings of and conferences between DOE and the contractor.
- Reviewing project QA audit reports and any resulting Corrective Action (CA) disposition.

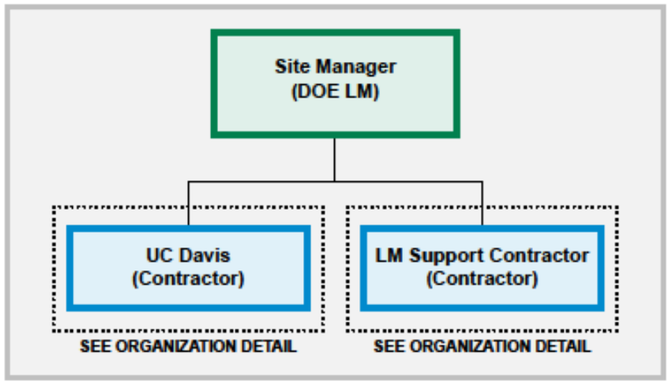
2.2.2 Contractor Roles and Responsibilities

2.2.2.1 Contractor Project Manager

The contractor project manager reports to the LM site manager for the project. He or she is responsible for project quality and for supervising technical, compliance, financial, and scheduling matters and will control project performance and approve resulting invoices. Other duties, as appropriate, include:

- Procuring, along with the contract administrator, materials and services.
- Organizing the project staff, including subcontractors; assigning duties; and orienting the staff to the needs and requirements of the project.
- Ensuring qualified resources are assigned to the project.
- Reviewing, approving, and implementing project planning documents (e.g., work plans, project HASP, QAPP) and standard procedures.
- Planning and authorizing fieldwork in accordance with work control processes.
- Reviewing and approving changes in the scope of work.
- Serving as the "point person" for project staff and matrixed support personnel reporting and for the disposition of nonconformances and changes in work instructions and activities.
- Assessing the effects of changes and nonconformances on the project and reporting significant changes and nonconformances to the LM site manager.
- Reviewing procurement documents and final reports.
- Reviewing quality assessment reports and any resulting CA disposition.
- Ensuring the project complies with applicable DOE orders, regulations, statutes, and ordinances.
- Coordinating with subcontractors on project matters.
- Researching and documenting new and emerging compliance issues and regulations.

PROJECT ORGANIZATION



——— Line of authority
DOE U.S. Department of Energy
LM Legacy Management
UC Davis University of California, Davis

Notes:
1. See QAPP Section 2 for definitions and roles and responsibilities.
2. Navarro and UC Davis operate independently, as directed by DOE, under parallel organizational structures.
3. UC Davis's work for LM is performed under a federal grant.

ORGANIZATION DETAIL

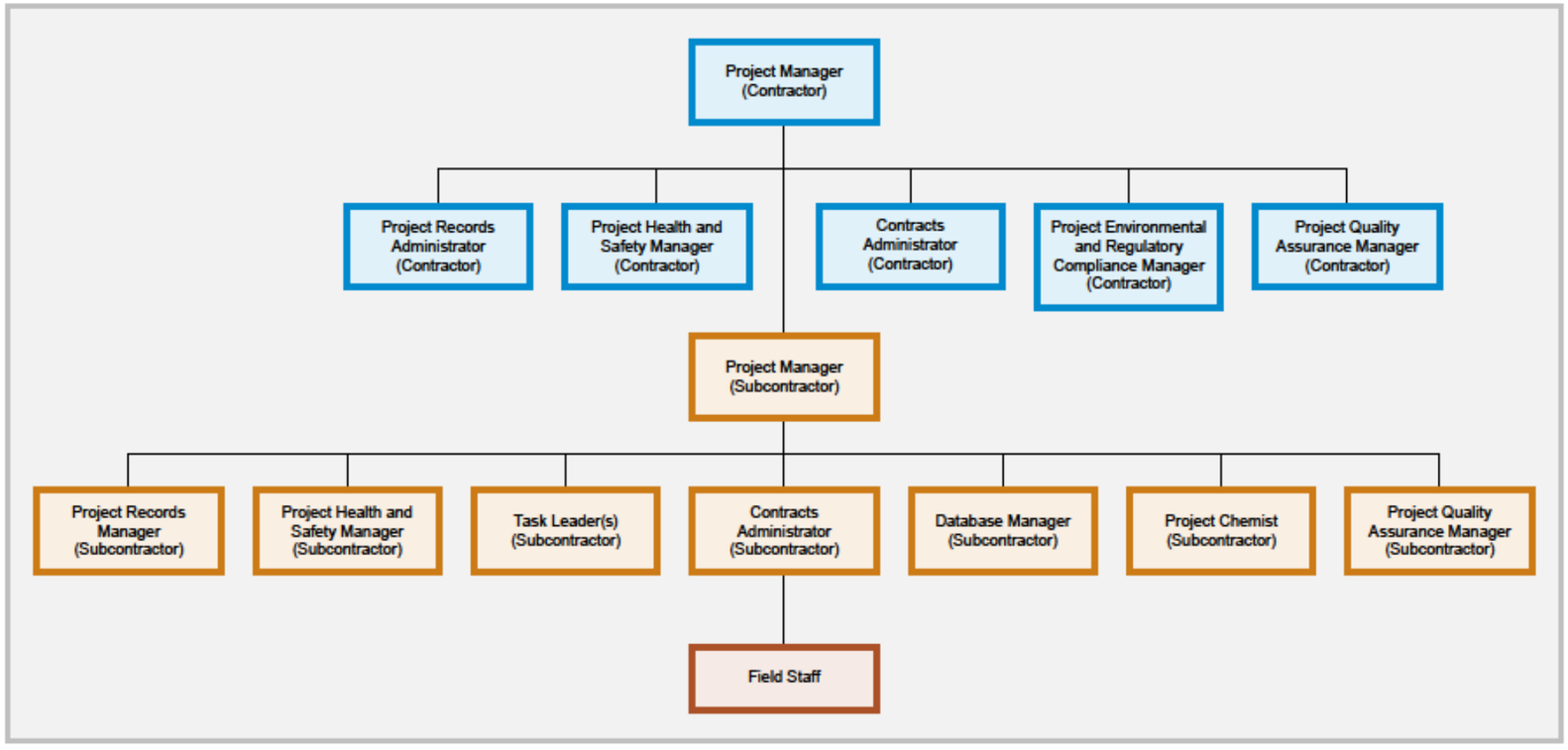


Figure 4. LEHR Project Organizational Chart

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2.2.2.2 Contractor Environmental Compliance Manager

The contractor environmental compliance manager supports the contractor project manager by ensuring that the project meets all applicable environmental industry standards and complies with all applicable regulatory conditions. Other supporting duties for this position include:

- Ensuring the project complies with applicable DOE orders, regulations, statutes, and ordinances.
- Coordinating with subcontractors on project compliance matters.
- Researching and documenting new and emerging compliance issues and regulations.

2.2.2.3 Contractor Contracts Administrator

The contractor contracts administrator has overall responsibility for contract administration related to contract compliance and to the acquisition of supplies, services, materials, and equipment for project execution. The contracts administrator will administer the subcontracts; he or she is responsible for placing and reviewing all procurements performed for the project, including negotiating with vendors, soliciting adequate competitive bids, and executing purchase orders. The contracts administrator receives direction from the project manager with respect to project matters. Other duties, as appropriate, include:

- Developing, awarding, and administering all subcontracts and subcontract amendments.
- Ensuring that subcontractors are accountable for EH&S requirements.
- Complying with small-business and small-disadvantaged-business regulations.
- Assisting in the negotiation of the subcontract and modifications.
- Providing guidance for and resolving contractual issues.
- Distributing and controlling purchase orders and receiving reports.
- Ensuring that all procurement activities are conducted in accordance with corporate and institutional policies, procedures, government regulations, and orders.
- Maintaining all subcontract and purchase order files.
- Reviewing subcontractor and vendor invoices.

2.2.2.4 Contractor Project Health and Safety Manager

The contractor project health and safety manager are responsible for consulting with the project manager on health and safety issues concerning occupational safety and health, industrial hygiene, radiation protection, protection from hazardous chemicals exposure, and permitting activities. The project health and safety manager advises the project manager and has the organizational freedom and authority to require changes in work practices, identify problems, and propose solutions. Other duties, as appropriate, include:

- Ensuring regulatory and operational compliance with requirements of the Occupational Safety and Health Administration (OSHA), the project HASP, and DOE requirements.
- Ensuring that health and safety training (e.g., tailgate safety meetings) and medical monitoring are conducted.

- Ensuring that field and facility safety inspections are conducted and any resulting CAs are carried out.
- Coordinating health and safety physics responsibilities.

2.2.2.5 Contractor Project Quality Assurance Manager

The contractor project QA manager supports the project manager as appropriate, on the following tasks:

- Reviewing and concurring with project plans and procedures for quality concerns
- Assessing project activities (e.g., performing surveillances, audits, and inspections) for compliance with the planning documents and procedures
- Implementing QA procedures
- Providing QA indoctrination and training to project personnel and assisting in procedure training
- Identifying the need for corrective action and initiating, recommending, and coordinating solutions for problems related to project quality
- Concurring with the disposition of nonconformances

2.2.2.6 Contractor Project Records Administrator

The contractor project records administrator assists the project manager and is responsible for:

- Tracking and maintaining copies of all documents produced for the project.
- Ensuring public access to project documents.

2.2.3 Environmental Subcontractor Roles and Responsibilities

Environmental subcontractors will support the contractors on most project tasks. Environmental subcontractors specialize in site environmental sampling and analysis, subsurface characterization, and site remediation, and they are expected to plan and implement most of the field activities, database management, data analysis, and technical reporting for the project.

2.2.3.1 Subcontractor Project Manager

The subcontractor project manager reports to the contractor project manager. He or she will be responsible for project quality and the day-to-day management of technical, financial, and scheduling matters. The subcontractor project manager will manage project performance and prepare resulting invoices. Other duties, as appropriate, include:

- Procuring, along with administrative personnel, materials and services.
- Organizing the subcontractor staff, assigning duties, and orienting staff to the needs and requirements of the project.
- Evaluating the qualifications of subcontractor staff and identifying individuals who need additional training.

- Reviewing, approving, and implementing project planning documents (e.g., work plans, project HASP, QAPP) and standard procedures.
- Identifying and documenting changes in the scope of work and notifying the contractor project manager of any changes.
- Reviewing procurement documents, design bases, specifications, and final reports.
- Reviewing quality assessment reports and any resulting CA disposition.

2.2.3.2 Subcontractor Contracts Administrator

The subcontractor contracts administrator has overall responsibility for contract compliance and the acquisition of supplies, services, materials, and equipment required for project execution by the subcontractor. He or she will review project cost estimates prepared by the project manager and help the project manager identify and prepare task revisions. The contracts administrator will administer the subcontracts and be responsible for placing and reviewing all procurements performed for the project, including negotiating with vendors, soliciting adequate competitive bids, and executing purchase orders.

Procurement activities will follow the requirements of the subcontract and corporate purchasing policies and procedures. The contracts administrator receives direction from the project manager with respect to project matters. Other duties, as appropriate, include:

- Reviewing and approving contract and task assignment modifications from the contractor.
- Developing, awarding, and administering lower tier subcontracts and subcontract amendments.
- Ensuring that lower tier subcontractors are accountable for EH&S requirements.
- Complying with small-business and small-disadvantaged-business regulations.
- Assisting in the negotiation of the contract and modifications and various task authorizations.
- Providing guidance for and resolving contractual issues.
- Following program-specific procurement procedures.
- Distributing and controlling purchase orders and receiving reports.
- Ensuring that all procurement activities are conducted in accordance with corporate policies, procedures, government regulations, and orders.
- Preparing and awarding purchase orders and purchase order revisions.
- Maintaining all contract, subcontract, and purchase order files.
- Reviewing lower tier subcontractor and vendor invoices.

2.2.3.3 Subcontractor Project Health and Safety Manager

The subcontractor project health and safety manager is responsible for consulting with the project manager on health and safety issues concerning environmental protection, fire protection, occupational health and safety, industrial hygiene, radiation protection, protection from hazardous chemicals exposure, and permitting activities. The project health and safety manager

advises the project manager and has the organizational freedom and authority to require changes in work practices, identify problems and propose solutions, and, if necessary, stop work activities that could pose a danger to personnel or the environment. Other duties, as appropriate, include:

- Ensuring regulatory and operational compliance with the OSHA requirements, the project HASP, and DOE requirements.
- Recommending corrections and updates to the project HASP to the contractor project health and safety officer.
- Ensuring that health and safety training (e.g., tailgate safety meetings) and medical monitoring are conducted.
- Ensuring that field and facility safety inspections are conducted and any resulting corrective actions are carried out.
- Coordinating health and safety physics responsibilities.
- Interfacing with DOE and UC Davis Health physics staff.

2.2.3.4 Subcontractor Project Quality Assurance Manager

Because the project size is limited, this is a matrixed and as-needed position utilized by the project manager to support his or her role of developing and maintaining the QAPP. The subcontractor project QA manager supports the project manager, as appropriate, on the following tasks:

- Reviewing and concurring with project plans and procedures for quality concerns
- Assessing project activities (e.g., performing surveillances, audits, and inspections) for compliance with the planning documents and procedures
- Implementing QA procedures
- Providing QA indoctrination and training to project personnel and assisting in procedure training
- Reporting regularly to project management on the status of QA implementation
- Identifying the need for corrective action and initiating, recommending, and coordinating solutions for problems related to project quality
- Disseminating applicable QA information to project staff
- Concurring with the disposition of nonconformances
- Coordinating and interfacing with external organizations on quality-related matters

2.2.3.5 Subcontractor Project Database Manager

The subcontractor project database manager reports to the project manager and is responsible for the design, maintenance, and stewardship of the database(s) used for recording and archiving all pertinent environmental data generated as part of the task(s) assigned to the subcontractor by the contractor project manager. The project database manager is responsible for all of the following tasks:

- Maintenance of the database used to store site data
- Import of electronic data deliverables to the database

- Ensuring QA/QC of data imports and exports from the database
- Backup, security, and maintenance of overall integrity of site data stored in the subcontractor database
- Ensuring all site data can be exported in a format compatible with the master DOE and UC Davis site databases

2.2.3.6 Subcontractor Project Chemist

The subcontractor project chemist reports to the project manager. He or she will also interface with the subcontractor task leader and provide support for the project sampling activities. Duties of the project chemist include:

- Assisting the subcontractor project QA manager in preparing the QAPP and reviewing task-specific Sampling and Analysis Plans (SAPs) for conformance with the QAPP.
- Auditing sample collection and handling performed by field personnel.
- Auditing onsite and offsite laboratories.
- Auditing preventive maintenance conducted on facilities and instruments used for sampling and analysis.
- Overseeing data validation activities.
- Conducting data quality assessments.

2.2.3.7 Subcontractor Project Records Manager

The subcontractor project records manager reports to the project manager and is responsible for:

- Tracking and maintaining copies of all documents produced for the project.
- Maintaining a copy of the CERCLA administrative record for DOE areas of the site.
- Supplying copies of project documents to the contractor project records administrator upon request.

2.2.3.8 Subcontractor Project Task Leaders

Subcontractor task leaders or their designees support the project manager and are responsible for the implementation of project tasks delegated to them by the project manager. They are responsible for coordinating support personnel and maintaining communication with the project manager regarding progress on project tasks. Other duties, as appropriate, include:

- Directing office support personnel.
- Directing field support personnel.
- Ensuring implementation of the QAPP.
- Approving fieldwork variances and preparing variance documentation required by SQP 11.1, “Field Work Variance/Modification.”
- Coordinating field labor and technical personnel.
- Ensuring that staff is properly trained.

- Supporting the implementation of the project HASP.
- Coordinating day-to-day activities for project task execution.
- Orienting the staff to the needs and requirements of the project.
- Identifying and documenting changes in the scope of work and notifying the subcontractor project manager of any changes.
- Exercising operational supervision over project field staff (labor and technical personnel).
- Evaluating worker input and implementing improvements.

2.2.4 Personnel Assignment and Additional Key Personnel

Additional key personnel may be required for select tasks depending on the type and complexity of the project. The task-specific planning documents and SAPs will clearly identify the project-specific personnel who are performing work or involved in tasks that could affect the quality of environmental remedial activities.

2.2.4.1 Graded Approach to Personnel Assignment

A graded approach will be used in assigning staff to fill the roles described in the QAPP. If key personnel do not require assistance in discharging their duties on a particular task, staff will not be assigned to provide such assistance (e.g., subcontractor project manager may perform subcontractor task leader duties if he or she is qualified to do so).

2.2.4.2 Field Staff

Field staff perform a critical role in the project and are a key part of the QA team. Field staff report to the subcontractor task leader. Duties for field staff include:

- Ordering and transporting supplies, tools, and equipment for onsite tasks.
- Inspecting the supplies, tools, and equipment.
- Participating in safety meetings and performing activities in accordance with safety plans and procedures.
- Calibrating and maintaining measuring and test equipment.
- Collecting soil, groundwater, and vegetation samples.
- Decontaminating reusable sampling equipment.
- Maintaining sample chain of custody.
- Delivering samples to contract laboratories.
- Conducting field chemical and physical parameter analysis.
- Maintaining and repairing remedial action equipment, monitoring wells, and facilities.
- Staging and coordinating disposal of generated waste according to project plan specifications.
- Implementing QC procedures.
- Documenting sample collection, field activities, and field conditions.

- Delivering field documentation records to the subcontractor task leader.
- Maintaining a safe workplace.
- Identifying unsafe conditions and executing stop-work authority when necessary.

2.2.4.3 Data Users

DOE and other regulatory agencies overseeing the project will use data generated during the project to evaluate the protectiveness of the remedies implemented at LEHR and determine if additional action may be required or if termination of the remedies is appropriate.

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3.0 Quality Control Management

Project planning activities include preparation of the plans and procedures required to verify that activities affecting quality comply with the specified requirements and are accomplished under controlled conditions in a specified manner and sequence. Controlled conditions include controls for materials; equipment; processes and procedures; computer software; personnel; and associated supplies, utilities, and environments.

This section describes the controls to be implemented in the overall management of the program to provide effective and economic QC direction for project tasks in a timely and cost-effective manner.

3.1 Quality Assurance Project Plan

The QAPP provides procedures, practices, and objectives for meeting EPA's and DOE's quality expectations for ongoing operations and maintenance of remedial actions and other remedies specified in the RD/RAWP for DOE areas at LEHR (DOE 2010). This QAPP presents a unified approach for all project task activities to be conducted subject to the ROD for DOE areas at LEHR (DOE 2009). This document supplants other historical QAPPs that may have been prepared and approved for use on the project, either by contractors or subcontractors. This QAPP is intended to be a stand-alone document that covers every necessary project QA element for anticipated project tasks.

This document presents the guiding principles to be followed by all subcontractors on this project. Subcontractors may have their own specific methods, procedures, and forms that can meet the intent of this document. In accordance with the graded approach and in the interest of project efficiency, subcontractors are encouraged to submit requests to the contractor project manager to use their methods, procedures, and forms, but subcontractors cannot proceed with using their specific methods, procedures, or forms without the prior written approval of the contractor project manager. Such approval will not be considered a variance to this document. The contractor project manager will provide such approval if doing so reduces variances, revisions to documents, and CAs that result from audits. This approach will also reduce nonconformance with the details of this document.

3.2 Project Planning

It is the contractor project manager's responsibility to initiate planning so prework activities are accomplished in a timely manner and are adequate for the scope of work involved. The contractor project manager may delegate the planning activities but must document any such delegation in writing or electronically. In addition to this document, overall project planning is addressed in the project-specific schedule, work plan, HASP, and procedures, as may be required for the task. In planning project activities, protecting the public, the workers, and the environment shall be a priority.

Project planning is conducted on various levels in the project organization. The first aspect of project planning is to translate any new DOE task request into a task plan. The next level of planning depends on the nature and complexity of the task or activity being conducted. Certain activities require the preparation of a work plan, while others may be conducted without

a work plan as long as all program requirements are met. The following sections discuss the amount and type of preparation and documentation required at each level.

The objective of the planning operation is to identify the sequence of operations and the overall methods to verify work quality. Planning operations will address, as applicable, the following elements:

- Definition of project objectives and listing of the primary activities involved in the work breakdown structure
- Identification of staff training and qualification requirements applicable to project responsibilities
- Identification of requirements (e.g., regulations, standards) applicable to project activities
- Selective application of appropriate technical, regulatory, or programmatic requirements and procedural controls to items and activities
- Health, safety, and environmental protection aspects of the project

3.2.1 Task Plans Submitted to DOE

Task plans are prepared in response to a request by DOE for work to be performed (i.e., a task description). It is the responsibility of the contractor project manager to prepare and provide task plan documents to the LM site manager. At this level of planning, the task scope and budget are defined using the work breakdown structure and the contract terms applicable to the activity being requested. It is necessary to ensure that all activities associated with the project are included in the scope and accounted for in the budget. The following considerations are evaluated at the task plan preparation stage:

- Preparation of or revisions to required planning documents (e.g., program plans, management plans)
- Project planning and integration of work with subcontractors
- Preparation of reports required by the contract, regulations, and DOE orders
- Management of cost, schedule, and control systems for the project
- Health and safety support requirements
- Environmental compliance requirements and programs
- Self-assessment requirements
- Public relations management
- Records management
- Human resources
- Subcontracting
- Training
- Procurement
- QA support

- Performance metrics
- Other project-specific requirements

3.2.2 Work Plans

Work plan preparation (including SAP preparation) is the combined responsibility of project management; the project staff; and health and safety, radiation protection, and QC personnel. The planning process is designed to establish the most effective methods of performing project work and will be coordinated among participating organizations to minimize impacts to the overall work being performed in DOE areas.

With the exception of those activities already addressed in the RD/RAWP (which include the implementation of land-use controls, long-term groundwater monitoring, and contingent remediation for the DOE soil management areas), work plans will be prepared for all nonemergency projects that meet any of the following criteria:

- Project duration is more than 5 days
- Cost is equivalent to or exceeds $10,000
- Project includes potential environmental impacts associated with radiological, chemical, or biological hazards
- Project objective is to generate data to support regulatory requirements

No work plans will be required for emergency projects or for storm water sampling activities. Emergency projects are projects dealing with environmental activities directly associated with serious and unexpected situations requiring immediate or rapid action to protect human or animal health, the environment, or property.

Projects that do not require a work plan according to the criteria listed above should still be evaluated to ensure they will meet the project objectives, comply with all program requirements, and be performed such that the public, workers, and environment are adequately protected.

Work plans will be developed for activities that include implementation of programs (such as soil management) or programmatic elements not otherwise covered by existing instructions. If sampling and analyses are required to complete the work scope, the work plans shall include sampling and analysis instructions. If only sampling and analyses are required, SAPs will be developed before any samples are collected.

The work plan or SAP will describe the planned scope of work and background information as it relates to the acquisition of geological, geophysical, hydrogeological, chemical, and any other data. Work plans should include the information listed below. SAPs should cover the aspects detailed below, to the extent relevant, and the development of task-specific DQOs (see Sections 3.3 and 8.1).

- Scope, objectives, and primary requirements and activities involved in the work
- Cost and schedule constraints, as appropriate
- Specific information to be collected

- Applicable technical, regulatory, or task-specific quality standards, criteria, or objectives and acceptance criteria
- Organizational engineering specifications and compatibility, reliability, serviceability, maintainability requirements for design tasks
- Personnel, equipment (including field and laboratory testing requirements), and other resources required to perform scheduled activities
- Assessment tools needed (e.g., technical and peer reviews, preparatory and initial inspections, independent assessments) that apply to each task
- Safety hazards and hazard control methods, including consideration of safeguards for unintended uses
- Roles and responsibilities and verification that personnel qualifications have been evaluated to ensure their competence is commensurate with assigned responsibilities
- Environmental protection requirements (including standards, regulations, monitoring and reporting requirements, as applicable) and methods to comply with these requirements
- Waste management requirements
- Communication protocols and feedback mechanisms necessary for continuous improvement
- Required records
- Signature by the professional(s) in charge of preparing the work or SAP

3.3 Data Quality Objectives and Criteria for Investigations and Studies

For any plans that cover the acquisition of data for investigations and studies, DQOs will be developed in accordance with the process illustrated in Figure 5.

A detailed description of the problem to be solved or decisions to be made will be included in task-specific SAPs, as appropriate. The DQO process is consistent with *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006a) and will be followed to define DQOs and the process for obtaining data. The contractor project manager and the contractor project QA manager will approve the DQOs.

Sufficient information about the problem; past history; any previous work or data; regulatory or legal context; and any applicable, relevant and appropriate requirements will be provided to present a clear description of the task objectives. The goal(s) of the activities will be clearly stated, and diagrams detailing areas to be sampled to achieve the stated goals will be included with a level of detail appropriate for the task. Data needed to meet project objectives (e.g., geological, geophysical, hydrogeological, and chemical data) and how those data will be used will be explicitly described.

Sample locations will be clearly identified on figures or by other suitable means. The rationale for the sampling design will be described. If sampling locations are to be determined in the field based on observation (e.g., cone penetrometer, hydropunch, monitoring well), the criteria and guidelines to be used for this assessment will be specified. Field data may also be specified for use in designing monitoring well installation to define filter packs and well screen intervals.

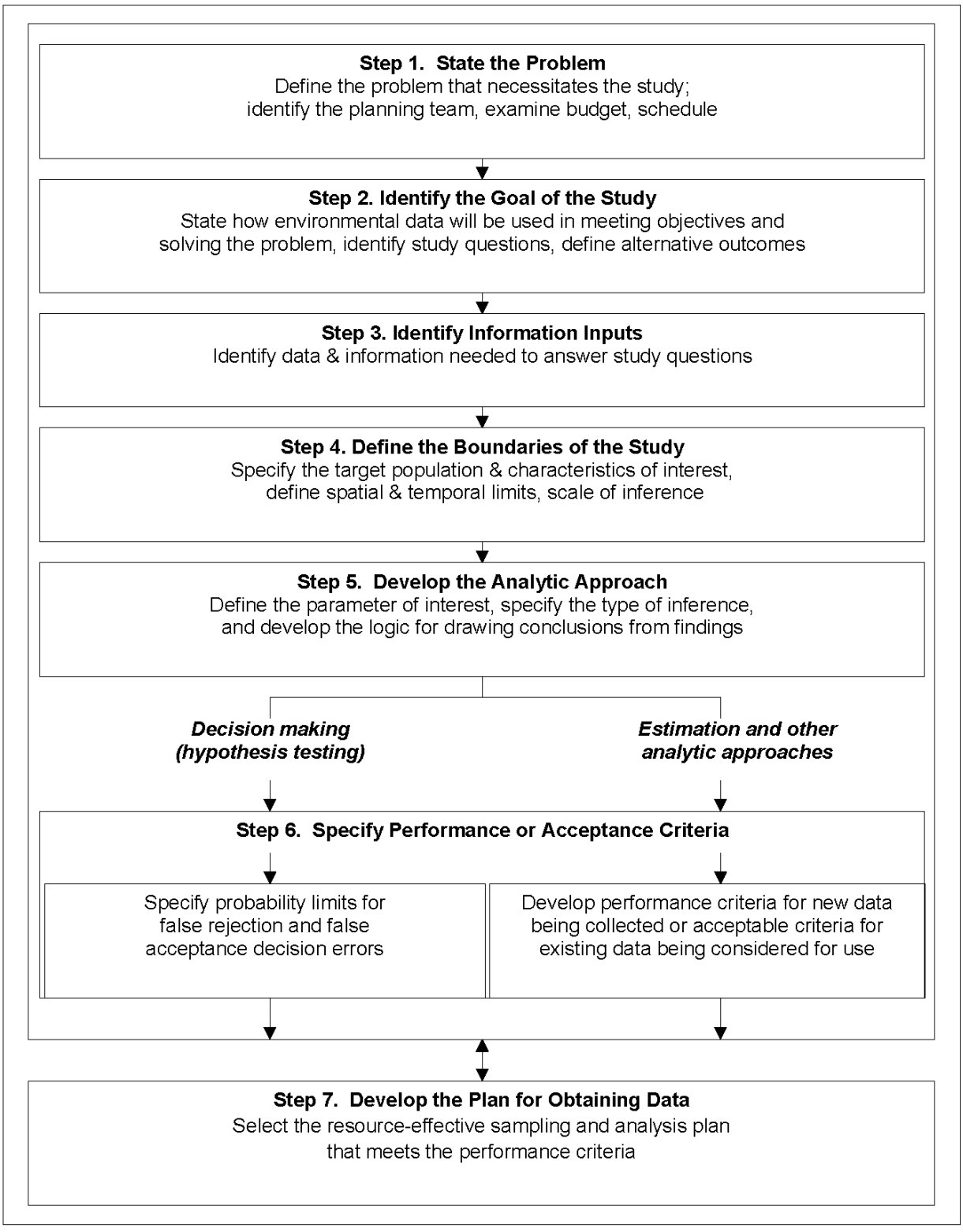

Figure 5. The Data Quality Objective Process (Figure 2, EPA 2006a)

SAPs will include control mechanisms and standards required to obtain data that meet or exceed project objectives, such as the quality procedures described below, and sampling and analytical methods, QC parameters, and QA procedures described in Section 8.3.

Further detail of the DQO implementation process for sample collection and analysis is presented in Section 8.1.

3.4 Data Quality Indicators

To ensure that data are sufficiently accurate and consistent with the DQOs, data quality indicators will be used to assess the quality of the measurement data. These parameters will be specified for each major measurement and matrix to be sampled and will be described in SAPs in quantitative terms. Different types of sensitivity (e.g., quantitative, qualitative, screening) for each major measurement parameter will be described, along with a qualitative discussion of representativeness and comparability.

The data quality indicators are precision, accuracy, completeness, representativeness, comparability, traceability, and sensitivity.

Precision is the degree of variability in the agreement. A routine program of replicate analyses is performed to determine the precision of the method or laboratory analyst. The results of the replicate analyses are used to calculate the relative percent difference (RPD), which is the governing QC parameter for precision.

$$RPD = \frac{|S - D|}{(S + D)/2} \times 100\%$$

where:

S = sample result (original)
D = duplicate result

Accuracy is the agreement between a measurement and the true value. The accuracy and precision of data collected in the investigation depend on the measurement standards used and their meticulous, competent use by qualified personnel. A periodic program of sample spiking, using a clean laboratory control matrix, is conducted to determine the accuracy of an analytical method or the laboratory analyst. The results of sample spiking are used to calculate the QC parameter for accuracy evaluation, the percent recovery (%R).

$$\%R = \frac{|S_1 - S_2|}{T_1} \times 100\%$$

where:

S1 = observed spiked sample concentration
S2 = sample concentration
T1 = true concentration of the spike

Completeness is the adequacy in quantity of valid measurements to prevent misinterpretation and to answer important questions. A laboratory and field data completeness objective of 90%

will be used to support project decisions. It is expected that most data generated can be re-collected to obtain higher decision confidence if the completeness goal of 90% is not met. The completeness goal is per analyte and sampling task, not per sample. In cases where the DQOs may not be achieved using a 90% goal, an appropriate goal is developed and documented in the SAP.

Representativeness is the extent to which discrete measurements accurately describe the greater picture they are intended to represent. Good representativeness is achieved through the careful, informed selection of sampling sites, drilling sites, drilling depths, and analytical parameters and through the proper collection and handling of samples to avoid interferences and to minimize contamination and loss.

Comparability is the extent to which comparisons among different measurements of the same quantity or quality yield valid conclusions. Comparability among measurements is achieved through the use of standard procedures, standard field data sheets, and the use of data sets of known and documented quality.

Traceability is the extent to which data can be substantiated by documentation. Traceability documentation exists in two essential forms: one that links quantitation to authoritative standards, and one that explicitly describes the history of each sample from collection to analysis and the determination of the reported result.

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. Sensitivity can be quantified through analytical and statistical procedures to determine the lowest level of measurement response necessary to identify the presence of an analyte in a sample.

Analyte-specific sensitivity, precision, accuracy, and completeness criteria are presented in Section 8.0.

3.5 Quality-Specific Procedures

Instructions and procedures have been developed (or will be developed for future tasks) to ensure project quality at the task level. These include equipment and systems operation manuals, methods for installing or using devices, engineering drawings for remedial design, specification packages for construction, and SOPs for acquisition of environmental data.

A procedure is defined as industry accepted (for example, accepted by the American National Standards Institute [ANSI] or ASTM International [ASTM]) when a well-documented procedure is adopted and successfully carried out on a large scale. Industry-accepted procedures include manufacturers' instructions and documented industry standards, which are to be used whenever it is practical.

When standard procedures do not exist or do not provide sufficient information, SQPs or SOPs, as appropriate, are developed to provide instructions for conducting an activity. The contractor project manager and the QA manager, or designee, review and approve the SQPs or SOPs before procedures are used. A table of contents lists the revision status of each procedure along with approval signatures.

Procedures for nonconformance control (SQP 10.1, "Nonconformance Control") and CAs (SQP 10.2, "Corrective Action") provide a means for addressing failures to conform to prescribed instructions and procedures, and they document and resolve conditions significantly adverse to quality. Nonconformance control and CAs are addressed in Section 15.0.

3.5.1 Project Industry Standard Procedures

No industry standard procedures are in use for the project. If an industry standard will be used, the standard will be referenced in planning documents for the applicable tasks.

3.5.2 Project Standard Quality Procedures

The SQPs included in Appendix B have been developed to address the most common ongoing and anticipated activities. SQPs supplement or support the implementation of this QAPP. SQPs may be incorporated by reference or as attachments to specific work plans. Project planning documents may reference specific SQPs as supporting documentation applicable to specified tasks. The methods and responsibilities for the development, control, and implementation of SQPs are described in SQP 5.1 "Preparation, Review, and Approval of Plans and Procedures."

3.5.3 Project Standard Operating Procedures

The SOPs included in Appendix B have been developed to implement the technical and operational requirements of the QAPP, work plans, and project specifications. Personnel knowledgeable in the activities covered by each SOP have developed, reviewed, and approved these procedures. The contractor project manager and QA manager, or designee, review and approve all SOPs relevant to the project. SOPs may be incorporated by reference or as attachments to project work plans. Project planning documents may reference specific SOPs as supporting documentation.

4.0 Document Control and Records Management

This section describes the methods and practices for the control of issuance, distribution, storage, and maintenance of quality-affecting documents and records, including those provided to the contractor by subcontractors, laboratories, and vendors.

4.1 Project Documents and Records

4.1.1 Project Documents

The following document types are expected to be produced by the project and are considered project documents:

- HASPs
- Progress reports
- SOPs/SQPs
- Work plans
- Five-Year Reviews
- Land-Use Covenant Inspection Reports
- SAPs
- Technical reports and memoranda
- Waste profiles
- Responses to regulatory comments
- Regulatory presentations
- Meeting minutes

The format and contents of project documents developed to support the CERCLA process shall conform with the applicable requirements of Title 40 *Code of Federal Regulations* Section 300 (40 CFR 300), "National Oil and Hazardous Substances Pollution Contingency Plan," and applicable EPA guidance documents. Unless otherwise specified, official project documents shall be issued as electronic files in Adobe PDF, with physical copies made available upon request to members of the distribution list.

4.1.2 Project Records

Project records include items generated or obtained during project implementations that generally provide evidence of activities performed; they may include field notes, permits, raw environmental data, laboratory reports, and driller reports. These records are generally retained and preserved by incorporating them into project documents (e.g., laboratory reports included as an appendix to a groundwater monitoring report).

4.2 Document Review

Project plans and reports will be reviewed by the LM site manager and regulatory agencies. Responses to all regulatory agency comments will be prepared in writing and approved by DOE. Changes from comments approved by the regulatory agency and DOE will be incorporated in the document under the oversight of the contractor project manager. Original copies of all project-related plans and reports will be retained in the project files and copies will be distributed to appropriate project personnel in electronic format. Distribution lists (e.g., transmittal email) for each document will be retained in the project records. Any approved modifications to the RD/RAWP or QAPP will be distributed to the individuals holding those documents.

4.3 Document Version Control and Distribution

4.3.1 Version Control

Project documents will be revised and the distribution of documents will be controlled by the contractor records administrator. Changes to procedures specified in work plans, SAPs, and SOPs will be subject to the same level of review and approval as the original procedures (Section 3.2.2, "Work Plans"). Changes will be evaluated to determine their impact, significance, and consequences. Upon review and approval, changes will be distributed to end users, and previous versions will be replaced.

4.3.2 Document Distribution

Unless otherwise specified, official project documents shall be distributed to the LM site manager, contractor project manager, and, when applicable, to designated representatives of regulatory agencies and other parties of interest. The contractor project manager is responsible for distribution of current document versions. Distribution will be in the form of secure attachments to email or secure download with instructions transmitted by email.

4.4 Engineering Drawings and Specifications

Engineering drawings and specifications, when required, are reviewed, approved, and maintained by the contractor project manager and the Professional Engineer licensed in California in charge of the design. Drawings and specifications submitted to the subcontractor project manager shall be reviewed and verified by qualified staff assigned by the subcontractor project manager; qualified staff shall be other than those who originally designed the process or item and may include one or more consultants. Revisions shall be marked up to show changes to the original design. Verification of final design documents will be performed by final drawings, and specifications may require an official approval stamp of the design professional.

Variation from the approved versions of drawings or specifications during construction and implementation shall be systematically logged and described as variances, and any design changes will be documented and marked on the corresponding drawings and specifications. Marked-up drawings and specifications showing field changes and actual as-built details are returned to the originator of the design to be incorporated into the as-built drawings and record specifications. A transmittal letter or report describing the changes will also be developed by the originator of the design, and a final report and as-built set of drawings shall be provided to the

contractor records administrator, the UC Davis Design and Construction Management Department, and the Professional Engineer licensed in California in charge of the design. The transmittal letter or report describing the changes will also be included in the project file.

4.5 Laboratory Reports

Contents of analytical data reports to be obtained from analytical laboratories will be specified in the SAPs or work plans. The laboratory shall provide: (1) a signed certified analytical report issued in PDF or as a hard copy; (2) an electronic data deliverable (EDD) in the approved project database format (currently Earthsoft Environmental Quality Information System [EQuIS] IV); and (3) QA documentation that can be validated consistent with the National Functional Guidelines (EPA 2017a; EPA 2017b). Unless necessary to meet the DQOs specified in the SAPs or work plans, Level II reports (summary data with QC) shall be obtained from the analytical laboratories, which will, at a minimum, include the following:

- Narrative, cross reference, chain of custody (COC), and method references
- Analytical results
- Blank results summary
- Surrogate recoveries (as applicable)
- Laboratory control sample recoveries
- Sample spike recoveries
- Duplicate sample or duplicate sample spike results

If Level III reports (summary data with additional QC details) are specified, the following additional information will be obtained in the analytical reports:

- Certificate of analysis
- Initial and continuing calibration records
- Gas chromatography and mass spectrometry tuning records
- Internal standard retention times and areas
- Manual integrations
- Second column confirmations
- Inductively coupled plasma (ICP) interference check samples and serial dilutions

For Level IV reports (comprehensive, validation-ready reports), a sample preparation log and analytical instrument output (raw data) used by the laboratory to determine sample results and QC data will be obtained in the analytical reports in addition to the records specified above for Level II and III data reports.

4.6 Computer Models, Simulation Methods, and Electronic Data Management Systems

4.6.1 Environmental Database

The master project database maintained by the subcontractor shall be capable of securely storing, archiving, and retrieving the anticipated volume and types of environmental data to be collected at the site, including well construction and location; groundwater elevation data; and soil, soil gas, and groundwater sample data.

The current master database is maintained in the EarthSoft EQuIS environmental data management system. Use of alternative databases for primary environmental data shall be approved in advance by the contractor project manager and QA manager. The subcontractor database is copied over to the contractor database annually and as needed.

4.6.2 Modeling and Engineering Design Software

Modeling and engineering design software shall be evaluated to determine whether they are recognized by national consensus (i.e., industry standard) as being verified and peer reviewed and having had sufficient history of use to establish their validity. If possible, software developed, tested, and approved by agencies (e.g., RESRAD, AutoCAD) will be selected preferentially. If an industry standard software is not available for a proposed analysis or design, the selected software shall be validated by qualified third-party peer reviewers and validation document(s).

4.6.3 Geographic Information System Software

Geographic data processing, analysis, and display shall be conducted with Geographic Information System (GIS) software with the precision, accuracy, industry acceptance, and operational stability of ArcGIS by Esri, and any GIS-specific output designated as a project record shall be in the most common industrywide file format for that data type (e.g., Esri shapefiles).

4.6.4 Specialized Computer Programs

Specialized computer programs may be used for data management, computation, simulation, instrument control, or engineering design and will be documented to establish the ability to perform the functions to which the program would be applied (Section 8.4.1, "Computer Software and Hardware") and to permit a qualified individual to follow the procedure by which output is obtained.

Project use of specialized software will be evaluated, documented, and accepted at the discretion of the contractor project manager. The following factors will be considered with specialized computer programs:

- History and general acceptability of the given software
- Compatibility of the hardware-software combination
- Theoretical limitations of the mathematics or physical phenomena simulated

- Complexity of the software package in relation to its purpose
- Specificity of the software and its use

Standard office software (e.g., word processing, spreadsheet, email, scheduling) are not considered specialized computer programs. Recent versions of industry standard software shall be used for these activities, and no documentation of these software categories is required.

4.7 Filing and Storage of Documents and Records

4.7.1 Transmittal and Storage

Project documents (Section 4.1.1) shall be electronically filed and maintained by the contractor records administrator in a searchable electronic document archiving system in a manner that precludes loss or damage from cyber attacks and other threats. This electronic filing system shall have redundant backup systems to mitigate potential data loss. The electronic filing system used by the contractor records administrator shall be organized by project or task and indexed such that project documents and records can be efficiently searched and retrieved. Consultants shall, upon completion of assigned tasks, transmit a copy of their final report to the contractor records administrator to be included in DOE project records. The contractor project manager shall contractually require the subcontractor(s) to transfer to DOE upon contract termination all quality records and records that support or potentially support cleanup decisions at the site, including all final work plans, SAPs, field notes, field variances, QA noncompliance reports, lessons learned reports, final and as-built drawings and specifications, reports, responses to regulatory comments, and letters from regulatory agencies. For completed tasks, the contractor records administrator will confirm that these items are documented in one or more project reports. For in-progress tasks, draft documents and other working files will be retained by the entity performing the work; if the work is being transferred, it shall be provided in an acceptable format to the contractor records administrator and then transferred to the entity assigned to complete that task. In most cases, draft versions of these documents will not be retained beyond the end of the task, unless a draft document was documented elsewhere as being the final approved version.

4.7.2 Document Retention

Final project documents and records shall be retained for a minimum of 10 years after delisting the site from the National Priorities List or as otherwise required for compliance with CERCLA. All requests for copies of records will be made through the contractor project manager.

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5.0 Personnel Training and Qualification

Quality-related activities will be performed by personnel whose qualifications are based on education, experience, and training.

5.1 Personnel Qualifications

Personnel qualifications will be evaluated and documented by résumés that include academic credentials, employment histories, professional registrations, and certifications. General and task-specific training, as required, will be provided to program and project supervisory personnel and documented on training records stored in the project record files in accordance with Section 4.0 of this document and SQP 3.2 "Indoctrination and Training."

Project staff will primarily be composed of Professional Engineers, geologists, scientists, environmental field technicians, and QA personnel. Before an individual participates in project activities, his or her qualifications will be evaluated and verified by the applicable contractor project manager, or designee, and, as needed, by the contractor health and safety manager, or designee.

For site activity assignments, the qualification evaluation shall also ensure that the individual is physically capable of performing the procedure or work plan, has demonstrated capability to perform the specific function in accordance with the approved procedure or work plan, and is familiar with the technical aspects of the equipment and procedures.

5.2 Training

To maximize personnel performance, several types of general and project-specific training will be provided. Training may consist of lessons in a classroom; computer-based, required readings; on-the-job training; or any combination of those methods. Training consistent with that specified by OSHA standards for Hazardous Waste Operations and Emergency Response will be completed by staff who perform or supervise site activities that involve potential exposure to hazardous materials or waste. Training will be documented and maintained in the project record files in accordance with Section 4.0 of this document and SQP 3.2.

General orientation and training in the requirements of this document will be required of all project supervisory personnel. The subcontractor QA manager will conduct and document formal training sessions. The training program will address:

- QA/QC policies.
- Regulatory requirements, as appropriate.
- Basic QC practices, including checks and balances inherent in the system.
- Responsibilities of the technical staff and contractor QC personnel.

The subcontractor project manager will be responsible for providing his or her staff with the instructions necessary to perform quality-related activities. This training may include contractual and regulatory requirements, scope of work, specific QA/QC requirements, and applicable

SQPs and SOPs. Experienced personnel will be available to supervise and instruct junior staff. The procedures for implementing personnel qualification and training are described in SQP 3.2.

6.0 Instructions, Procedures, and Drawings

This section provides for the control of instructions, procedures, and drawings (e.g., equipment and systems operation manuals, methods to employ for installing or using devices, engineering drawings for remedial design, specification packages for construction) applicable to project tasks.

6.1 Design and Constructability Reviews

When the design for project tasks is provided by others, the contractor will review the design documents to determine if documents conflict with the task actions the contractor is to perform. At a minimum, these reviews will include the scope of work, design drawings, and specifications.

The review of design documents may include value engineering concepts and constructability evaluation. When a conflict arises between the design documents and the task activities to be performed, the contractor will immediately notify DOE of the conflict in writing or through a fieldwork variance request (using a *Field Work Variance/Field Work Modification Form* [Section 14.1]) and will recommend solutions to resolve the conflict.

6.2 Procedures

6.2.1 General

Procedures are defined as standard and industry accepted (e.g., accepted by ANSI or ASTM) based on the scope, complexity, and uniqueness of the activity described by the procedure. Standard procedures include SQPs and SOPs developed by the contractor to describe how work is to be performed. Industry-accepted procedures include manufacturer instructions and industry standards; these will be used whenever practical, as these procedures have proved to effectively produce acceptable results.

When standards do not exist or do not provide sufficient information, SQP or SOPs, as appropriate, will be developed to provide instructions on proceeding with an activity. The contractor project manager and QA manager, or designee, will review and approve the SQP or SOP before it is used. A table of contents that lists the revision status of each procedure and approval signatures will form the basis for approval of the SQP or SOP revisions listed.

6.2.2 Standard Quality Procedures

SQPs that address activities frequently applied in the development and implementation of this QAPP have been developed. SQPs are also developed to address requirements that may be unique to a program or project task.

SQPs are developed to supplement or support the implementation of this QAPP and may be implemented by reference or as attachments to specific work plans. Also, task-planning documents will reference specific SQPs as supporting documentation to accomplish task activities.

The project task-specific planning documents will include the appropriate SQPs and SOPs for performing the specified activities for each project task. The methods and associated responsibilities for the development, control, and implementation of SQPs will be implemented in accordance with SQP 5.1.

6.2.3 Standard Operating Procedures

In addition to SQPs, SOPs will be developed to implement the technical and construction operational requirements of the work plans, this QAPP, and project task specifications. Technical personnel knowledgeable of the activities covered by each SOP will develop, review, and approve the SOPs.

In addition, the contractor project manager and QA manager, or designee, will review and approve all SOPs that are developed to supplement or support the implementation of this QAPP and may be implemented by reference or as attachments to specific work plans. Also, task-planning documents will reference specific SOPs as supporting documentation to accomplish task activities.

6.2.4 Health and Safety Procedures

In addition to the SQPs and SOPs, health and safety procedures will be developed to implement the technical and construction operational requirements of the work plans safely and in accordance with the requirements of the project HASP, this QAPP, and project task specifications.

The contractor project manager, and health and safety manager, or designee, will review and approve all health and safety procedures that are developed to supplement or support the implementation of this QAPP and may be implemented by reference or as attachments to specific work plans. Also, task-planning documents will reference specific health and safety procedures as supporting documentation to accomplish task activities safely.

7.0 Procurement Quality Assurance Activities

This section describes the requirements for the preparation, review, and approval of procurement documents and changes to those documents to ensure that quality is maintained.

7.1 General

The procurement of items and services will be controlled so that:

- Appropriate technical and quality requirements, along with applicable acceptance criteria, are adequately specified to the supplier.
- Applicable EH&S requirements are specified to the supplier.
- Sufficient reviews and approvals are received before procurement to verify that the procurement reflects project quality objectives.
- The procurement process appropriately transmits QA requirements to suppliers and subcontractors.
- Qualified suppliers and subcontractors are selected for use.
- Items and services conform to QA, commercial, and technical procurement requirements.

7.2 Procurement Document Control

Procurement documents issued by the contractor, including bid requests and contracts, will be prepared, reviewed, and approved in accordance with the institutional or corporate purchasing policies. The contractor project manager, contract administrator, or a qualified designee will review the procurement requisition or procurement documents for the inclusion of appropriate quality requirements before procurement of services or items begins.

Procurement documents will state applicable requirements for technical performance, quality, acceptability, and documentation, as appropriate. Technical performance requirements may include the following:

- General requirements:
  - Scope of work
  - Personnel qualifications
  - Necessary licenses or permits
- Fitness for duty
- Required training
- Pertinent regulations and standards
- Applicable EH&S requirements
- Material composition and physical and chemical requirements:
  - Type
  - Composition

  - Grade
  - Properties
  - Size or volume
  - Packaging
  - Handling
  - Shipping
  - Storage
- Quantity required, milestones, hold points, and scheduling
- Work procedures
- Testing and calibration requirements:
  - Method
  - Frequency
  - Environmental conditions
- Performance and acceptance criteria

Technical requirements will either be directly included in the procurement documents or referenced in specific drawings, specifications, statements of work, procedures, or regulations (along with specific revision numbers and issue dates) that describe the items or services to be furnished.

7.3 Procurement Quality Assurance Documentation Revision

Revisions to procurement documents that have been issued will be initiated using the same method as the original procurement and will be accomplished using the following considerations:

- Determination of any additional or modified design criteria
- Appropriate requirements as identified in Section 7.2 are identified or modified
- Analysis of exceptions or changes requested by the subcontractor or supplier and the effect the changes will have on the procurement activity

7.4 Control of Purchased Items and Services

In accordance with the requirements of the procurement documents, a field quality check will be performed before subcontracted activities commence. Qualified technical or administrative personnel, as assigned, will perform a receipt inspection and document the results on the receipt inspection report.

If deficiencies are noted during the receipt inspection, the supplier will be notified, and corrective actions completed before work begins.

When quality-affecting items are supplied, the contractor QC staff will inspect them upon receipt, in accordance with procurement requirements, before items are released and used in the work.

7.5 Procurement Quality Assurance Source Evaluation and Selection

Major suppliers of quality-related materials or services, including analytical laboratories, will be evaluated before their materials or services are used. The evaluation will include the following, as appropriate:

- Historical quality performance data: The previous ability of a potential subcontractor to provide an item or service in a satisfactory manner will be evaluated. The experience of other purchases of similar items, or services provided by the prospective subcontractor, and any contractor records of previous procurements can form the basis for the evaluation. The subcontractor's reputation and experience in the industry will also be considered.
- Subcontractor records: A review of the subcontractor's current quality records and available audit reports.
- Prequalification determination: A potential subcontractor's management capability, plant facilities, and technical or quality capabilities may be directly evaluated through a prequalification determination. Prequalification determinations will be implemented using a graded approach (i.e., acceptable, unacceptable) and will not normally be required for small or noncritical activities.

During the term of the purchase order, contract, or subcontract, the field activities of quality-affecting subcontractors or vendors will be monitored to verify the quality of the items and services being furnished. This will be accomplished through the inspection and monitoring of field activities consistent with the extent of ongoing activities and the project schedule.

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8.0 Data Generation and Acquisition

For activities involving sampling and analysis, a SAP shall be prepared in conformance with the requirements outlined in this section.

8.1 Components of Sampling and Analysis Plans

8.1.1 Project and Site Introduction

SAPs should include an information summary orienting the reader to the project and site. Detailed descriptions of project objectives and site features relevant to sample collection and analysis should be presented in a subsequent DQO section. A brief description of the work site that includes an area, location, or site map (or all three) and information about the site's history as it relates to the current work will be included, as applicable. A summary of site geology and hydrogeology based on previous studies or physical properties will be included, if applicable. The site and project background information should outline any special project requirements for items or services.

8.1.2 Data Quality Objectives

Each SAP will contain a complete DQO process evaluation or reference to an applicable DQO process evaluation previously completed for the specific site investigation, study, or program, including relevant iterations of the DQO process. The DQO process evaluation will contain seven steps:

1. Problem statement: A concise problem description will be formulated for each data need, project planning team members will be identified, environmental conceptual model(s) will be developed, and the necessary resources to support the study will be determined.

2. Goal identification: The principal question(s) that the study intends to answer will be identified, the potential alternative outcomes that can occur as a result of answering the study questions will be characterized, decision statement(s) will be formulated and organized for project decisions, and items that need to be estimated will be defined for estimation problems, including key assumptions.

3. Information input identification: The sources of information needed to answer study questions or produce project estimates will be identified, a decision rule based on supported criteria will be developed, and appropriate sampling and analysis methods to be used in obtaining the necessary data will be selected.

4. Study boundary definition: The target population of interest and its relevant spatial boundaries will be defined, sampling unit(s) will be defined, temporal boundaries and other practical constraints on data collection will be specified, and the scale of inference will be specified.

5. Analytic approach development: The parameter(s) that will be used to represent the sample population in decision-making will be specified (e.g., mean, percentile, maximum). A decision rule will be constructed, and appropriate action levels will be identified for decision problems. Detection limits will be specified such that accurate comparisons to the

action levels are possible. For estimation problems, the parameter and population of interest will be specified relative to the scale of estimation and other relevant population boundaries.

6. Performance or acceptance criteria specification: The acceptable probability or likelihood of drawing the wrong conclusion from the data collected will be specified. If sufficient data will be collected and project decisions can be described in the form of statistical hypothesis statements, the null and alternative hypothesis statements will be presented, and acceptable decision error probabilities will be specified. For estimation problems, the sources of estimation uncertainty will be identified along with a plan for evaluating uncertainty in the results that will be reported.

7. Data collection plan development: The sample collection design will be selected based on the type of study and level of rigor as determined in steps 4 through 6. The number of samples to be collected in each study area or limits for the parameters that define the sampling scope will be determined based on evaluation of the level of certainty required and the resource constraints. Based on the study design and scope, the sampling and analysis methods will be identified, but detailed sampling and analysis specifications will be presented in the SAP in text sections, tables, or graphical representations following the DQO evaluation.

In addition to the DQO evaluation, general site information will be included in the SAPs as described below.

8.1.3 Sampling Approach

The sampling methods, sample handling and custody, analytical methods, sample storage and disposal, and QC requirements are discussed below. Data validation requirements (discussed in Section 8.9) shall be addressed at a level appropriate for the sampling task.

8.1.3.1 Sampling Methods

Sampling methods will be specified in the SAP in accordance with industry standard practices, approved program plans (e.g., QAPP, Field Sampling Plan, Remedial Action Work Plan) and project SOPs (Appendix B).

SOPs applicable to sampling and analysis include:

- SOP 1.1 – Sample Custody
- SOP 1.2 – Field Activity Daily Log
- SOP 1.3 – Field Measurements, Maintenance, and Calibration of Instruments
- SOP 2.1 – Sample Handling, Packaging, and Shipping
- SOP 3.1 – Surface and Shallow Soil Sampling
- SOP 3.2 – Subsurface Soil Sampling While Drilling
- SOP 5.1 – Water Level Measurements in Monitoring Wells
- SOP 6.1 – Sampling Equipment and Well Material Decontamination
- SOP 6.2 – Drilling, Development, and Heavy Equipment Decontamination

- SOP 8.3 – Borehole and Well Abandonment
- SOP 9.3 – Low-Flow Groundwater Sampling
- SOP 9.4 – Surface Water Sampling
- SOP 10.1 – Soil Organic Vapor Sampling
- SOP 11.1 – Aquifer Testing
- SOP 11.2 – Data Logging and Transducers
- SOP 14.1 – Hollow Stem Auger Drilling
- SOP 14.5 – Direct Push Technology
- SOP 15.1 – Borehole Lithologic Logging
- SOP 17.1 – Sample Labeling
- SOP 17.2 – Sample Numbering
- SOP 17.3 – Sampling Protocol
- SOP 17.4 – GeoTracker Electronic Reporting
- SOP 18.1 – Field QC Sampling
- SOP 20.1 – Sample Containers, Preservation, and Holding Times
- SOP 21.1 – Data Validation
- SOP 21.2 – Data Verification
- SOP 23.1 – Land Surveying

SQPs applicable to sampling and analysis include:

- SQP 3.2 – Indoctrination and Training
- SQP 3.3 – Readiness Review Inspection
- SQP 4.1 – Document Control
- SQP 4.2 – Records Management
- SQP 4.3 – Records Tracking
- SQP 5.1 – Preparation, Revision, and Approval of Plans and Procedures
- SQP 7.1 – Quality Inspections and Inspection Records
- SQP 7.2 – Receipt Inspection
- SQP 8.1 – Calibration and Maintenance of Measuring and Test Equipment
- SQP 10.1 – Nonconformance Control
- SQP 10.2 – Quality Corrective Action
- SQP 10.3 – Stop Work Order
- SQP 11.1 – Field Work Variance/Modification
- SQP 12.1 – Quality Audits
- SQP 12.3 – Quality Surveillances

Task-specific sampling and analysis methods, not covered by SOPs, will be discussed in sufficient detail in the SAP to ensure conformance to DQOs.

8.1.3.2 Sampling Equipment

Various types of equipment are used to collect samples, and those that are reusable are decontaminated before use. Project SAPs will specify the equipment and field supplies necessary to perform sample collection tasks. Sampling equipment may include:

- Hand augers
- Drilling equipment
- Split barrel and continuous core samplers
- Hand trowels
- Pumps
- Tubing
- Bailers
- Sample containers
- Sample coolers
- Decontamination supplies
- Personal protective equipment
- Forms, pens, and cameras

Procedures for the use of sampling equipment are provided in the sampling method SOPs listed above. To the degree practicable, the sampling equipment shall be constructed of materials that will not react with or contaminate samples collected through its use. Unless otherwise specified, the sample containers are precleaned according to EPA protocols. Where permitted and available, sampling equipment made of disposable materials may be used and discarded following use if this is deemed cost-effective. This practice minimizes the need for field decontamination of sampling equipment as well as the number of equipment rinseate samples necessary to verify lack of cross contamination.

All reusable sampling equipment used during a project is decontaminated before initial use and between each use; this is necessary to prevent or minimize cross contamination between sampling locations through the use of contaminated sampling equipment. Procedures for decontaminating sampling equipment are described in SOP 6.1, "Sampling Equipment and Well Material Decontamination"; and SOP 6.2, "Drilling, Development, and Heavy Equipment Decontamination."

8.1.3.3 Sample Handling and Custody

Before samples are collected, sample identification nomenclature should be defined in the SAPs. All samples will be collected using proper sampling tools, transferred into appropriate sample containers, and preserved as specified in site-specific SAPs and applicable SOPs. Sample

custody will be maintained from the time each sample is collected until its final disposition (SOP 1.1, "Sample Custody").

Samples will be transferred to containers appropriately labeled to uniquely identify each sample in accordance with SOP 17.2, "Sample Numbering." The sample label information includes the sample type; date and time the sample was collected; and sample number. Whenever possible, labels are placed on all sample containers before samples are collected, in accordance with SOP 17.1, "Sample Labeling." The sample number is recorded on the COC form, field activity daily log, or a sampling data sheet, along with all pertinent sample identification information.

Samples planned for extraction or QC parameter determination (i.e., matrix spike and matrix spike duplicate) will be communicated to the laboratory via the COC form. The laboratory is responsible for ensuring that QC analyses are performed.

8.1.3.4 Sample Preservation and Holding Times

Chemicals to be used for sample preservation and sample holding times are specified in Table 1 for soil samples, Table 2 for soil gas samples, and Table 3 for water samples. For analytes not included in these tables, sample containers, preservatives, and holding times shall be specified in project planning documents in accordance with SOP 20.1, "Sample Containers, Preservation, and Holding Times." Sample preservation and holding times shall be specified in SAPs, which may be by reference to these tables if appropriate. Rationale for deviations from the requirements listed in these tables shall be provided in the plans.

All samples are to be placed on ice in coolers and cooled to approximately 4 °C ± 2 °C, except for samples collected for nonvolatile radiological and metals analysis, which do not require refrigeration. Appropriate blank samples will be included in the shipping containers in accordance with Section 8.3.1. Upon receipt at a staging point with a refrigerator or the laboratory, the samples and blanks shall be stored in controlled and locked refrigerators at 4 °C ± 2 °C until analyzed. The pH of preserved nonvolatile aqueous samples and the temperature of the temperature blank shall be checked upon delivery to the laboratory. Vials used for collection of samples for volatile organic analysis shall not opened until analysis begins.

At the time of sample receipt, the laboratory shall record on its sample receipt form the pH (when applicable), temperature, sample condition, and any failure to deliver samples before holding time expiration. If samples with a nonconforming pH, a temperature outside the acceptable range (4 °C ± 2 °C for chemicals and carbon-14), or expired holding time arrive at the laboratory, the laboratory shall notify the subcontractor project chemist, who shall notify the subcontractor project manager. The subcontractor project chemist and subcontractor project manager will decide, on a task-specific basis, whether the analysis should proceed or if samples should be re-collected and resubmitted for analysis. If pH is nonconforming, laboratory personnel should adjust the sample to the proper pH as soon as possible.

Table 1. Reporting Limits, Containers, Preservation, and Holding Times for Soil Samples in the DOE Areas

Parameter	Background[a]	Reporting Limit[b]	Units	Method Reference	Container	Preservation	Holding Time
Volatile Organic Compounds	**0 [c]**		**µg/kg**	**SW-846 Methods 8260B/5035**	**3 each preweighted VOAs, 60-gram amber**	**4 °C ± 2 °C, methanol**	**14 days**
1,1,1-Trichloroethane		1.0					
1,1,2,2-Tetrachloroethane		2.0					
1,1,2-Trichloroethane		1.0					
1,1-Dichloroethane		1.0					
1,1-Dichloroethene		1.0					
1,2,3-Trichloropropane		2.0					
1,2,4-Trichlorobenzene		2.0					
1,2-Dibromo-3-chloro-propane (DBCP)		10					
1,2-Dibromethane (EDB)		1.0					
1,2-Dichlorobenzene		1.0					
1.2-Dichloroethane		1.0					
1,2-Dichloropropane		1.0					
1,3-Dichlorobenzene		1.0					
1,4-Dichlorobenzene		1.0					
2-Hexanone		20					
Acetone		50					
Benzene		1.0					
Bromodichloromethane		1.0					
Bromoform		5.0					
Bromomethane		20					
Carbon disulfide		10					
Carbon tetrachloride		1.0					
Chlorobenzene		1.0					
Chlorobromomethane		2.0					
Chloroethane		2.0					
Chloroform		1.0					
Chloromethane		20					
cis-1,2-Dichloroethene		1.0					
cis-1,3-Dichloropropene		1.0					
Dibromochloromethane		2.0					
Ethylbenzene		1.0					
m,p-Xylenes		2.0					
Methyl ethyl ketone (2-Butanone)		20					
Methyl isobutyl ketone (4-methyl-2-pentanone)		20					
Methylene chloride		10					

Table 1. Reporting Limits, Containers, Preservation, and Holding Times for Soil Samples in the DOE Areas (continued)

Parameter	Background[a]	Reporting Limit[b]	Units	Method Reference	Container	Preservation	Holding Time
o-Xylene		1.0					
Styrene		1.0					
Toluene		1.0					
trans-1,2-Dichloroethene		1.0					
trans-1,3-Dichloropropene		2.0					
Trichloroethylene		2.0					
Tetrachloroethene		1.0					
Vinyl chloride		1.0					
Semivolatile Organic Compounds	**0[c]**		**mg/kg**	**SW-846 Methods 8270C/3545**	**8 oz glass jar**	**4 °C ± 2 °C**	**14 days to extraction; 40 days to analysis**
1,2,4-Trichlorobenzene		0.50					
1,2-Dichlorobenzene		0.50					
1,3-Dichlorobenzene		0.50					
1,4-Dichlorobenzene		0.50					
1-Methylnaphthalene		0.50					
2,4,5-Trichlorophenol		0.50					
2,4,6-Trichlorophenol		0.50					
2,4-Dichlorophenol		0.50					
2,4-Dimethylphenol		0.50					
2,4-Dinitrophenol		2.0					
2,4-Dinitrotoluene		0.50					
2,6-Dichlorophenol		0.50					
2,6-Dinitrotoluene		0.50					
2-Chloronaphthalene		0.50					
2-Chlorophenol		0.50					
2-Methylnaphthalene		0.50					
2-Methylphenol (o-cresol)		0.50					
2-Nitroaniline		0.50					
2-Nitrophenol		0.50					
3,3'-Dichlorobenzidine		2.5					
3,4-Methylphenol		1.0					
3-Nitroaniline		0.50					
4,6-Dinitro-2-methlyphenol		2.5					
4-Bromophenyl phenyl Ether		0.50					
4-Chloro-3-methylphenol		0.50					
4-Chlorophenyl phenyl-ether		0.50					
4-Nitroaniline		0.50					
4-Nitrophenol		0.50					

Table 1. Reporting Limits, Containers, Preservation, and Holding Times for Soil Samples in the DOE Areas (continued)

Parameter	Background[a]	Reporting Limit[b]	Units	Method Reference	Container	Preservation	Holding Time
Acenaphthene		0.50					
Acenaphthylene		0.50					
Aniline		0.50					
Anthracene		0.50					
Azobenzene		0.50					
Benzidine		5.0					
Benzo[a]anthracene		0.50					
Benzo[a]pyrene		0.50					
Benzo[b]fluoranthene		0.50					
Benzo[g,h,i]perylene		0.50					
Benzo[k]fluoranthene		0.50					
Benzoic acid		2.5					
Benzyl alcohol		0.50					
Bis(2-chloroethoxy)methane		0.50					
Bis(2-chloroethyl)ether		2.5					
Bis(2-chloroisopropyl)ether		0.50					
Bis (2-ethylhexyl)phthalate		0.50					
Butyl benzyl phthalate		0.50					
p-Chloroaniline		0.50					
Chrysene		0.50					
Dibenzo[a,h]anthracene		0.50					
Dibenzofuran		0.50					
Diethyl phthalate		0.50					
Dimethyl phthalate		0.50					
Di-n-butyl phthalate		0.50					
Di-n-octyl phthalate		0.50					
Fluoranthene		0.50					
Fluorene		0.50					
Hexachlorobenzene		0.50					
Hexachlorobutadiene		0.50					
Hexachlorocyclopentadiene		1.5					
Hexachloroethane		0.50					
Indeno[1,2,3-cd]pyrene		0.50					
Isophorone		0.50					
Naphthalene		0.50					
Nitrobenzene		2.0					
N-Nitrosodimethylamine		0.50					
N-Nitroso-di-n-proplyl-amine		0.50					
N-Nitrosodiphenylamine		0.50					

Table 1. Reporting Limits, Containers, Preservation, and Holding Times for Soil Samples in the DOE Areas (continued)

Parameter	Background[a]	Reporting Limit[b]	Units	Method Reference	Container	Preservation	Holding Time
Pentachlorophenol		2.5					
Phenanthrene		0.50					
Phenol		0.50					
Pyrene		0.50					
Pyridine		0.50					
Pesticides	**0 [c]**		**µg/kg**	**SW-846 Method 8081A/3545**	**8 oz glass jar**	**4 °C ± 2 °C**	**14 days to extraction; 40 days to analysis**
4,4'-DDD		5.0					
4,4'-DDE		5.0					
4,4'-DDT		5.0					
Aldrin		5.0					
alpha-BHC		5.0					
alpha-Chlordane		1.0					
beta-BHC		5.0					
delta-BHC		5.0					
Dieldrin		1.0					
Endosulfan I		5.0					
Endosulfan II		5.0					
Endosulfan sulfate		5.0					
Endrin		5.0					
Endrin aldehyde		5.0					
Endrin ketone		5.0					
gamma-Chlordane		5.0					
gamma-BHC		5.0					
Heptachlor		5.0					
Heptachlor epoxide		5.0					
Methoxychlor		5.0					
Toxaphene		25					
Polychlorinated Biphenyls	**0[c]**		**µg/kg**	**SW-846 Method 8082A/3545**	**8 oz glass jar**	**4 °C ± 2 °C**	**14 days to extraction; 40 days to analysis**
Aroclor-1016		50					
Aroclor-1221		50					
Aroclor-1232		50					
Aroclor-1242		50					
Aroclor-1248		50					
Aroclor-1254		50					
Aroclor-1260		50					
Aroclor-1262		50					
Aroclor-1268		50					

Table 1. Reporting Limits, Containers, Preservation, and Holding Times for Soil Samples in the DOE Areas (continued)

Parameter	Background[a]	Reporting Limit[b]	Units	Method Reference	Container	Preservation	Holding Time
Metals and Elements			**mg/kg**	**SW-846 Methods 6010B/3050B**	**8 oz glass jar**	**None**	**180 days**
Antimony	1.4	0.750					
Arsenic	8.14, 10.9	0.750					
Barium	211, 294	0.500					
Beryllium	0.564,0.924	0.250					
Cadmium	0.51	0.500					
Chromium	199, 125	0.250					
Cobalt	31	0.250					
Copper	48.8, 61.8	0.500					
Iron	44,000	20					
Lead	9.5	0.500					
Manganese	750	5.0					
Molybdenum	ND<0.26	0.250					
Nickel	334, 246	0.250					
Selenium	1.2	0.750					
Silver	0.55	0.250					
Thallium	1.6	0.750					
Vanadium	66.8, 80.3	0.250					
Zinc	72.4, 93.1	1.00					
Mercury	**3.94, 0.248**	**0.083**	**mg/kg**	**SW-846 Method 7471A**	**4 oz glass jar**	**None**	**28 days**
Chromium, Hexavalent	**1.3[d]**	**0.80**	**mg/kg**	**SW-846 Method 7196A**	**4 oz glass jar**	**4 °C ± 2 °C**	**30 days**
Miscellaneous Organics	**0 [c]**						
Formaldehyde		2.0	mg/kg	**SW-846 Method 8315A**	4 oz glass jar	4 °C ± 2 °C	72 hours
TPH as gasoline		0.10	mg/kg	SW-846 Methods 8015M/5035	3 each preweighed VOAs, 60-gram amber	4 °C ± 2 °C, Methanol	14 days
TPH as diesel		5.0	mg/kg	SW-846 Methods 8015M/3550B	4 oz glass jar	4 °C ± 2 °C	14 days to extraction, 40 days to analysis
TPH as motor oil		25	mg/kg	SW-846 Methods 8015M/3550B	4 oz glass jar	4 °C ± 2 °C	14 days to extraction, 40 days to analysis
General Chemical Analysis							
Nitrate (as nitrogen)	35	1.0	mg/kg	EPA 300.0	4 oz glass jar	4 °C ± 2 °C	28 days
Percent moisture	na	0.10	%	ATM D2216	4 oz glass jar	4 °C ± 2 °C	10 days
Liquid Scintillation							**180 days**
Tritium	ND<1.2	6	pCi/g	EPA 906.0 M	4 oz poly	None	
Carbon-14	ND<0.13	0.2	pCi/g	EPA EERF C-01 M	4 oz poly	None	
Plutonium-241	ND<0.50	15	pCi/g	DOE EML	4 oz poly	None	

Table 1. Reporting Limits, Containers, Preservation, and Holding Times for Soil Samples in the DOE Areas (continued)

Parameter	Background[a]	Reporting Limit[b]	Units	Method Reference	Container	Preservation	Holding Time
				HASL 300, Pu			
Gas Flow Proportional Counting					**4 oz poly**	**None**	**180 days**
Strontium-90	0.056	2	pCi/g	EPA 905.0 M			
Gross Alpha	7.42, 8.85	4	pCi/g	EPA 900.0			
Gross Beta	15	10	pCi/g	EPA 900.0			
Gamma Spec				**DOE EML HASL 300**	**16 oz poly**	**None**	**180 days**
Cesium-137	0.102, 0.00995	0.1	pCi/g				
Cobalt-60	ND<0.006	0.3	pCi/g				
Lead-210	1.6	1	pCi/g				
Radium-226 (ingrowth)	0.752	0.1	pCi/g				
Thorium-234	0.78	0.5	pCi/g				
Alpha Spec Thorium				**DOE EML HASL 300, Th**	**4 oz poly**	**None**	**180 days**
Thorium-228	0.627,0.771	0.1	pCi/g				
Thorium-232	0.63, 0.80	0.1	pCi/g				
Alpha Spec Uranium				**DOE EML HASL 300, U**	**4 oz poly**	**None**	**180 days**
Uranium-233/235	0.559,0.706	0.025	pCi/g				
Uranium-235	0.038	0.025	pCi/g				
Uranium-238	0.565,0.645	0.025	pCi/g				
Alpha Spec Americium				**DOE EML HASL 300, Am**	**4 oz poly**	**None**	**180 days**
Americium-241	ND<0.014	0.001	pCi/g				

Notes:

[a] Background values from Weiss 2000; values for shallow (0–4 feet) and deep (4–40 feet) provided when available. Current commercial laboratories cannot reach some of the previously established site background activity concentrations (e.g., carbon-14, tritium and cesium-137). Additional comparison criteria may apply to specific tasks.

[b] Reporting limits from Eurofins Calscience Laboratory January 8, 2021 (chemicals) and GEL Laboratories LLC February 6, 2020 (radionuclides). Reporting limits will be evaluated and tailored, if required, to meet the DQOs established for a specific task.[c] Background is zero for organic compounds.

[d] Hexavalent chromium background value from Weiss 2005.

Abbreviations:

4,4'-DDD = 4,4'-Dichlorodiphenyldichloroethane
4,4'-DDE = 4,4'-Dichlorodiphenyldichloroethylene
4,4'-DDT = 4,4'-Dichlorodiphenyltrichloroethane
CFC = chlorofluorocarbon
DOE EML HASL 300 = *The Procedures Manual of the Environmental Measurement Laboratory* (DOE 1997)
EERF = Eastern Environmental Radiation Facility
mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram
na = not available
ND<## = not detected in background; detection limit of ## shown
pCi/g = picocuries per gram
spec = spectroscopy
SW-846 = *Test Methods for Evaluating Solid Waste, Physical/Chemical Method* (EPA SW-846)
TPH = total petroleum hydrocarbons
VOA = volatile organic analysis vial

Table 2. Reporting Limits, Containers, Preservation, and Holding Times for Soil Gas Samples in the DOE Areas

Parameter	Reporting Limit[a] (µg/m^3)	Method Reference	Container	Preservation	Holding Time
Volatile Organics in Soil Gas			**6-liter Summa**	**None**	**30 days**
1,1-Dichloroethene	0.044	TO15 SIM			
1,2,4-Trichlorobenzene	6.2	TO15			
1,2-Dichloroethane	0.045	TO15 SIM			
1,3-Dichlorobenzene	0.84	TO15			
1,4-Dichlorobenzene	0.16	TO15 SIM			
Acetone	2	TO15			
Benzene	0.057	TO15 SIM			
Bromodichloromethane	0.93	TO15			
Bromomethane	3.2	TO15			
Chlorobenzene	0.64	TO15			
Chloroform	0.054	TO15 SIM			
Ethylbenzene	0.048	TO15 SIM			
Isopropylbenzene	0.68	TO15			
m,p-Xylenes	0.048	TO15 SIM			
Methyl ethyl ketone (2-Butanone)	2.4	TO15			
Methyl isobutyl ketone (4-methyl-2-pentanone)	0.57	TO15			
o-Xylene	0.48	TO15			
Styrene	0.59	TO15			
Tetrachloroethene	0.075	TO15 SIM			
Toluene	0.52	TO15			
Trichloroethylene	0.06	TO15 SIM			
Trichlorofluoromethane	0.78	TO15			
Soil Gas Tracer		**ASTM D1946-90**	**1-liter Summa**	**None**	**30 days**
Helium	0.05%				

Notes:

[a] EPA Vapor Intrusion Screening Levels for target subslab and exterior soil gas (EPA 2019). Target cancer risk of 1 in 1,000,000. Target hazard quotient of 1. These values are subject to revision and screening levels developed by the state of California may be lower. Additional or updated comparison criteria should be applied to specific tasks.

[b] Reporting limits from Eurofins Air Toxics Laboratory April 2, 2018; assumes postsample Summa canister vacuum of 7.0 inches of mercury and no analytical dilution. Reporting limits will be evaluated and tailored, if required, to meet the DQOs established for a specific task.

Abbreviations:

µg/m^3 = micrograms per cubic meter
na = not available
SIM = selective ion monitoring

Table 3. Screening Criteria, Reporting Limits, Containers, Preservation, and Holding Times for Water Samples in the DOE Areas

Parameter	MCL[a]	Background[b]	Reporting Limit[c]	Units	Method Reference	Container	Preservation	Holding Time
Volatile Organic Compounds		**0**		**µg/L**	**SW-846 Methods 8260B/5030C**	**3 each 40 ml VOA**	**4 °C ± 2 °C, HCl, pH<2**	**14 days**
1,1,1-Trichloroethane	200		0.50					
1,1.2.2-Tetrachloroethane	1.0		0.50					
1,1,2-Trichloroethane	5.0		0.50					
1,1-Dichloroethane	5.0		0.50					
1,1-Dichloroethene	6.0		0.50					
1,2,3-Trichloropropane	0.0005		1.0					
1,2-Dibromo-3-chloro-propane (DBCP)	0.2		5.0					
1,2-Dibromethane (EDB)			0.5					
1,2-Dichlorobenzene	600		0.50					
1.2-Dichloroethane	0.5		0.50					
1,2-Dichloropropane	5.0		0.50					
1,3-Dichlorobenzene			0.50					
1,4-Dichlorobenzene	5.0		0.50					
Methyl ethyl ketone (2-Butanon)			5.0					
2-Hexanone			10					
Methyl isobutyl ketone (4-methyl-2-pentanone)			5.0					
Acetone			10					
Benzene	1.0		0.50					
Bromodichloromethane			0.50					
Bromoform			0.50					
Bromomethane			2.0					
Chlorobromomethane			1.0					
cis-1,2-Dichloroethene	6.0		0.50					
cis-1,3-Dichloropropene			0.50					
Carbon disulfide			10					
Carbon tetrachloride	0.5		0.50					
Chlorobenzene	70		0.50					
Chloroethane			0.50					
Chloroform	70		0.50					
Chloromethane			5.0					
Dibromochloromethane			0.5					
Ethylbenzene	300		0.50					
Methylene chloride	5.0		1.0					
o-Xylene	1,750		0.50					
m,p-Xylenes	1,750		1.0					

Table 3. Screening Criteria, Reporting Limits, Containers, Preservation, and Holding Times for Water Samples in the DOE Areas (continued)

Parameter	MCL[a]	Background[b]	Reporting Limit[c]	Units	Method Reference	Container	Preservation	Holding Time
Styrene	100		0.5					
Volatile Organic Compounds (continued)		**0**		**µg/L**	**SW-846 Methods 8260B/5030C**	**3 each 40 ml VOA**	**4 °C ± 2 °C, HCl, pH<2**	**14 days**
trans-1,2-Dichloroethene	10		0.50					
trans-1,3-Dichloropropene			0.50					
Tetrachloroethene	5.0		0.50					
Toluene	150		0.50					
Trichloroethene	5.0		0.50					
Vinyl chloride	0.5		0.50					
1,2,3-Trichloropropane	**0.005**		**0.005**	**µg/L**	**EPA Method 524.2**	**3 each 40 ml VOA**	**4 °C ± 2 °C, HCl, pH<2**	**14 days**
Pesticides		**0**		**µg/L**	**SW-846 Methods 8081A/3510C**	**2 each 1 liter VOA**	**4 °C ± 2 °C**	**7 days to extraction; 40 days to analysis**
4,4'-DDD			0.05					
4,4'-DDE			0.02					
4,4'-DDT			0.05					
Aldrin			0.05					
alpha-BHC			0.02					
alpha-Chlordane	0.1		0.02					
beta-BHC			0.02					
delta-BHC			0.02					
Chlordane	0.1		0.1					
Dieldrin			0.05					
Endosulfan I			0.05					
Endosulfan II			0.05					
Endosulfan sulfate			0.05					
Endrin	2.0		0.02					
Endrin aldehyde			0.1					
Endrin ketone			0.05					
gamma-Chlordane	0.1		0.05					
gamma-BHC	0.2		0.02					
Heptachlor	0.01		0.02					
Heptachlor epoxide	0.01		0.02					
Methoxychlor	30		0.05					
Toxaphene	3.0		0.30					
Metals and Elements				**mg/L**	**SW-846 Methods 6020/3010**	**250 ml poly**	**HNO_3, pH<2**	**180 days**
Aluminum	1.0	0.00586	0.05					
Antimony	0.006		0.001					
Arsenic	0.01		0.001					

Table 3. Screening Criteria, Reporting Limits, Containers, Preservation, and Holding Times for Water Samples in the DOE Areas (continued)

Parameter	MCL[a]	Background[b]	Reporting Limit[c]	Units	Method Reference	Container	Preservation	Holding Time
Barium	1		0.001					
Beryllium	0.004		0.001					
Cadmium	0.005		0.001					
Chromium	0.05	0.0437	0.001					
Cobalt			0.001					
Copper	1.3	0.0029	0.001					
Iron		0.502	0.05					
Lead	0.015		0.001					
Manganese		0.010	0.001					
Molybdenum		0.00313	0.001					
Nickel	0.1	0.141	0.001					
Selenium	0.05	0.00174	0.001					
Silver		<0.001	0.001					
Thallium	0.002		0.001					
Vanadium			0.001					
Zinc		0.0209	0.005					
Mercury	**0.002**	**0.0000479**	**0.0002**	**mg/L**	**SW-846 Method 7470**	**250 ml poly**	**HNO_3, pH<2**	**180 days**
Chromium, Hexavalent		**0.040**	**0.001**	**mg/L**	**SW-846 Method 7199**	**250 ml poly**	**4 °C ± 2 °C**	**24 hours**
Miscellaneous Organics				**mg/L**	**SW-846 Method 8315A**	**1-liter amber**	**4 °C ± 2 °C**	**72 hours**
Formaldehyde		0	0.05					
Chemical Ions				**mg/L**	**EPA 300.0**	**250 ml poly**	**4 °C ± 2 °C**	**48 hours**
Nitrate (as nitrogen)	10	15	0.10					
Liquid Scintillation				**pCi/L**	**EPA EERF C-01 M**	**1-liter poly**	**None**	
Carbon-14	2,000	<7	7					
Gas Flow Proportional Counting				**pCi/L**	**EPA Method**	**1-liter poly each**	**HNO_3, pH<2**	**180 days**
Strontium-90	8	<1	1		EPA 905.0 M			
Gross alpha	15		5		EPA 900.0			
Gross beta		2.88	3		EPA 900.0			
Gamma Spec				**pCi/L**	**DOE EML HASL 300**	**2-liter poly**	**HNO_3, pH<2**	**180 days**
Cesium-137	200	<5	5					
Radium-226 (ingrowth)	5	1.17	1					
Alpha Spec Uranium				**pCi/L**	**DOE EML HASL 300, U**	**1-liter poly**	**HNO_3, pH<2**	**180 days**
Uranium-233/234	20		1					
Uranium-235/236	20		1					
Uranium-238	20	0.946	1					
Alpha Spec Americium				**pCi/L**	**DOE EML HASL 300, Am**	**1-liter poly**	**HNO_3, pH<2**	**180 days**

Table 3. Screening Criteria, Reporting Limits, Containers, Preservation, and Holding Times for Water Samples in the DOE Areas (continued)

Parameter	MCL[a]	Background[b]	Reporting Limit[c]	Units	Method Reference	Container	Preservation	Holding Time
Americium-241	15	<0.71	1					
Field Parameters					**SOP 1.3[d]**	**Flow-through cell**	**None**	**15 minutes**
pH			0.01	pH				
Turbidity			0.1	NTU				
Temperature			0.1	°C				
Electrical conductivity			0.1	µS/cm				
Redox potential			0.1	mV				
Dissolved oxygen			0.1	mg/L				

Notes:

[a] MCLs may not be risk-based and are not available for all chemical constituents. Additional comparison criteria may apply to specific tasks.

[b] Background values from Weiss 2014. Background is zero for organic compounds.

[c] Reporting limits from Eurofins Calscience Laboratory January 8, 2021 (chemicals) and GEL Laboratories LLC September 14, 2019 (radionuclides). Reporting limits will be evaluated and tailored, if required, to meet the DQOs established for a specific task

[d] SOP 1.3, "Field Measurements, Maintenance, and Calibration of Instruments."

Abbreviations:

4,4-DDD = 4,4'-Dichlorodiphenyldichloroethane
4,4-DDE = 4,4'-Dichlorodiphenyldichloroethylene
4,4,-DDT = 4,4'-Dichlorodiphenyltrichloroethane
DOE EML HASL 300 = *The Procedures Manual of the Environmental Measurement Laboratory* (DOE 1997)
EERF = Eastern Environmental Radiation Facility
HCl = hydrochloric acid
HNO_3 = nitric acid
MCL = maximum contaminant level (SWRCB 2018)
poly = polyethylene plastic
spec = spectroscopy
SW-846 = *Test Methods for Evaluating Solid Waste, Physical/Chemical Method* (EPA SW-846)
VOA = volatile organic analysis vial

Units:

mg/L = milligrams per liter
µS/cm = microsiemens per centimeter
µg/L = micrograms per liter
ml = milliliters
mV = millivolts
NTU = nephelometric turbidity unit
pCi/L = picocuries per liter

8.1.3.5 Field Activity Daily Log and Sampling Data Sheets

The work plan or SAP shall specify sampling documentation requirements consistent with SOP 1.2, "Field Activity Daily Log." Field personnel shall document sample collection activities on the field activity daily log, data sheets designed specifically for a sample matrix and collection procedure, or equivalent record. The following information should be included, as appropriate for the task:

- Project name and number
- Date and time of sampling
- Drilling and sampling methods
- Sample number
- Sample location
- Boring number
- Sample depth
- Sample description
- Unusual events
- Signature or initials of sampler

Field logs and sampling data sheets shall be scanned electronically and temporarily filed in the contractor files sequentially by date. This documentation comprises an inventory of the samples and their locations and facilitates monitoring of the timeliness and completeness of all sampling activities in the field. This documentation is used to verify shipment of samples to the analytical laboratory.

8.1.3.6 Sample Custody and Documentation

To ensure sample integrity, all sample containers and coolers should have at least one custody seal in place. Evidence of collection, personal custody, secure storage until shipment, laboratory receipt, and laboratory custody until disposal shall be documented on a COC form, which shall list each sample and the individuals performing the sample collection, shipment, and receipt, in accordance with SOP 1.1, "Sample Custody."

Upon sample receipt, the laboratory's designated custodian shall inventory each sample shipment before signing and dating the original COC form. Any discrepancy in the number of samples or their temperatures and any breakage shall be communicated immediately to the subcontractor project chemist, who shall immediately notify the subcontractor project manager of any such problems.

Custody of the sample is transferred from the relinquishing signatory to the accepting signatory. This procedure is followed each time the custody of a sample changes hands. The laboratory archives and maintains custody of the samples as required by the contract or until further notification from the subcontractor project chemist, at which time the samples may be disposed of. The completed COC form is supplied with the laboratory report.

8.1.3.7 Sample Packaging and Shipping

Sample handling and shipment to the analytical laboratory shall be specified in the work plans or SAPs, as appropriate.

Packaging of sample containers shall provide protection for samples during handling, shipping, and storage, and serve to maintain the desired in situ characteristics to the extent possible.

Proper packaging may include the following:

- Inner packing (e.g., plastic bags, metal cans, absorbent packing material, frozen gel)
- Overpacks (e.g., metal or plastic ice chest, cardboard box, rock core box, or undisturbed tube rack)
- Overpack sealing (e.g., custody tape)
- Marking and labeling of overpack (e.g., laboratory address, any appropriate U.S. Department of Transportation [DOT] hazard class labels, handling instructions)
- Radioactive contamination survey of shipping containers for radiological samples

Shipping shall be in accordance with DOT regulations and SOP 2.1, "Sample Handling, Packaging, and Shipping," to prevent damage, loss, or unacceptable deterioration. International Air Transportation Association guidance shall be followed for sample shipping by air courier services. Transportation methods shall be selected to ensure that the samples arrive at the laboratory in time to allow testing in accordance with established holding times and project schedules.

The receiving laboratory shall be instructed to notify the subcontractor project chemist if samples lack a properly prepared COC form or proper labels or if they are damaged during shipping.

8.1.3.8 Sample Storage and Disposal

The subcontractor project chemist shall communicate minimum sample retention to the analytical laboratories based on project-specific objectives. Deviations from the sample retention times described below shall be documented in work plans or SAPs.

Original samples shall be stored at the analytical laboratory refrigerated at 4 °C ± 2 °C for a minimum of 2 months after final data are submitted. Samples for metals analysis or radiological analysis (except ^{14}C) and metals digestates may be stored at room temperature.

Occasionally, a project may require contingent analyses that require samples to be stored or held for a short time before analysis or disposal. The procedure to hold samples for possible future analysis shall be discussed in advance with the analytical laboratory by the subcontractor project manager or designee and identified in the planning documents. Samples to be held shall be clearly noted on the COC form. The decision to analyze or dispose of any of these held samples shall be made by the subcontractor project manager in consultation with the subcontractor project chemist, who will communicate the protocol to the laboratory.

The laboratory will be held contractually responsible for disposal of all samples, extracts, and digestates in accordance with federal and state regulations within 1 year of sample receipt.

8.2 Analytical Methods

The selection of analytical methods for a given sampling task or program will be specified in a SAP and based on the DQO process. Regulatory drivers, laboratory performance criteria, site-specific cleanup levels, applicable action levels, and the need for comparability to data from historical investigations will be evaluated during the selection of appropriate analytical methods. Whenever possible, the most current version of the analytical method should be employed.

For soil, soil gas, and water samples, the constituents and analytical methods anticipated to support project objectives are listed in Tables 1, 2, and 3, respectively. These constituents, methods, and reporting limits shall be evaluated and tailored, if required, to meet the DQOs established for a specific task. Justification for using methods and analytical parameters different than those identified in these tables shall be included in SAPs.

The soil sample reporting limits in Table 1 available from the existing contract laboratories (Eurofins Calscience Laboratory of Garden Grove California [Eurofins Calscience] and GEL Laboratories LLC of Charleston South Carolina [GEL]) are generally sufficiently low to allow comparison to site background levels of metals and some radionuclides. Organic compounds are assumed not naturally occurring (background concentration of zero), and reporting limits are not comparable to zero. Best available reporting limits for tritium, carbon-14, plutonium-241, strontium-90, cesium-137 in deep soil (4 to 40 feet below ground surface) and cobalt-60 are above established background. In some soil samples, increased counting time or sample volume, or both, provided minimum detectable activities that were below background for strontium-90, but this approach was not successful for the other listed radionuclides. The reporting limits listed in Table 2 for soil gas analysis by EPA Method TO-15 and TO-15 SIM were achieved by Eurofins Air Toxics Laboratory of Folsom, California (Eurofins Air Toxics) for the DOE areas vapor intrusion evaluation (DOE 2018). The water sample reporting limits listed in Table 3, available from contract laboratories Eurofins Calscience and GEL, are sufficiently low to allow comparison to the drinking water maximum contaminant levels (SWRCB 2018) and established background thresholds. Alternate established analytical methods may be considered for analysis of constituents that a commercial laboratory cannot analyze at a sufficiently low detection limit to meet project-specific DQOs.

Reporting limits shall be specified for all analytes in the SAP. If any reporting limit exceeds the comparison criterion, the resulting uncertainty will be evaluated to determine whether it is acceptable. If the evaluation indicates the uncertainty is unacceptable, alternative sampling and analysis methods may be specified or the technical infeasibility of not reaching the criterion shall be noted in the SAP.

Only laboratories accredited by the Environmental Laboratory Accreditation Program administered by the California State Water Resources Control Board to perform analyses in accordance with the methods selected may be utilized (SWRCB 2019). QA plans for each laboratory selected for ongoing and upcoming work are included in Appendix C. SOPs referenced in the laboratory QA plans can be obtained upon request.

8.3 Quality Control

Samples are to be collected in accordance with approved SAPs which shall include qualitative and quantitative requirements for the specific collection methods to be used. Analytical methods to be followed for acquisition of data shall be described in SAPs (see Section 8.2), along with tabular summaries of analyses required for the project or task; these summaries shall include the number of samples required, number of QA/QC duplicates, field blanks and rinseate blanks, and estimates of trip blanks for each analytical method, as applicable. Task-specific analytical requirements that differ from the methods provided in Section 8.2 shall be included in SAPs along with rationale for the selection of such differing methods.

The laboratory or laboratories that will conduct the required analyses shall be specified by name in SAPs. Laboratory-specific reporting and QC limits shall be included.

Table 4 presents an overview of QC parameter requirements to be applied to project work. Tables 5, 6, and 7 provide analyte-specific acceptance criteria for soil, soil gas, and water samples, respectively. These criteria are based on documented performance achieved for the analytical methods and expected confidence levels appropriate for use of the data. If these control parameters are not expected to be met at the planning stage, justification for the control parameter deviation shall be provided in SAPs.

DQOs and required analytical and statistical control parameters for field samples and laboratory analyses are described below. Deviations from these objectives and parameters may be required; any deviation and rationale shall be documented. Sample data will be validated and qualified as described in Section 8.9 of this document and SOP 21.1, "Data Validation." When the specified control limits are exceeded to the extent that the data are not usable for their intended purpose, corrective actions shall be taken and documented as provided in SQP 10.2.

8.3.1 Field Sample Quality Control

For sample collection QC, trip blank, equipment blank, field duplicate, and matrix spike samples will be utilized as described below. The primary purpose of these samples is QC of field sample collection, and their collection procedures are provided in SOP 18.1, "Field QC Sampling," which includes detailed procedures on the topics discussed below.

Trip blanks: The primary purpose of a trip blank sample is to detect sources of contamination that could potentially cause false positive detection or positive bias in values reported in soil or water samples. Trip blanks serve as QC for sample bottle preparation, blank water quality, and sample handling. They are submitted to the laboratory in shipments of samples that will be analyzed for volatile organic compounds. The trip blank sample travels to the site with the empty sample bottles and returns from the site with the collected field samples. One trip blank per shipment container will be submitted for analysis. Contaminated trip blanks may indicate inadequate bottle cleaning or blank water of questionable quality. The following have been identified as potential sources of contamination:

- Contaminants in trip blank water provided by the supplier
- Contaminants in sample container

- Cross contamination during sample collection activities, storage, or shipment
- Ambient air or contact with contaminated analytical instrumentation during preparation and analysis at the laboratory and laboratory reagents used in analytical procedures

The start of holding time for a trip blank begins at the start of sample collection of the first sample collected in the batch placed in the shipping container.

Equipment blanks: The primary purpose of an equipment blank is to detect sources of contamination related to nondedicated and nondisposable field sampling instruments. Analyte-free water is passed over or through decontaminated sample collection equipment and collected in an empty sample container for analysis. Equipment blanks should be handled, transported, and analyzed in the same manner as the samples acquired that day. Equipment blanks must be submitted to the laboratory with the set of sample bottles they accompanied into the field. Equipment blanks must be packaged with the field samples they represent. One equipment blank will be collected for each investigation activity in each investigation area. The equipment blanks will be tested for the same analyte list as the associated field samples.

Temperature blanks: The purpose of a temperature blank is to assess attainment of sample preservation temperature requirements during storage and transport of samples before delivery at the laboratory. A temperature blank will be provided in each shipment container that has samples requiring refrigeration. Most radiological samples do not require refrigeration. The temperature specification for samples requiring refrigeration is 4 °C ± 2 °C. The temperature specification cannot always be met when delivering samples to the laboratory a short time after their collection. Professional judgment must be used when assessing sample preservation based on temperature blank measurement.

Field duplicates: The collection of field duplicate samples provides for the evaluation of analyte distribution in the sample matrix and precision of field sampling procedures by comparing analytical results of two samples of the same matrix from the same location. Field duplicate samples will be collected at a frequency of 1 duplicate sample per 10 primary samples. Field duplicate precision (RPD) control limits for the project are 35% for water samples and 50% for soil and soil gas samples.

Field duplicates will be obtained by collecting a second sample from the sampling device for each analyte. Field duplicates will be collected, preserved, and handled in a similar fashion to primary samples. Field duplicate samples will be assigned unique identification codes consistent with primary samples, so they are blind to the laboratory. RPDs between duplicate measurements are reviewed in accordance with applicable data validation procedures in SOP 21.1, “Data Validation.”

Split or duplicate samples will be provided to EPA and DTSC upon request. Split or duplicate samples collected by EPA or DTSC will be accepted and submitted for analysis.

Table 4. Summary of Quality Control Parameters and Criteria in the DOE Areas

QC Parameter	Sample Matrix; Analysis Suite	Minimum Frequency	Control Criteria	Corrective Action
Trip blank	Soil and water; VOCs only	Each shipping container carrying VOC samples	Detection	Qualify associated samples per SOP 21.1;[a] assess impact on field sample data quality; resample if necessary
Equipment blank	Soil and water; all field sample analytes	Each investigation activity and investigation area when sample collection equipment is reused	Detection	Qualify associated samples per SOP 21.1;[a] assess impact on field sample data quality; resample if necessary
Temperature blank	Soil, water, and air; all analytes requiring refrigeration	Each shipment container carrying samples requiring refrigeration	4 °C ± 2 °C	Assess impact on field sample preservation; resample if necessary
Field duplicates	Soil, water, and air; all primary field sample analytes	1 per 10 field samples	Water RPD ≤35%; soil and soil gas RPD ≤50%	Qualify sample and duplicate per SOP 21.1;[a] assess matrix and field procedures; resample if necessary
Matrix spikes	Soil and water; MS suite per method and laboratory QA plan	1 per 20 field samples	5% (see Tables 5 and 7) water RPD ≤35% soil RPD ≤50%	Qualify sample and duplicate per SOP 21.1;[a] assess matrix and field procedures; resample if necessary
Initial calibration	Soil, water, and air samples; all sample analytes	Per method specification	%RSD, r^2, RF, ICV %R, ICB as specified by method and laboratory QA plan	Perform instrument maintenance, recalibrate instrument, and reanalyze samples if necessary
Continuing calibration	Soil, water, and air samples; all sample analytes	Bracket samples in instrument sequence per method specification	CCV, CCB as specified by method and laboratory QA plan	Perform instrument maintenance, recalibrate instrument, and reanalyze samples if necessary
Method blank	Soil, water, and air samples; all sample analytes	1 per 20 field samples	Detection	Qualify associated samples per SOP 21.1;[a] assess impact on field sample data quality; reanalyze or resample if necessary
Laboratory control samples	Soil, water, and air samples; all sample analytes	1 per 20 field samples	%R and RPD (see Tables 5 to 7)	Reprepare and reanalyze samples in associated QC batch
Surrogate standards	Soil, water, and air samples; organic compounds	Each sample analyzed for organic compounds	%R statistically determined by laboratory	Qualify associated samples per SOP 21.1;[a] assess impact on data quality; reanalyze or reprepare if necessary
Postdigestion spike	Soil and water; metals, elements	When MS recoveries are unacceptable	%R (see Tables 5 and 7)	Qualify sample per SOP 21.1;[a] assess matrix
Interference check sample	Soil and water; ICP metals, elements	Beginning and end of each instrument sequence	%R between 80% and 120%	Select applicable alternate method if interference is known; reanalyze sample when applicable
Laboratory duplicates	Soil and water samples, radiological	1 per 20 samples	RER ≤1.0	Qualify sample per SOP 21.1; [a] assess matrix; reanalyze sample if necessary

Table 4. Summary of Quality Control Parameters and Criteria in the DOE Areas (continued)

QC Parameter	Sample Matrix; Analysis Suite	Minimum Frequency	Control Criteria	Corrective Action
Compound identification	Soil, water, and air samples; all sample analytes	Each compound in each sample	Per method specification (varies)	Qualify associated samples per SOP 21.1; [a] assess impact on data quality; reanalyze sample if necessary
ICP serial dilution	Soil and water samples; ICP metals, elements	Concentration >50 times the MDL in undiluted sample	%D ≤10%	Qualify sample per SOP 21.1;[a] assess matrix; reanalyze sample if necessary

Note:
[a] Standard Operating Procedure 21.1, "Data Validation."

Abbreviations:
%D = percent difference
%RSD = percent relative standard deviation
CCB = continuing calibration blank
CCV = continuing calibration verification
ICB = initial calibration blank
ICP = inductively coupled plasma (atomic Emission Spectroscopy or Mass Spectrometry)
ICV %R = initial calibration verification percent recovery
MDL = method detection limit
MS = matrix spike
r^2 = correlation coefficient
RER = relative error ratio
RF = response factor
RPD = relative percent difference
VOC = volatile organic compound

Table 5. Precision, Accuracy, and Completeness Criteria for Soil Samples in the DOE Areas

Parameters	Method Reference	LCS Precision Criteria[a] (RPD)	LCS Accuracy Criteria[a] (%R)	MS Accuracy Criteria[a] (%R)	Completeness[b] (%R)
Volatile Organic Compounds	**SW-846 Methods 8260B/5035**				**90**
1,1,1-Trichloroethane		≤20	71–131	71–131	
1,1,2,2-Tetrachloroethane		≤20	77–120	77–120	
1,1,2-Trichloroethane		≤20	80–120	80–120	
1,1-Dichloroethane		≤20	74–120	74–120	
1,1-Dichloroethene		≤20	71–125	55–133	
1,2,3-Trichloropropane		≤20	60–120	60–120	
1,2,4-Trichlorobenzene		≤20	74–128	74–128	
1,2-Dibromo-3-chloropropane		≤20	54–132	54–132	
1,2-Dibromoethane		≤20	80–120	57–153	
1,2-Dichlorobenzene		≤20	80–120	38–128	
1,2-Dichloroethane		≤20	79–121	79–121	
1,2-Dichloropropane		≤20	80–120	80–120	
1,3-Dichlorobenzene		≤20	80–120	80–120	
2-Butanone		≤20	56–176	56–176	
2-Hexanone		≤20	67–151	67–151	
4-Methyl-2-pentanone		≤20	72–126	72–126	
Acetone		≤20	30–150	30–150	
Benzene		≤20	79–120	79–120	
Bromochloromethane		≤20	80–120	80–120	
Bromodichloromethane		≤20	73–127	73–127	
Bromoform		≤20	55–133	55–133	
Bromomethane		≤20	36–144	36–144	
cis-1,2-Dichloroethene		≤20	80–123	80–123	
cis-1,3-Dichloropropene		≤20	74–128	74–128	
Carbon dilsulfide		≤20	53–125	53–125	
Carbon tetrachloride		≤20	58–142	49–133	
Chlorobenzene		≤20	80–120	54–126	
Chloroethane		≤20	60–120	60–120	
Chloroform		≤20	80 - 120	80–120	
Chloromethane		≤20	50–122	50–122	
Dibromochloromethane		≤20	50–122	80–120	
Ethylbenzene		≤20	57–153	2–146	
Methylene chloride		≤20	72–120	72–120	
o-Xylene		≤20	79–127	79–127	
m,p-Xylene		≤20	80–122	80–122	
Styrene		≤20	80–123	80–123	
trans-1,2-Dichloroethene		≤20	80–120	80–120	

Table 5. Precision, Accuracy, and Completeness Criteria for Soil Samples in the DOE Areas (continued)

Parameters	Method Reference	LCS Precision Criteria[a] (RPD)	LCS Accuracy Criteria[a] (%R)	MS Accuracy Criteria[a] (%R)	Completeness[b] (%R)
trans-1,3-Dichloropropene		≤20	66–120	66–120	
Tetrachloroethene		≤20	75–123	75–123	
Toluene		≤20	80–120	39–141	
Trichloroethylene		≤20	80–120	57–129	
Vinyl chloride		≤20	68–120	47–137	
Surrogates					
1,2-Dichloroethane-d4		na	71–155	na	
1,4-Bromofluorobenzene		na	80–120	na	
Dibromofluoromethane		na	79–133	na	
Toluene-d8		na	80–120	na	
Semivolatile Organic Compounds	**SW-846 Methods 8270C/3545**				**90**
1,2,4-Trichlorobenzene		≤27	45–129	56–120	
1,4-Dichlorobenzene		≤30	42–132	43–120	
2,4-Dinitrotoluene		≤28	51–129	28–120	
2-Chlorophenol		≤20	58–124	53–120	
4-Chloro-3-methylphenol		≤20	55–121	32–120	
4-Nitrophenol		≤27	24–126	14–128	
Acenaphthene		≤26	51–123	35–148	
Acenaphthylene		≤28	52–120	53–120	
Butyl benzyl phthalate		≤29	43–139	15–189	
Dimethyl Phthalate		≤27	51–123	44–122	
Fluorene		≤27	54–126	12–186	
Naphthalene		≤20	32–146	20–140	
N-Nitroso-di-n-propylamine		≤29	40–136	38–140	
Pentachlorophenol		≤22	23–131	10–124	
Phenol		≤20	40–130	22–125	
Pyrene		≤20	47–143	31–169	
Surrogates					
2,4,6-Tribromophenol		na	18–138	na	
2-Fluorobiphenyl		na	27–120	na	
2-Fluorophenol		na	25–120	na	
Nitrobenzene-d5		na	33–123	na	
Phenol-d6		na	26–122	na	
p-Terphenyl-d14		na	27–159	na	
Pesticides	**SW-846 Methods 8081A/3545**				**90**
4,4'-DDD		≤17	50–149	12–180	
4,4'-DDE		≤18	48–144	8–184	
4,4'-DDT		≤17	37–149	2–187	

Table 5. Precision, Accuracy, and Completeness Criteria for Soil Samples in the DOE Areas (continued)

Parameters	Method Reference	LCS Precision Criteria[a] (RPD)	LCS Accuracy Criteria[a] (%R)	MS Accuracy Criteria[a] (%R)	Completeness[b] (%R)
Aldrin		≤15	43–139	9–153	
alpha-BHC		≤17	51–138	10–149	
alpha-Chlordane		≤16	47–136	9–161	
beta-BHC		≤17	47–135	9–156	
delta-BHC		≤20	40–146	6–162	
Dieldrin		≤16	48–141	11–164	
Endosulfan I		≤16	43–139	4–156	
Endosulfan II		≤16	48–142	12–161	
Endosulfan sulfate		≤16	47–144	10–165	
Endrin		≤18	35–144	6–166	
Endrin aldehyde		≤13	35–138	1–156	
gamma-Chlordane		≤59	33–155	7–177	
gamma-BHC		≤17	51–137	9–154	
Heptachlor		≤17	47–137	3–150	
Heptachlor epoxide		≤17	49–135	7–169	
Methoxychlor		≤17	39–142	8–163	
Surrogates					
Decachlorobiphenyl		na	20–137	na	
2,4,5,6-Tetrachloro-m-xylene		na	23–124	na	
Polychlorinated Biphenyls	**SW-846 Methods 8082/3545**				**90**
Arochlor-1016		≤20	50–135	50–135	
Arochlor-1260		≤20	50–135	50–135	
Surrogates					
Decachlorobiphenyl		na	24–168	na	
2,4,5,6-Tetrachloro-m-xylene		na	25–145	na	
Metals and Elements	**SW-846 Methods 6010B/3050B**				**90**
Antimony		≤20	80–120	50–115	
Arsenic		≤20	80–120	75–125	
Barium		≤20	80–120	75–125	
Beryllium		≤20	80–120	75–125	
Cadmium		≤20	80–120	75–125	
Chromium		≤20	80–120	75–125	
Cobalt		≤20	80–120	75–125	
Copper		≤20	80–120	75–125	
Iron		≤20	80–120	75–125	
Lead		≤20	80–120	75–125	
Manganese		≤20	80–120	75–125	
Molybdenum		≤20	80–120	75–125	

Table 5. Precision, Accuracy, and Completeness Criteria for Soil Samples in the DOE Areas (continued)

Parameters	Method Reference	LCS Precision Criteria[a] (RPD)	LCS Accuracy Criteria[a] (%R)	MS Accuracy Criteria[a] (%R)	Completeness[b] (%R)
Nickel		≤20	80–120	75–125	
Selenium		≤20	80–120	75–125	
Silver		≤20	80–120	75–125	
Thallium		≤20	80–120	75–125	
Vanadium		≤20	80–120	75–125	
Zinc		≤20	80–120	75–125	
Mercury	**SW-846 Method 7471A**	≤10	85–121	71–137	**90**
Chromium, Hexavalent	**SW-846 Method 7196A**	≤20	78–120	75–125	**90**
Miscellaneous Organics					**90**
Formaldehyde	ASTM D6303-98 M	≤20	80–120	70–130	
TPH as gasoline	SW846 Methods 8015B(M)/ 5035	≤20	70–124	48–114	
TPH as diesel	SW846 Methods 8015B(M)/ 3550B	≤20	67–121	33–153	
TPH as motor oil	SW846 Methods 8015B(M)/ 3550B	≤20	75–123	64–130	
Miscellaneous Inorganics					**90**
Nitrate (as Nitrogen)	EPA 300.0	≤15	90–100	80–120	
Percent moisture	ASTM D2216	≤10	na	na	
Liquid Scintillation					**90**
Tritium	EPA 906.0 M	≤20	75–125	75–125	
Carbon-14	EPA EERF C01-M	≤20	75–125	75–125	
Plutonium-241	DOE EML HASL 300, Pu	≤20	75–125	75–125	
Gas Flow Proportional Counting					**90**
Strontium-90	EPA 905.0 M	≤20	75–125	75–125	
Gross alpha	EPA 900.0	≤20	75–125	75–125	
Gross beta	EPA 900.0	≤20	75–125	75–125	
Gamma spec[c]	**DOE EML HASL 300**				**90**
Actinium-228					
Bismuth-212					
Bismuth-214					
Cesium-137		≤20	75–125	75–125	
Cobault-60		≤20	75–125	75–125	
Lead-210					
Lead-212					
Lead-214					

Table 5. Precision, Accuracy, and Completeness Criteria for Soil Samples in the DOE Areas (continued)

Parameters	Method Reference	LCS Precision Criteria[a] (RPD)	LCS Accuracy Criteria[a] (%R)	MS Accuracy Criteria[a] (%R)	Completeness[b] (%R)
Potassium-40					
Radium-226 (ingrowth)					
Radium-228					
Thallium-208					
Thorium-234					
Alpha Spec Thorium	**DOE EML HASL 300, Th**				**90**
Thorium-229					
Thorium-230		≤20	75–125	75–125	
Thorium-232		≤20	75–125	75–125	
Alpha Spec Uranium	**DOE EML HASL 300, U**				**90**
Uranium-233/234					
Uranium-235/236					
Uranium-238		≤20	75–125	75–125	
Alpha Spec Americium	**DOE EML HASL 300, Am**				**90**
Americium-241		≤20	75–125	75–125	

Notes:

[a] LCS, surrogate spike, and MS limits established by current contract laboratories (Eurofins Calscience Laboratory for chemicals; GEL Laboratories LLC for radionuclides). Postdigestion spike recovery limits are the same as MS recovery limits.

[b] Completeness goal is per analyte and per sampling task, not per sample.

[c] Gamma LCS will also include Americium-241 with same control criteria.

Abbreviations:

4,4'-DDD = 4,4'-Dichlorodiphenyldichloroethane
4,4'-DDE = 4,4'-Dichlorodiphenyldichloroethylene
4,4'-DDT = 4,4'-Dichlorodiphenyltrichloroethane
DOE EML HASL 300 = *The Procedures Manual of the Environmental Measurements Laboratory* (DOE 1997)
EERF = Eastern Environmental Radiation Facility
LCS = laboratory control sample
MS = matrix spike
na = not applicable
spec = spectroscopy
SW-846 = *Test Methods for Evaluating Solid Waste, Physical/Chemical Method* (EPA SW-846)
TPH = total petroleum hydrocarbons

Table 6. Precision, Accuracy, and Completeness Criteria for Soil Gas Samples in the DOE Areas

Parameters	Method Reference	LCS RPD Precision Criteria (RPD)	LCS Recovery Criteria (%R)
Volatile Organics			
1,1-Dichloroethene	TO15 SIM	25	70–130
1,2,4-Trichlorobenzene	TO15	25	70–130
1,2-Dichloroethane	TO15 SIM	25	70–130
1,3-Dichlorobenzene	TO15	25	70–130
1,4-Dichlorobenzene	TO15 SIM	25	70–130
Acetone	TO15	25	70–130
Benzene	TO15 SIM	25	70–130
Bromodichloromethane	TO15	25	70–130
Bromomethane	TO15	25	70–130
Chlorobenzene	TO15	25	70–130
Chloroform	TO15 SIM	25	70–130
Ethylbenzene	TO15 SIM	25	70–130
Isopropylbenzene	TO15	25	70–130
m,p-Xylenes	TO15 SIM	25	70–130
Methyl ethyl ketone (2-Butanone)	TO15	25	70–130
Methyl isobutyl ketone (2-methyl-2-pentanone)	TO15	25	70–130
Methylene chloride	TO15	25	60–140
o-Xylene	TO15 SIM	25	70–130
Styrene	TO15	25	70–130
Tetrachloroethene	TO15 SIM	25	70–130
Toluene	TO15	25	70–130
Trichloroethylene	TO15 SIM	25	70–130
Trichlorofluoromethane	TO15	25	70–130
Soil Gas Tracer	**ASTM D1946-90**		
Helium		25	85–115

Abbreviations:
LCS = laboratory control sample
SIM = selective ion monitoring

Table 7. Precision, Accuracy, and Completeness Criteria for Water Samples in the DOE Areas

Parameters	Method Reference	LCS Precision Criteria[a] (RPD)	LCS Accuracy Criteria[a] (%R)	MS Accuracy Criteria[a] (%R)	Completeness[b] (%R)
Volatile Organic Compounds	**SW-846 Methods 8260B/5030C**				**90**
1,1,1-Trichloroethane		≤23	80–128	72–132	
1,1,2,2-Tetrachloroethane		≤30	80–121	75–132	
1,1,2-Trichloroethane		≤21	80–120	75–125	
1,1-Dichloroethane		≤30	71–210	68–128	
1,1-Dichloroethene		≤26	77–120	66–126	
1,2,3-Trichloropropane		≤30	76–120	75–125	
1,2-Dibromo-3-vhloropropane		≤23	80–120	75–126	
1,2-Dichlorobenzene		≤30	80–120	75–125	
1,2-Dichloroethane		≤23	80–122	75–127	
1,2-Dichloropropane		≤23	80–120	75–125	
1,3-Dichlorobenzene		≤30	80–122	75–126	
1,4-Dichlorobenzene		≤20	80–120	75–125	
2-Butanone		≤30	55–187	20–180	
2-Hexanone		≤30	67–151	74–122	
4-Methyl-2-pentanone		≤30	73–127	65–137	
Acetone		≤30	50–150	20–180	
Benzene		≤22	80–120	75–125	
Bromochloromethane		≤27	75–123	75–128	
Bromodichloromethane		≤29	80–121	75–125	
Bromoform		≤30	74–140	71–137	
Bromomethane		≤30	50–150	37–181	
cis-1,2-Dichloroethene		≤26	75–123	75–130	
cis-1,3-Dichloropropene		≤30	80–122	75–128	
Carbon dilsulfide		≤34	64–130	58–136	
Carbon tetrachloride		≤36	80–129	69–135	
Chlorobenzene		≤29	80–120	75–125	
Chloroethane		≤30	72–126	20–180	
Chloroform		≤29	76–124	75–129	
Chloromethane		≤30	53–143	41–149	
Dibromochloromethane		≤30	79–127	75–125	
Ethylbenzene		≤25	80–120	75–125	
Methylene chloride		≤24	77–120	74–128	
o-Xylene		≤30	80–120	75–127	
m,p-Xylene		≤30	80–120	75–125	
Styrene		≤24	80–120	28–166	
trans-1,2-Dichloroethene		≤30	77–125	73–133	
trans-1,3-Dichloropropene		≤26	80–120	75–125	

Table 7. Precision, Accuracy, and Completeness Criteria for Water Samples in the DOE Areas (continued)

Parameters	Method Reference	LCS Precision Criteria[a] (RPD)	LCS Accuracy Criteria[a] (%R)	MS Accuracy Criteria[a] (%R)	Completeness[b] (%R)
Tetrachloroethene		≤29	79–121	58–124	
Toluene		≤28	80–120	75–125	
Trichloroethylene		≤25	80–120	75–125	
Vinyl chloride		≤30	63–135	52–142	
Surrogates					
1,2-Dichloroethane-d4		na	80–128	na	
1,4-Bromofluorobenzene		na	68–120	na	
Dibromofluoromethane		na	80–127	na	
Toluene-d8		na	80–120	na	
Pesticides	**SW-846 Methods 8081A/3510C**				**90**
4,4'-DDD		≤27	52–165	52–165	
4,4'-DDE		≤27	52–150	52–150	
4,4'-DDT		≤27	15–169	15–169	
Aldrin		≤61	26–148	26–148	
alpha-BHC		≤34	53–151	53–151	
alpha-Chlordane		≤25	51–142	51–142	
beta-BHC		≤25	53–144	53–144	
delta-BHC		≤26	29–163	29–163	
Dieldrin		≤56	49–151	49–151	
Endosulfan I		≤26	43–144	43–144	
Endosulfan II		≤25	53–145	53–145	
Endosulfan sulfate		≤25	50–145	50–145	
Endrin		≤27	49–152	49–152	
Endrin aldehyde		≤27	35–145	35–145	
gamma-Chlordane		≤31	53–143	54–143	
gamma-BHC		≤30	57–143	57–143	
Heptachlor		≤45	30–148	30–148	
Heptachlor epoxide		≤28	54–148	54–148	
Methoxychlor		≤54	12–172	12–172	
Surrogates					
Decachlorobiphenyl		na	11–130	na	
2,4,5,6-Tetrachloro-m-xylene		na	39–146	na	
Metals and Elements	**SW-846 Methods 6020/3020A**				**90**
Aluminum		≤20	80–120	47–161	
Antimony		≤20	80–120	85–133	
Arsenic		≤20	80–120	73–127	
Barium		≤20	80–120	74–128	

Table 7. Precision, Accuracy, and Completeness Criteria for Water Samples in the DOE Areas (continued)

Parameters	Method Reference	LCS Precision Criteria[a] (RPD)	LCS Accuracy Criteria[a] (%R)	MS Accuracy Criteria[a] (%R)	Completeness[b] (%R)
Beryllium		≤20	80–120	56–122	
Cadmium		≤20	80–120	84–114	
Chromium		≤20	80–120	73–133	
Cobalt		≤20	80–120	79–121	
Copper		≤20	80–120	72–108	
Iron		≤20	80–120	27–201	
Lead		≤20	80–120	79–121	
Manganese		≤20	80–120	72–126	
Molybdenum		≤20	80–120	83–137	
Nickel		≤20	80–120	68–122	
Selenium		≤20	80–120	59–125	
Silver		≤20	80–120	68–128	
Thallium		≤20	80–120	73–121	
Vanadium		≤20	80–120	77–137	
Zinc		≤20	80–120	43–145	
Mercury	**SW-846 Method 7470A**	≤20	80–120	55–133	**90**
Chromium, Hexavalent	**SW-846 Method 7199**	≤20	80–120	70–130	**90**
Miscellaneous Organics	**SW-846 Method 8315A**				**90**
Formaldehyde		≤20	30–142	59–120	
Chemical Ions	**EPA 300.0**				**90**
Nitrate (as Nitrogen)		≤15	90–110	80–120	
Liquid Scintillation	**EPA EERF C-01 M**				**90**
Carbon-14		≤20	75–125	75–125	
Gas Flow Proportional Counting					**90**
Strontium-90	EPA 905.0 M	≤20	75–125	75–125	
Gross alpha	EPA 900.0	≤20	75–125	75–125	
Gross beta	EPA 900.0	≤20	75–125	75–125	
Gamma spec[c]	**DOE EML HASL 300**				**90**
Cesium-137		≤20	75–125	75–125	
Radium-226 (ingrowth)					
Alpha Spec Uranium	**DOE EML HASL 300, U**				**90**
Uranium-233/234					
Uranium-235/236					
Uranium-238		≤20	75–125	75–125	
Alpha Spec Americium	**DOE EML HASL 300, Am**				**90**
Americium-241		≤20	75–125	75–125	

Table 7. Precision, Accuracy, and Completeness Criteria for Water Samples in the DOE Areas (continued)

Parameters	Method Reference	LCS Precision Criteria[a] (RPD)	LCS Accuracy Criteria[a] (%R)	MS Accuracy Criteria[a] (%R)	Completeness[b] (%R)
Field Parameters	**SOP 1.3**[d]	na	90–100[e]	na	**90**
pH					
Turbidity					
Temperature					
Electrical conductivity					
Redox potential					
Dissolved oxygen					

Notes:

[a] LCS, surrogate spike, and MS limits established by current contract laboratories (Eurofins Calscience Laboratory for chemicals; GEL Laboratories LLC for radionuclides). Postdigestion spike recovery limits are the same as MS recovery limits.

[b] Completeness goal is per analyte and per sampling task, not per sample.

[c] Gamma LCS will also include Americium-241 with same control criteria.

[d] SOP 1.3, "Field Measurements, Maintenance, and Calibration of Instruments."

[e] Field calibration check control limits.

Abbreviations:

DOE EML HASL 300 = *The Procedures Manual of the Environmental Measurements Laboratory* (DOE 1997)
EERF = Eastern Environmental Radiation Facility
LCS = laboratory control sample
MS = matrix spike
na = not applicable
spec = spectroscopy
SW-846 = *Test Methods for Evaluating Solid Waste, Physical/Chemical Method* (EPA SW-846)

Matrix spike samples: Matrix spikes are performed by the analytical laboratory to evaluate the accuracy and precision of analyte extraction in the sample matrix. Where appropriate to the method, matrix spike and matrix duplicate samples will be collected and analyzed at a rate of 1 for every 20 field samples for each matrix. Matrix spike percent recovery control limits are presented in Table 5 for soil samples and Table 7 for water samples. Matrix spike and matrix spike duplicate precision control limits for the project are the same as those for field duplicates: 35% for water samples and 50% for soil and soil gas samples.

The matrix spike and spike duplicate will consist of additional volumes of a field sample spiked in the laboratory with compounds analyzed according to the laboratory method to be employed. Analyses of these samples often necessitates the collection of additional sample volume in the field. Additional sample containers will be filled and submitted to the laboratory, if necessary, to provide the required sample volume. Matrix spike recoveries are reviewed in accordance with applicable data validation procedures in SOP 21.1, "Data Validation." For some methods (e.g., total dissolved solids, alkalinity, hardness), spiking native samples is not appropriate. The referenced methods provide guidance on the appropriateness of performing spike analyses.

8.3.2 Laboratory Quality Control

Laboratory QC practices and CA procedures are described in the contract laboratory QA plans provided in Appendix C. The contract laboratories will be contractually bound to conform to their plans with regard to sample frequency checks, handling, preparation, and analytical procedures and will conduct evaluations of calibrations, blanks, spikes, duplicate analysis, compound identification, and interference checks, as follows:

Initial calibration: Initial calibration QC parameters can include percent relative standard deviation, correlation coefficient, response factor, initial calibration blank, and initial calibration verification percent recovery.

Continuing calibration: Continuing calibration QC parameters can include the response factor and percent difference from the expected value.

Method blanks: The concentrations of any analytes detected in method blanks are reported, and the effect of laboratory contamination on field sample results is evaluated.

Laboratory control samples: The percent recovery of each analyte spiked in the laboratory control sample is determined. The RPD is determined for each analyte spiked when laboratory control sample duplicates are analyzed.

Surrogate standards: The percent recovery of each surrogate compound in the samples, blanks, and other QA/QC samples are determined.

Matrix spikes: The percent recovery of each analyte spiked in the sample is determined. The RPD is determined for each analyte spiked when matrix spike duplicates are analyzed.

Postdigestion spike: The percent recovery of each analyte spiked in a postdigestion spike sample is determined when matrix spike recoveries are unacceptable. Postdigestion spikes are applicable to ICP spectrometer methods of analysis.

Interference check sample: The percent recovery of analytes potentially subject to interfering elements is determined. Interference check samples are applicable to ICP spectrometer methods of analysis.

Laboratory duplicates: The RPD or relative error ratio is determined for each analyte detected in the sample and its duplicate.

Compound identification: Compound identification criteria include mass spectra, retention time, percent difference between columns, and wavelength, depending on the analysis technique.

ICP serial dilution: The percent difference between concentration in initial and serial dilution analysis is determined.

8.4 Instrument and Equipment Testing, Inspection, and Maintenance

Computer hardware and software and field instruments and equipment will be tested as needed for initial acceptance, maintained in good working condition, and inspected and calibrated as required.

8.4.1 Computer Software and Hardware

The contractor project manager working with his or her information technology organization will ensure that computer software and hardware is installed, maintained, controlled, and documented to meet project objectives and industry standards and that it will be protected by current best practices with respect to system backup and cybersecurity. Hardware and software configurations of measuring and testing equipment do not require testing unless they are modified from the manufacturer's configuration. If any changes are made to hardware or software configurations, the equipment will be tested before use. If project requirements change so that the capability of the existing hardware and software configurations to meet project requirements is uncertain, the existing hardware and software will be tested before use.

8.4.2 Field Instruments and Equipment

Field equipment will be maintained as prescribed by the manufacturer's specifications. Scheduled maintenance will be performed by trained personnel. Procedures specific to the testing, inspection, and maintenance of field equipment are presented in SOP 1.3, "Field Measurements, Maintenance, and Calibration of Instruments." The subcontractor project manager, or designee, is responsible for documenting the maintenance of all field instruments and equipment under the procedures described in this QAPP. Laboratories are responsible for all analytical equipment calibration and maintenance as described in their laboratory QA plans (Appendix C). Subcontractors are responsible for maintenance of all equipment needed to carry out subcontracted duties.

All supplies (e.g., bottles, equipment, reagents) will be inspected before use in the field or laboratory. A current inventory and appropriate storage system will ensure their integrity before use. Efficiency and purity of supplies will be monitored through the use of standards and blank samples. Supplies and spare parts are stored in the LEHR field office in the main building of the UC Davis Center for Health and the Environment.

If instrument or equipment deficiencies are identified during testing, inspection, or maintenance, the instrument or equipment will be removed from service and tagged as out of service. Out-of-service instruments or equipment will be segregated from operational equipment when practical. The specific reason for removal from service and the date of removal will also be stated on the out-of-service tag. The instrument or equipment will then be repaired or recalibrated by project personnel, the vendor, or the manufacturer as deemed necessary by the subcontractor project manager. The instrument or equipment will be inspected or tested, or both, before removing the out-of-service tag and returning to service. Instruments or equipment that cannot be repaired will be replaced, as necessary, to provide support to the project. Any instrument or equipment consistently found deficient will be replaced.

Results of activities performed using deficient equipment will be evaluated by the subcontractor project manager or a designee. If the activity results are adversely affected, the results of the evaluation will be documented as a nonconformance as described in SQP 10.1.

8.5 Calibration of Measuring and Test Equipment

This section describes the responsibilities and methods for the control and calibration of quality-affecting measuring and test equipment to ensure proper operation. Written and approved procedures shall be used for the calibration of measuring and testing equipment. All calibration procedures shall be in accordance with the equipment manufacturer's current procedures or a nationally recognized authority (e.g., ASTM, EPA). Devices such as rulers, tape measures, and levels do not require calibration controls.

The subcontractor project manager is responsible for the overall field and onsite laboratory calibration and preventive maintenance program. Although the subcontractor project manager retains this responsibility, field personnel performing measurements and tests are individually responsible for the program's effective implementation and continued improvement.

The following types of calibrations and checks shall be conducted by qualified field personnel, as appropriate:

- Calibration verification standard measurements are performed at prescribed intervals established for the measuring and test equipment (typically each day of use) to ensure equipment is operating within its designed range and accuracy. Outside personnel, vendors, and manufacturers usually perform periodic calibrations and provide a calibration certificate documenting the operational and functional acceptance of the equipment.
- Specific calibrations are performed for specific measurements or tests and vary from instrument to instrument and procedure to procedure. Specific calibrations are performed before work starts; are reestablished at prescribed, predetermined intervals; and are instrument- and procedure-specific.
- Recalibration is performed when a calibration verification standard measurement fails to meet acceptance criteria. If instrument recalibration fails, the instrument is shipped to the manufacturer or vendor for repair and recalibration.

Measuring and test equipment that requires calibration and is used for field screening requires the same level of calibration and documentation as other measuring and test equipment.

However, procedures developed and approved for field screening reflect the level of accuracy needed to perform the desired task.

The calibration procedures, frequency, and CA requirements for measuring and test equipment used in the ongoing DOE areas remedy are specified in SOP 1.3, "Field Measurements, Maintenance, and Calibration of Instruments," and Appendix C, "Contract Laboratory Quality Assurance Plans." SOPs referenced in the laboratory QA plans can be provided upon request. Appropriate calibration requirements for measuring and test equipment will be specified in SAPs for activities that are not ongoing, such as soil disturbance.

8.5.1 Equipment Identification

Measuring and test equipment that requires calibration shall be uniquely identified by the manufacturers' serial numbers or a suitable assigned number, typically with the identification number permanently marked on the equipment with a stamp, engraving tool, or other suitable means in a readily visible area that does not infringe on the function or performance of the equipment; this is preferably on the outside casing (top, bottom, or side). If this is not practical, an identification label is typically affixed, with the identification number clearly visible. This label is replaced, as needed, to provide clear identification of the equipment. A calibration label shall also be affixed to the equipment, as discussed below.

8.5.2 Calibration Frequency

Measuring and testing equipment shall be calibrated before initial use and at prescribed intervals. Once the calibration is completed, a reference value or response is established and checked periodically during equipment use to verify calibration accuracy (calibration check). The frequency of periodic calibrations is based on the manufacturers' recommendations, national standards of practice, equipment type and characteristics, and past experience.

For some equipment, periodic calibration may not be required by manufacturer or standard practices. In such cases, the equipment is still subject to specific calibrations before initial use.

A calibration label shall be attached to equipment requiring periodic calibration. This label provides, at a minimum, the equipment identification number, date of the current calibration, and due date of the next required calibration. If labels cannot be attached, records and appropriate calibration documentation shall be readily available for reference. If a calibration due date is missed, the equipment shall be removed from service and tagged as out of service to prevent inadvertent use until it has been appropriately recalibrated.

Scheduled calibrations do not relieve the user of the responsibility for selecting the appropriate and properly functioning equipment.

8.5.3 Reference Standards and Equipment

Calibration reference standards and equipment shall have known relationships to National Institute of Standards and Technology or other nationally recognized standards. If a national standard does not exist, the basis for calibration shall be fully documented and approved by the subcontractor project chemist, a designee, or the vendor performing calibration. Physical or

chemical standards that are repackaged or split shall have traceable lot or batch numbers transferred onto the new container.

It is the responsibility of the user to select, verify, and use the correct standard in accordance with an approved procedure or established practice.

8.5.4 Calibration Failure

Each individual user of measuring and test equipment is responsible for checking the calibration status of the equipment to be used and confirming the acceptable calibration status before use. Measuring and test equipment with a periodic calibration period that has expired or that fails calibration or becomes inoperable during use shall be removed from service and tagged as "out of service."

Out-of-service equipment shall be segregated from operational equipment, when practical. The specific reason for removal from service and the date of removal should be stated on the out-of-service tag. The vendor or manufacturer will repair the equipment, recalibrate it, or both, as appropriate. Equipment that cannot be repaired shall be replaced, as necessary, to support the project.

The subcontractor project chemist or a designee will evaluate the results of activities performed using measuring and test equipment that has failed recalibration. If the activity results are adversely affected, the results of the evaluation are documented as a nonconformance and the appropriate personnel are notified.

8.5.5 Calibration and Maintenance Records

Specific calibration records are prepared and documented for each piece of calibrated measuring and test equipment used. Calibration data are recorded on the applicable data collection log for field screening activities. For nonscreening activities, the calibration records are documented on a *Test Equipment List and Calibration Log* form (Attachment 6-1 in SQP 8.1, "Calibration and Maintenance of Measuring and Test Equipment"). The subcontractor project chemist or a designee is responsible for reviewing the calibration data for appropriateness, accuracy, readability, and completeness (see SQP 8.1). Documentation of calibration is maintained in the project files according to SQP 4.2, "Records Management."

8.5.6 Measuring and Test Equipment Currently in Use

The following measuring and test equipment are currently used for the project:

- YSI ProDSS multimeter or equivalent–Used for measurement of low-flow groundwater sampling stabilization parameters (pH, turbidity, electrical conductivity, redox potential, and dissolved oxygen) for ongoing groundwater monitoring program
- In-Situ Inc. Level Troll 500 or equivalent–Used to measure water levels in groundwater wells

The equipment shall be calibrated according to SOP 1.3, "Field Measurements, Maintenance, and Calibration of Instruments"; initial and continuing calibration may be performed by field personnel, vendors, or manufacturers of the equipment. Calibration verification shall be

performed each day before field measurements are taken with a YSI ProDSS multimeter or equivalent. If the multimeter fails to meet calibration criteria specified in Table 7 or criteria specified by the manufacturer, field personnel shall recalibrate the instrument and analyze calibration standards.

Calibration of the In-Situ Inc. Level Troll 500 or equivalent should be performed every 12 to 18 months or in accordance with the manufacturer's recommended calibration interval or at any point when the data appear to drift significantly. If field recalibration fails, the instrument shall be tagged as out of service and shipped to the manufacturer for repair and recalibration or permanently removed from service.

8.6 Procurement, Inspection, and Acceptance of Items and Services

The procurement of items and services will be controlled so that:

- All legal and contractual/grant requirements are met.
- Appropriate technical and quality requirements, along with applicable acceptance criteria, are adequately specified to the supplier at the procurement phase.
- Applicable environmental health and safety requirements are specified to the supplier.
- Sufficient reviews and approvals are received before procurement to verify that the procurement reflects project specifications.
- The procurement process appropriately transmits QA requirements to suppliers and subcontractors.
- Qualified suppliers and subcontractors are selected for use.
- Items and services conform to QA, commercial, and technical procurement requirements.

Procurement documents issued, including bid requests and contracts, will be prepared, reviewed, and approved in accordance with DOE purchasing policies. In some cases, DOE will conduct the procurement directly. Otherwise, the contractor contract administrator will review the procurement documents for the inclusion of appropriate quality requirements before services or items begin to be procured. The contractor contract administrator will be responsible for ensuring that quality requirements flow down, as applicable, to any subcontractors and suppliers.

Procurement documents will state applicable requirements for technical performance, quality, acceptability, and documentation, as appropriate, including all of the following:

- Personnel qualifications
- Necessary licenses or permits
- Pertinent regulations and standards
- Applicable environmental and safety requirements
- Material composition and physical and chemical requirements
- Milestones, hold points, and scheduling
- Insurance requirements
- Sustainability

- Work procedures
- Testing and calibration requirements
- Performance and acceptance criteria

Technical requirements will either be directly included in the procurement documents or referenced in specific drawings, specifications, statements of work, procedures, or regulations (along with specific revision numbers and issue dates) that describe the items or services to be furnished.

Revisions to procurement documents that have been issued will be initiated using the same method as the original procurement and will be accomplished using the following considerations:

- Determination of any additional or modified design criteria
- Modifications to requirements listed above
- Analysis of exceptions or changes requested by the subcontractor or supplier and the effect the changes would have on the procurement activity

Major subcontractors and suppliers of quality-related materials or services, including analytical laboratories, will be evaluated before their materials or services are used. The evaluation will include the following, as appropriate:

- Historical quality performance data: The previous ability of a potential subcontractor to provide an item or service in a satisfactory manner will be evaluated. The experience of other purchases of similar items, or services provided by the prospective subcontractor, and any contractor records of previous procurements can form the basis for the evaluation. The subcontractor's reputation and experience in the industry will also be considered.
- Price: A comparison of the subcontractor's price to bids or internal government estimates, or both.
- Prequalification determination: A potential subcontractor's management capability, plant facilities, and technical or quality capabilities may be directly discernable (i.e., acceptable or unacceptable), and quality performance data will not normally be required for small or noncritical procurements evaluated through a prequalification determination. Prequalification determinations will be implemented using a graded approach.

Items and services required for the ongoing and anticipated project activities and their current sources include:

- Laboratory analytical services (GEL and Eurofins Calscience)
- Sample containers and shipping containers (GEL and Eurofins Calscience)
- Courier service (Eurofins Calscience)
- Calibration standards (Cole-Parmer)
- Filters (0.45 micron) (EnviroTech)
- Pump tubing, traffic controls, buckets (W.W.Grainger, Inc.)

- Common carrier service (FedEx)
- Sample labels, packing tape, bubble wrap, absorbent (Staples, Amazon)

8.6.1 Inspections

All project supplies and equipment (e.g., bottles, equipment, reagents) will be inspected before their use according to SQP 7.2, "Receipt Inspection." The subcontractor task leader will assure that personnel inspecting supplies upon receipt have knowledge of the item to be inspected and its application to the work being performed. Inspectors may be designated by the subcontractor project manager based on specialized technical expertise or familiarity with the items to be inspected.

Items arriving at the staging location or project site will be routed to a designated receiving area. The recipient shall notify the requestor that the items have arrived and are ready for inspection.

The inspector will visually inspect the item for physical damage and compliance to procurement documents requirements. If the item is unacceptable, the inspector will notify the subcontractor project manager, and the basis for rejection will be documented on the *Receipt Inspection Report* form in SQP 7.2 and indicated on the shipper's receipt document.

Laboratory inspections (i.e., audits) are discussed in Section 15.0.

8.6.2 Acceptance

If the item meets the procurement document requirements and no visual deficiencies are observed, the inspector will document acceptance on the *Receipt Inspection Report* form in SQP 7.2 and release the item for use.

After an item is inspected and approved for use, it will then be released for use. The item will be stored in a secure area in a manner that protects its physical and operational characteristics from damage, deterioration, or tampering.

Completed *Receipt Inspection Report* forms will be maintained in the project record files.

8.7 Nondirect Measurements

Pertinent information previously developed by DOE or others may be needed to inform additional investigations or studies. This information is currently used in groundwater monitoring program and Land-Use Covenant decisions. The contractor project manager will determine the scope of information needed, which may include:

- Applicable federal, state, and local regulations and rulings
- Project status such as history, background, future plans, requirements, and schedule
- Methodologies available for:
  - Field exploration, monitoring, testing, and sampling
  - Laboratory testing

  - Processing and volume reduction of radioactive and hazardous material
  - Isolation and disposal of radioactive and hazardous material
  - Numerical analysis and design
- Existing data generated for the site and surrounding region:
  - Demographic
  - Geological (surface and subsurface)
  - Hydrological and meteorological (e.g., groundwater quality, distribution, and usage)
  - Geochemical
  - Geotechnical
  - Facility development and practices (past, present, and future)
  - Type, volume, and extent of contamination
  - Physical layout of constructed facilities
- Data generated for specific wastes, materials, or constituents
- Previous or concurrent surveys, studies, analyses, and designs of a similar or parallel nature

Sources for the above-listed information may include:

- Government and private regulations, standards, guidelines, journals, periodicals, and data compilations
- The project database
- Textbooks and maps
- Reports and manuals previously issued by DOE, UC Davis, or other agencies or organizations
- The results of investigations being conducted by government and private agencies, corporations, and research facilities
- Personal communications
- Aerial photographs and satellite imagery
- Procurement documents issued by the client

Information collected shall be documented to indicate its source. Documentation, as appropriate, will include the author or individual contacted; the source title; identification of the periodical or journal; standard, guideline, or report number; identification of the publisher or originating organization; and date. Documentation shall be sufficient to allow other individuals to easily obtain or verify the information.

Whenever possible, the project files will include complete copies of articles, data compilations, maps, reports, and photographs. If this is not feasible, copies of title pages and pertinent sections will be included with complete source documentation. Project-critical regulations, standards, guidelines, and textbooks that are not readily available on the internet shall be retained in the project library.

Personal communications, such as interviews, correspondence, and telephone conversations, will be documented in the form of trip reports, meeting notes, memoranda, or telephone records, and the documentation will be included in the project files. Documentation should include, as appropriate, the name, organization, date, address, telephone number, and credentials of individuals contacted. Formal written confirmation of critical data obtained orally will serve as final documentation.

As necessary, the quality and credibility of the information will be estimated. Particular attention will be paid to information that is collected but not published in a peer-reviewed source or not collected under the controls of a documented QA program. This may include personal interviews, internal reports and memoranda, and newspaper articles. Any limitations in, or reservations about, the accuracy or credibility of acquired information that could affect project quality shall be clearly identified.

The collection of information should be consistent with the DQOs of the project. Project sample data previously collected for site investigations, studies, or ongoing programs have been stored in relational databases and are of documented quality. Data stored in the project databases will be reviewed against DQOs established in project work plans and SAPs before their use to determine if their quality and applicability are sufficient for project tasks, and programs. Studies of natural background concentrations of metals, elements, radionuclides, and compounds in site soil and groundwater have been conducted and reported in project documents issued by DOE and UC Davis.

8.8 Data Management

The data management process is designed to ensure that all environmental data collected meet the project DQOs. The management process begins when creating the planning documents and continues through sample and data collection, laboratory communication, sample tracking, laboratory analysis and reporting, data verification and validation, and successful import of the data to the project database. The data management process is described below.

8.8.1 Field Measurements

Field measurements are parameters collected, analyzed, and recorded by onsite personnel. They may be used for project decisions or to determine whether conditions are satisfactory for more rigorous sample collection. These data may be recorded on field forms or electronic devices approved by the subcontractor QA manager. Field personnel are responsible for assembling the records upon completion of fieldwork and submitting them to the subcontractor project manager or a designee for review for completeness, correctness, and legibility. Hard copies will be scanned and stored as PDF files in accordance with project requirements and procedures.

When planning documents specify storage of field data in the electronic database, these data may be entered into an EDD formatted file and loaded into the database. A QC report of database records is compared to field documents, and data entry errors are corrected. If planning documents do not specify storage of the field data in the electronic database, the records may be entered directly into tables, figures, or text for reporting. Any transcription of field data must be compared to original records and corrected if errors are found.

8.8.2 Sample Collection

Samples of environmental media are collected from a site to determine quantitative or qualitative information for project decisions. Samples are typically analyzed by an offsite laboratory for concentrations of hazardous chemicals. Exceptions include samples analyzed by mobile onsite laboratories or core samples logged by a field geologist. Sample information intended for offsite analysis is recorded on a COC form, the official record of sample collection and the primary means of sample analysis communication with the offsite laboratory (see SOP 1.1, "Sample Custody").

Sample information that must remain "blind" (unknown) to the laboratory, such as sample location and depth and field duplicate associations, are recorded separately from the COC form and submitted to the subcontractor project manager in the field data package. Sample locations and depths are typically marked for precise measurement by a professional land surveyor but may be measured by field personnel depending on project DQOs. When a professional land survey is conducted to record sample locations, the survey data are uploaded in the project electronic database. Professional land survey reports and location and depth measurements recorded by field personnel are scanned and stored as PDF files, in addition to any native file formats (e.g., AutoCAD).

8.8.3 Sample Login Verification

Sample login consists of receipt, inspection, and data entry upon sample delivery at the laboratory. Information provided on the COC form is entered into the laboratory data management system. The laboratory assigns its own sample identification number to each sample and a sample delivery group number (or work order number) to the group of samples received. A login report containing sample collection information and receipt inspection results is generated and sent by email to the subcontractor project manager or a designee. The sample login report should be transmitted by the laboratory on the day samples are received and no later than 24 hours after sample delivery. If the login report is not received from the laboratory within 24 hours of sample delivery, the subcontractor project manager or a designee shall contact the laboratory to obtain the report as soon as possible. Contractual arrangements with the laboratory should be made to ensure prompt login reporting. The subcontractor project manager or a designee shall review the login report as soon as possible and no later than 1 working day after the report is received. Login reports are verified using the *Sample Receipt Confirmation Checklist* included in SOP 2.1, "Sample Handling, Packaging, and Shipping."

The review will consist of a series of checks to ensure correctness of the laboratory login report, including verification of sample receipt within holding time, receipt temperature, custody seals, analysis methods, sample IDs, collection date, collection time, and COC form correctness. Corrections are communicated to the laboratory and documented in the project file. Any problems with sample receipt (e.g., broken or leaking containers, temperature, holding time, COC form) are addressed at this time.

8.8.4 Sample Tracking

The progress of samples analyzed by offsite laboratories must be tracked through the data management process to ensure data are valid, correct, and complete before they are used for

project decisions and reported in project documents. Data tracking is typically conducted in a table and must document key information on the progress of sample delivery groups, including the following:

- Laboratory work order number
- Sample identification
- Initials of the subcontractor project manager or designee
- Analytes
- Date of sample receipt by laboratory
- Date sample results are due from laboratory
- Date hard copy report is delivered by laboratory
- Date EDDs are delivered by laboratory
- Initials of individual performing data validation
- Date validation is completed
- Date EDDs are verified to be correct and data import is complete

8.8.5 Sample Analysis, Reporting, and Report Verification

Most samples will be analyzed by contracted offsite laboratories according to the process described in each laboratory's QA plan (Appendix C). Laboratories issue sample results as specified in project planning documents, laboratory contracts, and the COC, typically in the form of a report and EDDs. The report contains the official certified analytical results, and the EDDs should be contracted with the laboratory to contain the official certified analytical results. Exceptions to EDDs containing official certified analytical results should be restricted to specialty analyses performed according to techniques in which established environmental analytical method certification is not available. Certified EDDs shall contain sample results in a format that conforms to the specifications of the project database and other applicable databases (e.g., project database EDD and Geotracker electronic deliverable format files). The laboratory may issue report deliverables by email or place them on a secure internet site.

The subcontractor task leader or a designee will review all laboratory reports for correctness and completeness using the *Laboratory Report Verification Checklist* included in SOP 21.2, "Data Verification." The review will consist of a series of checks to ensure the laboratory results were reported as requested, including verification of turnaround time, analysis methods, analytes, level of report detail, EDD delivery, weight basis, detection limits, and any significant failures to analyze the samples.

Laboratory reports are saved in the project files and maintained for future access. The level of detail contained in a laboratory report can range from sample results with no QC data to raw data such that laboratory results for client samples, QC samples, and calibrations can be independently reconstructed. Laboratory reporting levels should be specified in project planning documents and sufficient to satisfy the DQOs. Laboratory report levels are:

- Level I – Certificates of analysis
- Level II – Certificates of analysis and QC results summary
- Level III – Certificates of analysis, QC results summary, specially requested details such as calibration data
- Level IV – Certificates of analysis, QC results summary, raw data and sequence logs for all client samples, QC samples, and calibrations

Some laboratories do not provide Level II, III, or IV reporting services.

8.8.6 Data Verification and Validation

In addition to the QC data review performed by the laboratory, data verification and validation must be performed by the subcontractor project chemist or designee on all results reported by the laboratory. Data verification and validation will be performed according to the process described in Section 8.9 and must be completed before the data are imported into the project database and made available for project applications.

8.8.7 Electronic Data Processing

The structure and contents of EDDs shall be specified in the laboratory contract at the beginning of each unique data collection project but can be updated as needs change according to the DQO process. Two types of EDDs are currently provided for project laboratory results analyzed by certified laboratories according to established environmental analytical methods: (1) EQuIS four-file format and (2) Geotracker electronic data file.

EDDs are entered into the project database, along with data qualifications resulting from validation, and the subcontractor database manager generates an EDD QC report of all loaded data. The EDD QC report should be in a format that is easily comparable to the laboratory results. The subcontractor project chemist or designee compares the EDD QC report to the COC, sample collection data sheets, laboratory report results, and data validation summary report to ensure correctness of the loaded sample information, results, and data qualifications (database import verification). When all discrepancies identified are resolved, the subcontractor database manager changes the data status to final in the database. When data are not entered into a project database, the subcontractor project manager or designee verifies all tabulations or other presentations of the data against the official records before a report is issued in draft or final form.

8.8.8 Data Transfer to DOE Project Database

In general, sampling and analysis data will be collected by the subcontractor and initially captured and stored in the project database maintained by the subcontractor database manager.

As directed by the contractor project manager, the data shall be periodically transferred to the DOE project database following DOE protocols to ensure the integrity and final archiving of the data. Retrieval of archived data will follow DOE protocols.

8.8.9 Data Reporting

Sampling and tests results and other data collected will be submitted to the regulatory agencies and other interested parties as required by project documents, agreements, or regulatory requirements. In general, data reporting involves table generation and comparison to numerical standards.

When a quantitative comparison table is generated from the database, the subcontractor project manager or designee sends a request via email to the database manager. The request specifies the project name, table name, table format, sample locations, sample collection dates, chemical suite, numerical standards, and file path to save the table. The database manager prepares or updates queries or database reports to generate the requested output. The requestor reviews the table to ensure the data and standards are correct, table format meets expectations, and information (e.g., title, abbreviations, and notes) is correct. Any corrections to the table are communicated to the database manager for revision until all issues are resolved.

8.9 Data Validation and Usability

Project data will be evaluated according to precision, accuracy, completeness, and detection limit criteria specified in this QAPP, task-specific work plans, and task plans, and they will be appropriately qualified with respect to their usability as discussed below.

8.9.1 Data Review, Verification, and Validation

The verification of analytical data will be an ongoing process that both the analytical laboratory generating the data and the subcontractor project chemist will perform. The laboratories shall be contractually required to meet the specification for analytical reports required for each work scope. Data will be validated and qualified, if necessary, consistent with EPA's *Guidance on Environmental Data Verification and Data Validation* (EPA 2002b), *National Functional Guidelines for Organic Superfund Methods Data Review* (EPA 2017a), and *National Functional Guidelines for Inorganic Superfund Data Review* (EPA 2017b).

The analytical laboratory will perform the initial step of the data verification process. Any problems or nonconformance issues encountered during the analysis will be noted in the case narrative that precedes each data package. Where unexplainable variations appear, calculations will be rechecked for errors, and the sample collection and analytical procedures will be reviewed to identify any causes for the inconsistencies. All calculation errors will be corrected and anomalies in the sampling or analytical procedures documented and reported in the analytical data package. The subcontractor project chemist will be notified of any existing problems and will be updated as conditions dictate. He or she will immediately notify the subcontractor task leader and subcontractor project manager concerning problems and updates.

The subcontractor project chemist or designee will review the data and compare it to the requirements provided in Tables 4 through 7 and in Section 8.3 and in applicable work plans

or SAPs. Industry standard data verification software may be used to perform data verification and validation provided the verification software input parameters and results are reviewed and approved by the subcontractor project chemist.

8.9.2 Verification and Validation Methods

Independent of QC review performed by the laboratory, data verification and validation will be performed for results reported by the laboratory. Section 8.8.3 discusses verification of laboratory login reports to ensure sample information and analysis requests are entered correctly into the laboratory information system; Section 8.8.6 discusses verification of laboratory report correctness and completeness; and Section 8.8.7 discusses verification of database import correctness.

The subcontractor project chemist or a designee will perform data validation tasks, or it may be performed by an independent data validation expert or firm designated by the subcontractor project chemist. The COC of the data will be reviewed for any anomalies; if any are identified, the subcontractor project chemist will notify the subcontractor project manager and work with the analytical laboratories to resolve them.

Level II data validation will be performed for all laboratory data unless other levels of data validation are necessary to meet project DQOs. In such cases, the validation levels described below and percentage of data validated at each level will be specified in the task-specific work plans or SAPs. In general, Level III and IV data validation will only be applied to data used to support human health or ecological risk assessments.

In all cases, analytical results may be qualified as a result of the data validation process in accordance with the flagging conventions listed in SOP 21.1, “Data Validation.” The data qualification codes (i.e., flags) are entered in the relational database, and the flags are reported with the results to the end users, so that usability of the data with respect to project objectives can be evaluated.

8.9.2.1 Level II Data Validation

Level II data validation consists of reviewing the laboratory report for holding times, detection limits, trace detections, surrogate spike recoveries, laboratory control sample recoveries, matrix spike, matrix spike duplicate results, blank contamination, and field duplicate precision. If QC parameters are outside control limits, the data reviewer applies qualifications according to the guidance described in Section 8.9.1. The Level II data review form is provided in SOP 21.1. The Data Qualification Module in the EQuIS database software application developed by EarthSoft Inc. will also be used in performance of Level II data review and the software output verified by the subcontractor project chemist.

8.9.2.2 Level III Data Validation

Level III data validation will be performed in accordance with SOP 21.1 and following the guidance described in Section 8.9.1. The subcontractor project chemist or designee, who is independent of laboratory analysis and report generation activities, will validate laboratory data to the extent warranted by the project DQOs. The Data Qualification Module in the EQuIS

database software application developed by EarthSoft will also be used in performance of Level III data validation.

The following reviews are performed for all analytical sample data:

- Organic data are reviewed for holding times, blank results, gas chromatography and mass spectrometry tuning, calibrations, internal standard retention times and areas, laboratory control samples, matrix spike and matrix spike duplicate results, surrogate recovery, manual integrations, second column confirmations, and field duplicates.
- Inorganic data are reviewed for holding times, blank results, matrix spike and matrix spike duplicate results, postdigestion spikes, sample duplicates, laboratory control samples, instrument initial and continuing calibration, ICP interference check samples, ICP serial dilutions, and field duplicates.

Level III data validation reports consist of three sections:

- Data validation summary report: A summary report is prepared for each sample delivery group. The project name, number, analytes, laboratory work order number, and field sample identification numbers are recorded in the report. Any major or minor deficiencies identified during the data validation process are tabulated for each analyte and sample number. If the data are qualified due to any outlier in QC results, a reason code is provided. The last part of the summary report includes the definitions of the data validation qualifiers that are assigned to the analytical data.
- Data validation worksheets: SOP 21.1 worksheets are attached to the report for each sample delivery group. Data review notes, calculations, and qualification decisions are recorded on the worksheets.
- Copy of laboratory report: A copy of the laboratory report is maintained in the project directory for reference to data and information on which validation decisions were based.

8.9.2.3 Level IV Data Validation

Level IV data validation involves reconstruction of laboratory results in addition to all elements of Level III validation. A Level IV report issued by the laboratory includes copies of all sample preparation log and analytical instrument output (raw data) used by the laboratory to determine sample results and QC data. The validation chemist reproduces select results starting with the raw data and equations specified in the analytical method or laboratory SOP. If a discrepancy is identified, the laboratory is contacted, and an attempt is made to resolve the difference between laboratory and reconstructed results. Laboratories are allowed to modify their procedures from the published analytical methods if the modification is demonstrated to provide equivalent or superior analytical results. Thus, discrepancies between laboratory results and reconstructed results are often a result of approved modifications to the method.

If Level IV validation does identify a laboratory error, the laboratory is notified, and a request is made to correct and reissue all affected data. Depending on the severity of the error, further action may be taken with the laboratory.

Level IV validation reports contain all Level III report elements in addition to copies of the calculations used to reconstruct the results.

8.9.2.4 Field Data Validation

All field documentation will be reviewed by the subcontractor project manager or designee to verify it is complete, legible, and sufficiently detailed that a qualified peer could reconstruct the work activity without the aid of the originator. If corrections or omissions are identified in field documentation, the documentation will be returned to the responsible field personnel for correction. To correct information in field documentation, the person making the correction marks a single line through the information to be corrected, enters the correction, and writes his or her initials and the date near the correction. In no instance should the original entry be obliterated by scribble, liquid correction fluid, or other means intended to mask the original entry. The corrected field document will be returned to the reviewer before field data are entered in an EDD format, provided to the subcontractor database manager for database import, used in project reports, or stored in project files.

8.9.2.5 Database Import and Final Quality Control Checks

After data validation and data import, including validation flag entry, the subcontractor project chemist will check the database entries against physical or electronic reports. The verification process is complete when the reviewer finds no discrepancies between the electronic data and the validated field and laboratory data.

8.9.2.6 Reconciliation with User Requirements

After data verification and validation are performed, data usability assessment is performed to determine if the data are of sufficient quality to support their intended use. A five-step process based on EPA's data quality assessment process (EPA 2006b) is used.

Step 1: **Review the DQOs, sample design, and field records:** Review the project planning documents and determine the DQOs applicable to the data being reviewed. Review the sample design and data collection records and note any discrepancies.

Step 2: **Conduct preliminary data review:** Review the data validation results; calculate basic statistics (minimum, maximum, average); and compare these with historical data, including graphing when appropriate, and note potential patterns and anomalies.

Step 3: **Select the data comparison or statistical methods:** Select an appropriate procedure for comparing the new data to existing data or numerical DQOs. In most cases, this analysis will include the direct comparison between detection limits and detected concentrations reported by the analytical laboratory for the new data and project numerical DQOs, such as risk-based screening standards. Document when detection limits exceed numerical DQOs. Statistical methods may be used for comparison with background reference data or to test for outliers if historical data for the sample location are available.

Step 4: **If a statistical method was used, verify the assumptions:** An evaluation is conducted to determine if the data fit the assumptions of the statistical test. Any statistical results from Step 3 shall be qualified if any statistical assumptions are violated or if alternative statistical approaches are recommended.

Step 5: **Drawing conclusions from the data:** Perform the statistical or other evaluation method(s) selected in Step 3, and document the conclusions regarding usability of the data. For example, direct comparison between new data and historical concentrations of a selected constituent might indicate that the data point is an outlier or that the laboratory detection limits were too high to answer critical project objectives. If retesting is required, evaluate the sampling design and analytical approach and make appropriate changes to ensure that project objectives are achieved.

All data usability issues and any recommendations to remedy the issues will be promptly reported in writing to the subcontractor project chemist, subcontractor project manager, and contractor QA manager.

8.10 Groundwater Monitoring Program

The DOE groundwater monitoring program is a key component of the site remedies, and all sampling and analysis for this program shall be performed in compliance with the analytical requirements specified in this QAPP.

Table 8 describes the current groundwater monitoring program analytes and sampling frequencies. This monitoring program is updated annually based on monitoring results and input from the project team. Future annual water monitoring reports should be referred to for up-to-date information on the groundwater monitoring program.

Table 8. 2020 Groundwater Monitoring Program Analytes and Sampling Frequencies

Well Name	1,1-Dichloroethane	Aluminum	Americium-241	Benzene	Beta, Gross	Carbon-14	Cesium-137	Chlordane	Chloroform	Chromium, Hexavalent	Chromium, Total	Dieldrin	Formaldehyde	Iron	Manganese	Mercury	Molybdenum	Nickel	Nitrate (as Nitrogen)	Radium-226	Selenium	Silver	Strontium-90	Uranium-238	Zinc
UCD1-013								A				A													
UCD1-021		B	B			B													A	A					
UCD1-023						A										B			B						B
UCD1-054							B			B	B					B	B					B	B		
UCD1-068		B	B		A	B			B	A	A		B					B	B	B	A			B	
UCD1-069	B	A			A	B			B				B	A	B		B		A			B		A	
UCD1-070					A	A										B			B					B	B
UCD1-071		B		B	A		B			A	A				B	B	B					B	B	B	
UCD1-072		B	B		A	B			A	A	A		B						A	B				A	

Notes:
Annual "A" and biennial "B" sampling both conducted in even numbered years (e.g., 2020). Only annual sampling conducted in odd numbered years.
Refer to the most recent annual water monitoring report for up-to-date information on the groundwater monitoring program.

Monitoring-only constituent
New well constituent
Constituent of concern

Abbreviations:
A = annual
B = biennial (once every 2 years)

9.0 Design Control

This section describes the controls to be implemented during design activities and applies to each stage of development from conceptual design to final design. The term "design" used throughout this section refers to specifications, drawings, design criteria, and component performance requirements for items and engineered environmental systems used in the performance of remedial actions.

9.1 General

Remedial design activities will be defined, controlled, and verified to provide confidence that design processes are carried out on a timely basis and that design input information is correctly translated into final design documents. These activities include:

- Ensuring that design objectives are specified and technical inputs are obtained on a timely basis.
- Ensuring that design inputs are correctly translated into design output documents.
- Identifying and controlling internal and external design interfaces.
- Performing design verifications of design output documents. (Individuals other than those who designed the item perform this step to provide independent verification that the documents satisfy the design objectives and are technically correct.)
- Ensuring that design changes, including field changes, are governed by controls that are commensurate with those applied to the original design.

9.2 Design Inputs

Design inputs will be collected during the sampling strategies development phase through data collection and reduction activities. The subcontractor task leader will ensure that approved design inputs (e.g., design bases, quality requirements, code requirements, performance requirements, and regulatory requirements) are properly documented and communicated to participating design organizations.

Documents that include design inputs will be reviewed, approved, and controlled in accordance with procedures that provide sufficient controls to ensure that current information is updated and used in design analysis activities. Independent technical reviews of design inputs will be performed before the input is authorized for use in design activities.

Before initiating preliminary design, the following will be determined and documented, as applicable:

- Overall design objectives
- The goals of structures, systems, components, or facilities
- The range of operating conditions
- Applicable design codes

9.3 Design Analyses

Design analysis includes the initial step of data reduction as well as broad-level system analyses (such as performance assessments) that integrate design inputs and analyses of individual parameters. The subcontractor task leader will ensure that personnel or organizations selected to perform design activities have been issued the current design input information necessary for the design to proceed in a planned, controlled, and documented manner. Additionally, design organizations assisting in design activities will implement the requirements established in this section.

Design analysis documentation will be prepared in enough detail that a person technically qualified in the subject can review and understand the analysis and verify the adequacy of the results. Documentation of design analysis will include the following, as appropriate:

- A definition of the analyses' objectives
- A definition of design inputs and their references
- The results of literature searches or other background data
- Identification of assumptions and indication of those that must be verified as the design proceeds
- Identification of computer calculation—including the computer hardware requirements, the computer code (e.g., name), revision identification, inputs, outputs, evidence of or reference to the computer code verification—and the bases (or reference thereto) supporting application of the computer code to the specific physical problem
- Review and approval by the subcontractor task leader

9.3.1 Design Calculations

Design analysis activities include numerical tasks that may involve the processing of acquired data, the evaluation of anticipated or actual performance, and the prediction of future conditions. These activities are performed using calculations that may range from simple hand calculations to complex computer simulations. Design calculations and revisions will be documented and the resulting documentation formally checked before using the result in design activities as a design input. Preliminary results of calculations may be used in design activities, but they must be identified as preliminary. The results of preliminary design calculations must be qualified as preliminary so that only finalized results are used.

9.3.1.1 Calculation Content and Documentation

Calculation content and document will be identified as follows:

- Calculations will be identified by project number and will be issued under the cover of a calculation sheet. Each calculation sheet will indicate the title, the number of sheets, the originator, the date, the checker, and the date that the checking was completed.
- Design input data, including the appropriate sources and criteria, will be clearly identified. Project-related documents such as drawings, design criteria, and other calculations will include official titles, identifiers, and revision indicators used on those project documents for cross-reference.

- Applicable codes and standards should be identified by title, including the date of issue and the revision or addenda number.
- Formulas and procedures will be identified by source (e.g., codebook) or logically derived.
- Assumptions made as part of the input conditions or as intermediate steps in the calculations will be clearly labeled as such. A brief statement on the rationale for the assumption should be included.
- Intermediate and final results will be identified by drawing a box around the results or by other suitable methods that will clearly identify the results.
- Content requirements listed above that are determined to be not applicable will be marked "N/A," and the responsible subcontractor task leader will justify the "N/A" designation by providing a rationale.

9.3.1.2 Signature Requirements

The cover sheet for each individual calculation will identify the originator. The subcontractor task leader will approve the calculation before it is issued or incorporated into a design document. The checker will initial and date the cover sheet of the calculation and each subsequent page. The subcontractor task leader will sign and date the cover sheet as the approval authority.

9.4 Computer Codes

Computer programs (codes) used for design will be documented as described in Section 4.6.2 to establish their ability to perform the functions to which they are applied and to permit a qualified individual to follow the procedure by which output is obtained.

9.5 Design Verification and Personnel Qualifications

9.5.1 Design Verification

Design analysis activities include numerical tasks that may involve the processing of acquired data, the evaluation of anticipated or actual performance, and the prediction of future conditions. The subcontractor task leader is responsible for implementing requirements for design verification, independent technical reviews, and peer reviews. Design verification for the level of design activity accomplished will be performed before the design is released for publication, for procurement, for manufacture, for construction, or to another organization for use in other design activities, except when this timing cannot be met (e.g., when insufficient data exist). In those cases, the unverified portions of the design will be identified and controlled. In all cases, the design verification will be completed before relying on the component, system, or structure to perform its function.

Design verification will be accomplished through one or more of the following methods:

1. Design reviews that will verify the following, at a minimum:
    - Design inputs were correctly selected
    - Assumptions necessary to perform the design activity are described, and assumptions are identified for subsequent verifications when the detailed design activities are completed
    - An appropriate design method was used
    - Design output is reasonable compared to design inputs
    - The necessary design input and verification requirements for interfacing organizations are specified in the design documents or in supporting procedures
    - The design can be constructed and includes value engineering components
2. Calculations or analyses using alternate methods to verify the results of the original calculation or analysis
3. Qualification tests to verify the adequacy of design, with the following issues being addressed:
    - The tests to be accomplished are clearly identified and documented
    - Testing demonstrates adequacy of performance under conditions that simulate the most adverse design conditions
    - When testing is intended to verify only specific design features, the other features of the design are verified by other means
    - Test results are documented and evaluated by the design organization and reviewed by the contractor QA manager or designee
    - When qualification testing indicates that modifications to the item are necessary to obtain acceptable performance, the modification is documented, and the item modified is retested or otherwise verified to ensure satisfactory performance
    - When tests are performed on models or mockups, scaling laws are established, verified, and subject to error analysis

9.5.2 Personnel Qualifications

An individual (licensed engineer) or group other than the one that performed the original design will perform the design verification. Individuals or groups are selected based on background, education, experience, and capability. A file of personnel résumés is maintained by the contractor project records administrator and is considered a sufficient basis for selection. The originator's supervisor may perform design verification provided the supervisor did not perform any of the design tasks and is competent to perform the verification. In this case, the need for design verification by the supervisor of the design originator will be documented, justified by the subcontractor task leader, and approved by the contractor QA manager before the verification is performed. Cursory supervisory reviews do not satisfy the intent of design verification. Personnel assigned verification responsibilities will be knowledgeable of the principles, techniques, and requirements of the activity being performed.

Engineering design drawings, plans, and specifications will be reviewed by a Professional Engineer holding a California license in the applicable field of practice. The licensed engineer will wet-stamp each page before submitting engineering plans and specifications to the UC Davis Design and Construction Management Department for approval.

9.6 Independent Technical and Peer Reviews

Engineering study reports and documents that support design information and design activities will be subjected to independent technical or peer reviews, as appropriate. The subcontractor task leader will ensure that qualified personnel have reviewed these documents before their use in design activities. Section 11.0 identifies the requirements for these reviews.

9.7 Drawings

The subcontractor task leader will assign qualified personnel with equivalent qualifications and technical expertise in the subject matter to check design-generated drawings to ensure they meet the requirements of the design specification. If the drawings are deemed acceptable, that acceptance will be documented on the drawings. The subcontractor task leader will indicate his or her approval of the final drawing or revision by signing and dating the design(s). Professional Engineer or registered geologist stamps may be applied, as necessary. Approval indicates that the drawing or revision has met the quality, technical, and contractual requirements and has been checked by a technically qualified independent reviewer. The checking process will verify, at a minimum, that:

- Detail is sufficient for intended use.
- The drawing is related to design input.
- Items or locations are depicted completely.
- Technical information is consistent with design outputs, plans, or report content.
- The drawing format is consistent with the contractor or contract format requirements.

If a design drawing is revised, the entire checking process will be repeated for the revised areas only. Under no circumstances will revisions be implemented without the formal checking procedure being repeated, as necessary.

Sketches used in the design to depict details of design output drawings will be checked to the extent necessary to determine that the details adequately represent the drawing information.

9.8 Logs and Tables

Final subsurface logs will be verified and approved by the lead technical individual or assigned registered geologist responsible for that portion of the design. The checking of logs will verify that changes from the original field logs to the final logs are consistent with the results of any laboratory testing or other analyses. The approver will initial and date the final log sheets, indicating his or her verification of information and approval for design use.

Tables containing information, data, or the results of analyses will also be checked against the source of the data.

9.9 Design Changes

The subcontractor task leader is responsible for design changes, field changes, and modifications to operating facilities. “Use as is or repair” decisions are justified by, and subject to, design control measures equivalent to those applied to the original design. Justification will include confidence that the design analysis for the item remains valid. Where a significant design change is necessary because of an incorrect design, the design process and verification procedures will be reviewed, evaluated, and modified as necessary. Changes to final design will be reviewed and approved by the originating design organization or group or by an approved alternate designated by the subcontractor task leader.

9.10 Instructions to Field Personnel

Design output (e.g., specifications and drawings) will be reviewed by the contractor project manager or designee to identify special design requirements or constraints that would affect the remediation effort. These special design considerations will be discussed during the preparatory phase inspection as they relate to the items to inspect (see Section 12.4).

9.11 Item Identification and Control

The identification and control of items and data used or collected in accomplishing project objectives will be conducted to ensure they are traceable, correct, and acceptable for use. Examples of items requiring identification and control include samples, hazardous waste, field and laboratory data, and computer programs in use.

Physical identification of items shall be used to the maximum extent possible; if this is not practical, other means (e.g., procedural control, tagging, or segregation) will be employed. Quality-affecting materials used in the field during the project, including material removed, will be identified from the initial receipt or removal through installation or waste packaging.

Items will be maintained in accordance with requirements established in the procurement documents, drawings, or other pertinent documents to prevent damage or loss and to minimize deterioration.

Items with limited shelf life that are brought for use at the project site will be sufficiently identified to trace the item to a certificate of conformance and labeled with the expiration date. When the labeling of items is impractical due to their configuration or size, records traceable to the items will include this information, and the items will be stored on shelves, in bins, or in areas that are identified for limited-life-item storage. Items associated with supplies, parts, or reagents for use at, and by, laboratories will accord with the laboratory QA plan as approved, and in use, by the laboratory.

10.0 Report Preparation

This section describes the methods and requirements for the preparation, review, and approval of project reports. The report type (e.g., technical reports and memoranda, construction and engineering reports) will be determined by the work to be performed, contractual and regulatory requirements, and the end use of the document.

For each report, the contractor project manager will:

- Determine the content of the report based on the project task scope of work, DOE requirements, and regulatory requirements.
- Determine the report format.
- Assign qualified personnel to prepare the various items required for the report.
- Distribute information pertinent to preparation activities and update this information as required.
- Coordinate with the various groups that may be working on the report.
- Assign qualified personnel to review the prepared report.

10.1 Report Format

Unless DOE requests, or regulations require, specific report formats, technical reports will, in general, contain the following items in the order presented:

- Table of contents: Specify the first page number of each section of the report text.
- List of figures: Sequentially identify figures referred to in text by report figure or drawing number and title.
- List of tables: Sequentially identify by number and title tables referred to in text.
- List of appendixes: Identify each appendix by a letter designation and title.
- Report text: The text includes an introduction, the body of text, and a section that summarizes the project task work and cites conclusions and recommendations. The body of the text must be formulated based on the scope of work, design, contractual requirements, and intent of the report.

The introduction should identify and describe the purpose for which the work was undertaken. It should briefly discuss activities pertinent to the report subject, including the following:

- Fieldwork
- Consultations with DOE, regulatory agencies, and others
- Laboratory testing
- The collection of data from other sources
- Analyses and resulting conclusions
- The formulation of recommendations

The body of the report should describe the work activities and accomplishments in clear and concise detail. The findings of any field explorations and testing, literature searches, external consultations, and observations should be included. Any laboratory-testing program should be described and its results discussed. The procedures employed and designs formulated should be indicated. The results of work performed should be discussed in detail and must be traceable to the project task and design records.

The final section of the text should summarize the purpose of the work and actions taken toward meeting that purpose. It should emphasize results of the work and any conclusions or recommendations reached.

- **List of references** should include references cited in the report text, tables, and figures, including external data, publications, or correspondence. References should include the author's name, title of the publication, publisher, and date, if the reference is a publication. If the reference is correspondence, the subject, date, names of the parties contacted, and type of correspondence should be included.
- **Figures** will be identified with a report figure number or a unique drawing number and a title. Figures may appear as a separate section following the list of references or at the end of each section of the text, or they may be embedded in the text. Figures will be "self-standing" (i.e., they do not depend on the text for explanation to the extent practical).
- **Tables** are generally included as a separate section following the figures but may be embedded in the text or included at the end of each section of text. Each table should have a title and number. The information listed in the table will be clearly labeled. Particular care will be taken to include necessary references, symbols, and reporting units so a table will be self-standing.
- **Appendixes** should include supplementary information pertinent to the report subject. Often information contained in an appendix is technical in nature and is included in the report to provide details about topics discussed in the text. Each appendix will be identified by a letter of the alphabet. Pages within the appendix will be in logical sequence but need not be numbered unless a sequence cannot be reasonably maintained without page numbers.

The above format is a generalized outline to be followed in report preparation. Other formats are acceptable (e.g., letter reports). The report will provide sufficient information to allow other organizations to use the results and findings for further development or operational use.

10.2 Submittal

The contractor project manager will determine DOE's requirements, regulatory agency requirements, or both for report submittal, including the recipients to whom the report should be transmitted. Reports may be issued as "draft," "draft final," or "final" presentations of the work. Draft reports submitted under this program will be considered drafts only in the sense that DOE or regulatory agencies have not reviewed and approved them. In all respects, draft reports will be complete, in proper format, and generally free of grammatical and typographical errors.

Draft reports will have completed an internal independent technical or peer review before being submitted or issued, unless otherwise requested by the contractor contracts administrator.

For document control purposes, draft reports will be labeled with a letter of the alphabet to indicate their revision. Typically, the version sent for internal review is Revision A; the version sent for DOE and contractor review is Revision B; and the version sent for regulatory agency review is Revision C. Reports will not be signed until issued as "final." Final reports will be dated and generally include "final" in the title but will not show a revision number or letter.

The subcontractor project manager will distribute reports to all recipients via email. If the report file is too large for email distribution, a link with download instructions will be provided in the email transmittal. If any recipient cannot accept reports via email attachment or download due to cybersecurity concerns or other reasons, a copy of the report will be recorded as an EDD on a storage device and mailed to the recipient.

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11.0 Review of Work Activities

Both technical review and formal peer review, as necessary, will be performed to assist in controlling the end products of project activities. Technical reviews will be conducted for work instructions and the various project task reports before being issued to DOE. Peer reviews, based on the scope and needs of individual project tasks, will be identified and scheduled.

11.1 Technical Review

A technical review is an in-depth analysis and evaluation of documents, activities, material, or data for applicability, correctness, technical adequacy, completeness, appropriateness of interpretation, and assurance that established requirements are satisfied. This type of review will be independently performed by qualified members of the project or task group other than the personnel who prepared the original report or instruction. Independent reviewers may be selected from within the project team, or they may be outside consultants retained in a review capacity. Cursory supervisory reviews do not satisfy the intent of technical reviews.

The review of plans, procedures, and reports is the responsibility of the subcontractor task leader. This individual will identify the documents to be reviewed, select qualified personnel to perform the reviews, participate in the review of specific documents as indicated below, and verify that the review process is completed before the document is released.

Technical and environmental remedial action reports will be reviewed by the subcontractor task leader and independent technical reviewers selected by the contractor project manager. The subcontractor task leader will forward the documents to be reviewed to the selected reviewers.

Technical reviews will, as appropriate, consider the following:

- Requirement satisfaction: Is the objective of the report defined? Does the document satisfy the scope of work, task requirements, and pertinent regulatory requirements?
- Technical correctness: Is the content of the document technically defensible? Are conclusions properly supported by correctly interpreted data? Are all figures, tables, and computations presented in the document correct?
- Executive summary: Does it state the purpose of the document? Is it informative? Does it describe the scope of work and summarize pertinent results and conclusions?
- Introduction: Does it clearly describe the problems addressed by the document, state the objectives and scope of the document, present pertinent background information, and acknowledge significant help?
- Methods: Were appropriate techniques used or recommended for the work? New, nonstandard methods should be described in the document text.
- Assumptions: Are they clearly stated and justified?
- Body of manuscript (text): Is it organized and presented in a logical sequence that contains the basic information, interpretation of that information, and results or conclusions of the interpretations?

- Figures and tables: Do they clearly present basic information? Figures and tables should be interpreted and referred to in the text but should be understandable without the text. Have they been prepared, checked, and approved?
- Conclusions and findings: Do they summarize the principal conclusions and findings of the report? Do they address each of the objectives described in the introduction? Are they technically defensible? Conclusions and findings should be given when supported in the body of the document.
- References: Are all references cited in the text, tables, and figures included in a list of references? Are references cited correctly? Were pertinent references omitted in preparing the document?

11.2 Peer Review

Peer reviews are documented reviews performed by qualified personnel who are independent of the original work but have the expertise to perform the work. Peer reviews are in-depth, critical reviews and evaluations of documents, material, or data that require interpretation or judgment to verify or validate results of conclusions. Peer reviews are also used when conclusions, material, or data contained in the report go beyond reasonably available technology or when technical criteria and requirements do not exist or are being developed. While verification and technical review provide examination and confirmation of largely definitive work, peer review provides evaluations and assessment of interpretations, judgments, and decisions made.

The contractor project manager will determine, during the planning stage of a project task, if peer review will be required, the points in the work when the review will be performed, and the independent individuals who will perform the review. The need for peer review will be based on the level of expertise required for the project task. Peer reviews should be considered when:

- The technical complexity of the work requires specialty expertise.
- Technical criteria and requirements do not exist or are being developed.

Peer reviews generally will be performed before the initiation of project task work that will be affected by the peer review process or before issuing the draft report to DOE. The subcontractor project task leader will forward the documents to be reviewed to the selected peer reviewer(s).

After receiving the peer review comments, the author(s) of the document will review all comments and conduct any additional research or computation necessary to address the comments. Proposed document changes and comment responses will be recorded in a comment response matrix and be reviewed by the contractor project manager and peer reviewer(s), whose concurrence will be obtained before changes are incorporated into the document. The document will then be revised and submitted for internal approval. All peer review records will be maintained in the project files.

12.0 Inspections

This section provides the criteria for performing inspections on this project. The inspection system is based on the three-phase system of control to cover both onsite and offsite work; it includes the preparatory, initial, and follow-up phases. The need for, and content of, a readiness review is also presented. Inspections may be stipulated by the contractor project manager or project QA manager in task-planning documents to ensure the quality of the work performed. Inspection activities typically cover fieldwork that requires planned inspections to assess that the quality of the work meets project standards.

12.1 Items to Inspect

Items to inspect will consist of activities, documentation, materials, or equipment that may require inspection before or during performance of a task. The subcontractor task leader will define and identify items to inspect for each project task using the *Items to Inspect Checklist* (Attachment 6-1 of SQP 7.1, "Quality Inspections and Inspection Records"). Inspections are not typically required for small or noncritical tasks. The inspection procedures detailed in this section are intended to provide guidance for independent inspections. However, personnel on the project are also encouraged to inspect their own work to ensure that the degree of quality necessary for the project is maintained.

12.2 Inspection Scheduling

Inspection activities will be conducted for ongoing project activities. The contractor project QA specialist is responsible for the coordination of inspections relevant to ongoing project activities.

Inspections will be performed, as specified, and will be consistent with scheduled project activities. The contractor project QA specialist will identify inspection needs for each activity and either assign qualified personnel to perform the required inspections or perform the inspection himself or herself. The procedures for implementing inspections and maintaining inspection records are described in SQP 7.1.

12.3 Personnel Qualifications

Personnel assigned to perform inspections will be sufficiently independent of the activity being inspected and will not inspect their own work. The contractor project QA specialist will be responsible for assigning inspection personnel and ensuring that personnel are appropriately qualified and, when applicable, certified to perform the inspection activities. In general, personnel qualified to perform an activity will also be qualified to inspect it.

12.4 Preparatory Phase

Preparatory-phase inspections will be conducted to establish and document that all required preliminary activities necessary to start a task have been accomplished, all submittals for the task are complete, services are procured, required materials and equipment are available and in conformance, and required testing has been made or will be accessible during the work. The contractor project QA specialist (or a designated representative), site superintendent, field staff,

and subcontractors involved in the task will participate in the preparatory-phase inspection as appropriate to the work to be performed. The preparatory-phase inspection should follow an *Items to Inspect Checklist* tailored to the task preparation scope of work defined in project planning documents.

As appropriate, during the preparatory-phase inspection, those involved in the task will:

- Verify that all necessary authorizations have been received and notifications made.
- Verify that all new purchase orders are complete and existing purchase orders are not expired.
- Verify that any required laboratory, utility, drilling or other service vendors have the capability and capacity to meet project specifications and schedule.
- Review specification requirements and project task drawings.
- Verify that all appropriate drawings and submittals for materials and equipment have been submitted and approved.
- Review and verify that plans are available to provide required testing.
- Verify that all required preliminary work has been completed.
- Verify that all required materials and equipment are on hand or available and sample work has been verified to determine that work conforms to the specified requirements.
- Verify that the project HASP, hazard analysis, and required Safety Data Sheets conform to the specified requirements.
- Verify that all hazards have been analyzed and controls identified.
- Verify that all environmental protection requirements have been identified and addressed.
- Discuss sampling methods, remediation processes, and construction methods.
- Ensure that the project HASP, work plan, and other planning documents are approved and available where the work is to be performed.

The results of preparatory-phase inspections will be documented on the *Items to Inspect Checklist*. When required, readiness reviews may substitute for, or be incorporated into, the preparatory-phase inspection. The procedures for implementing materials receipt are described in SQP 7.2.

12.5 Initial Phase

As specified in the planning documents or by the contractor project QA specialist, an initial-phase inspection may be performed at the beginning of task activities. A representative sample of the work to be performed will be observed to verify that the work complies with the planning document specifications. Concurrence with the workmanship and inspection criteria for the feature of work will be established in the initial-phase inspection. The contractor project QA specialist (or a designated representative), site superintendent, applicable crew member foreman, and subcontractors involved in the activity will be present as appropriate to the work being performed. Initial-phase inspections should follow the *Items to Inspect Checklist* tailored to verify that the representative sample of the work being inspected is proceeding according to the project planning document specifications.

At a minimum, the following attributes will be addressed during an initial-phase inspection:

- Establish quality of workmanship and inspection levels
- Review the *Items to Inspect Checklist* for the preparatory-phase inspection and confirm compliance
- Resolve conflicts
- Verify that work conforms to the project HASP and hazard analysis

Initial-phase inspections will be documented on the *Items to Inspect Checklist*.

12.6 Follow-up Phase

As specified in the planning documents or by the contractor project QA specialist, follow-up inspections may be performed periodically when work on specific tasks is ongoing. More frequent follow-up inspections may be required commensurate with the extent of activities being performed. The follow-up inspections will continue until the task is completed. Follow-up inspections will be documented on an *Items to Inspect Checklist* tailored to the tasks being inspected.

Follow-up inspections will address and verify that:

- Work complies with the specification requirements.
- Quality of workmanship is maintained.
- Required tests are made.
- Nonconforming conditions are identified, and any CAs are conducted.

12.7 Readiness-Review Inspection

Readiness-review inspections will be conducted upon DOE's request in the following cases:

- Before major scheduled or planned work starts (usually associated with a documented work plan)
- Before reinitiating work following the closure of a stop-work order

The purpose of the readiness-review inspection is to ensure that appropriate steps have been taken to conduct field activities in a safe, efficient, and timely manner that complies with the project HASP, QAPP, and all other related controlling documents and regulations.

This is not intended as a technical review of the work, but rather to verify that:

- Work prerequisites have been satisfied (e.g., subcontract status, permits, required notifications to government agencies).
- Hazards associated with the work have been analyzed, and controls have been identified.
- Environmental protection requirements and associated compliance methods have been identified.

- Detailed technical and quality procedures have been reviewed for adequacy and appropriateness.
- Personnel have been suitably trained and are qualified.
- The proper equipment, material, and resources are available.

DOE may participate in and comment on the readiness-review process. A detailed procedure for use of readiness-review inspections is described in SQP 3.3, "Readiness Review Inspection." Readiness-review inspections differ from preparatory-phase inspections due to DOE notification of, or involvement in, the readiness-review inspection process. Project activities requiring inspection will have an *Items to Inspect Checklist* or similar work product (or checklist) prepared for that activity.

12.7.1 New Tasks

The contractor project manager is responsible for scheduling readiness reviews for new tasks. The readiness review will be scheduled to allow sufficient time between the review and start of fieldwork to respond to any issues or concerns coming out of the review. DOE will be notified of planned readiness-review inspections.

Review participants will include the LM site manager, contractor project manager, subcontractor task leader, subcontractor and contractor project health and safety manager, contractor project QA manager, subcontractor project chemist, subcontractor field staff, and other parties associated with the work being initiated.

The contractor project manager, or designee, conducts the review. In general, the depth and detail of information presented will be commensurate with the scope of the task. At a minimum, the following topics will be addressed:

- Personnel training requirements
- Scope and objectives
- Proposed activities description
- Identified risks and hazards or concerns and measures to mitigate or control them
- Environmental protection requirements and implementation methods
- Identification of uncertainties that may adversely affect the project
- Required documentation (including software), the QAPP, health and safety procedures, the work plan, and SOPs
- Special equipment or calibration needs
- Other topics, as appropriate
- Necessary materials or equipment documentation (e.g., calibration certifications, cost of compliance)

Following the review, the contractor project QA manager and UC Davis project QA manager will document in writing that activities can proceed as planned and will ensure that any issues or concerns that must be considered before fieldwork can start have been addressed.

12.7.2 Resumption of Work

If the readiness review is required due to the resumption of work from a nonconformance or stop-work order, a modified review that focuses on the adequate completion of the CA or remedial action will be conducted. The root cause analysis to prevent a reoccurrence will be reviewed.

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13.0 Nonconformance Control and Corrective Actions

This section describes the responsibilities and methods for all personnel to promote and ensure continuous improvement of items and work processes, thereby enhancing the effectiveness of the program or project tasks and resultant quality. Items, processes, and services that do not meet established requirements during the environmental remedial activities will be identified, controlled, and corrected as specified within written procedures. Correction will be focused on determining the cause of the deficiency and instituting actions to correct the deficiency and prevent a reoccurrence.

13.1 Nonconformance Report

Nonconformance reports are used to identify noncompliance and deficiencies found during the normal course of activities and during inspections. Such physical deficiencies could be associated with installed equipment, construction elements, samples, or data. A nonconformance report will be generated when a deficiency is encountered during a specific project task and cannot be immediately corrected during the operations or is repetitive. The processing of nonconformances will be implemented in accordance with SQP 10.1.

A nonconformance is defined as a deficiency or deviation in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate. Examples of nonconformances include test failures; physical defects; incorrect or inadequate documentation; data losses; or deviations from prescribed processing, inspection, or procedure. The originator of a nonconformance report will describe the nonconformance and the requirements deviated from on the form provided for that purpose and will notify the contractor project QA managers.

13.2 Responsibilities

The contractor project QA manager will maintain a nonconformance report log that provides the nonconformance report number, a brief description of the nonconforming condition, the date of issue, the organization or individual assigned to complete the report, the date of anticipated CA, and the date closed.

Nonconformances determined to be valid will be issued to the assigned organization or individual to identify the root cause, CAs, actions to preclude a reoccurrence, and the date when all CAs will be completed.

The contractor project QA manager will review each nonconformance and determine if the nonconformance is valid or if the condition reported is a repetitive condition adverse to the quality of project tasks. Nonconformance reports will continue to have open status until the CAs have been implemented and verified as acceptable by the contractor project QA manager.

Deficiencies identified by DOE personnel will also be controlled and tracked through the nonconformance-report system.

13.3 Corrective Action Requests

CA requests are used to identify, document, and provide actions to correct conditions or trends that are determined to be significantly adverse to quality (i.e., procedural or programmatic violations) and to provide methods to prevent them from reoccurring. The procedures for implementing the CA-request process are described in SQP 10.2 and provide for actions to preclude a reoccurrence and to verify the actions taken.

The conditions for which a CA request may be required include:

- A failure of the procedural system to produce the results desired in project deliverables.
- Identification of repetitive failure to comply with contract requirements, SQPs, SOPs, or conditions for which previous CAs have been ineffective.
- Significant deficiencies found during the review or validation of data.

13.4 Stop-Work Authority

The contractor project QA manager has the authority to stop or control further processing of activities that, in his or her opinion, are uncontrolled or nonconforming and, if not corrected, could affect the quality of the overall project or jeopardize the accomplishment of project goals or quality objectives.

A stop-work order should be issued if:

- Continuing an operation will directly affect the required work integrity or required documentation and would result in significant rework.
- Continuing an operation will jeopardize design integrity, cause design discontinuities for other items or activities, or compromise the essential features important to safety and waste isolation.

Stop-work orders will be coordinated through the contractor project manager and be implemented only when conditions cannot be resolved through the nonconformance system or normal task activity processes. Conditions that threaten safety, health, the public, or the environment will be brought to the attention of the contractor project health and safety manager for action, unless the conditions pose an immediate danger; in that case, the contractor project QA manager, project task leader, site superintendent, or individual responsible for the work being performed will stop the work immediately. SQP 10.3, “Stop Work Order,” describes the procedures for asserting stop-work authority.

13.5 Problem Prevention and Continuous Improvement

A principal objective of this QAPP is to provide a set of systems and requirements to ensure that project goals, objectives, and customer expectations are met. This QAPP is also designed to prevent conditions that may hinder the successful completion of the project in a cost-effective manner and to continually improve performance as project experience is gained.

This objective is achieved through a process approach to project tasks, including the use of an integrated set of management systems (including this QAPP) to guide and analyze the

performance of the project team. The process ensures that the project organization continues to identify potential problems and make changes that, when combined with the following three project objectives, continually improve quality results:

1. Hire technically knowledgeable, skillful, and qualified people to perform the work
2. Provide training that imparts necessary skills to people performing administrative, ES&H, QA, conduct of operations, and maintenance management tasks
3. Change the system if performance warrants

To ensure that identified significant quality problems are corrected, the contractor project manager, with assistance from the project QA manager (and the project health and safety manager, if applicable), will perform a root-cause analysis, a lessons-learned analysis, or both when deemed necessary, commensurate with the scope and severity of the problem. The quality-improvement process is described in more detail in SQP 5.1.

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14.0 Change Control

This section addresses the process to be implemented when a project task deviates from the contract or grant requirements.

14.1 Fieldwork Variance/Modification

Tasks cannot always be performed according to plan. Presumptions might not reflect actual conditions discovered during remediation. Feedback from workers may also precipitate changes in procedures. SQP 11.1, "Field Work Variance/Modification," describes the procedures for implementing the fieldwork variance process.

If the change affects the contract or grant total cost or schedule (i.e., a field work variance) the *Field Work Variance/Field Work Modification Form* shall identify that a task revision is required. The contractor project manager will then follow the ordering procedures in the DOE contract or grant. The subcontractor task leader, or designee, will complete the *Field Work Variance/Modification Form*, and the contractor project manager will approve it. The *Field Work Variance/Modification Form* will include, at a minimum, the following information:

- Description of present work requirements
- Description of proposed change
- Technical justification
- Documents requiring change
- Cost and schedule impacts

Changes that do not impact total contract or grant cost or schedule will be documented on the *Field Work Variance/Field Work Modification Form* (Attachment 6-1, SQP 11.1), except the section covering cost and schedule impacts should remain blank

The contractor project manager will review the completed *Field Work Variance/Field Work Modification Form* to verify that all quality requirements are maintained. The contractor project manager, and DOE when necessary, should evaluate the effect of the change on the project. The contractor contracts administrator must approve changes affecting the total task assignment cost estimate and schedule before the changes are implemented. Any requested change to or deviation from contract requirements will not be implemented until approved by DOE.

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15.0 Audits and Surveillance

This section establishes the methods and responsibilities for planning, scheduling, and performing audits, surveillances, and management assessments. Planned and scheduled audits will be performed to verify compliance with all aspects of this document, SAPs, and work plans, as applicable, and measure program performance against program goals.

15.1 Audits

Performance and system audits will be implemented in accordance with approved procedures presented in SQP 12.1, "Quality Audits." These audits will be performed to evaluate different levels of project quality activities as described below:

- *Performance audits* are direct observations of specific project activities to determine if these activities are being implemented in accordance with a specified requirement or procedure.
- *System audits* evaluate the entire project or project quality system by determining if appropriate objectives were developed, collected, executed, and documented. The objective of system audits is to evaluate the overall effectiveness and implementation of the established quality management system.

15.2 Audit Objectives

The objectives of performance and system audits are to:

- Determine if the approved project planning documents are being effectively implemented.
- Verify (by examining and evaluating objective evidence) whether the project elements (i.e., items, processes, work areas, or records, as appropriate) conform to specified requirements.
- Verify ongoing activities by direct observation.
- Assess the effectiveness of controls and verification activities.
- Report audit findings to appropriate levels of management for initiating CAs.
- Verify through follow-up activities that the CAs have been planned, initiated, and completed.
- Address technical considerations that verify the quality of the items, remediation processes, data, services, and activities, as well as programmatic compliance.

15.3 Audit Schedule

The LM site manager, or designee, will be responsible for the performance of an independent annual system audit ("management assessment") of the contract/grant QA implementation. The contractor, or designee, will audit individual tasks to the extent necessary to verify continued compliance with the requirements of this document. Both internal and external audits will be conducted in a manner that provides adequate coverage and coordination with QA activities. Audits will be scheduled at a frequency commensurate with the extent of activity of the project element(s), previously identified deficiencies of the project element(s), and the importance of the project element(s). The contractor project QA manager, in consultation with the contractor

project manager, will determine the scope, frequency and necessity of project task audits. Tasks not active at the time of the audit may not undergo an audit. Audits will only be conducted at out-of-state locations if authorized in the DOE task assignment. Tasks that are not active at the time of the audit may not undergo an audit. Task-specific plans (e.g., work plans, safety plans, preparatory inspection checklists, readiness reviews, SAPs) specify the frequency of and schedule for QA activities (e.g., audits, surveillances) for specific project tasks.

The subcontractor project chemist will conduct audits every 3 years for laboratories providing significant (more than 10% of) ongoing analytical services and before establishing a contract for any new laboratories. Laboratory audits will be performed in accordance with the procedures of SQP 12.1 and its attached *Laboratory Audit Checklist* (Attachment 6-3). If recent audits have been conducted on the laboratory by qualified third parties, the third-party audit report may be used to address some or all of this audit requirement depending on the scope of the third-party audit.

15.4 Auditor Qualifications

The contractor project QA manager will be responsible for ensuring that qualified and trained personnel are selected to perform auditing activities. Personnel selected for quality-auditing assignments will have experience or training commensurate with the scope, complexity, or special nature of the activities to be audited. Auditors will have, or be given, appropriate training or orientation to develop their competence for performing required audits.

15.5 Audit Teams

The contractor project QA manager or LM site manager will be responsible for designating an audit team and audit team leader for each audit to be conducted. Audit teams will consist of an audit team leader and qualified auditors who are aware of the types of activities to be audited, or the audit may be performed solely by the audit team leader.

Audits will be performed in accordance with preestablished written procedures or checklists as early in the life of the activity as practical and will continue at intervals consistent with the schedule for accomplishing the activity. Objective evidence, such as documents and records, will be examined to the depth necessary to determine if this QAPP, applicable work plans, and supporting procedures are being effectively and properly implemented.

Audit results will be documented by auditing personnel, analyzed by the audit team leader, and reported to the contractor project manager or subcontractor task leader for review, assessment, and appropriate action. Significant conditions requiring corrective action will be promptly reported to the contractor project manager along with a recommended CA, as appropriate.

15.6 Audit Reporting

The audit team leader will informally review the audit findings and observations with the project staff or subcontractors being audited. If significant audit findings or observations remain unresolved upon completion of the audit and informal review, the audit team leader will prepare and issue an audit report that provides the following information at a minimum:

- Unique audit number
- Description of the audit scope

- Audit personnel (including the audit team leader)
- People contacted during the audit activities
- Audit dates
- Summary of audit results
- Suggested opportunities for improvement, as applicable, in the form of observations and comments
- Description of each significant audit finding in sufficient detail to enable a CA to be performed

15.7 Audit Response

Management of the activity being audited will investigate significant audit findings, determine the root cause of the condition identified in the findings, and schedule CAs for the findings, including measures to prevent a reoccurrence. Management will also evaluate the impact of the findings on completed work and notify the contractor project QA manager, in a written response, of the action taken or planned.

A tracking system for audit findings will be established to help ensure that all findings are appropriately addressed and to analyze trends in audit findings for significant conditions adverse to quality. Follow-up action, including a re-audit of deficient areas, may be taken to verify whether a CA is accomplished as scheduled.

SQP 12.1 describes the procedures for implementing audits.

15.8 Management Assessment

The contractor project manager will conduct routine assessments, using a combination of formal and informal evaluation activities as described below:

1. Formal assessments are conducted by using the following methods, at a minimum:
    - Review of QC reports
    - Review of, and response to, performance or system audit reports
    - Review of, and response to, performance or system audits by DOE
    - Review and approval of project reports to DOE or regulatory agencies
2. Informal evaluations are conducted by using the following methods, at a minimum:
    - Review of responses to nonconformance reports
    - Review of responses to CA requests
    - Comparison of program performance to minimum goals
    - Project status meetings and site visits

Informal evaluations do not require documentation by the contractor project manager.

The LM site manager, or designee, performs an annual system assessment to evaluate the effectiveness of the quality management system controls that are established to achieve and ensure quality and the adequacy of resources and personnel to achieve and ensure quality.

Annual assessments are performed through a review of project quality-related activities and control mechanisms. This assessment will include reviews of internal audit reports and CA requests, both of which will include a review of specified CAs. Additionally, discussions with both employees and the contractor contracts administrator regarding the adequacy of program implementation will be conducted, and areas for improvement will be identified.

CAs will be implemented as agreed on by the LM site manager and contractor project managers such that recommendations contained within the annual assessment are implemented and monitored for effectiveness.

15.9 Surveillances

The contractor project QA manager, or his or her designated representative, will conduct surveillances of project task activities. Surveillances may be scheduled or unscheduled and consist of monitoring activities to verify that items or activities for each project task conform to the specified requirements.

Surveillances may or may not be documented. However, when nonconforming items or activities are identified during surveillances, they will be reported in a surveillance report to the subcontractor task leader or subcontractor project manager or on a nonconformance report or CA request as appropriate to the nonconforming conditions. Surveillances will only be conducted at out-of-state locations if authorized in the DOE task assignment.

SQP 12.3, “Quality Surveillances,” describes the procedures for implementing surveillances.

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Weiss (Weiss Associates), 2005. *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment (Part B–Risk Characterization for DOE Areas) at the Laboratory for Energy-Related Health Research*, Rev. 0, University of California, Davis, September.

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Appendix A

Assignment of Key Personnel to Project Roles

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Appendix A
Assignment of Key Personnel to Project Roles

Project Role	Contract Role/Title Weiss Applicable	Name	Agency or Organization	Contact Information
REGULATORY AGENCIES				
Regulatory Agency Representative	NA	Holly Hadlock	U.S. EPA 75 Hawthorne Street San Francisco, CA 94106	Phone: (415) 972-3171 Email: Hadlock.Holly@epa.gov
Regulatory Agency Representative	NA	Durin Linderholm	Central Valley RWQCB 11020 Sun Center Dr. #200 Rancho Cordova, CA 95670	Phone: (916) 464-4657 Email: Durin.Linderholm@waterboards.ca.gov
Regulatory Agency Representative	NA	John Bystra	DTSC 8800 Cal Center Drive Sacramento, CA 95826	Phone: (916) 255-3669 Email: John.Bystra@dtsc.ca.gov
RESPONSIBLE PARTY				
LM Site Manager	NA	Kathleen Whysner	U.S. DOE–Office of Legacy Management 2597 Legacy Way Grand Junction, CO 81503	Phone: (970) 812-7462 Email: kathleen.whysner@lm.doe.gov
CONTRACTOR – RSI EnTech, LLC				
Project Manager	LMS Site Lead	Mike Butherus	RSI EnTech, LLC 2597 Legacy Way Grand Junction, CO 81503	Phone: (970) 248-6332 Email: michael.butherus@lm.doe.gov
Project Records Administrator	LMS Records Contact	Shawn Hawkins		Phone: (970) 248-6174 Email: shawn.hawkins@lm.doe.gov
Project Health and Safety Manager	LMS Safety and Health	Nikole Cale		Phone: (304) 413-0349 Email: nicole.cale@lm.doe.gov
Contracts Administrator	LMS Contracts Administrator	Julie Dorris		Phone: (970) 248-6684 Email: julie.dorris@lm.doe.gov
Project Environmental and Regulatory Compliance Manager	LMS Environmental Compliance	Cameron Garcia		Phone: (970) 248-6189 Email: cameron.garcia@lm.doe.gov
Project Quality Assurance Manager	LMS Quality and Performance Assurance Manager	Raymond Keeler		Phone: (970) 248-6296 Email: raymond.keeler@lm.doe.gov

Appendix A
Assignment of Key Personnel to Project Roles

Project Role	Contract Role/Title Weiss Applicable	Name	Agency or Organization	Contact Information
CONTRACTOR–UC DAVIS				
Project Manager		Chris Wright	UC Davis EH&S One Shields Avenue Davis, CA 95616	Phone: (530) 681-1793 (cell) Email: cvwright@ucdavis.edu
Project Records Administrator		Rachel Lauesen		Phone: (530) 752-9184 Cell:(530) 312-4535 Email: rllauesen@ucdavis.edu
Project Health and Safety Manager		Rachel Lauesen		Phone: (530) 752-9184 Cell:(530) 312-4535 Email: rllauesen@ucdavis.edu
Contracts Administrator		Katarina Mitchel		Phone: (530) 712-2178 Email: kmitchel@ucdavis.edu
Project Environmental and Regulatory Compliance Manager		Chris Wright		Phone: (530) 681-1793 (cell) Email: cvwright@ucdavis.edu
Project Quality Assurance Manager		Rachel Lauesen		Phone: (530) 752-9184 Cell:(530) 312-4535 Email: rllauesen@ucdavis.edu
SUBCONTRACTOR				
Project Manager	NA	Robert O. Devany	Weiss Associates 2000 Powell Street, Suite 555 Emeryville, CA 94608	Phone: (510) 450-6144 Email: rod@weiss.com
Project Records Manager	NA	Michele Martinez		Phone: (510) 450-6116 Email: mlm@weiss.com
Project Health and Safety Manager	NA	Agata Sulczynski		Phone: (510) 450-6119 Email: aas@weiss.com
Task Leader	NA	Tim Utterback		Phone: (510) 450-6193 Email: tru@weiss.com
Task Leader	NA	Mary Stallard		Phone: (510) 450-6132 Email: mls@weiss.com
Contracts Administrator	NA	Mark Eley		Phone: (510) 450-6192 Email: mje@weiss.com
Database Manager	NA	Jim Martin		Phone: (510) 450-6126 Email: jam@weiss.com
Project Chemist	NA	Brian Bandy		Phone: (510) 450-6145 Email: bpb@weiss.com
Project Quality Assurance Manager	NA	Joyce Adams		Phone: (510) 450-6162 Email: jea@weiss.com

Appendix B

Standard Operating Procedures and Standard Quality Procedures

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Standard Quality Procedures

SQP 3.2 Indoctrination and Training

SQP 3.3 Readiness Review Inspection

SQP 4.1 Document Control

SQP 4.2 Records Management

SQP 4.3 Records Tracking

SQP 5.1 Preparation, Revision, and Approval of Plans and Procedures

SQP 7.1 Quality Inspections and Inspection Records

SQP 7.2 Receipt Inspection

SQP 8.1 Calibration and Maintenance of Measuring and Test Equipment

SQP 10.1 Nonconformance Control

SQP 10.2 Quality Corrective Action

SQP 10.3 Stop Work Order

SQP 11.1 Field Work Variance/Modification

SQP 12.1 Quality Audits

SQP 12.3 Quality Surveillances

Note: SQPs may be revised, added, or deleted in accordance with the provisions of the QAPP. An updated list of standard quality procedures will be maintained and be available to the team working on the LEHR project for use on the project. SQPs are not numbered sequentially. Therefore, a missing number in the above list does not signify that an SQP is missing.

Standard Operating Procedures

SOP 1.1–Sample Custody

SOP 1.2–Field Activity Daily Log

SOP 1.3–Field Measurements, Maintenance, and Calibration of Instruments

SOP 2.1–Sample Handling, Packaging, and Shipping

SOP 3.1–Surface and Shallow Soil Sampling

SOP 3.2–Subsurface Soil Sampling While Drilling

SOP 5.1–Water Level Measurements in Monitoring Wells

SOP 6.1–Sampling Equipment and Well Material Decontamination

SOP 6.2–Drilling, Development, and Heavy Equipment Decontamination

SOP 8.3–Borehole and Well Abandonment

SOP 9.3–Low-Flow Groundwater Sampling

SOP 9.4–Surface Water Sampling

SOP 10.1–Soil Organic Vapor Sampling

SOP 11.1–Aquifer Testing

SOP 11.2–Data Logging and Transducers

SOP 14.1–Hollow Stem Auger Drilling

SOP 14.5–Direct Push Technology

SOP 15.1–Borehole Lithologic Logging

SOP 17.1–Sample Labeling

SOP 17.2–Sample Numbering

SOP 17.3–Sampling Protocol

SOP 17.4–GeoTracker Electronic Reporting

SOP 18.1– Field QC Sampling

SOP 20.1–Sample Containers, Preservation, and Holding Times

SOP 21.1–Data Validation

SOP 21.2–Data Verification

SOP 23.1–Land Surveying

Note: SOPs may be revised, added, or deleted in accordance with the provisions of the QAPP. An updated list of SOPs will be maintained and be available to the project team for use on the project. SOPs will be reviewed for applicability and updated as necessary during the planning phase of each project task using the guidance presented in the QAPP. SOPs are not numbered sequentially. Therefore, a missing number in the above list does not signify that an SOP is missing.

INDOCTRINATION AND TRAINING

STANDARD QUALITY PROCEDURE 3.2

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities for the indoctrination and training of personnel who will perform quality-affecting activities on the Contract.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

3. Definitions

Indoctrination - The process that provides initial information to familiarize personnel with the general criteria of the project/task activities, applicable quality criteria, and job responsibilities.

Qualification (Personnel) - The characteristics or abilities gained through education, training, and/or experience, as measured against established requirements, such as standards, tests, and/or evaluations that qualify a person to perform a required function.

Training - To impart specific information with regard to job functions that will achieve initial proficiency, maintain proficiency, and adapt to changes in technology, methods, or job functions.

4. Procedure

4.1 General Requirements

Scheduling of all training activities will be on an as-needed basis. Training will be conducted to assure that personnel receive initial training and periodic refresher training when required.

Personnel will be indoctrinated, at a minimum, to the applicable quality plans and procedures, project/task objectives and goals, and applicable technical plans that identify technical criteria prior to performing work on a task. It is the responsibility of the Subcontractor Project Manager (SPM) or Subcontractor Task Leader (STL) to assure that personnel assigned to task

activities attend a quality assurance (QA) indoctrination, which is conducted by the Subcontractor Quality Assurance Manager (SQAM).

4.2 Training

Training of personnel performing quality affecting activities will be conducted in accordance with the training requirements established within training matrices (Attachment 6.1) for each job position on an assigned task.

The SPM or STL and SQAM will develop training matrices, which will include the planning documents and procedures. The training matrices will identify the training requirements for the plans and procedures by job classification. Other required training (e.g., operator, equipment, etc.) will also be identified.

Training will be performed using any combination of the methods listed below:

- Training provided by a Manufacturer or Supplier;
- Classroom instruction;
- On-the-job with demonstration of capabilities on actual equipment; and/or
- Required reading assignments.

Training instructors will be designated by the SPM or STL, based on trainee experience with the particular subject. He or she will have the option of using vendor representatives, or a combination of vendor and project/task personnel for instructors, as appropriate.

4.3 Project Task Requirements

The STL is responsible for ensuring that site personnel are properly indoctrinated and trained in the implementation of project task plans and procedures prior to their involvement in project task activities.

Attendance of indoctrination and training will be documented on a Training Attendance Record (Attachment 6.3), and/or a Required Reading Checklist (Attachment 6.4), as applicable.

4.4 Equipment Training

Personnel will be trained and qualified in the operation, maintenance, repair, and calibration of equipment, instruments, and tools prior to their utilization.

The instructor will provide training by reviewing with trainees the operation procedure or the operation and maintenance manuals of the equipment manufacturer.

The trainee will demonstrate the proper operation and maintenance of equipment for the instructor through utilization of that equipment, or the trainee will demonstrate an authentic mock-up of the safe operation and maintenance for the instructor, where this is more practical.

If equipment manufacturers or suppliers can provide acceptable training in the operation and servicing of their equipment, those services will be utilized.

5. Records

Records generated as a result of this SQP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Training Matrix Form

6.2 Personnel Qualification Evaluation

6.3 Training Attendance Record

6.4 Required Reading Checklist

A form referenced or attached to this SQP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

TRAINING MATRIX FORM

QUALITY ASSURANCE TRAINING MATRIX

Task Leader Approval: _____ Date: _____
Program Quality Assurance Manager Approval: _____ Date: _____
Employee Name: _____ Position: _____
Completion Reviewed by Task Leader: _____ Date: _____

Document Section		Signature/Date	Subcontractor Project Manager	Subcontractor Project Task Leader	Field Personnel	Subcontractor Project QA Manager	Subcontractor Chemist	Subcontractor Database Manager	Subcontractor H&S Manager	Subcontractor Contracts Administrator
QAPP	**QUALITY ASSURANCE PROJECT PLAN**									
Sect. 1	Introduction		X	X	X	X	X	X	X	X
Sect. 2	Responsibilities and Organization		X	X	X	X	X	X	X	X
Sect. 3	Quality Control Management		X	X		X	X	X		
Sect. 4	Document Control and Records Management		X	X		X	X	X		X
Sect. 5	Personnel Training and Qualification		X	X	X	X	X		X	
Sect. 6	Instructions, Procedures, and Drawings			X	X	X	X		X	
Sect. 7	Procurement Quality Assurance Activities		X	X	X	X	X	X		X
Sect. 8	Data Generation and Acquisition		X		X	X	X	X		
Sect. 9	Design Control		X	X	X	X	X			
Sect. 10	Report Preparation		X	X		X	X			
Sect. 11	Review of Work Activities		X	X	X	X	X		X	
Sect. 12	Inspections		X	X	X	X	X		X	
Sect. 13	Nonconformance Control and Corrective Actions		X	X	X	X	X	X	X	
Sect. 14	Change Control		X	X		X	X			X
Sect. 15	Audits and Surveillance		X	X	X	X	X			

QUALITY ASSURANCE TRAINING MATRIX

Document Section		Signature/Date	Subcontractor Project Manager	Subcontractor Project Task Leader	Field Personnel	Subcontractor Project QA Manager	Subcontractor Chemist	Subcontractor Database Manager	Subcontractor H&S Manager	Subcontractor Contracts Administrator
SQPs	**STANDARD QUALITY PROCEDURES**									
SQP-3.2	Indoctrination and Training		X	X		X				
SQP-3.3	Readiness Review		X	X	X	X	X	X	X	X
SQP-4.1	Document Control		X	X		X		X		X
SQP-4.2	Records Management		X	X		X		X		X
SQP-4.3	Records Tracking		X	X		X		X		X
SQP-5.1	Preparation, Revision and Approval of Plans and Procedures		X	X		X	X		X	X
SQP-7.1	Quality Inspections and Inspection Records			X		X				
SQP-7.2	Receipt Inspection			X	X	X				
SQP-8.1	Calibration and Maintenance of Measuring and Test Equipment			X	X					
SQP-10.1	Nonconformance Control		X	X	X	X	X	X	X	X
SQP-10.2	Corrective Action		X	X	X	X	X	X	X	X
SQP-10.3	Stop Work		X	X	X	X	X	X	X	X
SQP-11.1	Field Work Variance/Field Work Modification		X	X	X	X			X	
SQP-12.1	Quality Audits		X	X		X	X	X		X
SQP-12.3	Quality Surveillance		X	X	X	X	X	X	X	X

QUALITY ASSURANCE TRAINING MATRIX

Document Section		Signature/Date	Subcontractor Project Manager	Subcontractor Project Task Leader	Field Personnel	Subcontractor Project QA Manager	Subcontractor Chemist	Subcontractor Database Manager	Subcontractor H&S Manager	Subcontractor Contracts Administrator
SOPs	**STANDARD OPERATING PROCEDURES**									
SOP 1.1	Sample Custody									
SOP 1.2	Field Activity Daily Log									
SOP 1.3	Field Measurement, Maintenance, and Calibration									
SOP 2.1	Sampling Handling, Packaging and Shipping									
SOP 3.1	Surface and Shallow Soil Sampling									
SOP 3.2	Subsurface Soil Sampling While Drilling									
SOP 5.1	Water Level Measurements in Monitoring Wells									
SOP 6.1	Sampling Equipment and Well Material Decontamination									
SOP 6.2	Drilling, Development, and Heavy Equipment Decontamination									
SOP 8.3	Borehole and Well Abandonment									
SOP 9.3	Low-Flow Groundwater Sampling									
SOP 9.4	Surface Water Sampling									
SOP 10.1	Soil Organic Vapor Sampling									

QUALITY ASSURANCE TRAINING MATRIX

Document Section		Signature/Date	Subcontractor Project Manager	Subcontractor Project Task Leader	Field Personnel	Subcontractor Project QA Manager	Subcontractor Chemist	Subcontractor Database Manager	Subcontractor H&S Manager	Subcontractor Contracts Administrator
SOPs	**STANDARD OPERTATING PROCEDURES (continued)**									
SOP 11.1	Aquifer Testing									
SOP 11.2	Data Logging and Transducers									
SOP 14.1	Hollow Stem Auger Drilling									
SOP 14.5	Direct Push Technology									
SOP 15.1	Borehole Lithologic Logging									
SOP 17.1	Sample Labeling									
SOP 17.2	Sample Numbering									
SOP 17.3	Sampling Protocol									
SOP 17.4	GeoTracker Electronic Reporting									
SOP 18.1	Field QC Sampling									
SOP 20.1	Sample Containers, Preservation, and Holding Times									
SOP 21.1	Data Validation									
SOP 21.2	Data Verification									
SOP 23.1	Land Surveying									

ATTACHMENT 6.2

PERSONNEL QUALIFICATION EVALUATION

PERSONNEL QUALIFICATION EVALUATION

Task Name: _____

PERSON EVALUATED: _____

COMPANY/GROUP: _____

The above-named individual has been evaluated on the basis of his/her current education, work experience, and training, as represented in the attached documents, and has been found to be qualified to perform tasks in the following areas:

1. _____
2. _____
3. _____
4. _____
5. _____

These qualifications have been verified and found to be true and correct to the best of my knowledge.

Signed: _____ Title: _____

Date: _____

Additional training is recommended in the following subjects:

1. _____
2. _____
3. _____
4. _____

ATTACHMENT 6.3

TRAINING ATTENDANCE RECORD

TRAINING ATTENDANCE RECORD

Company:

Subject:			Date:
Instructor:		Location:	Contact Hours:
Brief Course Description:			

Name	Signature	Organization/Project	Position

ATTACHMENT 6.4

REQUIRED READING CHECKLIST

REQUIRED READING CHECKLIST

Company: Task Name:

Employee Name:			Job Title:
Document Title:			
Section Number	Rev. Number	Section Title	Employee Signature / Date
Reviewed by Employee's Task Manager / Date:			Reviewed by PQA Manager / Date:

READINESS REVIEW INSPECTION

STANDARD OPERATING PROCEDURE 3.3

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities for the performance and documentation of Readiness Review Inspection for activities performed during project tasks to ensure compliance with project requirements. The Readiness Review Inspection is designed to demonstrate that it is safe to start or resume a project field task. The inspections are not intended solely to be tools of line management to confirm readiness. Rather, the inspections provide an independent verification of readiness to start or restart an activity. This inspection is very similar to the Preparatory Phase Inspection (SQP 7.1) and differs primarily in client and third party notification and/or involvement in the Readiness Review Inspection. In general, the need for a Readiness Review Inspection will be dictated by the contract and/or client requirements. Thus, a Readiness Review Inspection is not conducted for all projects or tasks.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

SQP 7.1 - Quality Inspections and Inspection Records

SQP 10.1 - Nonconformance Control

3. Definitions

Inspection - Examination or measurement to verify whether an item or activity conforms to specified requirements.

4. Procedure

4.1 Qualification of Inspectors

Personnel performing inspection activities will have the necessary expertise in the area to be inspected, but will be sufficiently independent of the activity performed.

Prior to performance of inspection activities, personnel designated for that responsibility will review and be thoroughly familiar with the procedures, regulations, etc., governing the activities to be inspected.

4.2 Field Inspection Plans and Reports

Project activities requiring inspection (i.e., Preparatory Phase, Initial Phase, and Follow-up Phase) will have an "Items to Inspect Checklist" (see SQP 7.1) or similar work product (or checklist) prepared for that activity. Inspection(s) will be performed for activities which are identified for major tasks and will be performed consistent with ongoing project activities. As deemed applicable by the Subcontractor Project Manager (SPM) and the Subcontractor Project Quality Assurance Manager (SPQAM), a Preparatory Phase Inspection Checklist for each task shall be prepared by the Subcontractor Task Leader (STL).

The "Items to Inspect Checklist" will identify the items and activities to be inspected. If hold points are required, the definable "Items to Inspect Checklist" will identify them and indicate required notifications and sign-offs. The SPM and SPQAM will limit the number of Items to Inspect to ensure that undue inspection activities are not spent on smaller tasks.

If a Nonconformance Report (SQP 10.1) is required for activities being inspected, a reference will be provided on the Contractor QC Report (see SQP 7.1).

The Contractor QC Reports will be issued, identifying inspections performed. The report will be completed by the Subcontractor Project Chemist (SPC) and will address each inspection performed during the course of the daily activities.

Items or activities not conforming to inspection acceptance criteria will be resolved and, when determined necessary, documented on a Nonconformance Report. Contractor QC Reports will be logged and sequentially numbered by project task. Each Contractor QC Report will be signed by the SPC, certifying that the activities listed within the report have been completed in accordance with the project planning documents to the best of his or her knowledge.

5. Records

Records generated as a result of this SQP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

None.

DOCUMENT CONTROL

STANDARD QUALITY PROCEDURE 4.1

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities associated with the control and distribution of project documents.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

SQP 5.1 - Preparation, Revision and Approval of Plans and Procedures

SQP 11.1 - Field Work Variance

3. Definitions

Planning Documents - Those documents that establish the requirements and methods to implement the project activities. These documents are identified as Work Plans, Quality Assurance Project Plan (QAPP), Project Health and Safety Plan (PHSP), Standard Quality Procedures (SQPs), Standard Operating Procedures (SOPs), Health and Safety Procedures (HSPs), Contingency Plan and General Emergency Response Procedures (CPGERP), and Field Work Variances (FWV).

Controlled Documents - Documents that have been assigned a unique identifier and issued to a specific person, discipline, or facility. These documents are maintained current for their initial issue and revisions.

Uncontrolled Documents - A document that is issued current, but is not maintained current with revisions.

Decontrolled Documents - A copy of a controlled document that is issued current, but is not maintained current with revisions.

Decontrolled copies of controlled documents may be issued for informational purposes to parties not directly performing the governed work, but these copies must be clearly identified as decontrolled copies of a controlled document.

4. Procedure

4.1 Responsibilities

The Subcontractor Project Manager (SPM)/Subcontractor Task Leader (STL) is responsible for the control of project/task plans, procedures, and FWVs. This includes establishing and maintaining lists of personnel who are issued controlled copies of those documents.

The Subcontractor Project Records Manager (SPRM) is responsible for the full implementation of the requirements of this SQP.

4.2 Control and Distribution

Once project documents have been prepared and approved, they will be issued to applicable personnel who are identified as controlled document holders.

Each individual document issued will have a separate and distinct title page, which contains the name of the recipient and the control number of the document.

Controlled documents will be password protected, with read/write access available only to the administrative staff.

Distribution of documents will be controlled via a spreadsheet which will show the recipient name, control number, and date or dates of distribution.

A controlled copy document may be reissued to another document holder upon a written request. Reissuing an already existing controlled copy document to a new document holder will be done by transmitting a new cover page.

4.3 Revisions

Revisions to approved plans and procedures will be issued in the same manner as the original. Superseded record copies will be marked "Superseded by Revision X" in the project record files.

5. Records

Records generated as a result of implementing this SQP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

None.

RECORDS MANAGEMENT

STANDARD QUALITY PROCEDURE 4.2

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities associated with the management of project and task records.

2. References

Quality Assurance Project Plan (QAPP)

SQP 10.1 - Nonconformance Control

3. Definitions

Records - All forms of documentation relating to a project, including but not limited to paper and electronically stored documents, photographs, and video/audio tapes.

Administrative Documents - Documents that do not directly provide objective evidence of the quality of items or activities, or compliance to the contract or regulatory requirements.

4. Procedure

4.1 Discussion

Accurate records are critical to a project for historical purposes, including liability and regulatory issues. The proper management of these records is necessary to ensure that a complete and comprehensive historical representation of project activities is maintained.

4.2 Responsibilities

The Prime Contractor Project Manager (PCPM) has the overall responsibility for the management of records, including but not limited to providing for adequate physical and electronic storage facilities, maintaining those facilities, and assuring implementation of this SQP. He or she will designate the personnel authorized to add or remove program records from the records file area.

Consultants shall, upon completion of assigned tasks, transmit a copy of their final report to the PCPM to be included in the project records at the U.S. Department of Energy. The PM shall contractually require the contractor(s) to transfer all quality records and records that support or potentially support cleanup decisions at the Site, including but not limited to all final work plans, sampling and analysis plans, field notes, field variances, quality assurance (QA) non-compliance reports, lessons learned reports, final and as-built drawings and specifications, reports, responses to regulatory comments, letters from regulatory agencies, and UC Davis upon contract termination.

The Subcontractor Project Manager (SPM) is responsible for the collection, maintenance, and control of project records. For completed tasks, the SPM is responsible for generating and transmitting reports and other documents that contain all data, analyses, and interpretations constituting the contracted consulting effort. The PCPM will confirm that these items are documented in one or more project reports. For tasks that are still in-progress, draft documents and other working files will be retained by the PCPM and transferred to the Consultant assigned to complete that task. In most cases, draft versions of these documents will not be retained beyond the end of the task, unless a draft document was documented elsewhere as being the final approved version.

The Prime Contractor Quality Assurance Manager (PCQAM) advises the PCPM and is responsible for performing audits and surveillances of record files to verify the effectiveness of the records control system.

The Subcontractor Quality Assurance Manager (SQAM) reports to the SPM and is responsible for monitoring the records control system of project records for specific tasks.

4.3 Receipt

All incoming project and task records and administrative documents received will be sent to the SPM. Records generated in the field will be packaged and sealed at the end of each field activity, as a minimum, and sent to the SPM in the project office for incorporation into the records files. If records are missing, copies will be generated from the field records files and sent with the next shipment to the SPM.

The SPM is responsible for compiling all project records and transmitting to the PM, either within generated reports or as compiled sets of related task-specific records.

4.4 Indexing and Filing

The SPM shall organize and index all physical and electronic records in a systematic manner, with indexes created to facilitate effective and efficient document searching and retrieval. Working documents may be maintained in the Consultant's project office, but all official records shall be transmitted to the PCPM by the SPM and maintained at the U.S. Department of Energy.

Hard copy field forms will be transported back to the Consultant's project office, scanned, and filed electronically with the appropriate task-specific project files. Once scanned and transmitted to the PCPM, the physical copies of field forms may be destroyed.

When the project or part of the project is complete, the SPM will transmit all associated records to the PCPM, and will retain copies of all records within project files as specifically required by the U.S. Department of Energy in the Contract. For completed reports, drafts shall not be retained once the final report or other final deliverable is approved.

4.5 Storage

Records will be stored in a manner that will preclude their loss, damage, or tampering. The PCPM will affect administrative procedures and physical safeguards to ensure the security of the records at the U.S. Department of Energy. Each SPM will affect administrative procedures and physical safeguards to ensure the security of the records at their respective offices.

4.6 Project Close-out

Upon contract termination and demobilization from the project site, the SPM will turn over all unsubmitted project files to the PCPM for incorporation into the project files.

4.7 Records Retention

Project documents and records shall be retained, at a minimum, for a period of 10 years after delisting the Site from the National Priorities List or as otherwise required for compliance with CERCLA. All requests for copies of records will be made through the PCPM.

4.8 Digital Files

Many client files, working files, etc. are not held in the hard copy library, but are stored on our network. For some clients, a searchable pdf library of client deliverables is also maintained. These libraries are kept until the project closes, when they are transferred to an Archive drive.

4.9 Nonconformance

Any significant deviation to this SQP will be immediately reported to the SPM and the SQAM by the individual who discovers the deviation.

5. Records

Records generated as a result of implementing this SQP will be controlled and maintained in the project record files in accordance with this SQP.

6. Attachments

None.

RECORDS TRACKING

STANDARD QUALITY PROCEDURE 4.3

1. Purpose

This Standard Quality Procedure (SQP) establishes guidelines and procedures to be used by all contractor and subcontractor personnel for records tracking. Detailed logs and attention to these guidelines are necessary to assure the quality and integrity of all records. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

3. Definitions

Records - All forms of documentation relating to a project, including but not limited to paper and electronically stored documents, photographs, and video/audio tapes.

Incoming Log - The document used to track all incoming records.

Outgoing Log - The document used to track all outgoing records.

4. Procedure

This section contains both the responsibilities and procedures involved with records tracking. Adherence to proper records procedures is necessary to ensure the quality and integrity of the records. Accurate records are critical to a project for historical purposes, including liability and regulatory issues. The details within this SOP should be used in conjunction with SQP 4.2 (Records Management) and project work plans.

4.1 Responsibilities

The Subcontractor Program Manager (SPM) has the overall responsibility for the management of records, including but not limited to providing for adequate storage facilities, maintenance of those facilities, and assuring implementation of this SOP.

The SPM reports to the Subcontractor Program Manager (SPM) and is responsible for the collection, maintenance, and control of project records.

The Subcontractor Project Quality Assurance Manager (SPQAM) reports to the SPM and is responsible for performing audits and surveillances of records files to verify the effectiveness of the records control system.

Each Subcontractor Task Leader (STL) reports to the SPM and is responsible for monitoring the records control system of project records in the field office.

The Subcontractor Project Records Manager (SPRM) reports to the Subcontractor Project Quality Assurance Manager (SPQAM) and is responsible for properly logging incoming and outgoing records and filing records in the Project records file.

The Subcontractor Project Records Manager (SPRM) reports to the SPM and is responsible for properly filing and maintaining project records in the field office.

Each member of the Project team is responsible for informing the SPRM when in receipt of, or issuing, documentation critical to the Project.

4.2 Receipt

All incoming Project record(s) and administrative documents received at the Program office will be sent to the SPRM and stored in the client files.

Records generated in the field will be delivered to the office for incorporation into the records files.

4.3 Indexing and Filing

Records will be organized into logical file categories.

5. Records

None.

6. Attachments

None.

PREPARATION, REVISION, AND APPROVAL OF PLANS AND PROCEDURES

STANDARD QUALITY PROCEDURE 5.1

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities associated with the preparation, revision, and approval of quality-affecting documents.

2. References

Quality Assurance Project Plan (QAPP)

Project Health and Safety Plan (PHSP)

SQP 4.2 - Records Management

SQP 11.1 - Field Work Variance

3. Definitions

Quality Assurance Project Plan (QAPP) - A plan describing the quality assurance requirements to be applied, as applicable, to the project requirements, which includes the methods and responsibilities established to meet those requirements specified.

Standard Quality Procedures (SQPs) - A set of procedures that establish the responsibilities and describe the methods of performing quality-affecting activities in response to QAPP requirements.

Standard Operating Procedures (SOPs) - A set of procedures that prescribe the actions necessary to complete a work operation in accordance with accepted practices for quality.

Health and Safety Procedures (HSPs) - A set of procedures that describe the actions necessary to ensure that project work is conducted within accepted practices for health and safety.

Quality Achievement/Efficiency Improvement - A change in any aspect of the project that will result in meeting the quality goals of this project, with a corresponding improvement in project efficiency or reduction in project costs.

4. Procedure

4.1 Discussion

The QAPP is established and maintained as the documented basis for compliance with the project quality assurance requirements. The QAPP emphasizes the commitment of UC Davis and each of their contractors to meeting those requirements. The associated SQPs and SOPs establish methods and responsibilities for complying with those commitments.

4.2 Responsibilities

The Contractor Project Manager (PCPM) has the responsibility to assure that the QAPP is implemented effectively by all project personnel. Further, the subcontractor Project Manager (SPM) is responsible to ensure all SOPs and SQPs required for project performance are prepared by qualified personnel and reviewed and approved by authorized personnel prior to the implementation of project activities. The PCPM may assign this task to a Consultant but retains the ultimate responsibility.

The Subcontractor Quality Assurance Manager (SQAM) is responsible for the preparation and maintenance of the QAPP and SQPs. The SQAM reviews and approves SOPs to assure compliance with the requirements of the QAPP and that they constitute an acceptable approach to meeting QA objectives. He or she is also a part of the approval cycle for the technical project planning documents (e.g., work plan, sampling and analysis plan, etc.). The Contractor Project Quality Assurance Manager (PCQAM) may assign this task to a Consultant but retains the ultimate responsibility.

The Contractor Project Health and Safety Manager (PCPHSP) is responsible for the preparation and maintenance of HSPs. The PCPHSP reviews and approves HSPs to assure compliance with the requirements of the PHSP. He or she initiates revision of the HSPs due to programmatic requirement changes, audit findings, or corrective actions, as applicable. The PCPHSP may assign this task to a Consultant but retains the ultimate responsibility.

4.3 Preparation

The SQAM determines the need for establishing a procedure describing how to perform quality-affecting activities. He or she also initiates revisions to these documents due to programmatic requirement changes, audit findings, or corrective actions, as applicable.

Procedures, Field Work Variances (FWV), and drawings will include appropriate qualitative and quantitative acceptance criteria for determining satisfactory work performance and quality compliance.

4.4 Format

The SQPs, SOPs, and HSPs will adhere to a consistent format in accordance with the following guidelines:

Revision Block - This area will contain the document identification, section or procedure number, revision number, date, and pages. This information will appear on each page of the document.

Title Block - This area will contain the title of the SQP, SOP or HSP and will appear on the first page only.

4.5 Contents

Procedures required to implement project task activities will include the information listed below. When any of these items are not required or are inappropriate to the SQP, SOP, or HSP, they will be noted by the word "none."

Describe the purpose of the SQP, SOP or HSP. Be as specific as possible; do not generalize.

- ***References*** - Identify pertinent documents or procedures that interface with the SQP, SOP, or HSP being prepared. Reference to specific documents that are directly applicable to the SQP, SOP, or HSP (e.g., QAPP, PHSP, etc.) is acceptable.
- ***Definitions*** - Define words and phrases that have a special meaning of application within the SQP, SOP, or HSP. Definitions must be consistent with the glossary of terms located within the QAPP.
- ***Procedure*** - Identify the sequence of activities to be followed and assign responsibility for accomplishing activities; be specific in context. Include appropriate reporting requirements for assuring that important activities have been satisfactorily accomplished and incorporate examples of forms or documents that are required to be completed as a result of the procedure implementation.
- ***Records*** - If there are any special record handling requirements, identify them in this section; otherwise, state that records generated will be maintained in accordance with the SQP for records management.
- ***Attachment*** - List all attachments that will be included within the specific SQP, SOP, or HSP.

4.6 Approval

The signature of the PCPM, the SQAM, and others, as deemed necessary by the PCPM on the Table of Contents and Log of Revisions or cover page, will signify that the documents and

revisions listed are authorized for use. For SQPs and SOPs, the PCPM, and SQAM will sign the Table of Contents and Log of Revisions page of the procedure manual, indicating their approval.

4.7 Manual Change Requests

Personnel responsible for complying or interfacing with the requirements of the QAPP, SQPs, or SOPs may request revisions to these documents via a Document Change Request (DCR) submitted to the SQAM. Document change requests are different from field work modifications, as they are used to suggest improvements to existing processes or systems and are not structured to adjust the plans and procedures based on changing site conditions.

The SQAM is responsible for reviewing all DCRs and either accepting or rejecting them. If a DCR is accepted, the SQAM will make the change within the document.

If a DCR is not accepted, the SQAM will notify the originator that the DCR was not accepted and explain why.

4.8 Quality Achievement/Efficiency Improvement

Personnel responsible for complying or interfacing with the requirements of any aspect of a project may request quality improvements via a Quality Achievement/Efficiency Improvement Request (QIR). QIRs are used to suggest improvements to existing processes, systems, or procedures based on changing site conditions or observations of project inefficiency.

The SQAM and management are responsible for reviewing all QIRs and either accepting or rejecting them. If a QIR is accepted, the Project Team will be notified of each QIR that has been implemented.

If a QIR is not accepted, the SQAM will notify the originator that the QIR was not accepted and explain why.

4.9 Revisions

Revisions to an approved QAPP, SQP, SOP, or technical planning document will be documented and will receive the same level of review, approval, and control as the original document.

Field Work Variances (FWV), (SQP 11.1) will be issued by the SQAM using the FWV form. When 12 months have elapsed for a Field Work Modification Form or six have been issued, whichever comes first, the SQAM may elect to issue new revisions to the affected documents to incorporate the FWV.

5. Records

The original and originals of revisions of the QAPP, SQPs, and SOPs will be controlled and maintained in the program record files in accordance with SQP 4.2 – Records Management.

6. Attachments

None.

QUALITY INSPECTIONS AND INSPECTION RECORDS

STANDARD QUALITY PROCEDURE 7.1

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities for the performance and documentation of Quality Control (QC) inspection of activities performed during project activities to ensure compliance with established requirements.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

SQP 10.1 - Nonconformance Control

3. Definitions

Inspection - Examination or measurement to verify whether an item or activity conforms to specified requirements.

4. Procedure

4.1 Qualification of Inspectors

Personnel performing inspection activities will have the necessary expertise in the area to be inspected but will be sufficiently independent of the activity performed.

Prior to performance of inspection activities, personnel designated for that responsibility will review and be thoroughly familiar with the procedures, regulations, etc. governing the activities to be inspected.

4.2 Field Inspection Plans and Reports

Project activities requiring inspection (i.e., Preparatory Phase, Initial Phase and Follow-up Phase) will have an Items to Inspect Checklist (Attachment 6.1) prepared for that activity. Inspections will be performed for definable features of work that are identified for each task and will be performed consistent with ongoing project activities.

The Items to Inspect Checklist will identify the items and activities to be inspected. If hold points are required, the Items to Inspect Checklist will identify them and indicate required notifications and sign-offs. The Subcontractor Project Manager (SPM) and Subcontractor Quality Assurance Manager (SQAM) will limit the number of items to inspect to ensure that undue inspection effort is not spent on tasks with insignificant effect on project quality.

If a Nonconformance Report (SQP 10.1) is required for activities being inspected, a reference will be provided on the Contractor QC Report (Attachment 6.2).

The Contractor QC Reports will be issued identifying inspections performed. The report will be completed by the SQAM or designee and will address each inspection performed during the course of the daily activities.

Items or activities not conforming to inspection acceptance criteria will be resolved and, when determined necessary, documented on a Nonconformance Report (SQP 10.1). Each Contractor QC Report will be signed by the SQAM certifying that the activities listed within the report have been completed in accordance with the project planning documents to the best of his/her knowledge.

5. Records

Records generated as a result of this SQP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Items to Inspect Checklist

6.2 Contractor Quality Control Report

A form referenced or attached to this SQP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

ITEMS TO INSPECT CHECKLIST

Items to Inspect Checklist

Task Name:
Task Number:
Scope:

Anticipated Field Work Dates:

Authorization from Task Leader:

Action Items	N/A	Yes	Verification/Date	No	Remedy/Date
Notifications					
Affected Facility Occupants/Operations Notified	N/A	Yes		No	
Project Documents					
Work Plan is on-site	N/A	Yes		No	
Quality Control Plan is on site	N/A	Yes		No	
Health and Safety Plan is on-site	N/A	Yes		No	
Emergency Response Plan is On-site	N/A	Yes		No	
Waste Management Plan and SOPs	N/A	Yes		No	
AHA and/or ALARA Evaluation	N/A	Yes		No	
Personnel Training					
Personnel has been trained with and acknowledge Project Documents	N/A	Yes		No	
Site briefing	N/A	Yes		No	
40 hour OSHA completed	N/A	Yes		No	
8 hour OSHA refresher completed	N/A	Yes		No	
Rad Worker II completed	N/A	Yes		No	
Medical Clearance completed	N/A	Yes		No	
Bioassay Submitted	N/A	Yes		No	
Whole Body Count Completed	N/A	Yes		No	
Contingency Plan and GERT Training	N/A	Yes		No	
Permits					
USA clearance	N/A	Yes		No	
Owner clearance	N/A	Yes		No	
Excavation Permit	N/A	Yes		No	
Hazardous Work Permit	N/A	Yes		No	
Subcontractors					
Contracts complete	N/A	Yes		No	
Scheduled for work	N/A	Yes		No	
Subcontractor briefed on projects, documents, and procedures	N/A	Yes		No	

Items to Inspect Checklist

Action Items	N/A	Yes	Verification/Date	No	Remedy/Date
General					
Daily field logs	N/A	Yes		No	
Alconox	N/A	Yes		No	
Decon brushes	N/A	Yes		No	
Decon sprayer	N/A	Yes		No	
Decon containers	N/A	Yes		No	
Distilled water	N/A	Yes		No	
Poly sheeting	N/A	Yes		No	
Drums/Drum labels	N/A	Yes		No	
Camera	N/A	Yes		No	
Weather (hot/cold, wet/dry)	N/A	Yes		No	
Sampling Equipment and Supplies					
Sampling plan	N/A	Yes		No	
Sample collection log	N/A	Yes		No	
Drill rig	N/A	Yes		No	
Support vehicles	N/A	Yes		No	
Sampling device	N/A	Yes		No	
Hand auger and extensions	N/A	Yes		No	
Hand trowel	N/A	Yes		No	
Ziploc bags	N/A	Yes		No	
Paper towels	N/A	Yes		No	
Sample containers	N/A	Yes		No	
Sample labels	N/A	Yes		No	
Shipping containers	N/A	Yes		No	
Sample packing supplies	N/A	Yes		No	
Shipping documentation	N/A	Yes		No	
Chain of Custody	N/A	Yes		No	
Fixed lab contacted/contact	N/A	Yes		No	
On-site lab	N/A	Yes		No	
Earthwork Equipment and Supplies					
Loader	N/A	Yes		No	
Dump Truck	N/A	Yes		No	
Stockpile Area	N/A	Yes		No	
Dust suppression equipment	N/A	Yes		No	
Fuel	N/A	Yes		No	
Trench plate and/or protection fence	N/A	Yes		No	
Nuclear density gauge	N/A	Yes		No	
Source authorization	N/A	Yes		No	
Operator training certification	N/A	Yes		No	
Straw bales	N/A	Yes		No	
HDPE	N/A	Yes		No	
Track-mounted hydraulic backhoe	N/A	Yes		No	
Wheel-mounted hydraulic backhoe	N/A	Yes		No	
Trench compactor	N/A	Yes		No	
Geotechnical lab contacted/contact	N/A	Yes		No	
Shoring	N/A	Yes		No	
- Hydraulic fluid	N/A	Yes		No	
- Installation/removal tools	N/A	Yes		No	
- Hydraulic pump	N/A	Yes		No	

Items to Inspect Checklist

Action Items	N/A	Yes	Verification/Date	No	Remedy/Date
Waste Management					
Waste stockpile areas	N/A	Yes		No	
Waste sorting equipment	N/A	Yes		No	
Waste shipping containers	N/A	Yes		No	
Shaker screen	N/A	Yes		No	
Hand tools					
- Rakes	N/A	Yes		No	
- Hoes	N/A	Yes		No	
Gaskets for B-25s	N/A	Yes		No	
B-25 liners	N/A	Yes		No	
Postings/signage	N/A	Yes		No	
Waste inventory logs	N/A	Yes		No	
Waste container inspection	N/A	Yes		No	
Box labelling material	N/A	Yes		No	
Waste storage container	N/A	Yes		No	
- Drum	N/A	Yes		No	
- Bucket	N/A	Yes		No	
- B-25	N/A	Yes		No	
- Other	N/A	Yes		No	
Health and Safety					
Tailgate Safety meeting	N/A	Yes		No	
Hazards/HAZARDOUS WORK PERMIT posted	N/A	Yes		No	
PID onsite/calibrated	N/A	Yes		No	
First Aid Kit	N/A	Yes		No	
PPE (Tyveks, gloves, booties, steel-toed boots)	N/A	Yes		No	
TLD/finger ring	N/A	Yes		No	
Eye protection	N/A	Yes		No	
Air horn	N/A	Yes		No	
Eye wash	N/A	Yes		No	
Fire Extinguisher	N/A	Yes		No	
Drinking water	N/A	Yes		No	
Perimeter established	N/A	Yes		No	
Heat stress Monitoring	N/A	Yes		No	
Work zone air monitoring	N/A	Yes		No	
Perimeter air monitoring	N/A	Yes		No	
Respirator	N/A	Yes		No	
Air horn	N/A	Yes		No	
Radiological Equipment					
Ludlum 2121 Smear Counter	N/A	Yes		No	
Ludlum 3 44-9 Equipment Frisking Beta-Gamma	N/A	Yes		No	
Ludlum 177, 44-9 Personnel Frisking Beta-Gamma	N/A	Yes		No	
High volume air sampler	N/A	Yes		No	
Rad equipment calibrated	N/A	Yes		No	
LSC	N/A	Yes		No	

Items to Inspect Checklist

Action Items	N/A	Yes	Verification/Date	No	Remedy/Date
Chemical and/or Physical Equipment					
PID	N/A	Yes		No	
O_2 monitor	N/A	Yes		No	
	N/A	Yes		No	
	N/A	Yes		No	
	N/A	Yes		No	

Attachments

Readiness Review Checklist Completed by:

Contractor: Date

Sub: Date

ATTACHMENT 6.2

CONTRACTOR QUALITY CONTROL REPORT

CONTRACTOR QUALITY CONTROL REPORT

(Attach additional sheets if necessary)

Report No. _____

Date Filled Out. _____

Dates this Report covers: _____

Summary of Activities:

_____
_____
_____
_____
_____
_____

Nonconformance/Corrective Actions identified:

NCR/CAR #	Status of Nonconformance/Corrective Actions outstanding from previous report

Field Work Variances Created that affect the Quality:

FWV #	Status of Field Work Variances that effect Quality

Consulting QA Manager Remarks:

_____
_____
_____
_____
_____
_____
_____

I certify that this report is complete and correct, and that equipment and material used and work performed during this reporting period are in compliance with the contract drawings and specifications, to the best of my knowledge, except as noted in this report.

_____ _____
Consulting QA Manager Date

RECEIPT INSPECTION

STANDARD QUALITY PROCEDURE 7.2

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities for the performance and documentation of receipt inspections of quality affecting items. These items are to be used or installed during project activities to ensure compliance with established requirements. Receipt inspection of items purchased to support field activities (i.e., gloves, heavy equipment, hand tools, etc.) will generally be conducted by the requestor and will verify the type and number delivered.

2. References

Quality Assurance Project Plan (QAPP)

SQP 3.2 - Indoctrination and Training

SQP 4.2 - Records Management

SQP 7.1 - Quality Inspections and Inspection Records

SQP 10.1 - Nonconformance Control

3. Definitions

Inspection - Examination or measurement to verify whether an item or activity conforms to specified requirements.

Inspector - A person who performs an inspection.

Requestor - A person who requests a purchase requisition.

Item - An all-inclusive term used in place of any of the following: appurtenance, facility, sample, assembly, component, equipment, material, module, part, structure, subassembly, subsystem, system, unit, documented concepts, or data.

Supplier -

(1) Any individual or organization that furnishes items in accordance with procurement documents.

(2) An all-inclusive term used in place of any of the following: vendor, seller, contractor, subcontractor, fabricator, consultant, and their subtier levels.

Procurement Document - Purchase order, subcontract, micro-purchase order (verbal), drawings, specifications, or instructions used to define requirements for purchase.

4. Procedure

4.1 Qualification of Inspectors

Personnel performing receipt inspection activities will have knowledge of the item to be inspected and its application to the work being performed. If an individual is not completely knowledgeable of the item, additional inspectors will be assigned by the Subcontractor Quality Assurance Manager (SQAM) to inspect the items.

The SQAM will assure performance of receipt inspections by qualified personnel for site-specific items. Alternate inspectors may be designated by the SQAM based on their specialized technical expertise or familiarity with the items to be inspected.

4.2 Inspection Preparations

After a purchase requisition is processed, the Subcontractor Contract Administrator (SCA) will prepare and forward a copy of the applicable procurement document to the requestor for receipt inspection. The inspector will review the procurement documents and item specifications and, upon receipt of the item, ensure that the item meets the requirements of the procurement documents.

The supplier will provide the item as described in the procurement document. Any variation to the procurement document will require the same level of review and approval as the original procurement.

Items arriving at a project site or office will be routed to a designated receiving area. The recipient shall notify the requestor of its arrival and readiness for inspection.

4.3 Inspection

At the discretion of the Subcontractor Project Manager (SPM) or SQAM, the inspector will conduct a receipt inspection of items. If the item is rejected, the basis for rejection will be documented on the Receipt Inspection Report (Attachment 6.1) and indicated on the shipper's receipt document. The SPM and contract administrator will be notified when an item is rejected. No items will be returned to a supplier without prior authorization of both the SPM and the contract administrator.

The inspector will compare the shipping document (packing slip, etc.) with the procurement documents and note any discrepancies. When a minor discrepancy is identified, the SQAM or SPM will be notified and will resolve the issue with the supplier.

The inspector will visually inspect the item for physical damage and compliance to procurement documents requirements. The inspection of items will not include operational, performance or item applicability. If the item meets the procurement document requirements and no visual deficiencies are observed, the inspector will document acceptance on the Receipt Inspection Report and release the item for use. If the item is unacceptable, the inspector will notify the SQAM, who will determine if the item should be accepted or rejected. If the item is rejected, the requestor will immediately notify the SPM.

When the supporting documentation (i.e., catalog cuts, performance specifications) is not provided and the item meets the procurement document requirements, the SQAM will issue a conditional release for the item. The conditional release is temporary and allows use of the item contingent on future receipt of the missing documentation in a timely manner. If requests for documentation are non-responsive, the conditional release will be revoked. The SQAM will then consult with the SPM and contract administrator and resolve the issue in question. Items conditionally released will be tracked on the Conditional Release Tracking Log (Attachment 6.2) by the SQAM until closure.

After an item is inspected and approved for use, the item will be released for use. The item will be stored in a secure area in a manner that protects its physical and operational characteristics from damage, deterioration, or tampering.

5. Records

Receipt inspection will be documented using the Receipt Inspection Report. A copy of the Receipt Inspection Report will be forwarded to the SCA.

Records generated as a result of this SQP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Receipt Inspection Report

6.2 Conditional Release Tracking Log

A form referenced or attached to this SQP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

RECEIPT INSPECTION REPORT

RECEIPT INSPECTION REPORT

Date received:		Date released:	
Date inspected:		Released to:	
Contractor:		Report No.:	
Contract No.:		Task Name:	
Project No.:		P.O. No.:	
Vendor Name:			
Item Name or Description:			

Y - YES; N - NO (SEE REMARKS); NA - NOT APPLICABLE
— Procurement documents were reviewed and used for inspection
— Required supporting documentation has been received (i.e., MSDS, certifications)
— Item numbers/volume corresponds to those identified on procurement documents
— Item is visually free of defects or damage
— Item meets project specification
— Item is acceptable for release

REMARKS:

Receipt Inspector	Date
Consulting QA Manager or Consulting PM	Date

\\weissfs02\CLIENTS\UCDavis\LEHR\1.6_Project_Plans\1.6.2_QAPP\QAPP_2018\RevB\SQP_Admin_Outbox\SQP07_2 Receipt Inspection\SQP7.2 Attachment 6.1 Receipt Inspection Report_Rev B.DOC

ATTACHMENT 6.2

CONDITIONAL RELEASE TRACKING LOG

CONDITIONAL RELEASE TRACKING LOG

Project Description: _____ Task Name: _____

Item No.	Item Description	Vendor Name	P.O. Number	Release Restriction	Date Identified	Date Required	Date Received/ Closed	Remarks

CALIBRATION AND MAINTENANCE OF MEASURING AND TEST EQUIPMENT

STANDARD QUALITY PROCEDURE 8.1

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities associated with the calibration, control, and maintenance of measuring and test equipment (M&TE). It applies to all tools, gauges, instruments, and other test equipment where the manufacturer or planning documents require or recommend equipment accuracy to be calibrated periodically. In the case of commercial devices, such as rulers, tape measures, and levels, calibration controls will not be required.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

3. Definitions

Measuring and Test Equipment (M&TE) - Measuring and test equipment used to obtain data during the performance of tests or inspections.

Calibration - The comparison of a measurement standard or instrument of a known accuracy with another standard or instrument to detect, correlate, report, or eliminate by adjustment, any variation in the accuracy of the items being compared within allowable deviations.

Reference Standard - An item of known and verifiable value which is used to check or establish the basis for tests or inspections.

4. Procedure

4.1 Responsibilities

The Subcontractor Task Leader (STL) is responsible for assuring that M&TE used in activities affecting quality is calibrated or replaced at specific periods or uses intervals to maintain accuracy within necessary limits. The STL will also ensure implementation of this procedure and provide adequate facilities to store and maintain the M&TE.

The Subcontractor Quality Assurance Manager (SQAM) is responsible for monitoring the effective implementation of this SQP and/or the M&TE manufacturer's calibration recommendations.

The STL is responsible for the selection of M&TE to be used in the field activity and to assure that it is of the proper type, range, sensitivity, accuracy, and tolerance required to meet project objectives. MT&E selected for onsite chemical analysis must be approved by the Subcontractor Project Chemist (SPC) prior to field deployment. The STL is responsible for storage and protection of M&TE.

The field personnel performing tests are responsible for assuring that all M&TE is properly calibrated prior to and during use, and are also responsible for documenting the calibration data, standards, and results.

4.2 Equipment Identification and Control

M&TE that requires calibration will be uniquely identified by the manufacturer's serial number or other suitable identification code. If this should prove to be impractical, an identification label will be affixed, using materials and methods that provide a clear and legible identification and do not detrimentally affect the function or service life of the M&TE. This identification will be replaced as needed to provide clear identification of the M&TE.

All M&TE and reference standards shall be stored between uses in a manner that will minimize damage or deterioration.

4.3 Calibration

Written and approved procedures will be used for calibration of M&TE. Calibration procedures that have been previously established and approved by the M&TE manufacturer or a nationally recognized authority (i.e., ASTM International, United States Environmental Protection Agency [EPA]) will be used, when available. If no preexisting procedure is available, procedures will be developed by qualified personnel familiar with the M&TE and approved by the Subcontractor Project Manager (SPM) and SQAM. If a calibration procedure is developed for onsite chemical analysis, the procedure must be approved by the SPC. Development of procedures will take into consideration the intended use and objective of the resulting data, equipment characteristics, required accuracy and precision of data, location of examination, effects of climate, or any other parameter that would adversely influence the calibration. The procedures will include, as applicable:

- Name/type of equipment to be calibrated;
- Reference standards to be used;
- Calibration method and sequential actions;
- Acceptance criteria;
- Frequency of calibrations/checks;
- Data recording form/format;

- Data processing methodology;
- Any special instructions; and
- Operator training and qualification requirements.

Field M&TE will be calibrated prior to use. Calibrations of M&TE will be performed by trained and qualified personnel, approved external agencies, or the equipment manufacturer.

The following types of calibrations and checks will be performed by qualified personnel:

- Periodic calibrations, which are performed at prescribed intervals established for the M&TE to assure that the equipment is operating within its designed range and accuracy. These may be performed by qualified personnel, outside agencies, or the M&TE manufacturer.
- Specific calibrations, which are performed for specific measurements or tests and vary from instrument to instrument and from procedure to procedure. Specific calibrations are typically performed prior to conducting measurements or tests during a work shift.

4.4 Calibration Frequency

M&TE will be calibrated at prescribed intervals before each specific use. The frequency of periodic calibrations will be based on manufacturer's recommendations, national standards of practice, equipment type and characteristics, and the needs of the specific M&TE.

Scheduled calibrations of M&TE do not relieve the user of the responsibility for using only properly functioning equipment that is applicable and meets the requirements of the specific measurement or test.

In the event that the calibration has expired, the M&TE will be removed from service and tagged as "out-of-service," to prevent inadvertent use until it has been appropriately recalibrated.

4.5 Reference Standards and Equipment

Calibration reference standards and equipment will have known relationships to the National Institute of Standards and Technology (NIST) or other nationally recognized standards. If a national standard does not exist, the basis for calibration will be fully documented by the STL and approved by the SPM and SQAM. If a nationally recognized standard does not exist for an onsite chemical analysis, the alternative standard or calibration method must be approved by the SPC.

Physical and chemical standards will have certifications traceable to NIST, EPA, or other recognized agencies. Standards that are repackaged or split will also have traceable lot or batch numbers transferred onto the new container. The standard expiration date (applies to all chemical standards) will be recorded on the container.

Standards will be stored according to manufacturers’ specifications.

It is the responsibility of the user to select, verify, and use the correct standard in accordance with the applicable approved procedure or established practice.

4.6 Calibration Failure

Each individual user of M&TE is responsible for checking the calibration status of equipment to be used and confirming the acceptable calibration status prior to use. Equipment for which the periodic calibration period has expired, equipment that fails calibration, or equipment that becomes inoperable during use will be removed from service and tagged as out-of-service.

Out-of-service M&TE will be segregated from operational M&TE, when practical. The specific reason for removal from service and the date of removal will also be stated on the out-of-service tag. The M&TE will then be repaired and/or recalibrated by the appropriate vendor or manufacturer, as deemed necessary by the STL, CPM, or SPC as applicable. M&TE that cannot be repaired will be replaced, as necessary, to provide support to the project. Any M&TE consistently found to be out-of-calibration will be replaced.

Results of activities performed using equipment that has failed recalibration will be evaluated by the STL, SPM, and/or SPC and submitted to the SQAM for nonconformance determination. If the SQAM determines the activity results are adversely affected, the results of the evaluation will be documented as a nonconformance.

4.7 Calibration Documentation

Specific calibration records will be prepared and documented for each calibrated M&TE used. Periodic calibration certificates will be maintained and available for review in the project record files. Calibration data will be recorded on the Test Equipment List and Calibration Log form (Attachment 6.1) or a form specific to the M&TE. The STL (or SPC for onsite chemical analysis) will be responsible for reviewing the calibration data for appropriateness, accuracy, readability, and completeness, as well as for meeting the required calibration criteria.

Calibration records will include, as applicable, the following information:

- Equipment identification number;
- Calibration procedure used;
- Date/time of calibration;
- Time of calibration checks (if required);
- Identification of reference standard(s) used and their expiration date(s);
- Applicable responses or readings of calibration;
- Calculations of quality control parameters (correlation coefficient, percent difference, etc.);
- Calibration acceptance criteria;

- Calibration result (pass or fail);
- Name of individual performing calibration; and
- Item(s) that are being tested or inspected.

4.8 Preventive Maintenance

Preventive maintenance of M&TE will be performed in accordance with the manufacturers' recommendation to maintain proper M&TE performance, minimize equipment failure, and increase measurement reliability.

5. Records

The records generated as a result of implementing this SQP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Test Equipment List and Calibration Log

A form referenced or attached to this SQP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

TEST EQUIPMENT LIST AND CALIBRATION LOG

TEST EQUIPMENT LIST AND CALIBRATION LOG

Equipment Name and Number	Test Parameter	Date and Time of Calibration	Calibration Standard Used (Manufacturer, Lot Number, and expiration date)	Measured Calibration Response/Reading (include Units)	Calibration Acceptance Criteria	Calibration Result (pass/fail)	Calibrator's Initials

Note: Complete calibration and record information before use for all test equipment that requires calibration.

Area for Quality Control Parameter Calculations:

NONCONFORMANCE CONTROL

STANDARD QUALITY PROCEDURE 10.1

1. Purpose

This Standard Quality Procedure (SQP) establishes the method and responsibilities for documenting and resolving technical or other quality related nonconformance, which may not have been identified or resolved through assessments, inspections, or reviews.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

SQP 10.2 - Corrective Action

3. Definitions

Nonconformance - A deficiency in documentation or procedure that renders the quality of an item unacceptable or indeterminate with respect to established criteria. Examples of nonconformance include, but are not limited to, test failures, physical defects, incorrect or inadequate documentation, data losses, or deviations from prescribed work plan processes, inspections, or procedures.

4. Procedure

4.1 Precautions

Nonconformance may be related to hazards or potential safety concerns that require expedient action to resolve or mitigate. When prompt action is required, that action should not be unduly delayed for the processing of a Nonconformance Report (NCR). However, action that mitigates or even resolves nonconformance does not eliminate the requirement for documenting the deficiency on an NCR.

4.2 Nonconformance Identification

Any individual assigned to a project who discovers a nonconformance is responsible for preparing an NCR to describe and document it. The individual must complete the nonconformance description sections of the Nonconformance Report/Corrective Action (NCR/CA) form (Attachment 6.1). The NCR will be accurately and concisely written after consultation with the interested parties to ensure that the discrepancy is correctly described, the appropriate project task criteria are referenced, and sufficient data are provided to facilitate a proper and complete disposition for resolving the nonconformance. When this section of the NCR/CA form is completed, the report is sent to the Subcontractor Quality Assurance Manager (SQAM) for review. After this review is complete, the NCR/CA form is forwarded to the Prime Contractor Quality Assurance Manager (PCQAM) to determine and document the appropriate disposition.

4.3 Segregating Nonconforming Items

Whenever practical, nonconforming items will be segregated from the conforming items by separated storage, clearly marked storage boundaries utilizing signs, roped off areas, or other appropriate means to prevent the inadvertent installation or use of the nonconforming items, or the items will be identified as nonconforming by the use of tags or markings.

4.4 Nonconformance Reporting

Potential nonconformance will be evaluated by the SQAM to assess the extent of nonconformance, the significance, and any potential impact on safety, waste isolation, or quality. This assessment will be performed with the assistance of the responsible engineering/construction discipline.

Nonconformance that is evaluated and determined to be a condition "significantly" adverse to quality will be documented and reported in accordance with SQP 10.2. The following guidelines will be used to determine "significant" conditions.

- Failure of the procedural system to produce the results desired in project deliverables.
- Identification of repetitive conditions for which previous corrective actions have proven ineffective.
- Repeated failure to comply with contract requirements, QAPP and procedures.
- Significant deficiencies found during the review or validation of data.

NOTE: Situations described above will require immediate notification of the Subcontractor Project Manager and SQAM.

The Prime Contractor Project Manager (PCPM) and the PCQAM will be promptly notified of technical errors in work previously completed and transmitted to them.

The SQAM will maintain an NCR/CA status log (Attachment 6.2) of open and closed Nonconformance Reports. The Log will also serve as the basis for the NCR serial number system.

4.5 Nonconformance Resolution

The responsible organizational discipline will document the resolution of the nonconformance in the space provided on the NCR or on additional sheets, as necessary. The resolution response will also describe the cause, the corrective action to be taken to resolve the condition, the measures to be taken to prevent recurrence of the nonconformance, and the date when all actions will be completed and will be signed by management of the organization responsible for the nonconformance.

4.6 Verification and Closeout

Resolution of nonconformance will be verified by the SQAM. The nonconformance will not be closed until all corrective and preventative measures have been completed, or long-term corrective measures are established and implemented.

5. Records

Records generated as a result of implementation of this SQP will be retained for each NCR and will include the following:

- The initial notification which resulted in the NCR;
- The results of any technical evaluation;
- The original NCR/CA form issued with the appropriate resolution and signatures; and
- Other pertinent information necessary to document resolution of the NCR, including scope and significance of the problem, as applicable.

Upon closure of each NCR, records will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Nonconformance Report/Corrective Action

6.2 Nonconformance Report/Corrective Action Log

A form referenced or attached to this SQP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

NONCONFORMANCE REPORT/CORRECTIVE ACTION

NONCONFORMANCE REPORT/CORRECTIVE ACTION

NCR Number:	Company:	Date:

Nonconformance Description (include specific requirement violated):

Identified By: Date:

Root Cause of Nonconforming Condition:

Corrective Action to be Taken (include date when action(s) will completed):

To be Performed By:_____ Anticipated Completion Date:

Action to be Taken to Preclude Recurrence:

To be Performed By:_____ Anticipated Completion Date:

Acceptance By:_____ Date:_____ Acceptance By:_____ Date_____
Consulting Project Manager Consulting QA Manager

Corrective Actions Completed By and Date:	Verification Completed By and Date:

ATTACHMENT 6.2

NONCONFORMANCE REPORT/CORRECTIVE ACTION LOG

NONCONFORMANCE REPORT/CORRECTION ACTION LOG

NCR/CA #	COMPANY	DATE NCR REPORTED	DATE NCR ACCEPTED	DATE CA IDENTIFIED	DATE CA COMPLETED AND VERIFIED

CA – corrective action
NCR – nonconformance report

QUALITY CORRECTIVE ACTION

STANDARD QUALITY PROCEDURE 10.2

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities for documenting and resolving conditions "significantly" adverse to quality. These conditions require immediate management action or attention to resolve. Conditions adverse to quality, which are not determined to be “significant” shall be documented and reported in accordance with SQP 10.1.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

SQP 10.1 - Nonconformance Control

3. Definitions

Conditions Adverse to Quality - An all-inclusive term used in reference to any of the following: failure to meet performance objectives, malfunctions, deficiencies, defective items, and nonconformance. A significant condition adverse to quality is one that, if uncorrected, could have a serious effect on operability or project performance.

Corrective Action - Measures taken to rectify conditions adverse to quality and preclude repetition where necessary.

4. Procedure

4.1 Corrective Action Identification

A Corrective Action will be initiated for those conditions adverse to quality that are evaluated and determined by the Subcontractor Quality Assurance Manager (SQAM) to be "significantly" adverse to quality. The following guidelines will be used to determine "significant" conditions:

- Failure of the procedural system to produce the results desired in project deliverables;

- Identification of repetitive low quality or failed work products for which previous corrective actions have been ineffective;
- Repeated failure to comply with contract requirements, QAPP, SQPs, and Standard Operating Procedures (SOPs); and
- Significant deficiencies found during the review or validation of data.

4.2 Corrective Action Reporting

For nonconformance determined to be significantly adverse to quality, the Corrective Action (CA) to be taken will be documented on the CA portions of the Nonconformance Report/Corrective Action (NCR/CA) form (see SQP 10.1). Copies of all NCR/CA forms will be made available to the UC Davis Project QA Manager.

The SQAM will maintain an NCR/CA status log of open and closed CA requests. The log will also serve as the basis for an NCR/CA progress date tracking system and will be made available to the Contractor Quality Assurance Manager (PCQAM) with specific notification when the log is updated.

4.3 Corrective Action Follow-up

The SQAM will monitor the status of NCR/CAs and prepare correspondence relating to overdue responses. If a request for an extension of a response is received, an evaluation will be made, and a formal response submitted to the requestor. All extensions to response due dates will be recorded in the NCR/CA log.

Failure to address a nonconformance that requires CA will result in an evaluation of the condition to determine if a Stop Work Order (SWO) is warranted.

Implementation of CAs will be verified by the SQAM. The results of verification will be documented on the NCR/CA form and status log.

Upon completion (closeout) of the CA, the SQAM will note it as closed in the NCR/CA log.

5. Records

Records generated as a result of implementation of this SQP will be retained for each CA and will include the following:

- The original NCR/CA form along with all required CAs completed and all appropriate signatures;
- Any backup data necessary to substantiate the original condition noted in the NCR/CA form, the stated CA, evaluation, or verification; and

- Overdue response notifications, requests for extension of response due dates, and replies to extension requests.

Upon closure of each CA, records will be controlled and maintained in the project record files, in accordance with SQP 4.2 – Records Management.

6. Attachments

None.

STOP WORK ORDER

STANDARD QUALITY PROCEDURE 10.3

1. Purpose

This Standard Quality Procedure (SQP) describes the process and responsibilities for issuing, resolving, and verifying acceptable response/actions for Stop Work Orders (SWOs). SWOs are limited to Contractor and subcontractor/vendor activities.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

3. Definitions

Stop Work Order – The order issues to the Subcontractor Project Manager (SPM) or responsible individual for subcontractor/vendor services to stop further processing, delivery, installation, or operation until proper disposition of a nonconformance, deficiency, or unsatisfactory condition has occurred.

Action Party – The manager or responsible individual to whom the SWO is issued.

4. Procedure

4.1 Responsibilities

The Subcontractor Project Quality Assurance Manager (SPQAM) or Subcontractor Project Chemist (SPC) is responsible for issuing SWOs when conditions warrant and for assuring corrective action is accomplished. The SPQAM or SPC will notify the SPM that a SWO condition exists as described in Section 4.2.1. The SPQAM or SPC will maintain a SWO log and the original SWO(s); perform verification that corrective action is complete and effective; and notify responsible management of closure for SWOs.

The Action Party is responsible for stopping work upon verbal notification from the SPQAM or SPC and for implementing the required corrective action.

4.2 Stop Work Order Criteria

The following criteria are utilized as a guideline for determining whether to issue a SWO:

- Continuing an operation will directly affect the integrity of the work or documentation which is required and would result in significant rework.
- Continuing an operation will jeopardize the integrity of design, the nonconformance will cause design discontinuities to other item or activities, or compromise the essential features which are important to programmatic objectives or safety.

4.3 Issuance of the Stop Work Order

Upon determination by the SPQAM or SPC that the criteria for reissuing a SWO applies, the SPM will be notified verbally or by memorandum that an SWO condition exists and that a SWO will be issued.

The SPQAM or SPC will notify (written or verbal) the applicable Action Party of the intent to stop work, when the stop work is effective and to what activities the SWO applies.

The SPM or SPQAM will notify the following personnel (as soon as practical) when an SWO is issued:

- Client Contractor Officer
- Client Project Manager
- Action Party

NOTE: This verbal notification will include all data available at the time of notification and will be followed-up with a copy of the written confirmation.

The SPQAM or SPC will issue the written SWO, Attachment 6.1, as soon as practical, after verbal notice is given.

The SPM and/or Subcontractor Task Leader (STL), and SPQAM and/or SPC and Action Party will coordinate, as necessary, a corrective action plan and a date for completion. The SPM and/or STL and SPQAM and/or SPC, will sign the SWO signifying agreement with the corrective action required.

The SPQAM or SPC will forward a copy of the SWO to the Action Party. The original SWO will be maintained by the SPQAM for logging the SWO on the Stop Work Order Log (Attachment 6.2). The original SWO will be maintained by the SPQAM.

The Action Party will implement the required remedial action and notify the SPQAM or SPC when completed.

4.4 Stop Work Order Closure

Upon verification of satisfactory completion of remedial action, the SPQAM or SPC may verbally cancel the SWO by notifying the SPM or STL and obtaining concurrence.

The SPQAM and SPC will notify the Action Party that they may resume work.

The SPQAM and SPC will complete the SWO from, distribute copies, and forward the completed SWO to the project record files for retention.

5. Records

SWOs and subsequence documentation, generated as a result of implementation of this procedure will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

The Stop Work Order Log is not a Project Record. The SWO Log will be maintained, as a minimum, until the end of the Project Task.

6. Attachments

6.1 Stop Work Order

6.2 Stop Work Order Log

A form referenced or attached to this SQP may be replaced with a substitute form, with the approval of the SPQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

STOP WORK ORDER

STOP WORK ORDER

Company: _____ Location: _____

Date: _____

1. Written Notice Issued to:
   Name: _____
   Title: _____
   Org.: _____
2. P.O. # or Activity: _____
3. Location: _____
4. Issued by (name): _____
   Issued by (title): _____

5. Verbal Notice Issued to:
   Name: _____ Date: _____ Time: _____
   Title: _____

6. Associated NCR No.: _____ 7. Associate CAR No.: _____

8. Stop Work Order Condition Description: Attachment: _____

9. Remedial Action Required: Attachment _____
   By Whom: _____ By When: _____
   Required Remedial Action Determined by:
   Project Manager: _____ Date: _____
   PQA Manager _____ Date: _____

10. Follow-up of Remedial Action Taken: Attachment: _____
    Verbal Notice to Resume Operations Given to:
    Name: _____ Date: _____ Time: _____
    Title: _____
    Stop work Order Cancellation Authorized by:
    PQA Manager: _____ Date: _____

ATTACHMENT 6.2

STOP WORK ORDER LOG

STOP WORK ORDER LOG

Company:

SWO No.	Action Party/Organization	Subject	Date Issued	Date Closed

FIELD WORK VARIANCE/MODIFICATION

STANDARD QUALITY PROCEDURE 11.1

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities associated with the development and control of Field Work Variances (FWVs) and Field Work Modifications (FWMs).

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

3. Definitions

Field Work Modification - Changes that constitute a Field Work Modification based on the following:

(1) Constitutes an assignment of additional work outside the Statement of Work;

(2) Constitutes a change as defined in the contract;

(3) In any manner causes an increase or decrease in the total Task Assignment estimated cost or the time required for contract performance; and

(4) Changes any of the expressed terms, conditions, or specifications of the contract.

Work for a Field Work Modification should not commence without the written approval from the Prime Contractor Project Manager (PCPM).

4. Procedure

4.1 Discussion

Procedural or material changes may be required due to unforeseen events or assumptions based on limited data made during the development of plans, specifications, and procedures. To maintain and control project activities, changes must be documented and approved before their implementation. In general, changes will be documented through the use of an FWV/M form (Attachment 6.1) and tracked with a Field Work Variance/Field Work Modification (FWV/M)

tracking log (Attachment 6.2). The form should be completed in its entirety if the change affects the cost or schedule of work.

4.2 Responsibilities

The Subcontractor Project Manager (SPM) has the overall responsibility for the implementation and effectiveness of the FWV/M system. The SPM is responsible for reviewing and approving Project Task FWV/M forms and obtaining quality review by the Subcontractor Quality Assurance Manager (SQAM).

The Subcontractor Task Leader (STL) is responsible for the initiation of the FWV/M Form.

The SQAM is responsible for reviewing the FWV/Ms that affect quality, and for monitoring FWV/Ms to verify the effectiveness of the change control systems.

The PCPM is responsible for assisting the SPM in ascertaining if the variance requires a Task Plan Revision.

4.3 Implementation of Change

When an FWV/M is needed, the STL shall verbally advise the SPM of the change. Based on the information provided to the SPM, a decision will be made regarding what type of change is required, either variance or modification. The STL will then prepare the FWV/M Form, which will be submitted to the SPM for approval.

If the change is a variance, the SPM shall obtain the SQAM review, if necessary, and will subsequently approve the FWV/M. A copy of the approved FWV/M will be provided to the SPM for their information and files.

When approximately 75% of the Task Assignment costs have been expended, the SPM will determine if the current estimated total cost of the Task Assignment is adequate to complete the work, including all estimated costs of the variances. If a determination is made that additional funding is required, the SPM will notify the PCPM and begin the Task Plan Revision process.

If the change is a modification, the SPM shall obtain the SQAM review, if necessary, and will subsequently approve the FWV/M.

The SPM shall promptly notify the PCPM, requesting a Task Description that authorizes preparation of a Task Plan Revision. At this time the SPM may decide to issue a “stop work” order ending all effort pursuant to the Modification.

4.4 Preparation of FWV/M Forms

The STL or a designee will complete the FWV/M form. The FWV/M will clearly identify the present requirement, the proposed change, technical justification, cost and schedule impact (if needed), and documents requiring change.

Any requested change or deviation to contract requirements or plans will not be implemented until signed approval of the FWV/M is received from the SPM.

4.5 FWV/M Tracking Log

The STL or designee will maintain an FWV/M Tracking Log (Attachment 6.2) that will identify each item with a unique number, brief description, date of issue, and status of the individual FWV/Ms.

4.6 Document Distribution

A copy of the approved FWV/M Form shall be provided to the STL and the Subcontractor Contracts Administrator.

A copy of the FWV/M Tracking Log will be provided to the SPM and the STL when updated.

5. Records

Records generated as a result of implementing this SQP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Field Work Variance/Field Work Modification Form

6.2 Field Work Variance/Field Work Modification Tracking Log

A form referenced or attached to this SQP may be replaced with a substitute form with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

FIELD WORK VARIANCE/FIELD WORK MODIFICATION FORM

FIELD WORK VARIANCE/FIELD WORK MODIFICATION FORM

Project No.:	Date:	Variance No.:
Phase No:		☐ Task assignment revision required
Task Name:		Requested by:

PRESENT REQUIREMENTS:

PROPOSED CHANGE:

TECHNICAL JUSTIFICATION:

COST/SCHEDULE IMPACT: (not necessary for modifications)

ATTACHMENTS:

PQAM REVIEWED _____ DATE: _____

APPROVED BY _____ DATE: _____
Consulting Project Manager

APPROVED BY _____ DATE: _____
UC Davis Contracting Officer Representative

If modification affects subcontractor (s), submit a copy of this form to the appropriate subcontractor (s)

ATTACHMENT 6.2

FIELD WORK VARIANCE/FIELD WORK MODIFICATION TRACKING LOG

FIELD WORK VARIANCE/ FIELD WORK MODIFICATION TRACKING LOG

Company:

FWV/M No.	Activity and Guiding Document(s)	Description of Variance/Modification	Date Identified	Date Approved	Date Form Completed	Cost/Schedule Impact and Other Remarks

QUALITY AUDITS

STANDARD QUALITY PROCEDURE 12.1

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities for planning, scheduling, and performing project audits, which are designed to verify compliance to the Quality Assurance Project Plan (QAPP).

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

SQP 10.2 - Corrective Action

3. Definitions

Audit Team - One or more persons who are responsible for audit performance and reporting. The team may consist of, or is headed by, an individual designated as the Audit Team Leader.

Audit Team Leader - The individual responsible for organizing and directing the audit, who coordinates the preparation and issuance of the Audit Report and evaluates and performs follow-up of responses.

Technical Specialist - One or more persons who may be assigned to the audit team due to the specialized or technical aspects of the areas to be audited. Technical Specialists are selected based on their special abilities, specialized technical training, and/or prior experience in the specialized or technical aspects of the area to be audited.

Audit - A planned and documented activity performed to determine by investigation, examination, or evaluation of objective evidence the adequacy of and compliance with established procedures, instructions, drawings, and other applicable documents, and the effectiveness of implementation. An audit should not be confused with surveillance or inspection activities performed for the sole purpose of process control or product acceptance.

Finding - A documented statement of fact concerning a noncompliance or deviation from established requirements.

Observation - A statement of fact regarding the potential for a noncompliance that could lead to a more serious problem if not identified and/or corrected, but that does not constitute a lack of compliance with established requirements.

4. Procedure

4.1 Audit Schedule

The Subcontractor Quality Assurance Manager (SQAM) will develop a schedule for the performance of audits, unless previously specified in planning documents. QAPP elements will be audited as deemed appropriate by the SQAM. Tasks that are exempt from audit, as noted in the Quality Inspections and Inspection Records (SQP 7.1) or other task planning documents, will not be subject to audit.

The audit schedule is based on planning document requirements, previous audit results, and the results of performance audits and inspections (as applicable).

The audit schedule will be reviewed periodically and revised as necessary to assure that coverage is currently maintained.

Unscheduled audits will be used to supplement scheduled audits when conditions warrant.

4.2 Audit Teams

The SQAM will designate an Audit Team Leader for each audit to be conducted.

The Audit Team Leader selects and assigns auditors who are independent of any direct responsibility for performing the activities that they will audit. The Audit Team Leader assures that personnel who have direct responsibilities for performing the activities being audited are not involved in the selection of the Audit Team.

The Audit Team Leader orients the team and coordinates the audit to assure communications within the team and with the organization being audited.

4.3 Audit Planning and Preparation

The Audit Team Leader will complete an audit plan, Attachment 6.1, which identifies the following:

- Audited Organization and Location;
- Audit Scope;
- Audit Purpose;

- Audit Team;
- Reference Documents;
- Audit Schedule;
- Follow-up Items; and
- Special Concerns.

The Audit Team Leader will assure that the Audit Team is prepared prior to performance of the audit by providing applicable policies, procedures, standards, instructions, codes, regulations, and prior audit reports for information and review by the auditors, and by providing each auditor with the audit plan. In addition, he or she will assure that the audit team is familiar with the audited organization and key individuals.

The Audit Team Leader will provide notification to the organization to be audited before the audit.

4.4 Audit Performance

The Audit Team Leader will notify the organization to be audited to confirm the audit scope, introduce the Audit Team, and establish channels of communication.

Audits will be performed in accordance with established checklists or procedures. The auditor(s) will assure that the audit consists of:

- Review of procedures and work instructions for completeness, adequacy, and responsiveness to QAPP requirements;
- Review of work areas for evidence of implementation of procedures and instructions;
- Review of personnel training and qualification records where special skills and qualifications are required;
- Review of selected work, which has been accepted, such as products, design calculations, drawings, and comparison of findings with applicable requirements and the previous basis for acceptance; and
- Review of process controls and records to determine conformance with specifications.

Checklist forms for laboratory audits and field sampling/field analysis audits are provided as Attachments 6.3 and 6.4, respectively. The Audit Team Leader can modify these forms to meet the needs of the specific audit.

Auditor(s) will discuss audit findings with individuals being audited, so that finding(s) as stated are accurate and understood.

At the conclusion of the audit, the Audit Team Leader will provide management or supervisory personnel of the organization or activity audited, the audit findings, observations, and/or comments.

4.5 Audit Reporting

The Audit Team Leader, upon completion of the audit and with the aid of the audit team members, prepares an audit report using a format that provides the following information at a minimum:

- Audit date;
- Audited organization;
- Location;
- Scope of audit;
- Audit personnel (indicating lead auditor);
- Persons contacted; and
- Audit Results.

The audit report will be issued to the management of the audited organization.

Audit Reports that contain Quality Finding Reports (QFRs) will require the management of the audited organization to submit a written response of each QFR to the SQAM, identifying:

- The root cause that lead to the condition reported in the finding;
- The steps that have or will be taken to correct the condition reported in the finding;
- The steps that have or will be taken to preclude recurrence (if appropriate); and
- The dates when indicated action was or will be complete.

QFRs will clearly describe the condition(s) that led to the finding.

4.6 Audit Follow-Up

The SQAM will maintain the status of audit findings for active audits and prepare correspondence relating to overdue audit responses. If a request for extension of response is received, an evaluation will be made, and a formal response submitted to the requesting organization.

When an extension is granted for overdue responses, the SQAM will notify the responsible organization by telephone and issue correspondence indicating a new response due date. Responses not received within the period of time established for the extension will result in the issuance of a Corrective Action request (SQP 10.2).

Upon receipt of responses to audit findings, the SQAM will coordinate with the Audit Team Leader for the evaluation of responses.

The responsible evaluator will document the results of the evaluation on the QFR.

Unacceptable responses will be noted on the QFR, along with the specific reason for rejection. The SQAM will prepare transmittal correspondence reissuing the QFR to the responsible organization, delineate a new response due date, and include a copy of the original QFR with evaluation comments. Review and distribution of the reissued QFR will be the same as the original report.

The SQAM will assure that verification of corrective action implementation is accomplished and will document the results of verification on the QFR record copy.

NOTE: Unacceptable verification will be handled as noted above.

Upon completion (close-out) of all QFRs, the SQAM will notify the audited organization by memorandum or letter that all actions are complete and have been approved, and that the audit is closed.

5. Records

The following documents are generated as a result of implementation of this procedure:

- Audit plans;
- Audit reports;
- Quality finding reports, including response, evaluation, and verification;
- Audit closure letter; and
- Correspondence related to the audit.

Documents identified above will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Audit Plan

6.2 Quality Audit Finding Report

6.3 Laboratory Audit Checklist

6.4 Field Sampling/Field Analysis Audit Checklist

A form referenced or attached to this SQP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

AUDIT PLAN

AUDIT PLAN

Type of Audit: Performance Audit or System Audit (circle or **bold** one)

Contract Number: _____ **Project/System to be Audited:** _____

Audit Scope:

AUDIT PERSONNEL **AUDIT SCHEDULE**

Audit Team Leader: _____ **Audit Date:** _____

Auditor: _____

Objective Evidence (documents and records) to be Reviewed During Audit (list them):

Supporting Procedures (list):

Follow-up Items: _____ **Special Concerns/Items:** _____

AUDIT TEAM ASSIGNMENTS

Lead Team Leader:

Auditor:

ATTACHMENT 6.2

QUALITY AUDIT FINDING REPORT

QUALITY AUDIT FINDING REPORT

Company:

Audit Date:	QAFR Number:	Date:
Organization/Project/Department:		Person Contacted:
Finding (Include Specific Requirement Violated):		
Auditor:		Response Due Date:
Root Cause that Led to the Condition Reported:		
Corrective Action Taken/Proposed to Correct Deficiency:		
Corrective Action Taken to Preclude Recurrence:		
Corrective Action Taken by (Signature and Title:)		Date when Corrective Action Will Be Completed:
Corrective Action Evaluation: Evaluator Date		Verification of Implementation: Verified by Date

ATTACHMENT 6.3

LABORATORY AUDIT CHECKLIST

Laboratory Audit Checklist

Laboratory Name	**Date of Evaluation**	**Name and Affiliation of Auditor(s)**

Laboratory Personnel	Name
Project Manager	
Quality Assurance (QA) Officer	
Data Reporting/Delivery Officer	

Item to be Evaluated	Yes	No	NA	Comments
Part 1: Organization/Management				
Is a laboratory organization chart or other information available listing staff organization and responsibilities? Does it identify the QA Officer and all the relationships between QA Officer, technical operations, and support staff?				
If the laboratory is part of a larger organization, are there any organizational arrangements that could cause a conflict of interest?				
Are the education and technical background of all personnel documented?				
Is there a formal QA manual in place, and does the QA Officer maintain the current quality manual?				
Does the quality manual define the roles and responsibilities of technical management and the quality manager?				
Does the QA manual give the QA Officer authority to "stop work" and initiate action to prevent or minimize quality system variances?				
Does the QA Officer (and/or his or her designees) notify laboratory management of deficiencies in the quality system and monitor corrective action?				
Part 2: Facilities				
Is the laboratory maintained in a clean and organized manner?				
Does laboratory have a designated storage area that contains sufficient refrigerator space to maintain unused sample volume for 90 days after submission of a complete data package? Note: Samples, extracts, and standards shall be stored separately from one another.				
Are hoods equipped with charcoal and HEPA filters?				
Does laboratory contain a designated area for standards preparation that consists of a glove box, designated hood, or isolated area?				
Is there effective separation between neighboring areas in which there are				

Laboratory Audit Checklist

Item to be Evaluated	Yes	No	NA	Comments
incompatible activities?				
Are the solvent storage cabinets vented or located in such a way as to prevent possible laboratory contamination?				
Is access to and use of areas affecting the quality of the environmental tests controlled?				
Part 3: Laboratory Equipment				
Are maintenance logs kept for lab equipment/instrumentation?				
Are manufacturer's maintenance manuals available?				
Does the laboratory have a list of preventative maintenance procedures and schedules?				
Does the lab own or have access to an NIST-traceable factory certified thermometer?				
Are thermometers checked annually against a reference NIST-traceable thermometer or equivalent?				
Is the flow of the hoods periodically checked and permanently recorded?				
Are instruments, including GC/MS pumps, vented into hoods or control devices such as charcoal traps?				
Is an SOP available for glassware washing?				
Is there a separate designated area for cleaning glassware?				
Are adequate glassware cleaning procedures posted in that area?				
Is distilled or deionized water used for glassware final rinse?				
Part 4: Quality				
Does the laboratory maintain SOPs for the following procedures: sample handling logistics, extractions, concentrations, digestions, analyses, standards preparation, instrument maintenance, and report generation?				
Does each SOP clearly indicate the effective date of the document, the revision number, and the signature(s) of the approving authority?				
Are all relevant SOPs present and current?				
Are SOP copies located within easy access of the appropriate work area?				
Are MDL studies performed prior to sample analysis by that method?				
Are MDLs generated using the specifications in 40 CFR Part 136, Appendix B, or as specified in the individual methods?				
Are MDLs updated annually?				
Are initial calibration procedures specified in SOPs for all applicable analysis methods?				
Are the calibration requirements included in the appropriate SOP: Calibration procedure (including all formulas and calculations), Acceptance criteria including accuracy and precision requirements,				

Laboratory Audit Checklist

Item to be Evaluated	Yes	No	NA	Comments
Corrective action for failed criteria, Calibration frequency, and List of required standards?				
Is initial instrument calibration used directly for quantitation; is continuing instrument calibration verification used to confirm the continued validity of the initial calibration?				
If the initial instrument calibration results are outside established acceptance criteria, are corrective actions performed and all associated samples reanalyzed? Or, if reanalysis of the samples is not possible, are data associated with an unacceptable initial instrument calibration reported with appropriate data qualifiers?				
Is ICV performed for all methods with ICV requirements (ex-metals)?				
Is ICV concentration at approximately the mid-point of the calibration range?				
Are the ICV and CCV being performed at the appropriate frequency?				
Are method blank acceptance criteria included in SOPs?				
Is an acceptable method blank associated with each sample at the required frequency? (One per preparation batch, not to exceed 20 samples, or with each instrument analyses, as described in SOPs)				
Is blank subtraction specifically prohibited?				
Is the method blank processed along with and under the same conditions as the associated samples, including all steps of the analytical procedure?				
Are any affected samples associated with a contaminated method blank reprocessed for analysis or the results reported with appropriate data qualifying codes?				
Does the method blank consist of a matrix that is similar to the associated samples?				
Does the QA plan have procedures for investigating the source of blank contamination and specify measures to minimize or eliminate the problem? Are blank contamination corrective actions documented by the QA Officer?				
Does the laboratory have procedures in place for tracking, managing, and handling matrix-specific QC criteria, including spiking appropriate components at appropriate concentrations, calculating recoveries and relative percent difference, and reporting matrix spike results?				
Are the results of the matrix spike compared to the acceptance criteria, as published in the test method?				
When matrix spike results are outside of established acceptance criteria, are corrective actions taken and documented? Or are the data reported				

Laboratory Audit Checklist

Item to be Evaluated	Yes	No	NA	Comments
with appropriate data qualifying codes?				
Does documentation exist for standards preparation that uniquely identifies the reagents/solvents used and the method of preparation, date of preparation and identification of standard preparer, and concentrations of all solutions used?				
Are standards stored under appropriate conditions (i.e., refrigerated)?				
Are standards being replaced at proper intervals?				
Are high purity chemicals used to prepare standards?				
Are analytical reagents dated upon receipt?				
Are employee training records available and up to date?				
Do training records adequately document that technicians/analysts have successfully completed all training requirements?				
Does the laboratory have a policy and procedures for identifying training needs and providing training of personnel?				
Does laboratory management maintain documentation on file that demonstrates that each employee has read, understood, and is using the latest version of the laboratory's in-house quality documentation, which relates to his/her job responsibilities?				
Does the quality manual and related quality documentation include or reference corrective action procedures to be followed when testing discrepancies are detected, or departures from documented policies and procedures occur?				
Do these corrective action procedures include the following: 1. Identify individual(s) responsible for initiating and/or recommending corrective actions? 2. Define how the analyst shall treat a data set if the associated QC measurement are unacceptable? 3. Specify how out-of-control situations & subsequent corrective actions are to be documented? 4. Require management & the QA officer to review corrective action reports?				
Do the policy and procedures for nonconforming work ensure that corrective actions are taken immediately, together with any decision about the acceptability of the nonconforming work?				
Do the policy and procedures for nonconforming work ensure that where the data quality is or may be impacted, the client is notified?				
Does the laboratory document and implement any required changes resulting from corrective action investigations?				

Laboratory Audit Checklist

Item to be Evaluated	Yes	No	NA	Comments
Does the laboratory monitor the results to ensure that the corrective actions taken are effective?				
Are permanently bound notebooks with preprinted, consecutively numbered pages being used? Is the type of work and appropriate time period clearly displayed on the notebook?				
Are entries in logbooks signed, dated, and legible?				
Has the analyst avoided obliterating entries and the use of a pencil? Are changes to logbooks dated and initialed by the person who made the change?				
Are inserts (i.e., chromatograms, computer printouts, etc.) permanently affixed to the notebook and signed across the insert edge and page?				
Has the supervisor of the individual maintaining the notebook personally examined and reviewed the notebook periodically, and signed his/her name and date therein?				
Do supervisory personnel review the data and QC results?				
Does the quality manual include or reference procedures for data review?				
Does the laboratory have SOPs for manual calculations and manual integrations?				
Part 5: Sample Management				
Are there readily available SOPs for the receipt of samples?				
Has a sample custodian been designated?				
Is there adequate work space for receipt and handling of samples?				
Does the sample custodian check that shipping information is complete, including the time and date of sample receipt and sample condition, and note any discrepancies between samples on the traffic report and samples received?				
Are sample temperatures and preservation checked upon receipt?				
Are the samples logged into a Laboratory Information Management System (LIMS)?				
Are clients notified of any discrepancies?				
Is sample storage documented and inventoried?				
Are the sample receipt/storage and temperature logbooks completed in a manner consistent with the laboratory's SOP?				
Are sample receipt/storage areas secure (in accordance with the laboratory's SOP)?				
Are there separate storage areas designated for each analysis (i.e., volatile samples stored in different refrigerator)?				

Laboratory Audit Checklist

Item to be Evaluated	Yes	No	NA	Comments
Are samples stored away from all standards, reagents, food and other potentially contaminating sources?				
Does the laboratory properly manage and dispose of samples and chemical wastes?				
Part 6: Document Control/Data Storage				
Does laboratory notify the client of problems with documentation and/or condition of samples upon receipt?				
Does laboratory provide timely notification to the client (within 48 hours while samples are still within extraction/analysis holding times) of problems with extraction or analysis?				
Are sufficient raw data records retained to permit reconstruction of the initial instrument calibration? (e.g., calibration date, test method, instrument, analysis date, each analyte name, analyst's initials or signature; concentration and response, calibration curve or response factor; or unique equation or coefficient used to reduce instrument responses to concentration)				
Do values recorded on the data sheets match the reported values? What procedures are in place to assure this?				
Are data that are manually entered into the computer checked by a second person?				
Is there a project/run tracking/filing system in place?				
Is all information relating to analytical methods, sample receiving, and sample preparation included in the final data package?				
How long does the laboratory retain hard copy and/or electronic records of sample analyses?				
Are there written instructions for data storage and retrieval?				
Are data (electronic and hard copy) archived in a retrievable fashion?				
Does the laboratory have procedures to protect and backup records stored electronically and to prevent unauthorized access to or amendment of records stored electronically?				
If data is stored electronically, does the laboratory have an SOP for checking the accuracy of electronic data?				
If data are stored electronically, are redundant backup copies made and stored offsite?				
What procedure is in place for documenting that hard copy lab reports are identical to electronic reports?				

ATTACHMENT 6.4

FIELD SAMPLING/FIELD ANALYSIS AUDIT CHECKLIST

Field Sampling/Field Analysis Audit Checklist

Sampling Organization	Date of Evaluation	Name and Affiliation of Evaluator(s)

Item to be Evaluated	Yes	No	NA	Comments
Part 1: Sampling and Analysis Plan (SAP)				
Is there a sampling plan?				
Are there procedures for the transportation, handling, and storage of samples, including all provisions necessary to protect the integrity of the sample?				
Is there a documented system for uniquely identifying all samples, to ensure that there can be no confusion regarding the identity of such samples at any time?				
Is there a process for documenting corrective actions taken in the field?				
Are there SOPs for field activities available at the location where sampling is taking place?				
Have the SOPs been approved for the project?				
Part 2: Organization				
Are the sampling personnel's qualifications and/or training certifications adequate for the tasks performed?				
Do sampling personnel meet minimum qualifications specified in the contract?				
Part 3: Equipment				
Are supplies sufficient for the sampling project?				
Are up-to-date maintenance and repair records available?				
Is equipment storage appropriate?				
Are field instrument calibrations recorded on field forms or a field log book?				
Were calibrations performed following the applicable SOP?				
Is the following information recorded for initial calibrations and calibration verifications: Instrument ID? Date and time? Instrument readings (display values) with correct units? Name of analyst? Calibration standard IDs? Acceptance criteria?				
Are corrective actions performed on the instrument prior to recalibration documented?				

Field Sampling/Field Analysis Audit Checklist

Item to be Evaluated	Yes	No	NA	Comments
Does calibration documentation include the standard concentrations?				
Are sample containers well organized, protected from contamination, and ready for use?				
Are proper sample container materials, sizes, and preservatives used for each type of sample?				
Are defective containers and/or container caps removed from use?				
Are appropriate sampling tools and equipment used?				
Are sampling tools and equipment constructed of materials that are compatible with the analytes of interest?				
Are the decontamination procedures as defined in the sampling and analysis plan and/or SOP followed?				
If special circumstances require a deviation from the planned decontamination procedures, are the deviations appropriate?				
Part 4: Sample Collection				
Is the following information recorded during sample collection: Site name? Date and time of sample collection? Name of sampler? Unique field identification code for each sample? Required analyses for each sample? Sample preservation? Comments about samples, sample sources or other relevant field conditions?				
Are sampling locations documented according to the Sampling and Analysis Plan and/or SOP specifications?				
Are trip blanks and/or field blanks collected as specified in the approved sampling plan?				
Is sufficient sample volume for matrix spike/matrix spike duplicates collected?				
Are QC samples collected in the same manner as routine field samples?				
Are the samples collected from the planned locations?				
Are the samples homogenized if specified in the Sampling and Analysis Plan?				
When possible, does sampling start at the suspected least contaminated location and progress to the suspected most contaminated location?				
Are samples for different analyte groups collected in the appropriate order? (ex. soil VOCs first)				
Are samples collected for all analyses specified in the Sampling and				

Field Sampling/Field Analysis Audit Checklist

Item to be Evaluated	Yes	No	NA	Comments
Analysis Plan, if possible?				
Is reasonable effort made to prevent cross-contamination of samples?				
Are gloves worn by samplers and changed as appropriate?				
Is care taken to avoid contact with sample and sample container interiors?				
Are VOC sample containers protected from any fuel sources and fuel-powered equipment?				
Do sample containers remain capped until just prior to sample collection and do they remain capped after sample collection?				
Part 5: Sample Management				
Does each sample container have a weatherproof label with the correct sample ID written on it in indelible ink?				
Are the sample identification codes recorded in a manner that links the codes to the chain-of-custody, sample location records, and any other field records associated with the samples?				
Are samples stored on ice when required? (ex. not applicable for radiological analysis)				
Is the chain-of custody placed in a sealed plastic bag in the cooler with the associated samples?				
Is preservation information recorded on each sample label, as applicable?				
Are samples packaged to prevent container breakage?				
Are samples shipped the same day as collection or stored in a secure refrigerator for later shipment?				
Are sampling activity wastes stored for disposal according to applicable local, state, and federal regulations?				
Are sampling activity waste containers properly labeled?				
Does the chain-of-custody include the date, time, sample numbers, sampler name(s), number of containers, matrix, and comments?				
Are deviations, additions, or exclusions from planned sampling procedures documented?				
Are deviations communicated to appropriate persons in time for correct decisions?				
Are all errors in documentation (if applicable) corrected and initiated without obliteration?				
Are certificates of assay, grade, and other vendor specifications for standards and reagents retained?				
Are the expiration dates for calibration standards and reagents recorded on the containers?				
Are expired standards or reagents discarded?				
Are in-house standard or reagent preparations documented either by				

Field Sampling/Field Analysis Audit Checklist

Item to be Evaluated	Yes	No	NA	Comments
description or reference to an SOP?				
Part 6: Field Analysis				
Is field analysis documentation linked to the project, date, and sample location(s)?				
Are all field measurements recorded with the appropriate units, value, parameter, and time of measurement?				
Is the analyst name and instrument identification recorded with the test documentation?				
pH Does the pH meter and electrode system meet SOP and/or sampling event specifications? Are pH measurements corrected for temperature? Is a pH 7 buffer used as the first calibration standard? Do pH calibration verifications meet the established acceptance criteria? If the calibration and/or calibration verifications did not meet the acceptance criteria, was the failure resolved and calibration criteria met before proceeding with analysis? Are the field instrument probes rinsed properly between measurements? Are instrument pH readings allowed to stabilize before pH values are recorded?				
Temperature Does the temperature measurement device meet SOP and/or sampling event specifications? Are the temperature device readings allowed to stabilize before measurement values were recorded?				
Conductivity Do the specific conductance meter and electrode system meet the SOP and/or sampling event specifications? Do calibration verifications meet the acceptance criterion? If the calibration and/or calibration verifications did not meet the acceptance criteria, was the failure resolved and calibration criteria met before proceeding with analysis? Are conductivity measurements corrected for temperature? Is the instrument allowed to stabilize before measurement values are recorded?				
Turbidity Does the turbidimeter meet the SOP and/or sampling event specifications? Are all sample measurements associated with acceptable calibration verifications? If the calibration and/or calibration verifications did not meet the				

Field Sampling/Field Analysis Audit Checklist

Item to be Evaluated	Yes	No	NA	Comments
acceptance criteria, was the failure resolved and calibration criteria met before proceeding with analysis?				
Dissolved Oxygen Does the dissolved oxygen meter and electrode system meet the SOP and/or sampling event specifications? Are all sample measurements associated with acceptable calibration verifications? If the calibration and/or calibration verifications did not meet the acceptance criteria, was the failure resolved and calibration criteria met before proceeding with analysis? Are all measurements corrected for temperature? Are the dissolved oxygen readings allowed to stabilize before measurement values were recorded?				

QUALITY SURVEILLANCES

STANDARD QUALITY PROCEDURE 12.3

1. Purpose

This Standard Quality Procedure (SQP) establishes the methods and responsibilities for the conduct of surveillances in process activities to assure the effective implementation of the Quality Assurance Project Plan (QAPP) requirements.

2. References

Quality Assurance Project Plan (QAPP)

SQP 4.2 - Records Management

SQP 10.1 – Nonconformance Control

SQP 10.2 - Corrective Action

3. Definitions

Surveillance - The act of monitoring or observing to verify whether an item or activity conforms to specified requirements.

4. Procedure

4.1 Discussion

Surveillances are conducted to verify that activities that affect quality are being conducted in accordance with the requirements of the QAPP and implementing procedures. Surveillances may be performed on in-process work activities, as well as completed work. They are performed as unscheduled, announced, and unannounced verifications to assess activities and performance of personnel who are implementing the QAPP.

4.2 Responsibilities

The Subcontractor Project Manager (SPM) is responsible for project operations. He is responsible for the proper implementation of the QAPP requirements.

The Subcontractor Quality Assurance Manager (SQAM) is responsible for conducting surveillances of quality affecting activities. Additionally, he or she assures that discrepancies identified during surveillances are documented and reported and follow-up verification of corrective measures is conducted.

4.3 Performance of Surveillance

The SQAM conducts surveillances as needed or at periodic intervals as defined in project planning documents. He or she may select other personnel to participate in surveillances, as appropriate. Personnel performing surveillances will be selected based on background, education, experience, capability, and the judgment of the SQAM. The performance of surveillances supplements but does not replace the requirements for scheduled audits of activities or inspections.

Prior to performing surveillances, the SQAM will provide surveillance personnel with any necessary information (i.e., procedures, specifications, drawings, etc.).

The SQAM will, through discussion with surveillance personnel, assure that surveillance personnel are familiar with the activity and the requirements applicable to the activity being observed and proceed with the surveillance.

Surveillance personnel will verify the following as a minimum:

- The activity is proceeding in accordance with currently approved procedures;
- Personnel conducting the activity have been appropriately selected by project management; and
- Personnel performing the activity have received the required indoctrination and specific training required to perform the activity.

4.4 Surveillance Reporting

Upon completion of the surveillance activity, any comments or discrepancies noted will be discussed with the personnel performing the activity. Significant comments and discrepancies will be documented on the Surveillance Report, Attachment 6.1.

Discrepancies found during the surveillance that are determined by the SQAM not to be significantly adverse to quality will be reported by issuance of the surveillance report to management staff responsible for that activity.

Upon receipt of the surveillance report, responsible management will establish proposed corrective action for the discrepancies identified. Proposed corrective action will be documented on the surveillance report and must include the date when corrective action will be complete. The surveillance report with proposed corrective action is forwarded to the Subcontractor Project Manager for approval of the proposed corrective action.

The SPM forwards approved surveillance reports to the SQAM. Responses to surveillance reports must be submitted to the SQAM within thirty (30) days after receipt of the surveillance report. Discrepancies found during the surveillance that are determined by the SQAM to be significantly adverse to quality will be documented on the surveillance report and on a Nonconformance Report/Corrective Action (NCR/CA) form. The surveillance report is then closed as a result of the NCR/CA being issued. Corrective Action Requests that are generated as a result of this procedure will be handled and controlled in accordance with SQPs 10.1 and 10.2.

At the conclusion of the surveillance, surveillance personnel will conduct a brief post-surveillance meeting with relevant management or supervisory personnel of the activity observed, to discuss discrepancies noted and any other comments.

4.5 Surveillance Follow-up

The SQAM maintains the status of discrepancies for active surveillance reports and follows up on responses.

The SQAM, upon receipt of drafted surveillance reports, performs an evaluation of the proposed corrective action. If the proposed corrective action is acceptable, the SQAM signs the surveillance report in the "Approved" section.

Unacceptable responses will be noted on the surveillance report together with the specific reason for rejection. The SQAM will reissue the surveillance report to the responsible organization, delineate a new response due date, and include a copy of the original surveillance report with evaluation comments. Review and distribution of the reissued surveillance report will be the same as the original report.

The SQAM will assure that verification of corrective action implementation is accomplished and will document the results of the verification on the surveillance report.

NOTE: Unacceptable verification will be handled in accordance with two paragraphs above.

Upon completion (close-out) of the surveillance report, the SQAM will provide written notification to responsible management that all actions are complete and have been approved.

5. Records

The following documents may be generated as a result of this procedure:

- Surveillance Reports;
- Surveillance Report Response Correspondence;
- Surveillance Report Closure Correspondence; and
- Other correspondence Related to the Surveillance.

Documents identified above will be considered records after closure of each surveillance and will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Quality Assurance Project Surveillance Report

A form referenced or attached to this SQP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

QUALITY ASSURANCE PROJECT SURVEILLANCE REPORT

QUALITY ASSURANCE PROJECT SURVEILLANCE REPORT

Company:

Originator:	Surveillance No.:	Date:	Location:
Activities Under Surveillance: ☸ In Process ☸ Completed			
Surveillance Personnel:		Individuals Contacted:	
Surveillance Reference (Plan, Procedure):			
Surveillance Results:			
Deficiencies (Include Specific Requirement(s) Violated As Applicable:			
Proposed Corrective Action, As Applicable:			
		Corrective Action Completion Date:	
Consulting Project Manager:	Date:	Consulting QA Manager:	Date:
CORRECTIVE ACTION COMPLETED			
Title:	Signature:		Date:
VERIFICATION			
Verification Results: ☸ Accept ☸ Reject ☸ Elevated to NCR No.: _____			
Verified By:	Date:	Consulting QA Manager:	Date:
Verification Comments:			

SAMPLE CUSTODY

STANDARD OPERATING PROCEDURE 1.1

1. Purpose

This Standard Operating Procedure (SOP) establishes the method and responsibilities associated with the maintenance and custody of samples, which are to be used to provide data that form a basis for making project related decisions. It outlines the general procedures for maintaining and documenting sample chain of custody from the time of sample collection through sample disposition.

2. References

Other Relevant SOPs:

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 17.1 - Sample Labeling

SOP 17.2 - Sample Numbering

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Chain-of-Custody

The Chain-of-Custody (COC) document is the written record that traces the sample possession from the time each sample is collected until its final disposition; it is sometimes called the "cradle to grave" record. Chain-of-Custody is maintained by compliance with one of the following criteria:

- The sample is in the individual's physical possession;
- The sample is maintained in the individual's physical view after being in his/her possession;
- The sample is transferred to a designated secure area restricted to authorized personnel; or
- The sample is sealed to prevent tampering, after having been in physical possession.

Waybill

A document that contains a list of the goods and shipping instructions relative to a shipment.

4. Procedure

An overriding consideration for data resulting from laboratory analyses is the ability to demonstrate that the samples were obtained from the locations stated and that they reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal must be documented to accomplish this. Documentation will be accomplished through a COC record that lists each sample and identifies the individuals performing the sample collection, shipment, and receipt.

The original COC document will accompany the samples and a copy will be retained in the project file.

Sampling personnel will properly complete a COC Record upon collection of samples for analysis (Attachment). The COC will be the controlling document to assure that sample handling and custody are maintained, thereby assuring the sample(s) are representative of the environment from which they were collected. At a minimum, the following information will be recorded on the COC document:

- The unique identification number assigned to each sample;
- The date and time of the sample collection;
- A description of the sample method (e.g., grab or composite);
- A physical description of the sample matrix (e.g., soil, water, etc.);
- Number of sample containers;
- Confirmation that the sample was field filtered;
- Sample preservation (e.g., HNO_3, H_2SO_4, ice, etc.);
- Requested analyses (analyte and/or method identification);
- Special instructions to the laboratory including handling requirements, quality assurance/quality control, health and safety, and sample disposition;
- The project name and number;
- The date the analytical report is due;
- The names of all sampling personnel;
- The name and phone number of the project contact;
- The name and phone number of the laboratory contact; and
- The name of the courier and the waybill number (if applicable).

The COC document will be initiated in the field by the person collecting the samples and signed by each individual (custodian) who has the samples in their possession. The sample custodian is any person involved in the collection of the samples, including office personnel who transfer the samples from the office to a laboratory representative or courier. Each time that sample custody is transferred, the former custodian must sign the COC relinquishment and the new custodian must sign the COC receipt. Relinquishment and receipt signatures must be accompanied by the date and time, as well as the name of the project or company affiliation.

When transferring samples to a designated secure area, the sample custodian relinquishes the samples by signature and checks the box on the chain of custody that indicates the samples were released to a secured, locked area. Similarly, when retrieving samples from a designated secure area, the sample custodian takes custody of the samples by signing the chain of custody and checking the box that indicates the samples were received from a secured, locked area.

COC transfer from sampling personnel to the analytical laboratory will be performed in accordance with the requirements stated below.

If sampling personnel deliver the samples to the laboratory, or if a laboratory representative comes to the site/office to transport the samples to the laboratory, COC transfer occurs as follows:

- The sample custodian delivers the samples to the laboratory and relinquishes the samples directly to a laboratory representative or the laboratory representative comes to the custodian's location (such as the office) to transport the samples back to the laboratory.
- The custodian relinquishes the sample by signing the COC listing his/her name, affiliation, date, and time.
- The laboratory representative must receive the samples by signing his/her name, affiliation, date, and time on the COC. The laboratory representative may decline to take receipt of the samples if the COC is not properly completed or if the samples are not properly packaged. Any designated laboratory personnel may act as the sample custodian.
- A copy of the COC is placed in the project files and the original is maintained with the samples at the laboratory.

If the sampling personnel transfers sample(s) to the laboratory utilizing a common carrier, sampling personnel will retain COC responsibility and the common carrier is not responsible for maintaining sample custody. The sample collectors are responsible for packaging and sealing the samples to prevent tampering. When transferring samples to the courier for transport, COC procedures are maintained as follows:

- The sample collector lists the courier affiliation and waybill number on the COC.
- The sample collector relinquishes custody by signing his/her name, affiliation, date, and time. The collector keeps a copy of the relinquished COC for the project file.
- Copies of completed COCs will be sent to the Subcontractor Task Leader (STL) within 24 hours of relinquishing samples. At the end of each field activity, COCs will be scanned as a portable document format (PDF) file or raster graphic by the field personnel and emailed to the STL for archiving.
- The relinquished original COC is sealed in a watertight plastic bag and taped to the inside of the lid of the container used for transportation.
- The transportation container is sealed to prevent tampering and given to the courier for delivery to the laboratory.

- The sample collector obtains a copy of the waybill from the courier for the project file.
- The laboratory representative must sign his/her name, affiliation, date, and time on the COC upon receipt of the samples. The COC is maintained with the samples at the laboratory.
- The laboratory representative obtains a copy of the waybill from the courier for the project file.

The STL is responsible for assuring that a proper COC is initiated at the time the sample(s) are collected, and for making sure that the COC is maintained throughout the handling and subsequent transportation of the sample(s) to the designated laboratory. To ensure quality, the STL or their designee will review completed COCs daily; this means that the COCs (or a facsimile of) will be submitted to the STL at the end of each field day. Within 24 hours of the samples being collected, the STL or their designee is responsible for checking that the forms are completed correctly, contain the correct information, and that the appropriate samples and analyses have been requested. The STL, or their designee, will also check the lab log-in report to ensure that the appropriate samples and analyses have been logged into the system by the laboratory. The STL will determine the fate of sample(s) that have identified deficiencies (e.g., missed holding times, elevated temperature at receipt, etc.). The STL is responsible for disposal of all samples analyzed onsite or withheld from delivery to the offsite laboratory, and the laboratory is responsible for disposal of all samples received. The responsible party will dispose of samples in accordance with federal and state regulations within one year of sample collection, unless additional retention is requested by U.S. Department of Energy.

Project staff working under the STL are responsible for properly documenting and maintaining the COC from the time of sample collection until delivery of the sample to the laboratory.

Laboratory personnel are responsible for receipt of samples which have been submitted to the laboratory under a COC document. The laboratory will document and maintain the COC from the moment they take custody of the sample(s) until the sample(s) are disposed of or returned to the client. Copies of all COCs will be included in the laboratory narrative portion of the report, letter, or other official documentation of the analytical results.

5. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files, in accordance with SQP 4.2.

6. Attachments

6.1 Chain-of-Custody Record

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the Subcontractor Quality Assurance Manager, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

CHAIN-OF-CUSTODY RECORD

Chain of Custody Record

Please send analytic results, electronic deliverables and the original chain-of-custody form to:

Lab name:
address:
city, state, zip:
Phone:

INSTRUCTIONS FOR LAB PERSONNEL:

GeoTracker EDF required? ☐ **Yes** ☐ **No**
Equis 4-file EDWEDD required? ☐ **Yes** ☐ **No**
Report results to: ☐ **MDL** ☐ **RL**
Report soil results in: ☐ **Dry weight** ☐ **Wet weight**

Company Contact	**Project Manager:**	**Protocol ID/path:**	**COC Number:**
	Project ID:		
	Sampled by:		**Page_____ of _____**
	Sample date(s):		
Phone	**Analysis Turnaround Time:**		**SDG number:**
FAX			
Job Name:	_____		
Address:	**(Specify Days or Hours)**		**Sample Specific Notes:**

Lab ID	**Sample Identification**	**Sample Date**	**Sample Time**	**Sample Matrix**	**# of Cont.**	**Analyte (Method ID)**														**Moisture (ASTM D2216/CLP)**
						Field Filtered (X):														

Preservation Used: 1= Ice, 2= HCl; 3= H_2SO_4; 4=HNO_3; 5=NaOH; 6= Other _____

Special Instructions/QC Requirements & Comments: **Level ____ Report**

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:

☒ **= Samples released to a secured, locked area.**

● = Samples received from a secured, locked area

FIELD ACTIVITY DAILY LOG

STANDARD OPERATING PROCEDURE 1.2

1. Purpose

Field work documentation provides a complete record of all activities and interactions at the site. Field notes are the only record of what we do in the field and must map back to the chain of custody (COC) and document all activities, start/stop times, supplies used, and any deviations from the Work Plan.

Field work documentation is an essential and important part of any field activities. They can become legal documents, and as such, must meet the minimum standards described in this standard operating procedure (SOP).

Defined terms in the text of this SOP, and abbreviations are defined in Section 3.

This SOP is for all field personnel, to be used every time in the field for any activity, including site walks (i.e. Phase I investigation, site reconnaissance).

All field personnel, Subcontractor Task Leaders (STL) responsible for field activities, and Subcontractor Project Managers (SPM) should read and adhere to the process described in this SOP. This SOP should be included in the project instructions/kick-off meeting for all work that includes a field work component.

2. References

http://www.lanl.gov/environment/all/docs/qa/ep_qa/SOP-5181.pdf

http://www.nsf.gov/pubs/policydocs/rtc/epa_609.pdf

http://www.ornl.gov/~webworks/cpr/rpt/93647.pdf

SOP 1.1 – Sample Custody

SOP 1.3 – Field Measurement, Maintenance, and Calibration

SOP 3.1 – Surface and Shallow Soil Sampling

SOP 3.2 – Subsurface Soil Sampling while Drilling

SOP 5.3 – Treatment System Sampling

SOP 9.2 – Grab Ground Water Sampling

Standard Quality Procedure (SQP) 4.2 – Records Management

3. Definitions

Logbook – a book that can be used to record a field recording of information such as sample collection and handling, instrument usage, temperature monitoring, water quality monitoring, equipment use, and performance, calibration, maintenance, and similar applications

GPS – Global Positioning System, as a field instrument

PPE – Personal Protective Equipment

QA/QC – Quality Assurance/Quality Control

4. Procedure

Field Documentation Requirements

All information related to sampling activities will be recorded in a document-controlled field logbook or Field Activity Daily Log Form as well as a variety of other field sampling forms depending on the types of sampling to be conducted. A blank Field Activity Daily Log is included as Attachment 6.1. The Attachments to this procedure also include additional forms to be completed specific to water sampling, soil and confirmation sampling, air sampling, as well as logs for both calibration and treatment system alerts. Instructions for additional documentation for specific field tasks are contained in their own SOPs, which include, but are not limited to: Sample Custody (SOP 1.1), Surface and Shallow Soil Sampling (SOP 3.1), Subsurface Soil Sampling while Drilling (SOP 3.2), Grab Groundwater Sampling (SOP 9.2), Field Measurements, Maintenance, and Calibration (SOP 1.3), and Treatment System Sampling (SOP 5.3). Field documentation must also contain any deviations to the Work Plan that arise, based on field conditions.

Unless previously approved by the SPM, a Field Activity Daily Log will be completed whenever work of any kind is conducted onsite, including maintenance of systems and site walks. At a minimum the following information will be included as part of field documentation:

- Project name/number and exact location of area being investigated;
- Date, names of field personnel on site and the person keeping the log, weather, and miscellaneous field conditions on a new page in the logbook at the start of each workday;
- Time of day;
- Name and affiliation of persons contacted;
- Names of visitors on site and their affiliations;
- Description of activities conducted during the workday;
- Field equipment used in the investigation;
- Date and time of field calibrations, calibration checks, and calibration standards;
- Field measurements, calculations, and results, if applicable;
- Deviations from the Work Plan, complete explanations for the deviations, and corrective action taken;

- Unusual events;
- PPE level being used on site and any changes to PPE required during the day;
- Notation of all samples collected during the day, including sample locations, sample identification (QA/QC samples), boring identification, sample depth, sampling equipment used, volumes and containers, sampling remarks and observations, and personnel who collected the sample;
- Sketches of sample locations with locations measured from building corners and/or GPS coordinates, and specific site conditions;
- Field locations of any photographs taken;
- Number of sample coolers shipped and appropriate tracking numbers;
- Any other factors that could affect sample integrity; and
- The signature of the author and date at the bottom of each page in the space provided.

All field documentation will be made legibly with indelible ink, preferably blue ink. Entries should be objective, factual, and free of personal feelings or other terminology that might prove inappropriate. If using a logbook, no blank pages or sections of pages will be included in the logbook. If a page is not completely filled in, a line will be drawn through the blank portion and initialed by the person keeping the log.

Errors will be corrected by drawing a single line through the error and initialing and dating the correction. The field documentation will serve as a permanent record of the field activities and will become part of the project files.

To ensure quality, the STL or their designee will review completed Field Activity Daily Logs each day that field work is conducted; this means that the forms (or a facsimile of) will be submitted to the SPM at the end of each field day via electronic copy, hardcopy, or other equivalent transmittal method. Within 24 hours of the samples being collected, the STL or their designee is responsible for checking that the forms are completed correctly, contain the correct information, and that the appropriate samples have been collected.

At the end of each field activity, all completed field documentation will be scanned into a portable document format (PDF) or similar file by the field personnel and emailed to the SPM for archiving.

It is the responsibility of the personnel in the field to follow these procedures for field documentation. The SPM has final responsibility to make sure that staff are aware of and follow this SOP.

5. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with Standard Quality Procedure (SQP) 4.2. At a minimum, hard copy field forms will be transported back to the office where they will be scanned as PDFs and entered into the appropriate electronic project file stored on the network. Hard copies of field forms will also be archived in the project files.

6. Attachments

6.1. Field Activity Daily Log

6.2. Water Sampling Data Sheet

6.3. Shallow Soil and Confirmation Sampling Data Sheet

6.4. Indoor/Ambient Air Sampling Data Sheet

6.5. Helium Shroud Soil Vapor Sampling Data Sheet

6.6. Test Equipment List and Calibration Log

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the Subcontractor Project Quality Assurance Manager, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

FIELD ACTIVITY DAILY LOG

FIELD ACTIVITY DAILY LOG

Project Name: _____ Date: _____ Page _____ of _____

Project #: _____ Project Manager: _____ Vehicle (Field Use):

Name: _____ Personal _____ Odometer out: _____

Total Hours Billed: _____ Other: _____

Time	Activity Description

Time	Telephone Calls

Signature: _____ **Date:** _____

ATTACHMENT 6.2

WATER SAMPLING DATA SHEET

WATER SAMPLING DATA SHEET

Project Name: **Sample Location:**

Project Number: **Sample ID:**

Personnel: **Sample Date:** **Time:**

WEATHER ☐ Sunny ☐ Cloudy ☐ Rainy ☐ Foggy ☐ Windy Temp (units):

SAMPLE TYPE ☐ Original ☐ Duplicate ☐ Field Blank ☐ Equipment Blank ☐ Other:

SAMPLE SOURCE ☐ Monitoring Well ☐ Extraction Well ☐ Piezometer ☐ System ☐ Other:

PURGE/SAMPLE EQUIPMENT

Pump Dedicated? ☐ Yes ☐ No ID#: ☐ Bladder ☐ Submersible ☐ Sump ☐ Peristaltic ☐ Other:	Tubing Dedicated? ☐ Yes ☐ No ☐ Disposable ☐ PVC ☐ Polyethylene ☐ Teflon ☐ Silicone ☐ Tygon
Bailer Dedicated? ☐ Yes ☐ No Type: ☐ NA	Decon Method: ☐ Steam ☐ Alconox ☐ DI Water ☐ NA
Totalizer (Start): Rate:	Totalizer (End): Rate:

WELL MEASUREMENTS (Compare with Well Construction Details, if available)

Well Diameter in.	Well Casing Material:	Low-Flow/Micropurge Method? ☐ Yes ☐ No
Depth to Water ft.	DTW Reference Point[1]:	Required Purge Volume[2] (units):
Measured Well Depth ft.	Pump Intake Set At: ft. ☐ NA	Actual Purge Volume (units):

STABILIZATION PARAMETERS (Document instrument information on Calibration Log)

Pump **Rate/Volume** (units:)	Time	DTW ft	pH units	EC µS/cm	DO mg/L	ORP mV	Turbidity NTU
Final Readings:	**Temperature:** °C						
☐ Stabilization Goals (project specific):							
☐ Stabilization Goals (USEPA):			± 0.1 units	± 3%	± 0.3 mg/L	± 10 mV	± 10%

SAMPLE APPEARANCE VOAs free of air bubbles? ☐ Yes ☐ No (Explain):

Color:	☐ Clear ☐ Gray ☐ Yellow ☐ Brown ☐ Tan ☐ Black ☐ Cloudy ☐ Other:
Odor:	☐ None ☐ Gasoline ☐ Diesel ☐ Solvent ☐ Sulfur ☐ Metallic ☐ Other:
Solids:	☐ None ☐ Sheen ☐ Trace ☐ Measurable Amount (units): ☐ Silt ☐ Sand ☐ Gravel ☐ Organic Material ☐ Separate Phase Hydrocarbons ☐ Other:

COMMENTS, WELL CONDITIONS (LOCKS, CASING, PLUGS, SEAL, VAULT), PROBLEMS and/or CONCERNS:

VARIANCE FROM SAMPLING PROTOCOL: ☐ **No Variances**

Sampler Signature: **Date:**

Notes 1. Depth to water reference point can be top of casing (TOC), port, notch or other. 2. Normally, three water-filled casing volumes; for low-flow sampling see protocol.

ATTACHMENT 6.3

SHALLOW SOIL AND CONFIRMATION SAMPLING DATA SHEET

SHALLOW SOIL AND CONFIRMATION SAMPLING DATA SHEET

Project Name: **Sample Location:**

Project Number: **Sample ID:**

Personnel: **Sample Date:** **Time:**

WEATHER ☐ Sunny ☐ Cloudy ☐ Rainy ☐ Foggy ☐ Windy Temp (units):

CONFIRMATION SAMPLE? ☐ Yes ☐ No

SAMPLE SOURCE FOR CONFIRMATION SAMPLE ☐ N/A (Shallow Soil Sample)

(Check all that apply) ☐ Excavator Bucket ☐ Excavation Sidewall ☐ Excavation Bottom ☐ Soil Pile ☐ Other:

SAMPLE TYPE ☐ Original ☐ Duplicate ☐ Other:

SAMPLE DEPTH ☐ Feet bgs ☐ Inches bgs

SAMPLE EQUIPMENT

☐ Scoop ☐ Shovel ☐ Slide Hammer/Sleeve ☐ Trowel ☐ Hand Auger ☐ Terra Core/EnCore ☐ Excavator Bucket ☐

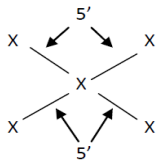
☐ Other:

COMPOSITE SAMPLE? ☐ Yes ☐ No

(REQUIRED FOR COMPOSITE SAMPLES)

Draw/describe composite sample pattern/scheme and measurements (show sub-sample locations with an "x"):

Example:



PID/FID READING (collect from sample head space, immediately prior to, or following containerization)

HOMOGENIZED PRIOR TO CONTAINERIZATION? ☐ Yes ☐ No

If yes, describe homogenization process:

COMMENTS, PROBLEMS, and/or CONCERNS:

VARIANCE FROM SAMPLING PROTOCOL: ☐ **No Variances**

Sampler Signature: **Date:**

ATTACHMENT 6.4

INDOOR/AMBIENT AIR SAMPLING DATA SHEET

INDOOR/AMBIENT AIR SAMPLING DATA SHEET

Project Name: _____ Date: _____ Page _____ of _____

Project #: _____ Project Manager: _____ Vehicle (Field Use):

Name: _____ Company _____ Odometer in: _____
Personal _____ Odometer out: _____
Rental _____ Mileage: _____

Total Hours Billed: _____ Other: _____

Weather Conditions: Wind Speed (mph): _____ Temperature: _____

Activity Description

FOR AMBIENT AIR SAMPLE COLLECTION -

NOTE: for information that is also required on lab-provided Chain-of-Custody, it is acceptable to write "see COC" on this form to eliminate duplicative entries on multiple forms

Sample Location: _____

Sample ID: _____

Type of Sample Circle one: background indoor air crawl space

Sample Device Circle one: Summa canister: 1L 6L _____ Sorbent Tube Other: _____

Serial ID of Summa Canister/Sorbent Tube _____

Serial ID of Flow Gauge _____

Vacuum in Summa canisters before sampling: _____ in. Hg

Vacuum in Summa canisters after sampling: _____ in. Hg

Information to be recorded for TO-17 Sampling

Pre-Test Flow rate (before sampling) _____ mL/min

Post-Test Flow rate (after sampling) _____ mL/min Average flow rate (use for sample pumps): _____ mL/min

Volume _____

Indoor Temp _____ Outdoor Temp _____

Note any known locations of VOC-emitting products in building:

Note any changes in building condition between start and end of sampling:

Other information:

in. Hg = inches of mercury

L = Liters

mL/min = milliliters per minute

Signature: _____ **Date:** _____

ATTACHMENT 6.5

HELIUM SHROUD SOIL VAPOR SAMPLING DATA SHEET

HELIUM SHROUD SOIL VAPOR SAMPLING DATA SHEET

PROJECT NAME:	**Sample Location:**	**Sample ID:**
PROJECT NO:	**Sample Depth:**	**Sample Date:**
	Sampled By:	**Sample Time:**

WEATHER

☐ Sunny ☐ Cloudy ☐ Rainy ☐ Foggy ☐ Windy Temp:
☐ Other (describe):

ACTIVITY DESCRIPTION

SAMPLE TYPE ☐ Original ☐ Duplicate ☐ Other:

PURGING

Helium Purge Monitoring			**Purging Specifications (Circle Units As Appropriate)**	
Time	He Measurement in Shroud (Ideal: 20-25%)	He Measurement in Purge Line (%)		
Baseline:			Calculated Soil Gas Purge Volume (Milliliters or Liters):	
			Purge Canister Regulator Flow Rate (mL/min):	
			Calculated Purge Time (Seconds or Minutes):	
			Purge Can Start Pressure (in. Hg.):	
			Purge Can Final Pressure (in. Hg.):	
			Helium Shroud ID No.:	
Total Purge Time:		**Seconds or Minutes**		

SAMPLING

Sample Collection			**Sampling Specifications**	
Time	Sample Canister Pressure (in. Hg.):	He Measurement (%) in Shroud:	Shut-In Test Performed Prior to Purge & Sampling (circle one)	YES / NO
			Sample Canister ID No.:	
			Sampling Regulator ID No.:	
			Sampling Start Time:	
			Sampling End Time:	
			Sample Can Start Pressure (in. Hg.):	
			Sample Can Final Pressure (in. Hg.):	
			Moisture in Tubing (circle one)	YES / NO

OTHER INFORMATION

Signature _____ Date _____

HELIUM SHROUD SOIL VAPOR SAMPLING EQUIPMENT LOG

PROJECT NAME:	**SAMPLING DATE(S):**
PROJECT NO:	**SAMPLED BY:**

INSTRUCTIONS

Use this Soil Vapor Sampling Equipment Log in conjunction with the Soil Vapor Sampling Data Sheet. The purpose of this equipment log is to track all sampling equipment used throughout the sampling day or event. To complete the form, list the following information:

- Up to four sample identifications (IDs) in each column (A, B, C, or D) for which the associated helium shroud equipment was used;
- ID numbers of helium supply canister(s) and helium supply regulator(s) used to collect the associated samples;
- ID numbers for the in-shroud and in-line helium monitors used to collect the associated samples; and
- ID numbers for the purge canister(s) and purge canister regulator(s) used to collect the associated samples.

SAMPLE ID(S) AND ASSOCIATED HELIUM SHROUD EQUIPMENT ID NUMBERS

(A) Associated Sample IDs:		**(B) Associated Sample IDs:**		**(C) Associated Sample IDs:**		**(D) Associated Sample IDs:**	
He Supply Canister	He Supply Regulator	He Supply Canister	He Supply Regulator	He Supply Canister	He Supply Regulator	He Supply Canister	He Supply Regulator
In-Shroud He Monitor	In-Line He Monitor	In-Shroud He Monitor	In-Line He Monitor	In-Shroud He Monitor	In-Line He Monitor	In-Shroud He Monitor	In-Line He Monitor
Purge Canister	Purge Can Regulator	Purge Canister	Purge Can Regulator	Purge Canister	Purge Can Regulator	Purge Canister	Purge Can Regulator

OTHER INFORMATION

Signature _____ Date _____

ATTACHMENT 6.6

TEST EQUIPMENT LIST AND CALIBRATION LOG

TEST EQUIPMENT LIST AND CALIBRATION LOG

Equipment Name and Number	Test Parameter	Date and Time of Calibration	Calibration Standard Used (Manufacturer, Lot Number, and Expiration date)	Measured Calibration Response/Reading (include Units)	Expected Calibration Response/Reading	Calibration Result (pass/fail) 90% - 110% is acceptable	Calibrator's Initials

Note: Complete calibration and record information before use for all test equipment that requires calibration.

FIELD MEASUREMENTS, MAINTENANCE, AND CALIBRATION OF INSTRUMENTS

STANDARD OPERATING PROCEDURE 1.3

1. Purpose

The purpose of this document is to provide personnel selecting field measurement equipment and personnel who support those operations with a general overview of and procedure for the use of these instruments to obtain field measurements. The actual operation of a specific field measurement meter will be subject to the manufacturer's equipment manual instructions. This will ensure the quality and continuity of data.

Practical methods for performing field measurements vary based on the precision, range, and number of parameters. The selection of a technique is often related to the types of samples to be measured. Considerations for sample preparation, sample size, desired parameters, and post-process data analysis are significant issues underlying the choice of the measurement method. Most modern electronic measurement systems are capable of providing accurate measurements for a variety of sample types at and above the levels required by regulatory agencies, as well as federal, state, and local requirements.

2. References

United States Environmental Protection Agency (EPA), 1987. *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988. *EPA Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

4. Procedure

4.1 Applicability

This procedure is applicable to all site personnel, contractors, and subcontractors using field measurement equipment for the purposes specified in this procedure and outlined in the project work plan.

4.2 Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that all sample collection activities are conducted in accordance with this Standard Operating Procedure (SOP) and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Subcontractor Project Quality Assurance Manager (SPQAM) is responsible for periodic review of field generated documentation associated with this SOP. The SPQAM is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformance documents, etc.) if problems occur.

Field personnel assigned to environmental and QC sampling activities and Subcontractor Task Leaders (STLs) overseeing such work are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures, including operating the instrument in accordance with the requirements of this procedure, keeping the equipment clean and free of contamination, properly calibrating the instruments and documenting these calibrations, and adhering to the work procedures, as outlined in the project documents.

All field staff are responsible for reporting deviations from procedures to the STL or the SPQAM..

5. Factors Affecting Sample Measurements

There are several factors that can directly affect the quality of results using field measurement equipment. The following are some of the most common factors.

5.1 Environmental Conditions

While many instruments are rugged and able to work under varied conditions, all have a range or limit affecting their performance. Temperature, pressure, humidity, vibration, electromagnetic interference, and sunlight are some factors that may adversely affect the field measurement device. Consult the manufacturer’s manual specifications for these limits. Always operate with a comfortable margin within these limits.

Optimally, the instrument should be installed away from any environmental influence or source of disturbance. Plan the activities for sample measurement to minimize exposure to the environmental factors that affect the measurement instrument. For example, shade the meter to keep the sun from overheating the case.

Another consideration is the location or area where the field measurement work is being conducted. One of the most common failures of an instrument relates to damage. Falling from a perch on a truck, water contact, or dust blowing onto the instrument are examples of the possibilities that need to be considered before starting field work. Carefully select an instrument that can operate in the conditions present on site and maintain vigilance over the protection of the device from damage.

5.2 Meter Resolution

Field measurement instruments come in a wide range of sensitivity, accuracy, and precision. A review of the project work plan and data quality objectives in the sampling and analysis plan or field work description will highlight the requirements of the necessary measurement instrument. The following is a practical discussion of meter performance verification.

5.2.1 Specifications

Review the manufacturer's equipment manual, inspect the meter's display, and review the specification sheet to determine the sensitivity, accuracy, and precision of the instrument. Select a meter whose accuracy and precision exceeds the data quality objectives of the work and whose specifications can be verified.

The range, division of the scale, and the displayed sensitivity of the meter are also factors to consider in the selection of a meter.

- Select a range at least twice that of the highest measurement likely to be encountered.
- The scale division on an analog meter determines how precise the reading can be. For example, if one can see between two scale divisions, the observable fraction of the division determines the precision of the reading but does not determine its accuracy.
- A meter should display units at least one more digit place than the lowest reading required to be measured. For example, if the requirement is to measure to the tenths place (e.g., 0.1), the meter should be able to read to the hundredths place (e.g., 0.01).

5.3 User Activities

5.3.1 Viewpoint

Some meter faces are susceptible to inaccuracy under some viewing angles. Consult the manufacturer's operation manual for specifications for the optimal viewing of the meter face. Experience may highlight the need for perpendicular viewing of a particular meter. In the field this may be difficult, so plan for these occurrences. Another meter may be better suited to the particular environment.

5.3.2 Use in Inclement Weather

Select an instrument that can be used in the field conditions that may be encountered such as high humidity, rain, and high or low temperatures. Laboratory meters are often inappropriate for use in outdoor conditions. Rugged field instruments are available that can resist inaccuracies, malfunctions, and errors under such conditions.

5.3.3 Calibration

Operation of an instrument for accurate and precise measurement requires periodic calibration to be performed. Follow the manufacturer's recommended procedure for calibration of the specific instrument that you will be using. The frequency of such calibration will not be longer than each day of use. The specific project work plan may specify additional requirements. Calibration standards will be traceable to a National Institute of Standards and Technology (NIST) standard and will not be used later than the expiration date.

6. Operation

6.1 Equipment

The following is a general description of some of the equipment described for use in specific work plans. Additional equipment may be required if additional analysis is to be performed.

6.1.1 Maintenance and Repair

Instruments shall be maintained in accordance with the manufacturer's recommendations. Repair of the instrument shall be by the manufacturer or equivalent technical personnel. Measurement instruments will be inspected visually each day prior to use. If evidence of tampering or significant damage is observed, the instrument will be taken out of service and labelled as such until proper operation is verified.

Out-of-service instruments will be segregated from operational instruments, when practical. The specific reason for removal from service and the date of removal will also be stated on the out-of-service tag. The instrument will then be repaired by the appropriate vendor or manufacturer, as deemed necessary by the Consulting Task Leader or the Consulting Project Manager. Instruments that cannot be repaired will be replaced, as necessary, to provide support to the project. Field personnel responsible for calibrating and operating the repaired instrument will inspect it upon receipt to verify the repairs. If repairs are unsatisfactory, the instrument will again be taken out of service, labelled, and returned to the repair vendor or alternate vendor until satisfactory repairs are verified.

6.1.2 Electronic Multi-parameter pH/turbidity/eC/DO/ORP Meter

Multi-parameter meters are the most commonly used meters in the field for water sampling. These procedures have been written for use with YSI multi-meters for pH, turbidity, conductivity, dissolved oxygen, and oxidation-reduction potential. Procedures and instructions in the manufacturer's equipment manual must be followed.

Prior to use, the manufacturer's equipment manual shall be reviewed by qualified personnel in accordance with the project work plans. Standards should be checked monthly for expiration of the source material. Standards should be handled carefully to minimize leakage.

6.1.3 Calibration of a Multi-parameter pH/turbidity/eC/DO/ORP Meter

The calibration method includes three-point calibration for pH and single point calibration for turbidity, conductivity, dissolved oxygen, and oxidation reduction potential. Refer to the manufacturer's operation manual for software interface instructions. Record the calibration data and standard solution data on the Calibration Log during each calibration.

6.1.4 Conductivity Calibration

Verify the temperature probe with a traceable thermometer before calibration and correct if needed.

Calibrate with a conductivity standard of 1,000 μMhos/centimeter (μMhos/cm) or greater for fresh water measurements. Higher calibration standards are required for brackish water or salt water analysis.

Pre-rinse the cup and sensors three times with a small amount of the calibration standard and discard. The vent hole in the side of the probe and sondes must also be completely submerged in standard for calibration. Verify that there are no trapped bubbles in the cells. Gently shake the sonde to help dislodge any air bubbles.

Investigate any calibration error messages if displayed. Typical error message causes are incorrect entry of the calibration solution concentration, low solution level, air bubbles in the probes cell, calibrating in the wrong mode, or bad standard.

6.1.5 pH Calibration

Go to the Report Menu and enable the pH mv output. Recondition the probe if it takes more than 90 seconds to stabilize in pH buffer.

Start calibration in pH 7 buffer. Rinse the sensor and calibration cup with a small amount of pH buffer. Fill the cup so that the pH probe tip and the sonde's temperature probe are submerged in buffer. Enter the pH value based on the solution temperature. Record the pH value and millivolt reading for each of the three calibration points.

Determine the difference between the pH 7 millivolt reading and the other two calibration points to determine the slope. The acceptable range for the slope is 165 to 180. If the slope drops below 160, the sensor should be taken out of service.

6.1.6 Oxidation Reduction Potential Calibration

Oxidation Reduction Potential (ORP) and pH sensors are combined on all current YSI sondes and pH must be calibrated before ORP. If pH will not calibrate then ORP has been disabled as well.

When calibrating the ORP sensor, the sonde's temperature sensor must also be submerged in the Zobell calibration solution.

6.1.7 Turbidity Calibration

Turbidity should be calibrated in a clean indoor environment. Verify that the sensor guard is installed on the sonde or use a calibration/storage cup with black endcap specifically made for turbidity calibration.

Ensure that the submerged parts of the sonde and wipers are clean before calibration. Verify that the optics are clean and without fingerprints.

Start with a zero (0) nephelometric turbidity unit (NTU) standard and pour down the side of the calibration cup to avoid air bubbles in the solution. Secure the sonde into the calibration cup and verify that there are no air bubbles on the probe face. Run the wiper at least once and wait for the probe's sampling period before accepting the first calibration point.

Calibrate the second point, typically 126 NTU. Wipe the probe at least once before pressing the enter button. Correct any calibration errors before proceeding to sample measurement.

6.1.8 Dissolved Oxygen (DO) Calibration

Set the sonde into the calibration cup with approximately 1/8 inch of water, but without allowing water to contact the membrane.

6.1.9 Calibrate Sonde in DO % and Enter the Local Barometric Pressure in mmHg. PID

Photo Ionization Detectors (PIDs) are used for various soil, water, and environmental checks. Measurements using a PID are affected by similar environmental, user, and functional limitations, as discussed previously. This procedure has been written for use of the MiniRAE PID meter. Procedures and instructions in the manufacturer's equipment manual must be followed.

Standards should be checked monthly for expiration of the source material. Standards should be handled carefully to minimize leakage.

6.1.10 Calibration of the PID.

The MiniRAE 2000 is factory calibrated with standard calibration gas and is programmed with default alarm limits. To calibrate the meter obtain the proper calibration gases, ensure that the meter has a fully charged battery, and start the meter.

After the meter has warmed up, the option menu can be selected to perform a fresh air calibration. One can use a clean air source such as nitrogen, a tedlar bag with a known quantity of clean air, or a charcoal filter on the meter inlet line.

The meter menu will ask if you wish to perform the fresh air calibration. Answer yes with the keyboard after connecting the source. After about 15 seconds, the meter responds by updating the data and then displays the zero reading. Record this reading on the Calibration Log.

The meter will ask again if a fresh air calibration is desired. Press no and the meter will ask if a span calibration should be performed. After connecting the span gas source press yes. The meter will take about 30 seconds to process and then will respond with updating data, span cal done, turn off gas. Record the value displayed on the Calibration Log. Remove the calibration gas. Press the menu button to return to operation.

6.1.11 Other Instruments

Field measurements often will be required for other instruments included (e.g., four-gas meters for hazardous environment testing, potentiometers for electrical troubleshooting, and particulate samplers for construction monitoring). The work plan should detail the required field measurements device and procedures for its use. In all cases, procedures and instructions in the manufacturer's equipment manual must be followed.

6.2 Precautions

The following precautions are to be observed during the performance of all activities associated with this procedure.

6.2.1 Exposure to Contaminated Samples

Since the measurement of samples may lead to exposure to contamination, procedures shall be followed to control worker exposures and the potential spread of contamination during sampling operations.

6.2.2 Exposure to Electrical Sources

Working with and working on electronic instruments, one has the potential to be exposed to:

- Batteries;
- Battery chargers; and/or
- Instrument internal circuitry.

Batteries contain materials that may be harmful if touched, ingested, or inhaled. The charging of batteries may have the risk of fire or high temperatures. Internal circuitry should never be exposed to water or other solvents that may short-circuit the instrument. Such actions may expose the operator to heat, fumes, and the risk of shock. Follow the manufacturer's recommendations on using and handling these components.

6.3 Prerequisites

6.3.1 Instrument Setup

Prior to use, the instrument shall be set up by qualified personnel in accordance with the manufacturer's instructions.

6.3.2 Experience with Equipment

The operator shall have familiarized himself with the operation of the equipment prior to use in the field. Test run measurements on known samples to increase experience with the meter prior to going into the field.

6.3.3 Procedures

The operator shall follow the procedures outlined in the project work plan and the manufacturer's operation manual.

6.4 Sample Collection

Samples shall be collected in accordance with the requirements of the procedures in the applicable Sampling and Analysis Plan or Field Sampling Plan. A sampling protocol that provides site contact information, supply lists, specific task instructions, SOPs, and forms for completing a sampling task in the field is typically prepared for each sampling task.

7. Performance Verification

7.1 Calibration

Calibration of meters used for measurements is required prior to its use. Refer to Section 3.0 for examples of the calibration procedures. Additionally, any changes in the instrument location, large verifiable changes in readings, or repairs to the instrument will require a new calibration to be performed.

7.2 Level of QA

Analytical options available to support field data collection activities are typically either offsite laboratory analysis of a fraction of the number of samples analyzed in the field or additional readings obtained from a second meter. The project work plan will specify any QA method to be employed during sampling.

7.3 Responsibilities

Personnel operating the instrument are responsible for controlling the custody of samples after measurement in accordance with the requirements of this procedure and the project work plan. The SPM is responsible for ensuring samples analyzed onsite are disposed in accordance with federal and state regulations.

The instrument custodian, operator, STL, and SPM are to ensure that they follow all of the applicable rules and procedures relating to the use, maintenance, and repair of the field measuring device. Copies of logs of repair, or maintenance of the equipment shall be maintained with the device for inspection. Calibration, maintenance, and repair documentation and measurements are stored in the project files.

8. Records

Records generated as the result of operations associated with this procedure shall be retained in accordance with the following requirements.

- Results of the most recent year's calibration data for the instrument shall be maintained by the instrument custodian in Calibration Logs contained in a book or binder located in the vicinity of the instrument. All calibration data will be controlled and maintained in the project record files, in accordance with (Standard Quality Procedure) SQP 4.2.
- Results of sample analysis will be controlled and maintained in the project record files, in accordance with SQP 4.2.

9. Attachments

No attachments.

SAMPLE HANDLING, PACKAGING, AND SHIPPING

STANDARD OPERATING PROCEDURE 2.1

1. Purpose

This Standard Operating Procedure (SOP) outlines the methods and responsibilities for field personnel to use in the packaging and shipping of environmental samples, including hazardous, low-level radioactive and mixed waste samples, for chemical and physical analysis. This SOP only applies to the packaging and shipping of limited quantity, environmental samples. This SOP also applies to sample receipt confirmation by recipient laboratories. The details in this SOP are only applicable to the general requirements for sample packaging and shipping and should only be used as a guide for developing more job-specific work plans.

2. References

United States Environmental Protection Agency (EPA), 1987. *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988. *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies Under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

Code of Federal Regulations (CFR), DOT 49 CFR Parts 100 to 177

International Air Transport Association (IATA), 2011. *Dangerous Goods Regulations*.

SOP 1.1 - Sample Custody

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Environmental Sample - A limited quantity sample of soil, water, air, or other substance found in the environment and collected specifically for chemical or physical analysis.

Hazardous material - A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated.

Hazardous substance for the purposes of this SOP is a material, including its mixtures and solutions, that:

- Is listed in Appendix A to 49 CFR Sec. 172.101;

- Is in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) listed in Appendix A to 49 CFR Sec. 172.101; and
- When in a mixture or solution:
  - For radionuclides, conforms to paragraph 6 of Appendix A to Sec. 172.101; or
  - For other than radionuclides, is in a concentration by weight which equals or exceeds the concentration corresponding to the RQ of the material, as described in 49 CFR Sec. 173.133.

Hazardous Waste - Any substance listed in 40 CFR Subpart D (260.30 et seq.) or otherwise characterized as ignitable, corrosive, reactive, or toxic as specified in Subpart C (261.20 et seq.) that would be subject to manifest and packaging requirements specified in 40 CFR 262. Hazardous waste is defined and regulated by the United States Environmental Protection Agency (EPA).

Sample - Physical evidence collected from a facility or the environment which is representative of conditions at the point and time at which the sample is collected.

4. Procedure

Compliance with this procedure is the responsibility of project management, task management, health and safety, and field personnel.

The Subcontractor Project Manager (SPM) is responsible for the development and review of site-specific work plans which address the specific sample handling, packaging, and shipping requirements for the project. The SPM should review the project-specific documentation forms to ensure that they are appropriate for the field activities. The SPM is also responsible for seeing that field personnel receive proper training and maintain quality assurance/quality control (QA/QC).

The Subcontractor Project Quality Assurance Manager (SPQAM) is responsible for the periodic review of documentation generated during sample handling, packaging, and shipping and the periodic review and audit of field personnel as they perform the work. If problems arise, the SPQAM is also responsible for swift implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to requirements, and issuing nonconformances).

The Subcontractor Project Health and Safety Manager (SPHSP) is responsible for ensuring complete compliance with the Health and Safety Plan by all personnel on site. He or she is responsible for ensuring that all protective measures are identified and implemented to adequately protect site workers.

The Subcontractor Task Leader (STL) is responsible for the proper implementation of the sampling plan and for ensuring that all sample collection activities are conducted in accordance with this SOP.

The Subcontractor Project Chemist (SPC) or designee is responsible for coordinating with the analytical laboratory and for ensuring that all analytical activities are conducted in accordance with the sampling and analysis plan.

The refrigerator monitor is responsible for inspecting the sample refrigerator and thermometer, maintaining temperature compliance, and notifying the applicable STL of expired samples left in the refrigerator.

Before collecting samples, the STL should contact the appropriate laboratory personnel to advise them of the forthcoming sample shipment. To minimize container breakage and sample loss, polyethylene plastic sample containers should be ordered when compatible with the planned analysis requests. Glass containers should only be used when required by the analytical method specified in the sampling plan.

After samples have been shipped and/or relinquished, the STL is responsible for reviewing the sample receipt confirmation checklist (SRC) provided by the laboratory and notifying the SPM of any deviations from the instructions on the chain-of-custody document (COC) or any problems encountered during shipping and/or receiving.

4.1 Sample Handling in Field

Inspect the sampling containers to ensure that they are appropriate for the samples being collected, and that the samples are correctly preserved and undamaged. When collecting a sample, always use approved/site specific personal protective equipment (e.g., gloves, etc.) to prevent cross-contamination from sample to sample, but also as a health and safety requirement.

Collect the samples in accordance with the site-specific sampling plans and applicable SOPs. As soon as possible after sample collection, tightly seal the container. Custody seals may be used for additional sample security. The custody seal should be placed over the cap so that any attempt to remove the cap will cause the seal to be broken. Do not place a custody seal over a volatile organic analysis (VOA) vial septum. Place all containers associated with a sample in an appropriately sized, airtight, seam sealing polyethylene bag(s) (e.g., Ziploc). Seal the bag, removing any excess air. Place the bagged containers inside an insulating shipping container, "cooler." This cooler should have ice inside to assure samples remain cool (4°C) during transit from the field to the packaging location. Maintain the samples under chain of custody (SOP 1.1) in accordance with the site-specific work plans and appropriate SOPs.

4.2 Sample Refrigerator

Samples requiring overnight storage prior to shipment to a laboratory shall be relinquished to a secured sample refrigerator maintained within the acceptable range of 4°C ± 2°C. A National Institute of Standards and Technology (NIST) traceable thermometer must be stationed in the refrigerator where samples are stored. The refrigerator temperature indicated by the thermometer must be within the acceptable range of 4°C ± 2°C before samples are transferred to the refrigerator. If the refrigerator temperature is outside of the acceptable range, notify the refrigerator monitor and store the samples temporarily in an iced cooler until the refrigerator temperature is corrected. If the refrigerator temperature is within the acceptable range, place the samples in a discrete group in the

refrigerator and record on the COC that the samples were released to a secured, locked, refrigerated location. Place the COC in a sealed plastic bag and place it with its group of project samples. Close the refrigerator and secure the lock.

When retrieving project samples, unlock the refrigerator and transfer the samples to an iced container. Record on the COC that the samples were received from a secured, locked, refrigerated area. Verify the refrigerator temperature upon retrieving the samples. If the refrigerator temperature is outside the acceptable range, notify the STL and do not ship the samples unless the STL approves the shipment.

Sample Refrigerator and Thermometer Maintenance

The sample refrigerator and thermometer shall be inspected, and the temperature recorded on a weekly basis by the refrigerator monitor. A temperature log form is attached to this SOP. The temperature log shall be maintained on the outside of the refrigerator. The acceptable temperature range is 4°C ± 2°C (from 2°C to 6°C with a target of 4°C). If the refrigerator temperature is outside the acceptable range, the refrigerator monitor shall inspect the refrigerator for project samples. If any samples were stored in a refrigerator that does not meet temperature specification, the refrigerator monitor shall notify the STL, place the affected samples in an iced cooler, and enter the temperature and necessary receiving information on the COC.

Inspect the refrigerator to determine any cause of temperature recordings outside the acceptable range such as samples obstructing the refrigerator door or an accidentally moved thermometer. Correct the refrigerator temperature by adjusting the refrigeration dial and monitor the temperature on an hourly basis until the temperature stabilizes within the acceptable range. If the refrigerator temperature stabilizes, return all project samples to the refrigerator with their relinquished COC as described above. If the refrigerator temperature remains unstable, notify the STL. If no cause for refrigerator temperature instability is found and the temperature remains unstable, obtain service for the refrigerator. Thermometer maintenance should be performed on a quarterly basis and recorded on the temperature log. Repair or replace any damaged parts and record maintenance actions on the thermometer log.

4.3 Packaging and Shipping by Common Carrier

Inspect the integrity of the shipping container. The container is generally a "cooler" constructed of heavy plastic with appropriate insulating properties so that variations in temperature during shipping are minimized. The shipping container should be flat-lidded rather than triangle/pivot-lidded to ensure sufficient packing material can be placed on top of the samples.

Carefully check the COC record against the collected sample labels and containers to ensure that the sample numbers, sample description, date and time of collection, container type and volume, preservative, and the required analytical methods are correct and in agreement.

When shipping potentially radioactive samples:

- Place samples within an inner container (a clear plastic bag or other transparent packaging);

- Seal the inner-container; and
- Label the container “Radioactive”.

Line the floor and walls of the shipping container with packing material. Individually place sample containers in bubble wrap sleeves. Place the samples upright in the shipping container to avoid failure of sample lids (can occur when containers are laid on their side). When sample refrigeration is required, bag and seal crushed or cubed ice in heavy-duty polyethylene bags. Place these bags of ice below, on top of, and between samples. Blue ice should only be used along with crushed/cubed ice; it does not maintain the 4°C temperature necessary for regulatory compliance. The remaining space will be filled with packing material. Place temperature blank between ice and inner-package.

All materials being offered for transportation shall be properly classified based on existing data, site history, chemical characteristics, radiological characteristics, etc. This is necessary to ensure that all appropriate packaging, marking, labeling, handling, placarding, shipping papers, and mode of transportation are utilized as applicable/required. Samples that contain or could potentially contain radioactive material shall only be sent to laboratories with an appropriate Nuclear Regulatory Commission (NRC) or Agreement State Radioactive Materials License. Prior to shipment of radioactive material, it should be verified that the laboratory/facility is able to receive/possess the nuclides and total activity present in the shipment. The person in charge of sample custody will relinquish custody on the COC by entering the time, date, their signature, and affiliation. Place the original copy of the COC record in a sealed, clear plastic envelope or bag and tape the COC record envelope to the inside lid of the shipping container. Retain a copy of the COC record for tracking purposes. Place a layer of packaging material on top of the samples such that closure of the shipping container lid requires gentle pressure. Using nylon reinforced strapping tape or mailing tape, bind the shipping container closed. Seal all potential leak points including any drain spout. Place custody tape over opposite ends of the lid. Mark the container "THIS END UP," or apply arrow labels that indicate the proper position to be maintained during shipping. Apply the air/waybill to the outside of the cooler and retain the sender’s copy. Turn the sample(s) over to the carrier for delivery to the laboratory. When refrigeration is required, samples should be shipped for delivery to the laboratory within 24 hours of packing the shipping container. In all cases samples must be delivered by a means that enables the laboratory to meet the required holding time. Complete the Attachment 6.1 checklist, including PM sign off, prior to transferring the container to the shipping vendor.

4.4 Packaging and Shipping for Transport by Courier to Local Laboratory

Samples transported by courier to a local laboratory should be packaged as described above if sample loss could result in significant recollection expense or if re-collection is not possible due to project constraints. Less protective packaging may be acceptable when samples can be recollected at negligible cost or project impact. The SPM is responsible for deciding when less packaging is appropriate and communicating the packaging requirements to the STL or packaging designee. When transferring sample custody to a courier service, the STL or designee must accompany the courier to their vehicle and confirm that:

- The courier and transport vehicle are capable of safely and securely transporting the samples;

- The courier's storage containers and packing materials meet the requirements of the project and the courier packages the samples as required before departing (does not apply to deliveries that are packaged and sealed by the STL or designee); and

- Sufficient ice is present in the courier's transport container, the samples are placed on ice, and the container is closed before departure (applies when samples require 4°C temperature preservation). If the courier does not have sufficient ice or transport containers, the STL or designee must provide them with these supplies.

4.5 Sample Temperature Verification upon Laboratory Receipt

All samples requiring 4°C temperature preservation will be acceptable within the range of 4°C ± 2°C. The laboratory should be instructed to record the temperature of receipt on an SRC report and send this report to the STL immediately after login is complete. For all samples received from 6°C to 10°C, the sample(s) and temperature (in 1°C increments) will be noted on the login report and then analyzed. Samples with temperatures greater than 10°C and VOA samples below 0°C must be reported immediately to the Consulting Project Manager.

Sample Receipt Confirmation

Upon receipt of samples under chain-of custody, the laboratory must generate an SRC and send it to the STL. This report must list all sample specific information provided on the COC as well as laboratory-generated sample identification numbers and the sample delivery group (SDG) number. The STL or designee must complete Attachment 6.2 Sample Receipt Confirmation Checklist comparing the laboratory SRC against the COC. Discrepancies must be communicated with the SPM immediately, and corrective action must be taken to ensure that all requested analyses and laboratory generated data meet with project objectives.

5. Records

Review the copied COC and original sample collection forms for completeness and turn them over to site or project management personnel within the time period specified on the sample collection protocol. The STL is responsible for verifying COC correctness and notifying the laboratory of COC corrections if errors are found. The STL or designee is responsible for signing off on the SRC checklist. Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2.

6. Attachments

6.1 Sample Packaging and Shipping Checklist

6.2 Sample Receipt Confirmation Checklist

6.3 Sample Refrigerator Temperature Log

ATTACHMENT 6.1

SAMPLE PACKAGING AND SHIPPING CHECKLIST

SAMPLE PACKAGING CHECKLIST FOR SHIPMENT BY COMMON CARRIER

Project Name: Project Number:

Packing Date/Time:

Instructions: This form and the approval signatures at the bottom of the form must be completed prior to delivering the shipment to the common carrier. Sample packaging must conform to Standard Operating Procedure 2.1 Sample Handling, Packaging, and Shipping (SOP 2.1). The person responsible for packing the samples for shipment is responsible for conducting and recording all checks on the checklist. The inspector must verify that the contents of the shipment meet the requirements of SOP 2.1 and any deviations noted on the checklist are addressed before the lid is closed. The inspector must verify that the container is properly sealed, and any deviations noted on the checklist are addressed before delivery. Provide completed form to the PM for inclusion in the project files.

Sample Packaging and Shipping Checks	**Yes**	**No** (explain)	**NA**	**Explanation**
Is the shipping container a flat-lidded, heavy plastic cooler in good condition? Do not use triangle/pivot-lidded coolers.				
Do sample labels agree with COC?				
Are all sample containers in good condition?				
If any sample containers are bags (sometimes soil samples), are these samples double bagged?				
Is shipping container floor, walls, and top lined with packing material? (use a minimum 2-inch thickness bottom and top, 1-inch thickness walls)				
Is strong plastic bag (trash liner bag) placed open and within the cooler's packing material lining?				
Are sample lids tight and samples placed upright in shipping container?				
Are glass sample containers packed in individual bubble wrap sleeves and all glass corners well padded, including the lid? (NA if no sample containers are glass)				
Are heavy duty sealed plastic bags containing wet ice placed below, on top of, and between samples? (applies when refrigeration is required; blue ice between samples is OK)				
Was sufficient ice packed with the samples? (record approximate ice and sample weight; a minimum of a 1 to 1 ratio of ice to samples by weight is required)				ice (lbs) _____ samples (lbs) _____

Are all voids filled with packing material?				
Sample Packaging and Shipping Checks	**Yes**	**No** (explain)	**NA**	**Explanation**
Is labeled temperature blank placed between ice and samples? (Should be visible near the top of the container on top of samples; applies when refrigeration is required)				
Is the strong plastic trash liner bag containing the ice, samples, temperature blank, and interstitial packing material twist tied closed?				
If the cooler has a drain, is the drain securely sealed?				
Is sample relinquishment properly recorded on the chain of custody? (date, time, signature, affiliation)				
Is there a copy of the completed chain of custody retained?				
Is the original chain of custody placed in a clear, sealed plastic bag placed above the last layer of packing material in the cooler?				
Is the shipment weight less than 40 pounds?				
Does the cooler lid contact the packing material when it is closed? (i.e., slight compression to stabilize the payload)				
Is 2-inch reinforced packing tape wrapped multiple times around both ends of the cooler?				
Is custody tape placed across the interface of the lid and container on both ends of the lid?				
Is the air/waybill attached to the outside of the cooler and the sender's copy retained?				
Is next-day AM delivery requested on the air/waybill? (applies when refrigeration and/or short holding times are required)				

Packed and checked by:	Date:
Inspected by (PM or designee):	Date:

ATTACHMENT 6.2

SAMPLE RECEIPT CONFIRMATION CHECKLIST

SAMPLE RECEIPT CONFIRMATION (SRC) CHECKLIST

Project Name: WA Project Number:

Lab Work Order Number: Sample Receipt Date:

Laboratory Sample Receipt Confirmation Checks	**Yes**	**No**	**NA**
1. Were samples received by the laboratory within all sample hold-times?			
2. Did the laboratory record the temperature of the samples/cooler?			
3. Was the temperature of the samples within acceptance criteria (4°C ± 2°)?			
4. Were custody seals present and intact on the sample shipment/coolers?			
5. Were custody seals present and intact on individual samples?			
6. Does the SRC contain copies of COCs and any modifications requested?			
7. Does the SRC indicate the requested reporting level (level II, III, IV)?			
8. Does the SRC indicate the turn-around-time as requested?			
9. Do all lab methods match the methods requested on the COC?			
10. Do all field sample IDs match those on the COC?			
11. Do all sample dates and times match those on the COC?			
12. Did the lab record the requested weight basis (as received/wet or *dry)?*			
13. Did the laboratory place any samples on HOLD as indicated on the COC?			
14. Did the laboratory indicate if results will be reported to MDLs or RLs?			
15. Did the laboratory request any clarification or edits to the COC?			
16. Has the Project Data Tracking spreadsheet been updated with SRC			

Comments:

Reviewed by: Date:

ATTACHMENT 6.3

SAMPLE REFRIGERATOR TEMPERATURE LOG

WEEKLY TEMPERATURE LOG

Date	Initials	Current Temp (°C)	Minimum Temp (°C)	Maximum Temp (°C)	Within 4°C ± 2°C? (Y/N) If N, explain	Comments

QUARTERLY INSPECTION LOG

Date	Initials	Thermometer Battery Change (Y/N)	Refrigerator OK? (Y/N) If N, explain	Thermometer OK? (Y/N) If N, explain	Comments

SURFACE AND SHALLOW SOIL SAMPLING

STANDARD OPERATING PROCEDURE 3.1

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for collecting soil and sediment samples from the ground surface (0 to 6 inches in depth) and shallow subsurface from boreholes or open excavations (e.g., pits and trenches). Shallow subsurface samples include soil that is collected from depths between approximately 6 inches and 6 feet below ground surface (bgs), or soil samples collected from the floor or walls of an excavation for confirmation sampling purposes. Collection procedures specific to the type of analyses being performed are integral to maintaining the quality and integrity of samples. It is imperative that contamination is not introduced into the sample from the sampling process, and that sampling procedures and field protocols are performed consistently and in no way contribute to the migration or introduction of hazardous substances. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

Sampling near-surface, unconsolidated soil and sediment is generally conducted to:

1) Evaluate whether releases of hazardous substances have occurred from shallow underground sources, such as shallow buried pipes, or surface spills/leaks;

2) Determine the near-surface extent of a hazardous substance release;

3) Estimate the volume of shallow soil containing hazardous substances for removal, disposal, or treatment; or

4) Provide confirmation soil data following remediation or excavation.

2. References

United States Environmental Protection Agency (EPA), 1987. *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988. *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies Under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

EPA, 2017. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium, SW-846*, https://www.epa.gov/hw-sw846/sw-846-compendium, Last updated on November 29, 2017, accessed on May 7, 2018.

Other Relevant SOPs:

SOP 1.1 - Sample Custody

SOP 1.2 - Field Activity Daily Log

SOP 1.3 - Field Measurements, Maintenance and Calibration of Instruments

SOP 2.1 - Sample Handling, Packaging and Shipping

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 15.1 - Lithologic Logging

SOP 17.1 - Sample Labeling

SOP 17.2 - Sample Numbering

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Surface Soil Sample - Soil collected from the surface to a depth of no more than 6 inches bgs.

Shallow Subsurface Soil Sample - Soil collected from a depth of 6 inches to approximately 6 feet.

Subsurface Soil Sample - Soil collected at any depth interval greater than 6 inches.

Disturbed Soil Sample - A soil sample whose *in situ* physical structure and fabric has been disturbed as the direct result of sample collection.

Undisturbed Soil Sample - A soil sample whose *in situ* physical structure and fabric has not been disturbed as the result of sample collection.

Grab Sample – A disturbed soil sample that is collected by using such devices as a shovel, stainless steel spoon, etc.

4. Procedure

This section describes the procedures to collect surface and shallow subsurface soil/sediment samples that will insure the quality and integrity of the samples. The procedures in this SOP should be used in conjunction with project work plans. Project work plans will generally provide the following:

- Sample collection objectives;
- Soil sample locations and depths;
- Number of soil samples and their volumes;

- Analysis to be conducted for each sample;
- Specific quality control (QC) procedures and sampling required; and
- Any additional surface or shallow subsurface soil sampling requirements or procedures beyond those covered in this SOP, as necessary.

The following subsections outline procedures for surface and shallow subsurface soil/sediment sampling.

4.1 Responsibilities

The Subcontractor Project Manager(SPM) is responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other relevant procedures included in project work plans and/or the quality assurance project plan (QAPP). The SPM is therefore also responsible for ensuring that staff working on the project is properly trained in this SOP and other relevant procedures to ensure quality assurance/quality control (QA/QC). The Consulting Project Manager may also choose to take on the role and responsibilities of the Subcontractor Quality Assurance Manager (SQAM) (see below), when appropriate.

A SQAM designated by the SPM is responsible for periodic review of field generated documentation associated with this SOP. The SQAM is also responsible for implementing corrective actions (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing field variances, etc.) to address deficiencies before problems may occur.

The SPM will designate a Subcontractor Task Leader (STL) who is responsible for all field activities, including preparations and demobilization. The STL oversees all field personnel to ensure that sampling is being conducted in accordance with the relevant SOPs and project plans. Field personnel assigned to conduct surface and shallow subsurface soil/sediment sampling activities are responsible for completing their tasks according to specifications outlined in this SOP, the project work plan, and other appropriate procedures. All of the staff are responsible for reporting deviations from procedures to the STL.

***4.2** Prerequisites*

Prior to collecting each sample, all sample equipment must be decontaminated according to the Sampling Equipment and Well Construction Materials Decontamination (SOP 6.1), as well as any additional procedures that may be outlined in the project work plans. In addition, sampling locations must be appropriately cleared of all underground utilities and buried objects per the project work plans. At a minimum, clearing of sampling locations should consist of notifying Underground Service Alert North 811 and the UC Davis Underground Utilities Coordinator at least 48 hours prior to any intrusive activities. Sample locations should be staked and cleared for subsurface utilities based on UC Davis utility maps and by a private utility locator using geophysical methods.

Much of the health and safety equipment used during field work comes calibrated from the vendor with a certificate of such. When field calibration of health and safety monitoring equipment is required, it should be conducted according to the instrument manufacturer's specifications and the

Field Measurements, Maintenance and Calibration of Instruments (SOP 1.3). Calibration results should be recorded on the appropriate form(s), as specified in the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications should be removed from service and tagged. Don appropriate personal protection equipment as specified in the project work plans. Clear the area to be sampled of surface debris and vegetation using equipment that will not be used for sample collection or will be decontaminated prior to use in sampling.

4.3 Sampling Equipment

The sampling and analytical requirements, as well as site characteristics, must be taken into account when determining the proper surface or subsurface soil or sediment sampling equipment to use. A number of devices may be used to collect surface soil and/or sediment samples, including core samplers, hand augers, spoons, scoops, trowels, shovels, triers, etc. These devices are constructed of a variety of materials, including stainless steel, brass, plastic, glass, Teflon, etc.

4.4 Surface and Other Non-Borehole Soil/Sediment Sample Collection

When the sample depth is less than about one foot, and not collected from a borehole, a sediment or soil sample can be collected by using tools such as a shovel, hand auger, trowel, or stainless steel spoon/scoop, disposable scoops, etc. These tools can also be used when collecting samples from an excavator’s bucket (see Section 4.6 below). These tools can be used to scoop or collect soil/sediment and directly transfer the matrix into a pre-cleaned sample container (e.g., glass jar, brass sample sleeve, etc.). The project work plans will specify the type of sampling equipment and sample containers to be used.

4.5 Subsurface Soil Sample Collection Using a Hand Auger or Drive Hammer

The common method for collecting shallow subsurface sediment samples, both disturbed and undisturbed, is to use a hand auger or drive hammer to bore to the desired sampling depth and then retrieve the sample with a core sampler. The core sampler is typically a hollow, stainless steel cylinder that is tapered at the leading end. The hand auger might also be used to recover the sample for direct transfer into glass jars. The exact methodology to be used will be specified in the project work plan.

When using the coring device, a sample sleeve (brass, stainless steel, Lexan, etc.) is inserted into the trailing end. The trailing end is then connected to a piston-type drive hammer. The core is driven into the soil by using the hammer (or pushed in the case of very soft soil) until the trailing end of the sleeve is at the soil surface. In this manner, a relatively undisturbed sample is collected in the sleeve. When the device is retrieved, check to see that soil recovery is adequate in the sample sleeve. If there is sufficient recovery, mark or note the leading (deeper) end of the sample sleeve to avoid confusion. The sample can then be sealed with Teflon tape, capped, handled, secured, and shipped in the sample sleeve.

4.6 Subsurface Soil Sample Collection Using an Excavator Bucket

There are two primary methods that can be used when collecting soil samples using an excavator bucket: 1) the excavator bucket is placed on the ground and the sample is collected from within it while the excavator is in neutral or the power is turned off or 2) the excavator bucket is emptied outside of the guardrail (or safety exclusion zone for the excavation) and the sample is collected from the resulting soil pile. In the second scenario, the bucket should be emptied a safe distance from the excavation or other machinery. Distances will vary depending on site conditions. In either scenario, a sediment or soil sample can be collected by using tools such as a shovel, trowel, or stainless steel spoon/scoop, disposable scoops, etc. These tools can be used to scoop or collect soil/sediment and directly transfer the matrix into a pre-cleaned sample container (e.g., glass jar, brass sample sleeve, etc.). In addition, the sample should be collected from the center of the excavator bucket or pile, in an effort to minimize sample disturbance and the introduction of outside contamination. The project work plans will specify the type of sampling equipment and sample containers to be used.

If sampling for non-volatile compounds such as metals or polychlorinated biphenyls (PCBs), sample collection from an excavator bucket or soil pile may also be satisfactory and can help reduce the physical safety hazards associated with entering an open excavation or trench. If sampling for volatile compounds, such as solvents and fuels, an undisturbed sample collected with minimum potential for volatilization is required. To do this, the sample should be collected immediately from recovered core or directly from the undisturbed sample location (i.e. an excavation sidewall) and transferred to pre-weighed, pre-preserved volatile organic analysis (VOA) vials using a 5-gram coring device as specified in EPA Method 5035 (EPA, 2017). However, this method of sample collection is limited to situations where the excavation can be entered safely. The exact procedure to be used will be specified in the project work plans.

The sampling event should be documented as described in the Field Activity Daily Log (SOP 1.3) or as specified in the project work plan. Descriptions of any examined core material should be recorded as described in the Borehole Logging (SOP 15.1). Appropriately preserve, handle, package, and ship the samples per the Sample Handling, Packaging, and Shipping (SOP 2.1) and Sample Custody (SOP 1.1), and the project work plans.

4.7 Subsurface Soil Sample Collection from an Open Excavation

If collecting samples from open trenches/excavations, borehole/sidewall stability should be maintained to prevent the recovery of slough in the samples. If sloughing cannot be controlled, then another sampling methodology may have to be considered. Additionally, the Occupational Safety and Health Administration (OSHA) and California-OSHA require vertical-walled open trenches or pits to be braced or shored if they are deeper than 5 feet, unless the walls are comprised entirely of stable rock. Alternatively, the trench or open excavation walls must be benched or sloped (slope will be determined by soil type). Lack of soil stability may require a flatter slope. Walls that appear stable can collapse or large slabs may dislodge from the trench wall along hidden fracture planes in the earth material. Such slumping or caving can be triggered by vibrations from the excavation equipment or unforeseen conditions. For these reasons, no one should enter an open excavation until appropriate safety precautions have been taken. An access bench or ramp should be excavated opposite the wall to be inspected as a safety exit. If shoring is needed, fast and convenient portable

hydraulic shores are often available and would be installed by personnel familiar with appropriate safety requirements.

If using sample sleeves, place Teflon tape over each end of the sleeve and seal each end with plastic end caps. If using glass jars, cap or seal the jars appropriately. Custody seals may be used for additional sample security on sleeves or jars. Appropriately label and number the sample containers per the Sample Labeling (SOP 17.1) and the project work plans.

5. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Shallow Soil and Confirmation Sampling Data Sheet

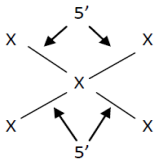
A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

SHALLOW SOIL AND CONFIRMATION SAMPLING DATA SHEET

SHALLOW SOIL AND CONFIRMATION SAMPLING DATA SHEET

Project Name:			**Sample Location:**		
Project Number:			**Sample ID:**		
Personnel:			**Sample Date:**	**Time:**	
WEATHER	☐ Sunny ☐ Cloudy ☐ Rainy ☐ Foggy ☐ Windy Temp (units):				
CONFIRMATION SAMPLE?	☐ Yes ☐ No				
SAMPLE SOURCE FOR CONFIRMATION SAMPLE			☐ N/A (Shallow Soil Sample)		
(Check all that apply) ☐ Excavator Bucket ☐ Excavation Sidewall ☐ Excavation Bottom ☐ Soil Pile ☐ Other:					
SAMPLE TYPE	☐ Original ☐ Duplicate ☐ Other:				
SAMPLE DEPTH	☐ Feet bgs ☐ Inches bgs				
SAMPLE EQUIPMENT					
☐ Scoop ☐ Shovel ☐ Slide Hammer/Sleeve ☐ Trowel ☐ Hand Auger ☐ Terra Core/EnCore ☐ Excavator Bucket ☐					
☐ Other:					
COMPOSITE SAMPLE?	☐ Yes ☐ No				
(REQUIRED FOR COMPOSITE SAMPLES)					
Draw/describe composite sample pattern/scheme and measurements (show sub-sample locations with an "x"):					
Example:					



PID/FID READING	(collect from sample head space, immediately prior to, or following containerization)
HOMOGENIZED PRIOR TO CONTAINERIZATION?	☐ Yes ☐ No
If yes, describe homogenization process:	
COMMENTS, PROBLEMS, and/or CONCERNS:	
VARIANCE FROM SAMPLING PROTOCOL:	☐ **No Variances**
Sampler Signature:	**Date:**

SUBSURFACE SOIL SAMPLING WHILE DRILLING

STANDARD OPERATING PROCEDURE 3.2

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for subsurface soil sampling at depths typically greater than six feet below ground surface (bgs). Several methods may be used to collect subsurface samples from boreholes; the more common drilling methods and sampling procedures are described below. Proper collection procedures are necessary to assure the quality and integrity of all subsurface soil samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

Sampling of subsurface soil is generally conducted to:

1) Evaluate whether releases of hazardous substances have occurred from underground sources or surface spills/leaks;

2) Determine the extent of a hazardous substance release;

3) Estimate the volume of soil containing hazardous substances for removal, disposal, or treatment; or

4) Provide confirmation soil data following remediation.

2. References

ASTM International (ASTM), 1989. *Standard Method for Penetration Test and Split-Barrel Sampling of Soils*, Method D-1586-84, Philadelphia, PA.

ASTM, 1986. *Standard Practice for Thin-Walled Tube Sampling of Soils*, Method D-1587-83, Philadelphia, PA, p. 304-307.

ASTM, 1986. *Standard Practice for Ring-Lined Barrel Sampling of Soils*, Method D-3550-84, Philadelphia, PA, p. 560-563.

Other relevant SOPs:

SOP 1.1 - Sample Custody

SOP 1.2 - Field Activity Daily Report

SOP 1.3 - Field Measurements, Maintenance, and Calibration of Instruments

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 8.3 - Borehole and Well Abandonment

SOP 14.1 - Hollow Stem Auger Drilling

SOP 14.5 – Direct Push Technology

SOP 15.1 – Borehole Lithologic Logging

SOP 17.1 - Sample Labeling

SOP 17.2 - Sample Numbering

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Borehole - Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil or water samples, and/or installing monitoring wells.

Split-spoon Sampler - A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. This device can be driven into resistant (semi-consolidated) materials using a drive weight or drilling jars mounted in the drilling rig. A standard split-spoon sampler (used for performing standard penetration tests) is 2 inches in outside diameter and 1-3/8 inches in inside diameter. This standard spoon typically is available in two common lengths, providing either 20-inch or 26-inch internal longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. Six-inch long sleeves (tubes) of brass, stainless steel, or plastic are commonly placed inside the sampler to collect and retain soil samples. A five-foot long split-spoon sampler is also available. A California modified split-spoon sampler is also commonly used. The design is similar to the standard split-spoon except the outside diameter is 2½ inches and the inside diameter is 2 inches.

Shelby Tube Sampler - A thin-walled metal tube with a cutting edge at the toe that is used to recover relatively undisturbed samples. These tubes are available in various sizes, ranging from 2 to 5 inches in outside diameter and 18 to 54 inches in length. A sampler head attaches the tube to the drill rod and contains a check valve and pressure vents. This sampler is advanced into the soil layer, generally 6" less than the length of the tube. The vacuum created by the check valve and cohesion of the sample in the tube cause the sample to be retained when the tube is withdrawn.

Drilling Jars - A set pair of linked, heat-treated steel bars. The jars may be attached to a wireline sampling string incorporating a split-spoon or other impact sampler. The jars are used to drive the sampler into the soil below the bottom of the borehole.

Direct Push Continuous Core Sampler - Continuous core sampling methods use a core barrel, which recovers a soil core from the interval the barrel is advanced through. Soil samples are collected in 1.5-inch to 2.65-inch diameter brass or stainless steel sleeves inside the inner sample barrel. Typically, the sleeves are removed from the sample barrel and given to the site geologist or engineer for testing, sampling, and lithologic description. The outer-drive barrel is recovered after the total depth of the boring is attained.

4. Procedure

This section describes the procedures to ensure the quality and integrity of samples when collecting subsurface soil samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives;
- Soil sample locations and depths;
- Numbers of soil samples and their volume;
- Analysis to be conducted for each sample;
- Specific quality control (QC) procedures and sampling required; and
- Any additional subsurface soil sampling requirements or procedures beyond those covered in this SOP, as necessary.

There are many different methods that may be used for subsurface soil sample collection during drilling. This SOP focuses on the two most common methods: split-spoon sampling and direct-push/continuous core sampling. If other subsurface soil sampling methods are deemed necessary to meet project objectives, the procedures for these methods will be updated in this SOP or included in the project work plans. The following subsections outline procedures for subsurface soil sampling.

4.1. Prerequisites

1. Prior to collecting each sample, all sample equipment must be decontaminated according to SOP 6.1 Sampling Equipment and Well Material Decontamination, as well as procedures outlined in the project work plans. In addition, sampling locations must have been appropriately cleared of all underground utilities and buried objects per the project work plans. At a minimum, clearing of sampling locations should consist of notifying Underground Service Alert at least 48 hours prior to any intrusive activities. Forms and diagrams documenting the location of the cleared sampling locations should be compared to existing as-built diagrams or other facility/utility plans that exist to avoid encountering any underground utilities, lines, or other buried objects.

2. As required, calibrate any health and safety monitoring equipment according to the instrument manufacturer's specifications and SOP 1.3 Field Measurements, Maintenance and Calibration of Instruments. Calibration results should be recorded on the appropriate form(s), as specified in the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications should be removed from service and tagged. Don appropriate personal protection equipment as specified in the project work plans. Clear the area to be sampled of surface debris and vegetation using equipment that will not be used for sample collection or that will be decontaminated prior to use in sampling.

3. The procedures described in this SOP should be used in conjunction with the appropriate Drilling SOP, which specifically discusses Hollow Stem Auger (14.1 and Direct Push (14.5) methods.

5. Sampling/Drilling Equipment

The split-spoon and continuous core sample methods can be paired with a variety of drilling technologies. The specific drilling technology will vary by location and will be influenced by site attributes such as soil type and sample depth. There are four primary drilling methods used to collect soil data from depths typically greater than around 6 feet: hollow stem auger, air rotary, mud rotary, and percussion drilling methods. This SOP discusses split spoon and continuous core sampling which are conducted when using hollow stem auger and percussion drilling methods, respectively. Split spoon samples can also be collected when using air or mud rotary drilling methods, however it is less common. These methods can also do continuous coring when using a 5-foot core liner with a wireline coring system.

5.1. Split-Spoon Methodology

Split-spoon samples for chemical analysis are usually collected in brass, plastic, or stainless steel sleeves. The types, dimensions, and number of sleeves to be used, along with the length and type of sampler, will be stated in the project work plans.

Before collecting each split-spoon sample, the borehole is advanced to the desired depth or target horizon where the sampling run is to begin and the drill bit or plug is removed from inside the drive casing or augers. Then the split-spoon sampler is prepared by placing the appropriate sleeves within the split-spoon sampler or "barrel." The split spoon sampler is held together by a rear (in the upper position when in drive position) threaded collar and front drive shoe (lower position when aligned for driving into soil); both of which are screwed on to the respective ends. The split-spoon sampler, lined with the sleeves, is then connected to the drill rod string, or a wireline sampling string, by the driller.

After the drill rod or wireline is lowered to the desired sample depth, the driller drops a 140 or 340 pound hammer, depending on the size of the sampler, onto the sampler to drive it into the undisturbed soil below the bottom of the borehole. Generally, the hammer is repeatedly dropped 30 inches until the sampler is driven the desired distance. However, there are two exceptions to this setup: 1) when the rig is equipped with an automatic hammer, which approximates the same impact and drop, and 2) when 5-foot samplers or "core barrels" are used, the rig exerts a combination of rotation and downward pressure on the core.

The drilling geologist counts the number of hammer blows per 6 inch drive length and records that number on the boring log as the "blow count". The blow counts give a relative measure of soil resistance and strength; however, true soil testing for engineering purposes is collected with a "standard penetration test" split spoon or SPT. The SPT is 18 inches long, and has a 2 inch outside diameter, and a 1.5 inch inside diameter core barrel. The SPT is used occasionally for environmental sampling but is much more common in the geotechnical sampling arena. The "California modified SPT" split spoon is likely used for environmental sampling, is 18 inches long, has a 2.5 inch outside diameter, and 2 inch inside diameter.

Next, the drill rod or wireline sampling string is pulled up from the bottom of the borehole and the sampler is removed. To extract the sample from the split-spoon sampler, the driller removes the drive shoe and rear collar from the sampler and opens the split barrel. The driller then places the soil-filled sleeves on the drilling geologist's table, indicating which end of the drive is the top and which is the bottom. After extrusion, the driller will insert new, steam cleaned or washed sleeves into the sampler, which is then lowered back into the borehole. Additional inner rods and outer drive casing can then be attached and the process is repeated until the desired depth is reached. Continuously repeat this sampling procedure until reaching the bottom of the borehole and/or the last sample has been collected as specified in the work plan.

Prior to or during sampling, record the type of sampler assembly and hammer weight on the appropriate forms, as described in the Lithologic Logging SOP 15.1. To minimize off-gassing of the volatiles, the split spoon sampler should not be driven until the sampling team is ready to process the sample. Additionally, during drilling, vapors in the breathing zone should be monitored according to the project work plan, the health and safety plan, and the Drilling SOP.

5.2. Continuous Core Methodology

Continuous core sampling system methods may be used where continuous soil cores are to be recovered by direct push coring methods (e.g., Geoprobe or Envirocore). The continuous core sampling method uses a core barrel to recover the soil core from the interval the barrel is advanced through. The barrel is recovered after the total depth of the boring is attained.

To begin, both the core barrel (inner sampling rod) and outer casing are simultaneously driven into the ground. If the desired sample depth does not start at the ground surface, the inner sampling rod will often contain a disposable tip that can be pushed off once the inner rod is at the desired upper sampling interval. Upon reaching this upper interval, the inner rod is pulled out of the borehole, opened, and sample sleeves (typically plastic) are placed within the inner rod. The inner rod is then lowered back through the outer casing until the upper interval is reached. At this point, both the inner rod and outer casing are advanced simultaneously and as a result, the inner rod is filled with the soil core. Once the soil has been continuously cored to the desired bottom depth, the inner rod is extracted once more and the sample sleeves, filled with soil core, are removed.

After extrusion, new sleeves are inserted into the sample barrel, which is then lowered back into the borehole. An additional three or more feet of inner rods and outer drive casing can be attached, and the process is repeated until the desired depth is reached. Repeat this sampling procedure continuously until the bottom of the borehole is reached and/or the last sample is collected as specified in the work plan.

5.3. Sample Collection

Soil samples are collected in 1.5- to 2-inches diameter sleeves inside the inner sample barrel or sampler in both the split-spoon and continuous core. The inner sleeves are then given to the site geologist or engineer to prepare for chemical analysis and for lithologic description. During sample collection using a hollow-stem drilling method, observe and record the amount of sample recovery and blow count for each 6-inch sleeve on the Borehole/Well Construction Log, as described in the

Lithologic Logging SOP (15.1). Any observed field problems associated with the sampling attempt (e.g., refusal) or lack of recovery should also be noted.

Selecting which sleeve to submit for analysis is based on five factors:

- Judgment that the sample represents relatively undisturbed intact material, not slough;
- Proximity to the drive shoe;
- Minimal exposure to air;
- Lithology; and
- Obvious evidence of environmental contamination in the sample.

The project work plans will specify which sample sleeves should be submitted for specific analyses and confirm the selection criteria. To secure the sample inside the sleeves, place Teflon tape over each end of the sleeve and seal each end with plastic end caps. Custody seals may be used for additional sample security. If using glass jars, cap or seal the jars appropriately. Custody seals may be used for additional sample security. Appropriately label and number the sample containers per the Sample Labeling SOP (17.1) and the project work plans.

Where required by the project work plans, remove the soil from one of the remaining sleeves and place it in a seam-sealing, polyethylene bag for organic vapor screening. Place the bag in the sunlight for at least five minutes, then using an organic vapor probe (e.g., portable photoionization detector, flame ionization detector, or other appropriate instrument), monitor the soil for organic vapors. Record the reading on the Borehole/Well Construction Log as specified in the Lithologic Logging SOP (15.1) and any other form(s) specified in the project work plans.

The sampling event should be documented as described in the Field Activity Daily Log SOP (1.2) or as specified in the project work plans. Descriptions of any examined core material should be recorded as described in the Lithologic Logging SOP (15.1). Appropriately preserve, handle, package, and ship the samples per the Sample Handling (2.1) and Sample Custody (1.1) SOPs and the project work plans. Fill and abandon the sample hole as required by the Bore Hole and Well Abandonment SOP (8.3) the project work plans.

5.4. Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other relevant procedures included in project work plans and/or quality assurance project plans (QAPP). The SPM is therefore also responsible for ensuring that the staff working on the project is properly trained in this SOP and other relevant procedures to ensure quality assurance/quality control (QA/QC). The SPM may also choose to take on the role and responsibilities of the Subcontractor Quality Assurance Manager (SQAM) (see below) and/or may assign specific responsibilities to a Subcontractor Task Leader (STL), when appropriate.

The SQAM, designated by the SPM is responsible for periodic review of field generated documentation associated with this SOP. The SQAM is also responsible for implementing corrective actions (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC

sampling requirements, issuing field variances, etc.) to address deficiencies before problems may occur.

The SPM or STL will designate a field coordinator who is responsible for all field activities, including preparations and demobilization. The field coordinator oversees all field personnel to ensure that sampling is being conducted in accordance with the relevant SOPs and project plans. Field personnel assigned to conduct surface and shallow subsurface soil/sediment sampling activities are responsible for completing their tasks according to specifications outlined in this SOP, the project work plan, and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the field coordinator.

6. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files in accordance with Standard Quality Procedure (SQP) 4.2 – Records Management.

7. Attachments

None.

WATER LEVEL MEASUREMENTS IN MONITORING WELLS

STANDARD OPERATING PROCEDURE 5.1

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines for personnel to use in determining the depth to water in monitoring wells.

2. References

United States Environmental Protection Agency (EPA), 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*, OSWER 9950.1, U.S. Government Printing Office, Washington, D.C.

EPA, 1991. *Environmental Compliance Branch, Standard Operating Procedures and Quality Assurance Manual*, Region IV, Environmental Services Division, Athens, Georgia, U.S. Government Printing Office, Washington, D.C.

SOP 1.2 - Field Activity Daily Log

SOP 6.1 - Sampling Equipment and Well Material Decontamination

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Procedure

Water level measurements are commonly taken in each monitoring well immediately prior to, during, and following well development, and both before and after well purging and sampling. Water level measurements may also be taken where no development or purging is being conducted, strictly to monitor or generate water table or piezometric surfaces. When such measurements are made to monitor water table or piezometric surfaces, water levels in all wells at the Site should be measured within a 24-hour maximum period whenever possible. When measuring wells for water table or potentiometric surface analysis, and if the contaminant history is known for each of the wells, it is advisable to monitor water levels beginning with the least contaminated wells first and progressing to the most contaminated wells last.

A number of devices are available for the determination of water level measurements in monitoring wells. Those most commonly used and covered in this SOP are electric sounders. The equipment must be capable of recording a measurement to the accuracy required by the project work plans, usually to the one-hundredth of a foot.

Prior to taking a water level measurement at each well, decontaminate the measuring device according to the procedures outlined in SOP 6.1. During decontamination, all measuring tapes should be inspected for kinks, cracks, or tears and, if present, repaired or replaced with undamaged equipment.

Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any damage or problems with the well head should be noted on the Field Activity Daily Log (FADL) (SOP 1.2) and the Subcontractor Project Manager (SPM) notified for repair or replacement of the equipment.

Uncap the well and monitor the air space immediately above the open casing per the project-specific health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the water level form (Attachment 5.1) or FADL as appropriate. If air is observed to be entering flowing out of the casing, the sounder should not be placed inside the well until the air flow stops and pressure equalizes.

Lower the electric sounder into the well until the water surface is encountered. Measure the distance from the water surface to the permanent reference point. For aboveground "stickup" completions, the reference point is usually a groove cut into the north side of the casing or a black mark made by a permanent marker. If no permanent reference point is available for an aboveground completion, measure from another permanently fixed structure or from ground level. The point of measurement should then be noted on the FADL and the appropriate form on which the water level is recorded. For flush mount completions, such as street boxes, the water level measurement should be referenced to the top of the well casing (TOC) or the top of the sampling port (TOP). Any aboveground completions without permanent reference points or marks should be brought to the attention of the appropriate supervisory personnel per the project-specific work plan.

Collect measurements until two consecutive measurements are identical or within the specified tolerance of the project-specific work plans (usually 0.01 foot). Record all appropriate information on the Water Level Form. At a minimum, the following information must be recorded:

- Project name and number;
- Unique well identification number;
- Date and time of measurement collection;
- Depth to water;
- Point from which the measurement was collected (TOC or TOP); and
- Any problems encountered.

Lastly the field team member will cap the well, relock the well, and secure the vault protective lid.

3.1 Responsibilities

3.1.1 Subcontractor Project Manager

The SPM is responsible for ensuring water level measurements are properly collected and documented in accordance with this SOP, and may assign specific responsibilities to a Subcontractor Task Leader (STL). This will be accomplished by staff training and by maintaining quality

maintaining quality assurance/quality control (QA/QC). The Consulting Project Manager will review the project-specific documentation forms to ensure they are appropriate for the field activities. The project-specific documentation (Job Protocol) shall include, but not limited to, specific job instruction, equipment/materials list, contact information, maps, health and safety plan, and forms to document water levels. Documentation (Job Protocol) will be made available, for review, to field team member's scheduled to perform activities a minimum of two weeks prior to the scheduled event.

3.1.2 Field Staff

The field staff assigned to perform this task are responsible for the proper collection of water level measurements, documentation of field activities , maintenance of field forms and other project documentation , maintenance of field equipment used for water level measurements and review of job protocol prior to event. All staff are responsible for reporting deviations from this SOP to the Consulting Project Manager, Consulting Task Leader, or the Consulting Quality Assurance Manager in writing.

3.1.3 Consulting Quality Assurance Manager

The Consulting Quality Assurance Manager (CQAM) is responsible for the review of documentation generated as a result of this SOP and the review and audit of field personnel as they perform the work. If problems arise, the CQAM is responsible for swift implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variance to requirements, issuing non-conformances, etc.), and through monitoring the continued implementation of stated corrective actions.

4 Records

Records generated as a result of this SOP will be controlled and maintained in the project records files in accordance with SQP 4.2.

5 Attachments

5.1 - Water Level Form

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the CQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 5.1

WATER LEVEL FORM

Water Level Form

Wells		Boring Depth (ft bgs)	Depth to Water (ft or "DRY")	Measuring Point (TOP or TOC)	IF DRY note depth DRY @ __ft	Date	Time	Tech Name (initials)	Comments
HSU-1	UCD1-013	65							
	UCD1-018	70							
	UCD1-021	73.5							
	UCD1-023	73							
	UCD1-054	73							
	UCD1-063	80							
	UCD1-068	70							
	UCD1-069	70							
	UCD1-070	70							
	UCD1-071	70							
	UCD1-072	70							
	UCD1-073	70							
	UCD1-081	70							

SAMPLING EQUIPMENT AND WELL MATERIAL DECONTAMINATION

STANDARD OPERATING PROCEDURE 6.1

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the decontamination of sampling equipment and well construction materials. Proper equipment decontamination is essential in ensuring the quality and integrity of samples collected during a given sampling event. Additional specific sampling equipment and well material decontamination procedures and requirements will be provided in the project work plans.

2. References

United States Environmental Protection Agency (EPA), 1987. *EPA Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988. *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

SOP 1.2 - Field Activity Daily Log

SOP 6.2 - Drilling, Development, and Heavy Equipment Decontamination

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Deionized Analyte-Free Water - Ion-free, analyte-free water produced on site or purchased from a supplier with a deionization chamber equipped with a carbon filter.

Potable Water - Treated municipal water or other drinking-grade water.

Laboratory Grade Detergent - A standard brand of laboratory-grade detergent, such as "Alconox" or "Liquinox."

Methanol - Laboratory-grade methanol alcohol, CAS #67-56-1.

Hexane - Laboratory-grade hexane, CAS #110-54-3.

UPB Water - Ultra pure blank water™; commercially available high purity water.

4. Procedure

This section contains responsibilities, requirements, and procedures for sampling equipment and well material decontamination. The decontamination is required to maintain proper quality and integrity of collected samples.

The details in this SOP should be used in conjunction with the project work plans. The project work plans will provide the following information:

- Types of equipment requiring decontamination under this SOP;
- Project-specific materials to be used for the decontamination; and
- Additional decontamination requirements and procedures beyond those covered in this SOP, as necessary.

All field personnel associated with decontamination of sampling equipment or well materials must read both this SOP and the project work plans prior to implementation of related decontamination activities. Information and requirements for the decontamination of any and all drilling and heavy equipment is provided in SOP 6.2.

5. Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that all sampling equipment and well material decontamination activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC). The SPM may assign some or all of these responsibilities to a Subcontractor Task Leader (STL).

The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of field generated documentation associated with this SOP. The SQAM is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to decontamination requirements, issuing nonconformances, etc.) if problems occur.

Field personnel assigned to sampling equipment and well material decontamination activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the STL or the SQAM.

6. Decontamination Zone

If possible, sampling equipment decontamination will take place in a zone designed exclusively for decontamination. This area will ideally be located within the contamination reduction zone on the project site. Well materials may be decontaminated at the zone set up for decontamination of drilling and heavy equipment (see SOP 6.2).

Each decontamination zone will be constructed so that the equipment, as well as all wastes generated during decontamination (e.g., soil, rinsate, liquid spray, debris, etc.), are contained to the extent appropriate. In addition, chemical products used in the decontamination process must be properly containerized and labeled.

7. Decontamination of Non-Dedicated Sampling Equipment

Each piece of reusable, non-dedicated sampling equipment will be decontaminated before each sampling event. The standard procedure will be performed as described below.

Suitable personal protective equipment (specified by the project work plans) must be worn by all personnel involved with the task to reduce personal exposure.

Heavily caked soil and/or other material will be scraped or brushed from equipment. Steam cleaning of equipment may be required to remove material in some cases.

Equipment that will not be damaged by water should be placed into a wash tub containing a laboratory-grade detergent solution and scrubbed with a brush or clean cloth. A two-stage rinsing process will then be conducted with fresh, potable water, followed by deionized water.

Methanol, hexane, and/or UPB water rinses may then follow for some sampler components when specified by the project work plans.

Any equipment that may be damaged by submersion into water will be wiped clean using a sponge and detergent solution. Cleaning will be followed by wiping the equipment with deionized water.

Air dry the rinsed equipment. Soil organic vapor (SOV) sampling equipment should be flushed dry with bottled air of known quality and/or as per the project work plans.

Place decontaminated equipment on clean non-permeable sheeting to prevent contact with contaminated soil. The non-permeable material is typically clean plastic sheeting or aluminum foil, depending on the analyte(s) of interest and the potential for their presence in the material. If equipment is not used immediately, cover or wrap the equipment in clean non-permeable sheeting or bags to minimize contact with airborne contamination.

Decontamination activities will be documented on the Field Activity Daily Log (SOP 1.2) or other appropriate form(s), as specified by the project work plans.

8. Decontamination of Dedicated Sampling Equipment

Dedicated sampling equipment, such as submersible pumps, will be decontaminated prior to installation inside monitoring wells. At a minimum, the procedure outlined below must be performed. If factory-cleaned, hermetically sealed materials are used, no decontamination will be necessary, provided that laboratory decontamination certification is available upon receipt of the equipment.

Suitable personal protective equipment will be worn by all personnel involved in the task, in accordance with the project work plans.

Pumping lines will be washed with a laboratory-grade detergent solution.

The equipment will then be rinsed twice with tap water, followed by a rinse with deionized water.

Air dry the rinsed equipment.

Place decontaminated equipment on clean non-permeable sheeting to prevent contact with contaminated soil. If equipment is not used immediately, cover or wrap the equipment in clean non-permeable sheeting or bags to minimize contact with airborne contamination.

Decontamination activities will be documented on the Field Activity Daily Log (SOP 1.2) or the appropriate form(s), as specified by the project work plans.

9. Decontamination of Well Materials

Well materials, including well casing, well screens, centralizers, and end caps, will be decontaminated prior to use in constructing monitoring wells. (If factory-cleaned, hermetically sealed materials are used, no decontamination will be necessary, provided that laboratory decontamination certification is available upon receipt of the equipment.) The standard procedure outlined below must be performed when decontaminating well materials.

Appropriate personal protective equipment will be worn by all personnel involved in the task, in accordance with the project work plans.

Materials will be thoroughly sprayed and washed with water using a high pressure steam cleaner.

Air dry the rinsed equipment.

Decontaminated materials will be placed on clean metal racks or clean non-permeable sheeting. If equipment is not used immediately, cover or wrap the equipment in clean non-permeable sheeting to minimize contact with airborne contamination.

Decontamination activities will be documented on the Field Activity Daily Log (SOP 1.2) or other appropriate form(s), as specified by the project work plans.

10. Records

Records generated as a result of this SOP will be maintained in the Project Records file in accordance with SQP No. 4.2 – Records Management.

11. Attachments

None.

DRILLING, DEVELOPMENT, AND HEAVY EQUIPMENT DECONTAMINATION

STANDARD OPERATING PROCEDURE 6.2

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines for use by field personnel in the decontamination of drilling, development, and heavy equipment. The details within this SOP are applicable as general requirements for drilling, development, and heavy equipment decontamination and should also be used in conjunction with project work plans.

2. References

United States Environmental Protection Agency (EPA), 1987. *EPA Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988. *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

SOP 1.2 - Field Activity Daily Log

SOP 6.1 - Sampling Equipment and Well Material Decontamination

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Laboratory Grade Detergent - A standard brand of laboratory-grade detergent, such as "Alconox" or "Liquinox."

Potable Water - Water dispensed from a municipal water system, or other drinking-grade water.

4. Procedure

Compliance with this procedure is the responsibility of the Subcontractor Project Manager (SPM), any assigned Subcontractor Task Leader (STL), and field personnel. This SOP and the project work plans should be reviewed before implementing drilling, development, and heavy equipment decontamination at the project field area.

The SPM has the responsibility for ensuring that the decontamination of drilling, development, and heavy equipment is properly performed through staff training and by maintaining quality assurance/quality control (QA/QC) and may delegate any of these responsibilities to a Consulting Task Leader.

The Subcontractor Quality Assurance Manager (SQAM) has the responsibility for periodic review of procedures and documentation associated with the decontamination of drilling, development, and heavy equipment. If perceived variances occur, the SQAM is also responsible for issuing notices of nonconformances and requesting corrective actions. Additionally, he/she will perform inspections and may monitor decontamination activities.

The project staff assigned to drilling, development, trenching, or construction activities are responsible for ensuring that subcontractors or equipment operators properly decontaminate the drilling, development, and heavy equipment associated with those tasks. The project staff are also responsible for documenting the decontamination activities on the Field Activity Daily Log (FADL) (SOP 1.2) and/or appropriate form(s) specified in the project work plans.

5. General

This section provides requirements for the set up of a decontamination facility for drilling, development, and heavy equipment and the decontamination procedures to be followed. The project work plans will provide specific information regarding:

- Types of equipment requiring decontamination under this SOP;
- Location of the decontamination station;
- Types and/or specifications on materials to be used in the fabrication of the decontamination station; and
- Types of materials and additional details on the procedures to be used in the decontamination process.

All field personnel associated with either the fabrication of the decontamination zone or the decontamination of drilling, development, or heavy equipment must read both this SOP and the project work plans prior to implementation of related decontamination activities. Information and requirements for the decontamination of any and all equipment used specifically for sampling is presented in SOP 6.1.

6. Decontamination Zone

A decontamination station will be set up in an area exclusively for decontamination of drilling, well development, and/or heavy equipment. The location of the decontamination zone will be specified in the project work plans. All decontamination of drilling, development, and heavy equipment will be conducted within this zone.

At a minimum, the zone will be constructed such that all rinsates, liquid spray, soil, debris, and other decontamination wastes are contained as appropriate and, if necessary, may be collected for appropriate waste management and disposal. If containment is required, the station may be as simple as a bermed, impermeable polyethylene sheeting of sufficient thickness. More sophisticated designs involving self-contained metal decontamination pads in combination with bermed polyethylene sheeting may also be used, depending on project-specific requirements. These requirements, along with specific equipment and construction specifications for the decontamination zone, will be provided in the project work plans.

7. Decontamination of Downhole Equipment

All downhole drilling and development equipment (including but not limited to drill pipe, drive casing, drill rods, bits, tools, bailers, etc.) will be thoroughly decontaminated before mobilization onto each site and between borings or wells at each site or as required in the project work plans. Decontamination will be performed in accordance with this SOP and the project work plans. The standard procedure will be performed as described below.

Appropriate personal protective equipment (as specified in the project work plans) must be worn by all personnel involved with the task to limit personal exposure.

Equipment caked with drill cuttings, soil, or other material will initially be scraped or brushed.

Equipment will then be sprayed with potable water and washed with a laboratory-grade detergent solution.

Washed equipment will then be rinsed with potable water.

Decontaminated downhole equipment (such as drill pipe, drive casing, bits, tools, bailers, etc.) will be placed on clean plastic sheeting to prevent contact with contaminated soil and allowed to air dry. If equipment is not used immediately, it may be covered or wrapped in plastic sheeting or bags to minimize contact with airborne contamination.

Decontamination activities will be documented by the STL, lead geologist, or lead engineer on the FADL (SOP 1.2 Field Activity Daily Log) and/or appropriate form(s), as specified in the project work plans.

8. Decontamination of Heavy Equipment

Heavy equipment (e.g., drill rigs, development rigs, backhoes, and other earthmoving equipment) will be decontaminated between drilling sites or inside the contaminant reduction area prior to entering and leaving an exclusion zone. Decontamination will be performed in accordance with this SOP and the project work plans. The standard procedure will be performed as described below.

- Appropriate personal protective equipment (as specified in the project work plans) will be worn by all personnel involved in the task, in order to limit personal exposure.
- Equipment caked with drill cuttings, soil, or other material will be initially scraped or brushed.
- Equipment will then be sprayed with potable water and washed with a laboratory-grade detergent solution.
- Clean equipment will then be rinsed with potable water.

During the decontamination effort, fluid systems should be inspected for any leaks or problems that might potentially result in an inadvertent release at the site, thereby contributing to the volume of waste or contamination. Any identified problems should be immediately repaired and documented on the FADL. Decontamination should be completed before moving the equipment onto the site or exclusion zone.

Decontamination activities will be documented by the STL, lead geologist, or lead engineer on the FADL and/or appropriate form(s), as specified in the project work plans.

Between boreholes at the same site, the back-end of the drilling rigs will be washed with potable water until surfaces are visibly free of soil buildup.

9. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 - Records Management.

10. Attachments

None.

BOREHOLE AND WELL ABANDONMENT

STANDARD OPERATING PROCEDURE 8.3

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for field personnel to use in the supervision of borehole or soil boring abandonment and groundwater monitoring well abandonment (destruction) activities. Additional specific borehole and well abandonment procedures and requirements will be provided in the project work plans.

2. References

California Department of Water Resources (CDWR), 1981. *Water Well Standards: State of California*, Bulletin 74-81, December.

CDWR, 1988. *Draft Monitoring Well Standards: State of California*, Bulletin 74-88, September.

CDWR, 1991. *California Wells Standards*, Bulletin 74-90 (Supplement to Bulletin 74-81), June.

SOP 1.2 - Field Activity Daily Log

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Borehole Abandonment - The process whereby boreholes or soil borings are grouted or sealed following completion of drilling, sampling and/or logging.

Well Abandonment - For the purposes of this SOP, "well abandonment" will refer to the abandonment of groundwater monitoring wells only. Well abandonment is the process of formally destroying the well such that it may never be used again and also to ensure that the well cannot act as a potential conduit for contaminants to travel either between the surface and any water bearing zones screened by the well or between different hydrostratigraphic units screened by the well. Well abandonment generally consists of two basic methods:

- Abandoning the well in-place; or
- Drilling the well out.

The exact type of methodology that is used at a site is dependent upon specific regulatory requirements and in some cases may be negotiated with the applicable regulatory agencies.

Abandoning the well in place consists of cementing the sand pack, well screen, and casing in place, usually with a cement bentonite grout. The grout is commonly pumped through a tremie pipe inside the well and then the well head is secured with a cap so that pressure can be applied to the grout column inside the well, forcing grout through the screens and out into the filter pack material. At certain sites regulators may require perforating the casing across low permeability zones, excess sand pack interval (i.e., behind blank casing), and/or intervals of poor cement seal (as determined from a cement bond log run inside the casing). The grouting is then conducted in successive stages across the perforated intervals. In other instances, the regulatory agencies may require in-place abandonment be conducted using pressure grouting techniques.

Drilling the well out is most commonly conducted using a hollow stem auger. In certain instances, a rotary wash might also be used. The auger size is selected so that the inside diameter of the auger is slightly greater than the well casing and screen. The auger is then centered over the casing, with the center plug and pilot bit removed or a small guide plug inserted in the casing. Additionally, heavy steel drill rods may be placed inside the well casing to act as a guide for the augers and to ensure that they stay centered on the well. The cement seal, bentonite seal, and sand pack are then drilled out with the augers as they are advanced or washed over the well casing and screen. Once the cement seal, bentonite seal, and sand have been drilled out and circulated to the surface, the well casing and screen are pulled from the hole. The remaining boring is then usually sealed with a tremied cement grout.

The above methodologies also commonly incorporate the removal of the well head and surface completion materials down to a pre-specified depth. The surface is then sealed, and a permanent marker or monument may also be emplaced at the surface.

Any of the above methodologies are effective in rendering the wells inoperable and preventing them from becoming conduits for enhanced vertical transport.

4. Procedure

This section contains responsibilities, procedures, and requirements for borehole and well abandonment. Abandonment procedures to be used at a particular site must incorporate project-specific regulatory requirements. Consequently, the project work plans will identify the following:

- Abandonment objectives;
- Boreholes to be abandoned;
- Monitoring wells to be abandoned;
- Applicable site-specific regulatory requirements for monitoring well abandonment; and
- Specific procedures for borehole and well abandonment beyond those covered in this SOP.

4.1 Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that all abandonment activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC). The SPM may assign these responsibilities to a Subcontractor Task Leader (STL).

The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of field generated documentation associated with this SOP. The SQAM is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to the abandonment requirements, issuing nonconformances, etc.) if problems occur.

Field personnel assigned to borehole and well abandonment activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the STL, SPM, or the SQAM.

4.2 Procedures for Abandonment of Boreholes

After drilling, logging and/or sampling, boreholes should be backfilled by the method described in the project work plans. This typically consists of backfilling to the surface with a bentonite-cement grout.

Bentonite should be thoroughly mixed into the grout and within the percentage range specified in the work plans. The grout is usually tremied into the hole; however, for selected boreholes (e.g., shallow borings well above the water table) at certain sites, the grout may be allowed to free fall. In either case, care must be taken to ensure the grout does not bridge, forming gaps or voids in the grout column.

The volume of the borehole should be calculated and compared to the grout volume used during grouting to aid in verifying that bridging did not occur.

When using a tremie to place grout in the borehole, the bottom of the tremie should be submerged into the grout column and withdrawn slowly as the hole fills with grout. If allowing the grout to free fall (and not using a tremie), the grout should be poured slowly into the boring. Free falling should only be used in shallow borings, less than 30 foot boreholes containing significant water should not be grouted by the free fall method. Regardless of the grouting method, the rise of the grout column should also be visually monitored.

If the method used to drill the boring utilized a drive casing, the casing should be slowly extracted during grouting such that the bottom of the casing does not come above the top of the grout column.

During the grouting process, the personnel performing the task should be supervised to assure that potentially contaminating material (oil, grease, or fuels from gloves, pumps, hoses, et al.) does

not enter the grout mix and that personnel are properly wearing personal protective equipment as specified in the Project Health and Safety Plan.

Following grouting, barriers should be placed over grouted boreholes, as the grout is likely to settle over time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to "top off" the hole.

The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface) unless otherwise specified in the project work plans.

4.3 Pre-Abandonment Activities for Monitoring Wells

The abandonment of monitoring wells should be done in compliance with applicable state and local regulations. Permits should be obtained from the county, or any other agency which requires them, prior to well abandonment.

For sites in California, well abandonment standards have been developed by the California Department of Water Resources (CDWR) (CDWR, 1981, 1988, and 1991). An abandonment report should be filed with the CDWR. The form ID numbers are unique, and an original form must be obtained from the CDWR. In addition, only a California-licensed drilling contractor possessing a valid C-57 State license should be contracted to perform abandonment activities at sites in California. The California Department of Toxic Substances Control (DTSC) may also have additional abandonment requirements for sites where they are the lead agency. In the past they have required a well abandonment workplan be compiled and approved before conducting abandonment activities.

Even if not required by the regulatory agencies, it is advisable to compile a well abandonment plan to be included in the project work plans for use by the well-site geologist/engineer and the driller. The procedures for the abandonment within the plan should be consistent with the above applicable regulatory requirements. The plan should be reviewed by the field crew prior to the abandonment of a well.

Certain information may be required to appropriately complete the plans and is important in planning and ensuring that effective abandonment of the well will be completed. This information may include the following:

- The subsurface lithology/soil types in the immediate vicinity of the well, as derived from the boring, soil core, and/or borehole geophysical logs compiled from the particular well;
- The well condition information based upon historical or operations records (including sample collection forms) and previous inspection activities (e.g., tape soundings, video camera logging, borehole geophysical logging, etc.);
- The well construction information, including type and diameter of casing and well screen, and depths, composition and thicknesses of sand packs, bentonite seals, and cement seals; and
- Past analytical results of groundwater samples collected from the well.

4.4 In-Place Well Abandonment Activities

This section describes basic requirements for abandoning (cementing) monitoring wells in place as discussed in Section 4.2 above.

Upon initiation of abandonment activities, all downhole sampling (e.g., dedicated purge pumps, sample pumps, etc.) and monitoring equipment must be removed from the well.

Obtain a measurement of the total depth of the well and compare to the existing well construction information. If granular material (e.g., sand pack, formation sediment, etc.) is believed to be present inside the well based upon the sounding, a bailer may be run to bottom to attempt to ascertain the type of debris.

The granular well debris should then be removed from the well by bailing, pumping, or other appropriate techniques.

If the condition of the well casing is suspect or of concern, it may be advisable to run a video log of the well, if it has not already been done. However, judgement and caution will need to be exercised to prevent the camera from becoming stuck or dirtied with sediment/debris inside the well during the video logging.

If significant scaling or encrustation of the well is observed, the well should then be brushed and cleaned.

If perforation across low permeability zones or voids in the cement seal (as determined from a cement bond log) is required by the appropriate regulatory agency, then the perforation is conducted using a perforation gun with explosive charges or equivalent, as approved by the SPM and regulatory agency. The intervals to be perforated are predetermined and specified in the well abandonment or project work plans or may also be based upon field evaluation of a cement bond log run inside the well. The perforating should be conducted:

- using either wireline or tubing conveyed guns;
- by an experienced driller or wireline company; and
- following all applicable requirements of the Project and/or Site-Specific Health and Safety Plan.

Upon completing the perforation, the screen interval and sand pack will be grouted with cement grout. The type and composition of the grout mixture will be specified in the abandonment and/or project work plans. The grout will be emplaced as required by the abandonment and/or project work plans.

The remainder of the well casing and the perforated intervals are then grouted in successive stages as specified in the abandonment and/or project work plans.

If the well is abandoned in-place without perforating, the well is sealed with cement grout after any necessary brushing and cleaning (see Section 4.4). The type and composition of the grout mixture will be specified in the abandonment and/or project work plans. If use of a tremie is required,

the grout should be pumped via a tremie pipe or equivalent placed near the bottom of the well with the tremie pipe or equivalent progressively removed as grouting progresses.

In all cases, while grouting the well, special care should be used to restrict the flow of groundwater into the well if subsurface pressure producing the flow is significant. During the grouting process, the personnel performing the task should be supervised to assure that potentially contaminating material (oil, grease, or fuels from gloves, pumps, hoses, et al.) does not enter the grout mix and that personnel are properly wearing personal protective equipment as specified in the Project Health and Safety Plan. Groundwater displaced by the cement grout shall be containerized if contaminants concentrations above drinking water Maximum Contaminant Levels are anticipated, and all excess grout shall be containerized.

Quantities of grout used are to be recorded on a Field Activity Daily Log (FADL) (SOP 1.2). It should be verified that the volume of the grout placed during destruction operations equals or exceeds the volume to be filled and sealed. This is to help determine whether the well has been properly destroyed and that no jamming or bridging of the grout has occurred.

The final well surface disposition should be completed as stated in the abandonment and/or project work plans.

Any problems or unusual conditions observed during the entire abandonment process should be recorded on the FADL (SOP 1.2).

4.5 Well Removal Abandonment Activities

This section describes basic requirements for monitoring well abandonment by drilling the well out. As hollow-stem auger drilling techniques are most commonly employed, they will be described in this section.

Upon initiation of abandonment, conduct equipment and debris removal activities.

If the condition of the well casing or screen is suspect (e.g. parting is suspected), a video log may be run inside the well. If parting of the casing or screen is evident, drilling the well out may not be feasible and abandoning the well in-place may need to be considered as a more viable option.

For drilling out the well, the site should be prepared and the rig centered over the well per the project work plans and appropriate drilling method SOPs. The lead auger is positioned so that it will wash over the well casing during drilling. A small guide plug may then be positioned through the inside of the auger and into the casing. Additionally, heavy steel drill rods may be placed inside the well casing to act as a guide for the augers and ensure that they stay centered on the well.

The cement seal and sand pack are then drilled out by advancing the augers and adding auger joints to the drill string. Drilling should be conducted following procedures specified in applicable drilling method SOPs and the project work plans.

Once the targeted total depth is reached, the hole is cleaned by circulating out all cement, sand pack and cuttings by spinning the augers.

The well casing is then removed as the augers and centering rods (if utilized) are pulled to the surface. If the casing is disconnected during removal, it is advisable to suspend and hold the casing with appropriate lifting slings and chain wrenches. Care should be taken to prevent the remaining casing from falling back into the hole.

The remaining boring is then sealed following procedures specified in Section 4.2 and the abandonment and/or project work plans.

The final well surface disposition should be completed as stated in the abandonment and/or project work plans.

Any problems or unusual conditions observed during the entire abandonment process should be recorded on the FADL (SOP 1.2).

5. Records

Records generated as a result of implementation of this SOP will be maintained in the Project Records file in accordance with SQP No. 4.2 – Records Management.

6. Attachments

None.

LOW-FLOW GROUNDWATER SAMPLING

STANDARD OPERATING PROCEDURE 9.3

1. Purpose

This Standard Operating Procedure (SOP) outlines the methods and responsibilities for field personnel to use when collecting groundwater samples using low-flow techniques. This SOP applies to low-flow groundwater sampling using a bladder pump.

The low-flow method recovers formation groundwater from a distinct interval resulting in representative samples of dissolved phase constituents and minimizing "surging" that can draw fines into the well and increase sample turbidity. Additional benefits to this method are that the samples only contact new, disposable equipment, the same device is used to both purge and sample the well and purge volumes are reduced. This minimizes cross-contamination and potential decontamination issues, reduces the amount of investigation-derived-wastes (IDW) generated, and provides a more sustainable sampling method.

2. References

United States Environmental Protection Agency (EPA), 1995. *Use of Low-Flow Methods for Ground Water Purging and Sampling: An Overview,* Region IX, 4 p.

EPA, 1996. *Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures*, EPA/540/S-95/504, 12 p.

EPA, 1996. *Low Stress (low flow) Purging and Sampling Procedures for the Collection of Ground Water Samples from Monitoring Wells*, Region I, Revision 2, 13 p.

EPA, 2002. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*, EPA 542-S-02-001. 53p.

SOP 1.1 - Sample Custody

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 5.1 - Water Level Measurements in Monitoring Wells

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 17.1 - Sample Labeling

SOP 17.2 - Sample Numbering

SOP 20.1 - Sample Containers, Preservation, and Holding Times

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Low-Flow sampling is recommended by EPA (EPA/540/S-95/504). It involves using low pumping rates (0.1 - 0.5 liters per minute [L/min]) until measured water characteristics exhibit steady-state conditions (stabilization), showing that the water is being drawn from the aquifer. The most useful stabilization parameters are turbidity, dissolved oxygen, and oxidation-reduction potential. Parameters of less value, but often measured, are temperature, pH, and specific conductance (EPA/540/S-95/504).

4. Responsibilities

4.1.1 Subcontractor Project Manager

The Subcontractor Project Manager (SPM) is responsible for ensuring groundwater samples are properly collected and documented in accordance with this SOP, and may assign specific responsibilities to a Subcontractor Task Leader (STL). This will be accomplished by staff training and by maintaining quality assurance/quality control (QA/QC). The SPM will review the project-specific documentation forms to ensure they are appropriate for the field activities. The project-specific documentation (Job Protocol) shall include, but not limited to, specific job instruction, equipment/materials list, contact information, maps, health and safety plan, and forms to document water levels. Documentation (Job Protocol) will be made available, for review, to field team member's scheduled to perform activities a minimum of two weeks prior to the scheduled event.

4.1.2 Field Staff

The field staff assigned to perform this task are responsible for the proper collection of groundwater samples, documentation of field activities , maintenance of field forms and other project documentation , maintenance of field equipment used for groundwater sampling and review of job protocol prior to event. All staff are responsible for reporting deviations from this SOP to the SPM, STL, or the Subcontractor Quality Assurance Manager (SQAM) in writing.

4.1.3 Subcontractor Quality Assurance Manager

The SQAM is responsible for the review of documentation generated as a result of this SOP and the review and audit of field personnel as they perform the work. If problems arise, the SQAM is responsible for swift implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variance to requirements, issuing non-conformances, etc.), and through monitoring the continued implementation of stated corrective actions.

5. Procedure

5.1 Equipment

(1) Down-hole bladder pumps must be used. Peristaltic pumps may be used only if volatile organic compounds are not on the list of contaminants of concern. Inertial pumps may not be used.

(2) It is impossible to perform low-flow sampling with a bailer. Inertial lift devices and high flow rate pumps may not be used. Down-hole, low-flow rate pumps must be used.

(3) A multi-probe, in-line flow cell, preferably transparent (to detect particulate build-up) is recommended for use. The design of the flow cell must prevent air bubble entrapment during use. The types of flow cells and multi-probes used must be specified in the sampling protocol, as well as the required calibration frequency (daily).

(4) Tubing used should be small diameter (1/4 or 3/8 inch) Teflon or Teflon-lined polyethylene. Polyvinyl chloride (PVC), polypropylene, or polyethylene tubing should only be used for samples restricted to inorganic analyses.

5.2 Sampling Requirements

- The monitoring well must be permanent, properly constructed, and developed.
- The water table must be above the top of the well screen.
- A dedicated, submersible pump is recommended. If a dedicated pump is not feasible, then the tubing used for each well should be dedicated and cut to length for that well. The pump must be lowered into place as slowly as possible to prevent mixing or surging of the well.
- The midpoint of the saturated screen is usually the optimum depth for the pump intake, but other depths may be used to target specific zones, such as maximum flow layers or zones of high chemical concentrations. Pump intakes must not be so close to the surface that the water level may be pulled below the intake and cause vortexing and cavitation.
- The pump intake should also be at least two feet above the bottom of the well to preclude excess turbidity from the well bottom.
- The rationale describing why, how, and where each pump intake depth was selected must be documented in sampling documents or field protocols.
- The pump should not be raised or lowered while taking samples.
- A depth gauge must be used during purging to take continual water level readings. Drawdown must be held to less than 0.3 foot during purging. During initial pump start-up, drawdown may temporarily exceed this before recovery.
- The field parameter and water level readings must be recorded and submitted in the sampling report.

- If the water level is pulled down to the pump intake, all concurrent attempts at sampling should cease for the well, and alternative procedures should be prepared to prevent this from happening during the next sampling period.
- The pump should be started at the lowest flow volume and adjusted higher as long as the maximum drawdown is not exceeded. Typical extraction volumes are 100 milliliters/minute (ml/min) to 300 ml/min. Volumes may approach 1.0 L/min in very highly permeable soils but should not exceed this.
- The parameters normally measured for stability (listed in increasing order of sensitivity) are pH, temperature, specific conductivity, oxygen-reduction (redox) potential, dissolved oxygen (DO), and turbidity. All measurements should be made using a multi-probe, in-line flow cell or a flow-through cup.
- The frequency of stability parameter measurements will depend on the rate of sampling, but generally should be on the order of three to five minutes. Stability will be achieved according to work plan specifications. In the absence of work plan specifications, stability will be achieved when three consecutive readings do not vary more than ± 10% for turbidity, conductivity, redox, and DO, and ± 0.1 for pH. The stability data must be recorded in the field sampling notes.
- If, during purging, the turbidity readings increase, this indicates that the well is being re-developed and the pumping rate should be lowered. Turbidity may be naturally high in some formations but should stabilize at or below 5 nephelometric turbidity units (NTU). If this does not happen, the well may require re-development. If the problem persists, other forms of sampling should be considered.
- If the well yield (recharge rate) is lower than the lowest extraction rate and the 0.3-foot maximum drawdown cannot be met, no-flow (or passive) sampling may be used. Permission must be obtained from the Consulting Project Manager before this option is used, and it must be noted in the sampling field notes.

6. Low-Flow Sampling Instructions Using a Bladder Pump

Purging and sampling equipment will consist of a bladder pump fitted with disposable polyethylene tubing. The following procedures will be used to sample the wells.

- The decontaminated bladder pump is attached to the air inlet tubing and the water discharge tubing. This tubing is usually polyethylene, cut to length to reach the screened interval location and the purging/sampling location.
- The bladder pump is lowered into the well to the specified location in the screened interval of the well.
- A clean air compressor is attached to the bladder pump controller.
- The bladder pump controller is attached to the air inlet tubing from the bladder pump.
- The water outlet tubing from the bladder pump is run to the flow through device.

- The bladder pump controller is started at a low-flow level and the flow rate is then adjusted to between 100 and 500 ml/min.
- Depth to water is measured continually.
- The stability parameters are measured every three to five minutes until, and prior to, sample collection.
- Stability parameters are measured with the meter probe positioned near the bottom of the cup, fully immersed, and aeration minimized.
- Purging continues until the stabilization parameters have stabilized to within the work plan criteria or the criteria listed above for three successive readings.
- Once stabilization is achieved, the tubing outlet is inserted into the sample container, and without touching the side of the container and minimizing aeration, the groundwater sample is collected.
- Collect samples that do not require filtration before attaching the filter and collecting filtered samples.

Fill sample bottles in the priority order specified by protocol, or sampling plan. Follow appropriate decontamination procedures. Document all work on field forms.

7. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 Records Management and SOP 1.2 Field Activity Daily Log.

8. Attachments

None.

SURFACE WATER SAMPLING

STANDARD OPERATING PROCEDURE 9.4

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of surface water samples for chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all surface water samples. Surface water samples will also follow the same sample handling and custody procedures outlined for groundwater samples in Section SOPs 1.1 through 2.1. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

2. References

United States Environmental Protection Agency (EPA), 1987. *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988. *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies Under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

SOP 1.1 - Sample Custody

SOP 1.2 - Field Activity Daily Report

SOP 1.3 - Field Measurements, Maintenance, and Calibration of Instruments

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 17.1 - Sample Labeling

SOP 17.2 - Sample Numbering

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Procedure

This section contains the procedures involved with surface water sampling to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives;
- Locations and depths at which water samples are to be collected;

- Numbers and volumes of water samples to be collected;
- Analysis to be conducted for each sample;
- Specific quality control (QC) procedures and sampling required; and
- Any additional surface water sampling requirements or procedures beyond those covered in this SOP, as necessary.

The following subsection outlines the procedure for surface water sampling.

3.1 Prerequisites

Equipment used for surface water sampling will vary depending on the type and depth of samples to be obtained. Prior to the collection of each sample, all sample equipment must be decontaminated according to the Decontamination SOP, as well as procedures outlined in the project work plans. Review and document review of Health and Safety Plan.

As required, calibrate any monitoring and parameter equipment according to the instrument manufacturer's specifications and the Field Measurements SOP. Calibration results should be recorded on the appropriate form(s), as specified in the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications should be removed from service and tagged. Don appropriate personal protection equipment as specified in the project work plans and Health and Safety Plan. Clear the area as appropriate for easy access of surface debris and vegetation using equipment that will not be used for sample collection or will be decontaminated prior to use in sampling.

3.2 Sampling Equipment

The sampling and analytical requirements, as well as site characteristics, must be taken into account when determining the proper surface water sampling equipment to use. A few devices are available for the collection of surface water samples. These include, but are not limited to: Bailer, Extended Sampling Stick, and a Dipping container.

3.2.1 Bailer

A bailer is an enclosed cylindrical tube containing a floating ball check valve at the bottom. Lowering the bailer into water causes the ball to float, allowing water to enter the cylinder. Raising the bailer through the water causes the ball to settle, creating a seal to trap the water so that it can be brought to the surface.

3.2.2 Easy Reach Extended Sampling Stick

An easy reach sampling stick is an extendable device that has a cup at the end for easy water retrieval. Generally, it can be extended from four to twelve feet in length. The easy reach stick is limited to collecting water from a pool or creek at no more than a twelve foot distance from the sampling technician.

3.2.3 Dip and Transfer by Hand Method

The dip and transfer by hand method involves using a non-preserved sampling container of the same material as the sample containers to be filled (i.e.: glass, poly), where the surface water is actually scooped out by hand with said container and then poured into sample bottles. For each new sampling point, a new "dipper" sample bottle is to be used to prevent cross contamination.

3.3 Surface Water Sample Collection

When the sample is ready to be collected, the best tool for the job should be selected based on the conditions of the site and what is stated in the work plan/protocol packet. Approach water source safely, referring to the Health and Safety Guidelines.

Dip either the bailer, Extended Sampler, or a sample bottle per Dip and Transfer by Hand Method into the water source, filling the bottle.

Transfer an adequate amount of water into a designated cup to measure and record any parameters required, as stated in the work plan/protocol packet.

Then take the remaining water and gently transfer the matrix directly into a pre-cleaned sample container (e.g., glass bottle, poly bottle, etc.), being careful not to overfill any bottles with preservatives.

Repeat with the dipper/bailer/bottle as many times as necessary to fill all required sample bottles. The project work plans will specify the type of sampling equipment and sample containers to be used.

3.4 Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance (QA) and QC.

A designated Contractor Quality Assurance Manager (PCQAM) is responsible for periodic review of field generated documentation associated with this SOP. The Subcontractor Quality Assurance Manager (SQAM) is responsible for implementation of corrective actions (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing field variances, etc.) should problems occur.

A Subcontractor Task Leader (STL) is responsible for all field activities, including preparations and demobilization. The STL oversees all field personnel to ensure that sampling is being conducted in accordance with the relevant SOPs and project plans. Field personnel assigned to conduct surface water sampling activities are responsible for completing their tasks according to specifications outlined in this SOP, the project workplan/protocol, and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the STL. When possible, approval should be received before making any deviations.

4. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files, in accordance with SQP 4.2 – Records Management.

5. Attachments

None.

SOIL ORGANIC VAPOR SAMPLING

STANDARD OPERATING PROCEDURE 10.1

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines for collecting soil organic vapor (SOV) samples and documenting the collection process. The details within this SOP should also be used in conjunction with project work plans. It is imperative that staff should review the most recent relevant guidance documents from the Department of Toxic Substances Control (DTSC) and the US Environmental Protection Agency (EPA) when preparing for soil vapor sampling.

2. References

Department of Toxic Substances Control (DTSC), 2015. *Advisory—Active Soil Gas Investigation*s, prepared by the California Environmental Protection Agency/Department of Toxic Substances Control, Los Angeles Regional Water Quality Control Board, San Francisco Regional Water Quality Control Board, July.

California Environmental Protection Agency (Cal/EPA), 2004. California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), *Guidance Document for the Implementation of United States Environmental Protection Agency Method 5035: Methodologies for Collection, Preservation, Storage, and Preparation of Soils to be Analyzed for Volatile Organic Compounds*, November.

United States Environmental Protection Agency (EPA), 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, Office of Solid Waste and Emergency Response Publication 9200.2-154, June.

McAlary, T.A., P. Nicholson, H. Groenevelt, D. Bertrand, 2009. "A Case Study of Soil-Gas Sampling in Silt and Clay-Rich (Low Permeability) Soils", *Ground Water Monitoring & Remediation*, 29, No. 1, p 144-152.

California Department of Water Resources (DWR), 1990. *Final Draft Bulletin 74-90, California Well Standards Water Wells; Monitoring Wells, Cathodic Protection Wells, Supplement to Bulletin 74-81*, January.

SOP 1.1 - Sample Custody

SOP 1.2 - Field Activity Daily Report

SOP 2.1 - Sample Handling, Packaging and Shipping

SOP 6.1 - Sampling Equipment and Well Material Decontamination

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

None.

4. Procedure

4.1 Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that SOV samples are properly collected in compliance with the most current SOV/soil gas sampling guidelines from DTSC and EPA, and that the sampling event is properly documented in accordance with this and any other appropriate procedure. This will be accomplished through staff training and by maintaining quality assurance (QA) and quality control (QC). The SPM may assign these responsibilities to a Subcontractor Task Manager.

The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of field generated documentation associated with SOV sampling. If perceived variances occur, the SQAM is also responsible for issuing notices of nonconformances and requests for corrective action.

Field personnel assigned to SOV sampling activities are responsible for completing their tasks according to the specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the APM.

4.2 Field Conditions

Field conditions, such as rainfall, irrigation, or fine-grained sediments may affect the ability to collect soil gas samples.

Rainfall decreases the air-filled porosity of the shallow soil, thereby limiting diffusion transport of volatile contaminants and potentially biasing soil gas sampling results. Hence, do not conduct soil gas sampling during or within five days of a significant rain event (1/2 inch or greater). Stop irrigation or watering of soil at least five days prior to the soil gas sampling event. Likewise, areas subject to soil gas sampling should be free of standing or ponded water for at least five days prior to sampling. Do not perform soil gas sampling in swales or depressions where large volumes of water can potentially accumulate. Barometric pressure fluctuations associated with the passage of frontal systems can introduce atmospheric air into the shallow vadose zone. Therefore, soil gas sampling should be delayed until frontal systems have passed the area. Alternatively, soil gas sampling times and depths may be chosen to minimize the effects of changes in barometric pressure.

If no-flow or low-flow conditions are caused by wet soils due to a rain event or irrigation or water is drawn into a probe, cease the soil gas sampling. Low or no-flow condition corresponds to

cases where the minimum flow rate of 100 milliliters per minute (mL/min) cannot be sustained at the maximum applied vacuum of 100 inches of water (McAlary et al., 2009). If the low-flow condition is due to wet conditions or shallow groundwater, then passive samplers may be deployed to detect volatile organic compounds (VOCs).

If low-flow or no-flow conditions are caused by fine-grained soil, clay, soil with vacuum readings that exceed approximately 136 inches of water or 10 inches of mercury are encountered at a sampling point, a new vapor well should be installed in a coarser lithology at a different depth or lateral location. The following should be considered if low flow conditions persist:

- Evaluate site lithologic logs;
- Collect new continuous soil core samples;
- Use alternate low flow sampling methods (see Appendix D of DTSC, 2015);
- Re-evaluate the need for the sampling location;
- Use passive soil gas methods as described in Appendix A of DTSC, 2015; and/or
- Collect and evaluate soil matrix VOCs sample using 5035/8260 (Cal/EPA, 2004).

4.3 Sample Collection Preparation

A number of devices are available for the collection of SOV samples. The analytical requirements, the sample depth, the material through which the sample probes are to be driven, and whether the sampling points are to be temporarily or permanently installed must be taken into account when determining the proper SOV sampling equipment to use. The project work plans will identify, as applicable:

- SOV sampling objectives;
- Depths and locations of sampling points;
- Sampling equipment to be used;
- Numbers and volumes of samples to be collected;
- Types of chemical analyses to be conducted for the samples;
- Specific QC sampling and procedures required;
- Drilling or installation requirements (for permanent points), as required; and
- Specific procedures to be performed in addition to those covered in this SOP.

The project work plans and this SOP should therefore be reviewed and understood before conducting SOV sampling at the site.

The standard procedure for field personnel to use in the collection of SOV samples is described below.

Prior to drilling or driving SOV sampling points, ensure that the sample locations have been appropriately cleared for all underground utilities per the project work plans. Review all forms and diagrams documenting the location of the cleared SOV points, as well as that of any underground utility lines or other obstructions.

Inspect all SOV sampling equipment to ensure that it is in good working order.

Refer to the project work plans to determine the appropriate instrument(s) needed to screen the borehole for VOCs. Calibrate all field analytical and health and safety monitoring equipment according to the instrument manufacturer's specifications. Calibration results will be documented on the appropriate form(s), as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

Don the appropriate personal protective equipment as specified in the project work plans and health and safety plan.

The sampling points should be surveyed or mapped and clearly marked prior to sampling. The sample should be collected at the marked location. If the collection point must be moved, significantly, the new location must be approved by the SPM.

Clear the area to be sampled of surface debris and vegetation using appropriate equipment, as specified in the project work plans. Sampling equipment should not be used for this purpose.

Prior to sampling and between sampling locations, decontaminate the sampling equipment according to the procedures outlined in SOP 6.1 – Sampling Equipment and Well Material Decontamination. Record the decontamination activities on the Field Activity Daily Log (FADL) (SOP 1.2) and/or the appropriate form(s), as specified by the project work plans.

Note: Some projects may require the collection of QC samples after decontamination of the sampling equipment. This sampling must be conducted as required by the project work plans.

Drive the sample probe to the appropriate depth (hydraulically, electrically, or manually), as specified in the project work plan.

4.4 Soil Vapor Well Installation

Vapor well installation procedures are described below. The probe tip, probe, and probe connectors should all have the same diameter to provide a good seal between the formation and the sampling assembly. Seal all holes and spaces with bentonite slurry to prevent ambient air intrusion.

Soil vapor wells may be installed using a variety of drilling methods, such as direct push methods, hollow stem auger, or other techniques, as appropriate. Certain types of drilling methods, such as air rotary and rotosonic, are not recommended because they can adversely affect soil gas data during and after drilling. However, for deeper soil gas wells or for drilling in denser/coarser formations, alternate drilling methods (e.g., air rotary and rotosonic methods) may be employed with longer equilibration times prior to sampling. The mud rotary drilling method is not acceptable for soil gas probe emplacement under any circumstances. When additional sampling is not anticipated,

properly remove or decommission vapor wells with concurrence from the regulatory agency and in accordance with state and local requirements.

Nylaflow, polyetheretherketone (PEEK), and Teflon are recommended for the soil vapor probe and soil vapor sampling train. Nylaflow is more rigid that Teflon tubing and may be preferred, depending upon the installation methods chosen. Use of low-density polyethylene (LDPE) is discouraged due to decreased performance relative to other tubing types in both introduction of background analytes and sample recovery. Reduced recovery of naphthalene has been observed when using Nylaflow tubing with small sample sizes (see Sample Tube, Section 2.3 of main text). For justification and additional information, see Appendix B of DTSC's *Advisory—Active Soil Gas Investigation* (DTSC, 2015).

Place the stainless steel probe tip midway in the sand pack, as shown on Figure 1. The sand pack should be a minimum of one (1) foot thick. Install the sand pack to minimize disruption of airflow to the sampling tip.

Emplace at least one (1) foot of dry granular bentonite on top of each sand pack, as shown on Figure 1. Following the dry bentonite, grout the borehole to the surface with hydrated bentonite. The bentonite should be hydrated at the surface and tremie piped into the borehole. The purpose of the dry granular bentonite between the sand pack and the hydrated bentonite is to preclude the hydrated bentonite grout from infiltrating the sand pack. Follow a similar procedure for deep well construction with multiple probe depths, in that one foot of dry granular bentonite should be emplaced on top of the sand pack encasing each probe, followed by hydrated bentonite grout. The hydrated bentonite grout should continue until the next sand pack, as shown on Figure 1. A cement/bentonite mixture in accordance with California well construction standards in the California Department of Water Resources Bulletin 74-90 (California Well Standards) may also be used above the dry bentonite layer to seal the borehole annulus.

A tremie pipe should be used for soil vapor wells deeper than 15 feet, to avoid bridging or segregation during placement of the sand pack and bentonite seal.

The use of a down-hole probe support may be required for vapor wells in excess of 40 feet bgs. The probe support may be constructed from a one-inch diameter bentonite/cement grouted PVC pipe or other solid rod, or equivalent, allowing probes to be positioned at measured intervals prior to installation. The support should be solid or properly sealed to avoid possible cross contamination or ambient air intrusion. Alternative probe support designs with accompanying descriptions may be proposed in the project work plan. Justification should be included in the project work plan if the project proponent chooses not to use probe support for deep vapor wells.

Tubing should be protected from damage or clogging from subsurface soil materials by placing the tubing inside a flush-mount casing. For deep vapor wells, ensure that the probe tip and tubing are properly placed and tubing is not damaged or kinked. Properly mark tubing at the surface to identify the probe location and depth.

Soil gas wells should be properly secured, capped, and completed to prevent infiltration of water or ambient air into the subsurface and to prevent accidental damage or vandalism. For surface completions, the following components may be installed:

A. Gas-tight valve or fitting for capping the sampling tube;

B. Utility vault or meter box with ventilation holes and lock;

C. Surface seal; and

D. Guard posts.

If probe refusal is encountered, document the time and depth of refusal on the FADL and report the refusal to the SPM. Refer to the project work plans to determine the proper course of action. In the event of probe refusal, soil gas samples may be collected as follows:

A. For sample depths less than five feet, collect a soil gas sample following the precautions for shallow soil gas sampling such as reducing the flow rate to less than or equal to 50 mL/min and maintaining a low vacuum of less than 100 inches of water should prevent ambient air breakthrough into samples. Also avoid extensive purging for soil gas samples collected at less than five feet bgs.

B. For sample depths greater than five feet, collect a soil gas sample at the depth of refusal.

C. Install a replacement vapor well at least five (5) feet laterally from the original vapor well decommissioned due to refusal. If refusal still occurs after three tries, use alternate vapor well installation methods.

4.5 Temporary Soil Vapor Wells

In most cases, temporary soil vapor wells should be installed using one of the methods described in Section 4.4.

Post-run tubing and drive point methods[1] used to create temporary soil vapor wells are not recommended for soil gas sampling (McAlary, et al, 2009). The tubing used to create temporary soil vapor wells for the post-run method is prone to sealing issues associated with connecting the tubing to the drive point. Additionally, the drive point probes may be deflected by cobbles, which can create gaps between the outer wall of the casing and the geologic materials that are difficult to observe and equally difficult to seal. A hydrated bentonite plug at ground surface does not stop communication along the outer wall of the casing between different depth intervals. Samples collected under these circumstances will primarily draw soil gas from the most permeable layer above the tip of the probe, which may introduce a significant bias. Moreover, this condition cannot be identified by any tracer applied at or near ground surface. Temporary soil vapor wells may also yield questionable results in moderate to low permeability soils such as clay and/or silt clay lenses, where the flow of gas through the geologic materials is low. In such case, soil gas will be collected from the path of least resistance at any depth along the drive shaft.

[1] Drive point methods may be appropriate for certain site conditions or circumstances, depending on Data Quality Objectives. The use of post-run tubing should be discussed with the Agency prior to inclusion in the work plan.

4.6 Equilibration Time

Subsurface conditions are disturbed during probe placement. To allow for subsurface conditions to equilibrate and vapor concentrations to stabilize, the following procedures are recommended:

A. For soil vapor wells installed with the direct push method, do not conduct the purge volume test, leak test, and soil gas sampling for at least two hours following vapor probe installation. Finer-grained material may take longer, up to 48 hours, to equilibrate.

B. For soil vapor wells installed with hollow stem or hand auger drilling methods, do not conduct the purge volume test, leak test, and soil gas sampling for at least 48 hours after vapor probe installation.

C. For soil gas wells installed with a combination of hand auger drilling or hollow stem auger and direct push methods, do not conduct purging, leak testing and soil gas sampling for at least two hours following vapor probe installation provided that at least five feet of the borehole was drilled by direct push technology. The five feet of direct push borehole should be drilled after the completion of hand auger or hollow stem auger drilling. The well screen should be located below this five-foot interval. If the well screen is located above the five-foot interval, do not conduct purging, leak testing and soil gas sampling for at least 48 hours after soil gas probe installation.

D. For soil vapor wells installed with the rotosonic or air rotary method, do not conduct the purge volume test, leak test, and soil gas sampling until it can be empirically demonstrated that the subsurface equilibrium time is sufficient for representative sample collection.

Vapor well installation method and equilibration time should be recorded in the field log book or field form.

4.7 Decontamination

Decontaminate all reusable equipment between sampling locations to prevent cross-contamination (SOP 6.1).

4.8 Leak Test

Before obtaining soil gas samples, leak testing (described below) is necessary. A leak test is used to evaluate whether a good seal was established in the sampling train, ground surface, and probe interface. A leak test should be conducted at every vapor monitoring well each time a soil gas sample is collected, because a poor seal may result in soil gas samples that are diluted by ambient air. This may result in an underestimation of actual site contaminant concentrations or, alternatively, introduce external contaminant into samples from ambient air.

Helium is used to assess the potential for leaks in the sample train and probe annulus by positioning an enclosure or "shroud" over the probe and sampling train, filling it with a measured amount of helium, and measuring the concentration of helium using an in-line detector. One of the benefits of this method is that it is reasonably quantitative. The shroud provides a measure of the proportion of the sample attributable to leakage. Small leaks may be acceptable, as long as the magnitude of the leak is small compared to other unavoidable sources of bias and variability in sampling and analytical data. Laboratories typically assign a relative percent difference of +/- 25% for duplicate samples, so a leak that comprises less than 5% of the sample is relatively insignificant.

Helium is released into the shroud and a helium detector is used to monitor and maintain a reasonably steady concentration of helium within the shroud.

The helium concentration in the shroud should be at least 10%, or two orders of magnitude higher than the reporting limit of the laboratory helium analysis or field meter used to analyze the sample, which will provide sufficient resolution against reporting limits.

The concentration in the shroud will decay over time after the initial helium dose, depending on the seal between the ground surface and shroud, wind speed, etc.; therefore, the concentration in the shroud should be monitored and adjusted as needed to maintain a reasonable steady state. The monitored helium concentrations in the shroud should be recorded.

Monitor the helium concentration using an in-line detector to determine if helium is leaking into the sampling train. No helium should be detected in the purge line. If an upward trend is measured in the purge line, stop the test to check for a leak. If helium is detected quickly in the purge line, the leak may be due to a malfunctioning ferrule between the probe and sampling train. Turn off the helium supply and remove the helium shroud. Check that all sample train and probe surface components are tightly sealed. If the helium concentration increases steadily over time, the leak may be due to a faulty seal in the vapor probe. Turn off the helium supply and remove helium shroud. Check for cracks around probe and spaces between probe and sleeve in the borehole.

Helium screening is confirmed by laboratory analysis of the contents of the SUMMA canister collected under the shroud. This analysis provides the helium concentration for the identical parcel of gas for which VOC concentrations are measured.

The helium concentration is measured in the canister in the analytical laboratory by modified EPA Method TO-3 or ASTM D1946 following analysis of VOCs by EPA Method TO-15.

If helium screening is done exclusively from a canister at a stationary laboratory and there is a significant leak, it will not be identified until after the sample has been collected and analyzed. Therefore, monitoring the helium concentration using an in-line detector is recommended. It should be noted when using this method that a helium concentration indicating >5% leakage should be clearly noted and discussed in the data validation process.

An ambient air leak up to 5% is acceptable if quantitative tracer testing is performed by shrouding. Otherwise, the soil gas vapor well should be decommissioned if the leak cannot be corrected. Replacement vapor wells should be installed at least five (5) feet from location where the original vapor well was decommissioned due to a confirmed leak.

The soil vapor sampling report should identify the leak check compound and include the concentrations detected in the soil gas and the concentrations maintained in the shroud.

4.9 Purge/Sample Flow Rate and Applied Vacuum

Introduce helium gas into the shroud at least 5 minutes prior to purging and ensure that helium concentrations in the shroud stays constant. Record the helium concentration and time periodically on the Sampling Data Sheet. Purge/sample flow rates between 100 to 200 mL/min and vacuums less than 100 inches of water for standard small diameter (1/8 to 1/4 inch) tubing should be maintained to minimize partitioning of vapors from pore water to soil gas (i.e., stripping), prevent ambient air from diluting the soil gas samples, and reduce the variability of purging rates.

Three purge volumes should be used. One purge volume includes the following:

- The internal volume of the tubing and probe tip;
- The void space of the sand pack around the probe tip; and
- The void space of the dry bentonite in the annular space.

Calculate how long to purge and record the start time on field sheet. A purge flow rate greater than 200 mL/min may be used in certain cases, such as when larger diameter tubing is used with deeper vapor wells that are greater than 40 feet bgs. When purging at rates of greater 200 mL/min, reduce the flow rate to 200 mL/min for sampling.

A vacuum of 100 inches of water or less must be maintained during sampling.

4.10 Sample Collection

Sample collection is based on using a Summa canister. If your project needs require another type of sample container, please check Section 2.7 of the DTSC's *Advisory—Active Soil Gas Investigation* (DTSC, 2015) document for requirements. Sample collection containers should be less than or equal to one liter for shallow samples collected at less than five feet bgs to avoid excessive air removal. Helium shroud components and Teflon tubing should be dedicated to each sample. Do not re-use across samples or sample locations.

Prior to collecting the samples, remove three purge volumes.

A Summa canister and flow regulator will then be connected to Teflon or nylon sample tubing using air tight compression fittings. The flow regulator will be placed in-line to maintain a flow rate of approximately 100 to 200 cubic centimeters per minute while collecting the samples.

During sample collection into the Summa canister, helium will be used as a tracer gas and applied inside a shroud around the sampling point and tubing.

Prior to collecting the sample, the helium concentration will be monitored using an in-line detector. If no helium is present, the sample tubing valve and sampling valve on the Summa canister will then be opened, and soil vapor sampling will begin.

Soil vapor sampling will be completed when the pressure in the Summa canister has changed from the laboratory established pressure of -30 inches of mercury (in Hg) to an approximate final pressure of -5 in Hg. The pressure inside the Summa canister will be measured in the field by observing the pressure gauge located on the flow regulator. Record the initial and final Summa canister pressure in the FADL.

Once the sample is collected, seal the sample container and handle the sample according to the procedures outlined in SOP 2.1 - Sample Handling, Packaging, and Shipping.

Label the sample appropriately (date and time sample was collected, sample location, sample team members and signatures, etc.). For SUMMA canisters, do not apply adhesive label to canister; use the tag provided. Document the sampling event on the FADL (SOP 1.2).

For samples submitted to a laboratory for analysis, a Chain-of-Custody record (SOP 1.1) shall be completed and maintained per the SOP and project work plans.

Remove the sample probe (if temporary) and abandon the hole in the manner specified in the project work plans. For permanent sampling installations, cap and secure the sample point as required in the project work plans.

5. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

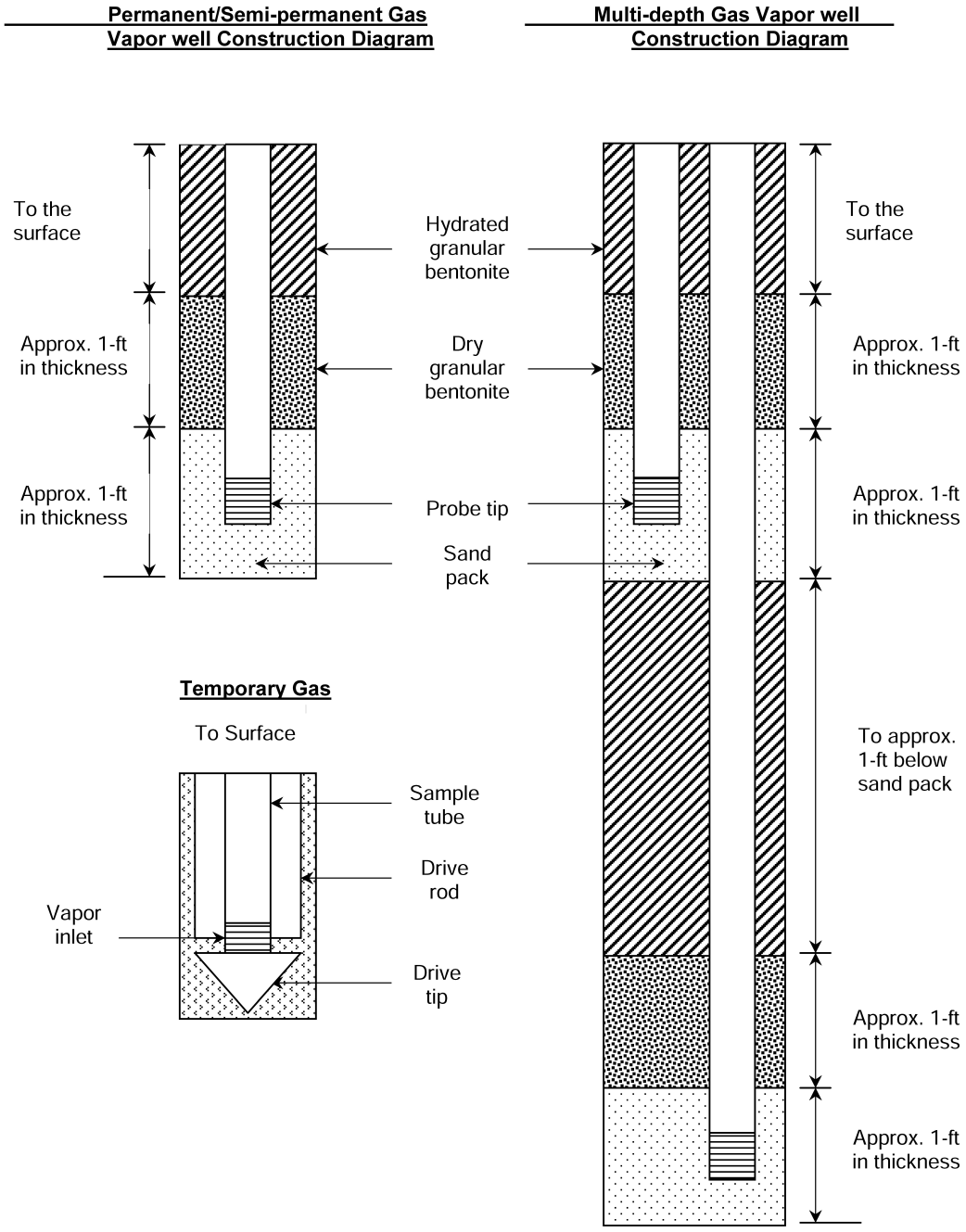
6.1 Soil Gas Vapor Well Emplacement Methods

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

SOIL GAS VAPOR WELL EMPLACEMENT METHODS

Figure 1 – Soil Gas Vapor Well Emplacement Methods



12/10/2009

SOP 10.1A Attachment 6.1 Soil Gas Vapor Well Emplacement Methods

AQUIFER TESTING

STANDARD OPERATING PROCEDURE 11.1

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for conducting aquifer testing. Proper testing guidelines and procedures are necessary to ensure effective evaluation of aquifer parameters and characteristics. Additional specific aquifer testing procedures and requirements will be provided in the project Work Plan.

2. References

Driscoll, F.G., 1986. *Groundwater and Wells*, Johnson Filtration Systems Inc., St. Paul, Minnesota.

Fetter , C.W., 2000. *Applied Hydrogeology*, Fourth Edition, Merrill Publishing Co., Columbus, Ohio.

Heath, R.C., 1987. *Basic Ground-Water Hydrology*, U.S. Geological Survey Water-Supply Paper 2220, Denver, Colorado, pp 34-50.

Lohman, S.W., 1979. *Ground-Water Hydraulics*, U.S. Geological Survey Professional Paper 708, Denver, Colorado, pp 11-56.

U.S. Department of the Interior Water and Power Resources Service, 1981. *Ground Water Manual*, New York, New York, pp 225-246.

SOP 5.1 - Water Level Measurements in Monitoring Wells

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 8.2 - Monitoring Well Development

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Aquifer Testing - Refers to physical testing methods used to determine the hydrologic characteristics of aquifers. Slug, specific capacity, step-drawdown, and constant rate pump tests are commonly used testing methods. Slug tests are conducted by instantaneously changing the water level in a well by adding, removing, or displacing a known volume of water and then monitoring the water level recovery in the well.

Specific capacity tests are short-term, single-well pump tests that are useful in highly transmissive units, which preclude slug testing. The method consists of measuring the stabilized drawdown in the well while pumping at a constant discharge. Specific capacity tests can be conducted immediately after well development, utilizing the pump used for the development. While less accurate than long-term multi-well pumping tests, the tests provide a fast and easy method to obtain data for estimating well capacity and aquifer hydraulic conductivity and transmissivity.

Step-drawdown tests are used to estimate well performance, determine a sustainable optimum pumping rate for the well, and estimate aquifer properties. The test is conducted by pumping the well at several successively higher rates and measuring the corresponding water level drawdown.

The constant rate pump test method involves discharging water at a constant rate from a well by pumping and monitoring the corresponding water level drawdown. The recovery of water levels in the well may also be monitored after pumping is terminated (recovery test). Water level monitoring during a pumping and recovery test commonly includes the pumping well and one or more nearby observation wells. In certain instances, observation wells are not available and water level monitoring is limited to the pumping well.

Cone of Depression - A depression in the groundwater table or potentiometric surface that has the shape of an inverted cone centered around a well from which water is being withdrawn.

Confined or Artesian Aquifer - An aquifer that is overlain and underlain by confining layers of lower hydraulic conductivity, where the total head of the aquifer is higher than the base of the upper confining layer. Artesian aquifers are a subset of confined aquifers where the total head elevation in the aquifer is higher than the ground surface elevation.

Drawdown - The difference between the static water level in a well or aquifer, and the water level during pumping or water withdrawal. In a confined aquifer, drawdown is the reduction of the pressure head due to pumping or water withdrawal.

Discharge - Volume of water removed per unit of time.

Electric Well Tape or Electric Tape - A water level measuring device that uses a light or sounds a buzzer to show that the end of the tape has entered the water. The water in the well completes an electric circuit that turns on the light or sounds a buzzer. The tape is graduated to allow direct readings of depth measurements, commonly to the nearest 0.01 foot.

Flow Regulator - Flow regulators (flow controllers) are used to control the discharge (in volume/time) of water from the well while pumping. The discharge is normally set at a constant rate to facilitate interpretation of the drawdown and recovery data.

Hydraulic Conductivity - A quantitative measure of the ability of a porous material to transmit a fluid. Also defined as the volume of fluid that will flow through a unit cross-sectional area of porous material per unit time under a unit hydraulic gradient. Hydraulic conductivity is dependent on properties of both the matrix material and fluid.

Measuring Point - A fixed and clearly identified point of reference from which water levels in a pumping or monitoring well may be measured. It is generally established on the upper rim of the outer protective well casing and has a surveyed location and elevation.

Observation Well - A non-pumping well used to observe the groundwater levels during a pumping test.

Potentiometric Surface - A hypothetical surface that represents the water pressure within a confined aquifer or hydrogeologic unit. It is analogous to the elevation to which water will rise in a tightly-cased well screened in the aquifer. In unconfined aquifers, it is equivalent to the water table.

Pressure Transducer and Data Logger - An electronic sensor and support hardware that can accurately measure and record hydrostatic pressure. By relating hydrostatic pressure to depth below the water level, changes in the water level can be electronically measured as the transducer responds to changes in water pressure. The data logger is connected to the pressure transducer and stores the output for later recall and data evaluation. The data logger and pressure transducer may be integrated into a single down-hole unit or the data logger may be deployed at a separate location (e.g., ground surface) and connected to the pressure transducer by a multi-wire cable or a telemetry system.

Recovery - The return of water levels or hydraulic heads toward pre-slug or pre-pumping static levels following slug insertion or withdrawal, or after cessation of pumping in a pumping test.

Saturated Thickness - For unconfined aquifers, the interval between the water table and base of the unconfined water bearing unit. For confined aquifers, the interval between the base of the upper confining unit and the top of the lower confining unit.

Slugging Rod - A solid metallic or polyvinyl chloride (PVC) rod (or cylinder) of known volume that is lowered into the well to displace the water during a slug test. Sometimes called a "pig".

Specific Capacity - Discharge per unit of drawdown in a pumping well.

Specific Yield - The volume of water that an unconfined aquifer will release under the influence of gravity, per unit surface area of aquifer per unit decline in the water table. Specific yield is dimensionless.

Storage Coefficient or Storativity - The volume of water that a confined aquifer releases from, or takes into storage per unit area of aquifer, per unit change in head. Storage coefficient is dimensionless. It should not be confused with specific storage, which is the volume of water that an aquifer releases from, or takes into storage per unit *volume* of aquifer, per unit change in head. Specific storage has units of 1/liter[L]. It should also not be confused with specific yield, which is the storage term for unconfined aquifers.

Transmissivity - A quantitative measure of the ability of an aquifer to transmit water. It is the product of the hydraulic conductivity and saturated thickness of the aquifer.

Unconfined Aquifer - An aquifer in which the water table forms the upper boundary.

Water Level - The position of the air-water interface in a well that is open to atmospheric pressure. The water level is usually measured as the depth to water from a measuring point (such as the top of the outer protective well casing) by the use of a weighted measuring tape or electric sounder. Changes in the water level over time may also be monitored by a pressure transducer installed at a known depth within the water column inside the well. The water level is called the static water level when it is not influenced by pumping or other disturbance, such as barometric pressure changes, well drilling activities, aquifer testing, well development, or groundwater sampling.

Water Table - The saturated zone surface at which the pore water pressure is equal to atmospheric pressure. The water table is the potentiometric surface for an unconfined aquifer.

Wellhead Flow Meter - A meter installed in the water discharge line near the well head to measure the discharge (in volume/time) of water by the mechanical pump, and as controlled by the flow regulator.

4. Procedure

This section contains responsibilities, requirements, and procedures for conducting aquifer testing, including slug, specific capacity, and pumping tests. All aquifer testing designs must consider:

- Known or expected site-specific conditions;
- Targeted parameters to be evaluated; and
- Methodology(ies) to be used to analyze the test data.

Consequently, the tests must be designed well before the project work plan is generated and implemented in the field. The project work plan will specify all necessary details to complete the aquifer testing at the particular site. Aquifer testing information and specifications to be included in the project work plan will include, at a minimum, the following:

- Objectives of the aquifer test;
- Aquifer parameters to be evaluated;
- Type(s) of aquifer test(s);
- Well(s) to be used;
- Equipment to be used;
- Slug size for slug tests and pumping rate(s) for pumping tests;
- For pumping tests, location of water discharge point and discharge permit information if a permit is required, or type of container if discharge water must be contained;
- Type, duration, and frequency of measurements; and
- Additional procedures or requirements beyond those covered in this SOP.

At a minimum, the requirements, responsibilities, and procedures described in the following section must be incorporated into the aquifer testing to be conducted at each site.

4.1 Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that aquifer testing activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance (QA) and quality control (QC). These responsibilities may be assigned to a Subcontractor Task Leader (STL).

The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of field generated documentation associated with this SOP. The SQAM is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of the project work plan and SOPs, variances to aquifer testing requirements, issuing nonconformances, etc.) if problems occur.

Field personnel assigned to aquifer testing activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the STL or the SQAM.

4.2 Aquifer Test Preparation

The setup procedures listed below are common to all types of aquifer testing.

Any newly installed wells used for testing or observation must be developed before testing begins (SOP 8.2). If testing will commence less than one week following well development, water levels should be measured daily, or if necessary, several times each day to make sure they have stabilized following well development.

Inspect the testing equipment to ensure that it is in good working order. The type and configuration of equipment will vary widely depending on the formation, other site conditions, the diameter and depth of the wells, and the number of the wells to be tested. The project work plan will outline the type of equipment to be used.

All measuring and testing equipment (M&TE) used for field activities should be calibrated by the equipment manufacturer or an approved calibration laboratory using standards which are traceable to the National Institute of Standards and Technology (NIST). Certificates of calibration for M&TE will be obtained from the M&TE supplier and kept in the project files. No M&TE will be utilized without verification of calibration certification.

Decontaminate all downhole equipment according to SOP No. 6.1. In the event that the contaminant histories of the wells to be tested are known or anticipated, the testing should be performed starting with the least contaminated well and ending with the most contaminated. This will reduce the potential for cross-contamination between wells.

Visually inspect and access the wellhead for each well involved in the test per SOP No. 5.1.

Obtain a water level depth measurement and sound the bottom of the well according to the procedures outlined in SOP No. 5.1. Compare the measured total depth to the bottom of the well with the well construction diagram to determine if sediment is in the bottom of the well. It is important not to set pressure transducers in the sediment.

Complete an aquifer test data field form (Attachment 6.1) for each well tested with as much of the following information as possible before the test starts, and the remainder as appropriate as the test proceeds. In multi-well tests, each observation well should have its own form.

1. Site Location: Brief description of general site location.

2. Well ID: Unique number assigned to each well.

3. Date: The date(s) when measurements are taken.

4. Distance from pumped well (feet): Distance to the observation well or piezometer from the pumping well in feet and tenths of feet.

5. Personnel: Initials of personnel performing field measurements or collecting samples.

6. Static Water Level: Depth to water, in tenths and hundredths of feet, in each observation well before pumping.

7. Test Start Date: The date when pumping began.

8. Test Start Time: Time in hours:minutes:seconds at which pumping began using 24-hour clock (e.g., 08:37:00 for 8:37 a.m.; 19:12:00 for 7:12 p.m.).

9. Test End Date: The date when pumping ends.

10. Test End Time: Time in hours:minutes:seconds at which pumping ended using 24-hour clock (e.g., 08:37:00 for 8:37 a.m.; 19:12:00 for 7:12 p.m.).

11. Average Pumping Rate: Time-weighted average of all entries recorded in the Pumping Rate Measurement Methods.

12. Type and serial number of instrument used to measure depth to water (this may include steel tape, electric sounding probes, Stevens recorders, or pressure transducers).

13. Comments: Appropriate observations or information for which no spaces are specifically provided.

14. Time: Record the time of water-level or flow-rate measurement in hours, minutes, and seconds, using a 24-hour clock.

15. Depth to Water: Depth to water, in tenths and hundredths of feet.

16. Pumping Rate: Flow rate of pumping well measured with an orifice, weir, flow meter, container, or other device.

17. Record time pump is stopped.

Procedures unique to each type of test are described below.

4.3 Slug Test Method

A slug test is an aquifer test in which the water level in a well is instantaneously changed by removing, adding, or displacing a known volume of water. The water level is monitored in the slugged well until it returns to its static level. The time required for this to occur is inversely proportional to aquifer transmissivity and hydraulic conductivity.

The well can be "slugged" by rapidly removing a known volume of water with a submersible pump or bailer, or potable water can be added rapidly to a well by directly dumping from barrels or tanks. However, the most common method used in environmental projects involves the insertion and/or removal of a solid slugging rod (or pig) which instantaneously displaces the water level inside the well.

During testing, water levels may be measured with an electric tape if the wells recover relatively slowly. In wells that recover rapidly, pressure transducers (with associated data loggers) are used, as they can rapidly record a large number of water level measurements. Many brands of transducer/data logger combinations are capable of pre-programmed rates of measurement to obtain frequent measurements during the initial portions of the test when water levels change relatively rapidly, and less frequent measurements near the end of the test as the water levels change relatively slowly.

The procedures described below are written for use with a slugging rod and pressure transducer/data logger during slug testing and apply to both slug insertion and slug withdrawal portions of the test. In certain instances only the slug withdrawal test data are used for analysis. However, it is advisable to still conduct the slug insertion test even if only using the withdrawal test data for evaluation of aquifer parameters. The slug insertion test results can provide information in the field to make necessary adjustments to the withdrawal test.

The procedures described below are readily adaptable for the other slug testing methods. The project work plan will outline specific slug testing methods and procedures to be used.

Perform procedures described under "Test Preparation."

Calculate the height of the water column in the well as follows:

$$(h_1 - h_2) = \text{height of water column in well}$$

where:

h_1 = total depth of well from top of casing (in feet)
h_2 = depth to water from top of casing (in feet)

The height of the water column should be sufficient to totally immerse the slugging rod and also allow concurrent use of a pressure transducer or other measuring equipment during the testing.

Connect the pressure transducer to the data logger. Install the pressure transducer in the water column to a depth that will not interfere with the insertion or withdrawal of the slugging rod during testing, but also will not exceed the maximum head limitation of the transducer.

Turn on the pressure transducer/data logger and set the recording frequency (the frequency that the recorder stores data measured from the transducer and displays a reading) for pre-test monitoring to that specified by the project work plan.

Check the calibration of the pressure transducer by raising or lowering it three feet within the water column and compare it with the readout on the data logger. The reading should correspond with the change in height of the transducer to the nearest 0.01 foot. Some error may be introduced if the transducer cable diameter is large relative to the well diameter, and aquifer transmissivity is low due to the water displacement of the cable. If the reading on the data logger does not correspond to the change in height of the transducer, it should be repaired or replaced.

If the pressure transducer is not vented (i.e., does not have barometric pressure compensating capability), and testing (recovery of water level) is expected to take longer than 30 minutes, obtain a barometric pressure measurement. Station barometric pressure may be recorded from on-site equipment or obtained from a local weather station.

Measure the water level with an electric tape (or equivalent) and record along with the measurement time. Commence pre-test monitoring with the pressure transducer/data logger. The total length of time over which the pre-test measurements are made will be specified in the project work plan. Ideally, the total time should be roughly equal to or greater than twice the length of time expected to run the slug test, but this may be reduced as specified in the work plan, depending on the degree of accuracy needed for the results.

Once the pre-test monitoring period is ended, re-measure the water level using the electric tape and record it, along with the measurement time. Record the length of the slug to the nearest 0.01 feet and the diameter as accurately as possible, preferably to the nearest 0.001 feet. If the slug is not cylindrical, measure the cross-sectional dimensions as accurately as possible so that the area can be determined.

Change the recording frequency on the data logger for the slug-in test, as specified in the project work plan. Lower the slugging rod to just above the static water level. Concurrently, start the data logger and lower the slugging rod as quickly and smoothly as possible to a depth below the static water level. Avoid dropping the slug and slapping it against the water surface and avoid jerking it to a stop. This will create shock waves that will affect the early test data. One method is to lower the slug gently until the water table is “felt”, then quickly and smoothly insert it to the full depth, which can be anticipated based on the known length of the slug. Record the time of initiation of the test on the appropriate form, as outlined in the project work plan.

After insertion, the slugging rod should be completely submerged. However, it is best to lower the rod only enough to make sure it is submerged, and not more. This will reduce the chance of pinching the transducer cables, dragging the transducer, or sticking the rod.

Continue to monitor water level decline with the pressure transducer/data logger, taking periodic water level measurements with the electric tape. Data logger and tape readings should be conducted in accordance with the schedule outlined in the project work plan.

The slug-in test may be terminated once the water level has recovered by more that 90 percent of its maximum displacement, or as specified in the project work plan. Once the slug-in test is terminated, take a physical water level measurement with the electric tape. Record the measurement and time on the appropriate form. Continue on to the slug withdrawal ("slug-out") test.

The slug withdrawal test should not be initiated until the water level has recovered, as defined above.

Re-measure the water level using the electric tape and record along with the time.

Change the recording frequency on the data logger to the appropriate frequency of data recording for the slug withdrawal test. The recording frequency will be specified in the project work plan but may be modified based upon a review of the slug-in test data. Concurrently with starting the data logger, immediately raise the slugging rod as quickly and smoothly as possible, so that the rod is completely out of the water column and above the static water level. Record the test initiation time on the appropriate form, as outlined in the project work plan.

Continue to monitor water level rise with the pressure transducer/data logger, taking periodic water level measurements with the electric tape. Data logger and tape readings should be conducted in accordance with the schedule outlined in the project work plan and/or based upon a review of the slug-in test data.

The slug-out test may be terminated once the water level has risen to within 90 percent of the pre-test static or as specified in the project work plan. Once the slug-out test is terminated, take a physical water level measurement with the electric tape. Record the measurement and time on the appropriate form.

The data should be reviewed in the field to help ensure the validity of the test. Complete all documentation on the appropriate form, as outlined in the project work plan.

The slug-in and slug-out tests may be repeated as necessary, and as required by the project work plan. If multiple wells will be tested, it is recommended to cut and remove the braided rope or line that has been submerged during testing of one well before moving on to another well. This practice will reduce the potential for cross-contamination between wells.

Once all tests are satisfactorily completed for the well, all down-hole equipment may be removed and decontaminated (SOP 6.1), and the wellhead secured.

4.4 Pumping Test Preparation and Startup

In addition to the steps listed in Section 4.2, the procedures listed below are common to all of the pumping tests.

Install the mechanical pump in the well using the manufacturer's instructions. Place the pump in the well so that the pump intake is just below the maximum allowable drawdown depth for the well, or at the top of the well screen if the maximum allowable drawdown is not specified. Note the height of the water column from the static water level to the pump motor housing and intake. Record all information on the appropriate form as specified by the project work plan. During testing, the drawdown should not be so great that water levels drop below the pump intake and cause the pump to cavitate.

Connect the flow meter and flow control valves to the pump discharge line at the wellhead. Connect a second discharge line to direct the pumped water to the receiving tank or surface discharge point specified in the work plan. Because in many cases a permit is required to discharge the water, any deviations from the work plan-specified location to discharge the water is not allowed. The discharge location will be far enough from the wellhead that no backflow or infiltration can occur that will influence the test results.

If a pressure transducer will be used to measure water levels, connect the pressure transducer to the data logger. Lower the pressure transducer inside the pumping well to a depth below the bottom of the anticipated drawdown. The transducer should be installed at a level that: 1) eliminates effects from the pump intake; 2) is below the anticipated water level during maximum drawdown; and 3) does not exceed the maximum transducer head limitation. In addition, the transducer must be secured inside the pumping well in such a manner that the transducer will not be affected by turbulence from the pump. Record the depth of the transducer.

Check the calibration of the pressure transducer by raising or lowering it three feet within the water column and compare the result with the readout on the data logger. The reading should correspond with the change in height of the transducer to the nearest 0.01 foot. Some error may be introduced if the transducer cable diameter is large relative to the well diameter and aquifer transmissivity is low due to the water displacement of the cable. If the reading on the data logger does not correspond to the change in height of the transducer, it should be repaired or replaced.

If the pressure transducer is not vented (i.e., does not have barometric pressure compensating capability), and testing (drawdown and recovery of water level) is expected to take longer than two hours, obtain a barometric pressure measurement at the beginning of the test and at regular intervals throughout the test. Station barometric pressure may be recorded from on-site equipment or obtained from a local weather station.

Immediately prior to turning on the pump, measure the water level in the well. Start the mechanical pump and adjust the valve or flow regulator to maintain a constant discharge specified by the project work plan, or as determined from the well development records (see SOP 8.2).

Once pumping starts, measure the water level decline with the electric well tape (or pressure transducer, if specified) as directed, at time intervals specified by the project work plan. Observe and record the wellhead flow meter readings at intervals specified by the project work plan. Record these measurements and the time on the appropriate form.

In addition to these steps, follow the procedures described below according to the type of test.

4.5 Specific Capacity Testing

Specific capacity tests are short-term single-well aquifer tests that are useful in highly transmissive units, which preclude slug testing. The method consists of measuring the stabilized drawdown in the well while pumping at a uniform rate. The tests may be conducted in monitoring, extraction, and injection wells. Specific capacity tests can be conducted at the end of well development, using the pump utilized for development. While less accurate than long-term multiple well pumping tests, specific capacity tests provide fast and easy to interpret data for estimating hydraulic conductivity and transmissivity in the immediate vicinity of the well being tested.

Perform procedures described under "Aquifer Test Preparation", Section 4.2. If specific capacity testing is to be conducted immediately after development using the same equipment, and the equipment has not been removed from the well site, then the equipment may not have to be decontaminated for the testing.

Perform the procedures described under "Pumping Test Preparation and Startup", Section 4.4. It is advisable that the discharge rate be sufficient to maintain a stabilized sustainable drawdown of at least 10 percent of the total available drawdown (distance between static water level and pump intake). Record the time of the start of the specific capacity test on forms specified in the project work plan.

The project work plan will specify the criteria for stabilization of water levels during drawdown, length of time to continue pumping after stability is achieved, and water level measurement frequency. Continue pumping and measuring until these criteria are satisfied.

Once the specified time period has elapsed, take a physical water level measurement with the electric tape and shut the pump down. Record the measurement and time on the appropriate form.

The data should be reviewed in the field as the test proceeds to ensure that valid data are being collected. This includes verification that discharge is being maintained at a constant rate, and that the drawdown stabilization criteria designated in the work plan have been met. Complete all documentation on the appropriate form, as outlined in the work plan.

The specific capacity tests may be repeated as necessary, and as required by the project work plan.

When testing is completed, remove and decontaminate the equipment, and secure the wellhead.

4.6 Aquifer Pumping Test Methods

The pumping test methods covered in this section include step-drawdown tests and constant rate pumping tests. A step-drawdown test is conducted for the pumping well and is recommended prior to initiation of any constant rate pump test. The data provided by the step drawdown test is used to evaluate well performance and determine the optimum discharge for the subsequent constant rate test.

A step drawdown test entails pumping a well for three or more intervals of equal duration at successively higher rates and recording water level drawdown. The duration of the intervals or "steps" is determined by the time required for drawdown to stabilize. Step drawdown tests are only performed on the pumping well, and recovery data is not collected.

A constant rate pumping test involves pumping the well at single, constant rate for a much longer period that a step-drawdown test. Water levels are monitored during both the drawdown and recovery phases. Water level monitoring may be limited to the pumping well (single well pumping test) or include one or more nearby observation wells (multiple well pumping test). The multiple well test utilizes one or more observation wells at selected distances and locations relative to the pumping well. Water levels are monitored in both the pumping and observation wells throughout the duration of the test.

The remaining discussion provides the requirements and procedures for step-drawdown tests and single and multiple well constant rate pumping tests. These represent minimum requirements. Additional site- and project-specific information will be specified in the project work plan.

The procedures below incorporate the use of pressure transducers/data loggers to monitor water levels during the pump testing. However, other water level measurement techniques may be substituted, and the procedures may be modified as appropriate in the project work plan.

4.7 Step-Drawdown Testing

Step-drawdown testing should be conducted before other pumping tests. All newly installed wells should be developed before conducting step-drawdown tests.

Perform procedures described under "Aquifer Test Preparation" (Section 4.2). If specific capacity testing is to be conducted immediately after development using the same equipment, and the equipment has not been removed from the well site, then the equipment may not have to be decontaminated for the testing.

Perform the procedures described under "Pumping Test Preparation and Startup", Section 4.4.

Turn on the pressure transducer/data logger, set the recording frequency for pre-test monitoring to that specified by the project work plan. (Data loggers should be placed in a secure location to prevent tampering.)

Physically measure the water level with the electric tape and record along with the time. Commence pre-test monitoring with the pressure transducer/data logger. The total length of time over which the pre-test measurements are made will be provided in the project work plan. Generally, water levels are recorded for a period before the step-drawdown test that is at least twice as long as the time expected for the step-drawdown test and the recovery period. Record the information, including times of measurements, on the appropriate form as specified by the project work plan.

Once the pre-test monitoring period is ended, re-measure the water level using the electric tape and record along with the time.

Change the recording frequency on the data logger to the appropriate frequency of step-drawdown data entry, as required by the project work plan. Begin recording water level measurements with pressure transducer/data logger, as required by the project work plan for the initial pumping phase of the step-drawdown test. Start the mechanical pump and adjust the valve or flow regulator to maintain the constant rate of discharge specified by the project-specific work plan. This rate will be the first step in the step-drawdown test. Record the time of the start of the step-drawdown test as specified in the project work plan.

Continue to monitor water level decline during the first step with the pressure transducer/data logger, taking periodic water level measurements with the electric tape. Data logger and tape readings should be conducted in accordance with the schedule outlined in the project work plan. As the first step continues, review the water level data and, if necessary, adjust the recording frequency of the data logger. Observe and record the wellhead flow meter readings as required by the project work plan.

Continue pumping and recording water levels and flow meter readings in the first step as long as required by the project work plan.

Once the first step is ended, measure the water level with the electric tape and record depth and time. Adjust the data logger as necessary (based upon review of data from the first step) or as specified in the project work plan for commencement of the second step of the test.

Without turning the mechanical pump off, initiate the second step of the test by changing the pumping rate with the valve or flow regulator to the rate specified by the project work plan.

Monitor the water levels and flow meter readings and continue the second step as described above.

Repeat the cycles of changing pumping rate and recording depth of water as often as is required (for each step of the step-drawdown test) by the project work plan and as described above.

Once the last step is completed, reset the data logger, if required, for the recovery period measurement duration and frequency, as specified in the project work plan. Obtain a water level measurement with the electric well tape and record the measurement and time. Shut down the mechanical pump. Record the time (to the nearest 10 seconds) that the pump was shut down on the appropriate form.

Continue to measure and record the water level recovery with the pressure transducer/data logger as long as is required by the project work plan or until the water level has recovered to within 90 percent of the level expected from the pretest trends. Also, continue to take physical water level measurements periodically during recovery. Once the recovery period is ended, take a physical water level measurement at the end of the test. Record the measurement and time on the appropriate form.

The data should be reviewed in the field to help ensure the validity of the test. The field data review may also be used to determine the discharge rate to be used during the subsequent single or multiple well pump testing. Complete all documentation on the appropriate form as outlined in the project work plan.

Once the step-drawdown test is satisfactorily completed for the well, the equipment may be left in the well for subsequent single or multiple well pump testing. If the subsequent testing will not be conducted, then all down-hole equipment may be removed and the wellhead secured.

4.8 Single and Multiple Well Constant Rate Pump Testing

The procedures in this section are written as if a multiple well pumping test is being conducted. However, these procedures are directly applicable to single well testing. The only difference is that testing and measuring equipment are installed only in the pumping well, and water level measurements are also only collected from this well. Cabled transducers and data loggers are described in the procedures outlined below. If integrated transducer/logger units are deployed, cable related procedures for connecting these devises do not apply.

Perform procedures described under "Aquifer Test Preparation", Section 4.2. If specific capacity testing is to be conducted immediately after development using the same equipment, and the equipment has not been removed from the well site, then the equipment may not have to be decontaminated for the testing.

Perform the procedures described under "Pumping Test Preparation and Startup", Section 4.4.

If a multiple well test is being conducted, connect the pressure transducers to their respective data loggers. Install the transducers inside the observation wells at this time. The transducers should be installed at a position inside each well that is below the anticipated water level during maximum drawdown and does not exceed the maximum head limitation. Set up another pressure transducer in an outlying well (outside of the suspected influence of the pumping well) to record station barometric effects, if required. If not already installed from the step-drawdown test, set the pressure transducer inside the pumping well as described in Section 4.4. Record the depth(s) of the transducer(s).

If any transducer cables are run across traffic areas, they must be appropriately protected. Data loggers should also be placed in a secure location to prevent tampering.

Turn on the pressure transducers/data loggers, set the recording frequencies for pre-test monitoring to that specified by the project work plan. It is also important before initiating pre-test monitoring for the pumping test to ensure that water levels from any previous step-drawdown testing have completely recovered.

Physically measure the water levels in the pumping and observation wells with the electric tape and record along with the time. Separate data sheets should be used for each well.

Commence pre-test monitoring with the pressure transducers/data loggers. The total length of time over which the pre-test measurements are made will be provided in the project work plan. Generally, water levels are recorded for a period before the pumping test that is at least as long as the time expected for the pumping and recovery period. Record the information, including times of measurements, on the appropriate form as specified by the project work plan.

Once the pre-test monitoring period is ended, re-measure the water levels in the wells using the electric tape and record along with time.

Change the recording frequencies in the data loggers for the pumping test as required by the project work plan. Just before starting the pump, begin recording the pressure transducer measurements.

Start the mechanical pump and adjust the valve or flow regulator to maintain a constant rate of discharge as determined from the step-drawdown test and/or specified by the project work plan. Record pump start time on the appropriate form.

Continue to monitor water levels during pumping with the pressure transducers/data loggers, taking periodic water level measurements in each of the wells with the electric tape. Data logger and tape readings should be conducted in accordance with the schedule outlined in the project work plan. However, the water level data should be evaluated during the test and, if necessary, the recording frequencies of the data loggers adjusted.

Observe and record the wellhead flow meter readings as required by the project work plan.

The project hydrogeologist or designee will determine the time that the mechanical pump should be shut down as specified in the project work plan and/or based on review of field generated drawdown versus time plots from the pumping and observation wells.

Once the pumping phase is completed, re-set the data loggers, if required, for the recovery period recording duration and frequencies as specified in the project work plan. Obtain a water level measurement in each of the wells with the electric well tape and record the measurements and times. Shut down the mechanical pump. Record the time (to the nearest 10 seconds) that the pump was shut down on the appropriate form.

Continue to record the water level recovery in the wells with the pressure transducers/data loggers as long as is required by the project work plan or until the water levels have recovered to within 90 percent of the level expected from the pretest trends. Also, continue to take physical water level measurements periodically during recovery. Once the recovery period is ended, take a physical water level measurement in each well at the end of the test. Enter the measurements and times on the appropriate form.

The project work plan may require additional depth to water measurements to be physically taken following complete well recovery in order to monitor post test trends in water level. The project work plan will specify the frequency of measurements, and the length of time that the measurements must be taken.

The data should be reviewed in the field to help ensure the validity of the test. Complete all documentation on the appropriate form as outlined in the project work plan.

Once the pump test is satisfactorily completed for the wells, all downhole equipment may be removed, and the wellheads secured.

5. Records

Records generated as a result of this SOP will be maintained in the project records file in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Aquifer Test Data Form

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the CQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

AQUIFER TEST DATA FORM

Aquifer Test Data Form

Date _____

Test Conducted by: _____ Page _____ of _____

Project _____ Well ID _____ Data Logger No. _____ Personnel _____

Location _____ Measuring Point Elevation _____

How Q Measured _____ Pumping, Recovery or Slug Data _____

How WLs Measured _____ Pumping Well Radius _____

Pump on: date _____ time _____ Depth of Pump _____

Pump off: date _____ time _____ Duration of Aquifer Test _____

Perforated Interval _____ Formation _____

Type of Aquifer Test _____ Distance to Observation Well _____

Disposition of Extracted Water _____

Clock Time	Elapsed Time	Depth to Water (ft)	Q (- = gpm, + = gal)					Comments

DATA LOGGING AND TRANSDUCERS

STANDARD OPERATING PROCEDURE 11.2

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for data logging and its uses as well as installation, removal, and maintenance procedures for the pressure transducers placed in groundwater monitoring wells for measuring and recording groundwater levels. This procedure applies to all personnel authorized to operate or maintain the water level recording pressure transducers or assist with these tasks. Additional specific procedures and requirements will be provided in project work plans.

2. References

SOP 1.1 - Sample Custody

SOP 1.2 - Field Activity Daily Report

SOP 1.3 - Field Measurements, Maintenance, and Calibration of Instruments

SOP 5.1 - Water Level Measurements in Monitoring Wells

SOP 6.1 - Sampling Equipment and Well Material Decontamination

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Data Logging - Data logging utilizes an electronic device (data logger) that records data over time or in relation to location, either with a built in instrument, a sensor, or via external instruments and sensors.

Gauged Pressure Transducer - Gauged pressure transducers have pressure sensors that compensate for atmospheric pressure. One side of the pressure sensor diaphragm is vented to the atmosphere, thus compensating for changes in atmospheric pressure and measuring water pressure only (pounds per square inch gauged or psig). Using these transducers, calculations of water depth above the transducer exclude atmospheric pressure considerations. These transducers use a tube in the cabling to vent the transducer to the atmosphere and are used in shallow monitoring wells and single-completion deep monitoring wells. All pressure transducers currently dedicated to the Laboratory for Energy-related Health Research/Old Campus Landfill (LEHR/OCL) Project are gauged.

Absolute Pressure Transducer - Absolute pressure transducers measure absolute pressure (pounds per square inch absolute, psia) and are not compensated for atmospheric pressure. Pressure measurements from this type of transducer include atmospheric pressure as a component; therefore, atmospheric pressure must be subtracted from the absolute measurement to determine the pressure from water.

4. Procedure

4.1 Application

Data loggers vary between general purpose types for a range of measurement applications to dedicated devices for measuring a few parameters in a single environment or application. The LEHR/OCL Project utilizes data logger units connected to Pressure Transducers (Pressure Data Loggers) to provide a continuous record of the rise, fall, and gradient of the groundwater surface in specific areas of the site over a given period of time. Pressure Data Loggers were also used to monitor drawdown performance at groundwater extraction system wells and measure aquifer response during hydraulic tests. While data can be transmitted remotely using wireless technology, Pressure Data Logger applications at the LEHR/OCL Project currently rely on data downloads at the wellhead using a portable laptop computer and USB connection. If a Pressure Data Logger application requiring frequent downloads and prolonged data collection becomes necessary, remote transmission would be implemented at wells that are not located in roadways.

4.2 Pressure Data Logger Operation

Review appropriate sections of the Site Safety Plan prior to starting any work. If unfamiliar with Pressure Data Logger operation, review the operator's manual and learn the software interface before performing field applications. Check the battery and data storage levels before deployment and at each data download to avoid data collection failure. Plan the acquisition rate such that data are sufficiently continuous while ensuring the memory does not become full between downloads and cause logger shutdown or data overwrite. When downloading, save a copy of the file on a separate memory device from the computer so that any mistakes do not delete the only copy of a logger file. Clear the logger memory when necessary to provide space for further acquisition.

Before deployment, verify that the Pressure Data Logger is operating properly. Test the Pressure Data Logger using a container of water (e.g., sink or bucket of water) and an engineering tape measure to move the transducer either deeper or shallower by a known distance. If the Pressure Data Logger is unresponsive or gives an erratic signal, attempt to troubleshoot obvious causes such as bad connections, low battery, or full memory. Call the manufacturer technical support line for troubleshooting assistance if needed. Ship the Pressure Data Logger to the manufacturer for maintenance if unable to correct performance issues. Pressure Data Loggers are calibrated by the manufacturer prior to delivery and when manufacturer maintenance is performed. In-house attempts to calibrate a Pressure Data Logger will likely void its warranty.

If possible, store an additional Pressure Data Logger in the field office for timely replacement in case of malfunctions. Locate the monitoring wells where the pressure transducers will be deployed and identify the appropriate decontamination areas. Decontaminate the Pressure Data Logger and cable (SOP 6.1). Measure the water level in the well before installation with a manual water level

meter to verify the pressure transducer placement depth (SOP 5.1). Record manual water level measurements on the water level form (SOP 5.1). Lower the transducer gently to approximately the desired depth. Position the instrument below the lowest anticipated water level, but not so low that its range might be exceeded at the highest anticipated level. Anchor the cable to the well cap, connect the cable end to the computer via the USB cable connector, and start the log according to manufacturer's instructions. After starting the log and disconnecting the computer, connect a desiccant tube to the top end of the cable if the transducer is gauged to prevent water blockage in the vent tube. Neatly coil the excess cable in the well vault without pinching the cable. A pinched cable will block the vent tube.

If groundwater elevation relative to mean sea level will be calculated, collect a manual water level measurement at least one day after transducer installation to allow the water level to recover to the formation's potentiometric surface after water displacement. Waiting for recovery is especially necessary when a dedicated pump must be removed to place the transducer below the pump level. For accuracy, manual water level measurements must be taken relative to the land surveyor's mark on the well casing or pump cap.

When performing a Pressure Data Logger download at a well, collect and record a manual water level measurement on the water level data sheet (Attachment 6.1) before the download. Do not disturb the Pressure Data Logger or dedicated pump before the manual water level measurement is complete so that an undisturbed measurement of the formation's potentiometric surface is obtained while the logger is acquiring data. Connect the computer to the cable as described above and download the data according to manufacturer's instructions. Check the desiccant tube while the data are downloading and replace the desiccant if spent. Re-attach the desiccant tube when download is complete.

4.3 Responsibilities

It is the responsibility of the personnel involved with the water level data logging activity to follow these general procedures. The Subcontractor Project Manager (SPM) has final responsibility to make sure that staff are aware of and follow this SOP. This SOP should be included in the project instructions/kick-off meeting and/or all work that includes water level data logging. The SPM may assign these responsibilities to a Subcontractor Task Leader STL.

5. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files, in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Water Level Data Sheet

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the Subcontractor Quality Assurance Manager, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

WATER LEVEL DATA SHEET

Water Level Data Sheet
Before Transducer Download
UC Davis LEHR

Wells		Measuring Point (ft msl)	Depth to Water (feet, TOC). Meter serial #	Depth to Water (feet, TOC). Measure to	IF DRY note depth DRY @__ft	Date	Time	Tech Name (initials)	Comments
HSU-1									

\\weissfs02\CLIENTS\UCDavis\LEHR\1.6_Project_Plans\1.6.2_QAPP\QAPP_2018\RevB\SOP_Admin_Outbox\SOP 11.2 Data Logging and Transducers\SOP 11.2 Attachment 6.1 Water Level Data Sheet_Rev B

Water Level Data Sheet
Before Transducer Download
UC Davis LEHR

Wells		Measuring Point (ft msl)	Depth to Water (feet, TOC). Meter serial #	Depth to Water (feet, TOC). Measure to	IF DRY note depth DRY @ __ft	Date	Time	Tech Name (initials)	Comments
HSU-2									
HSU-4									

HOLLOW STEM AUGER DRILLING

STANDARD OPERATING PROCEDURE 14.1

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for field personnel to use during the supervision of drilling operations involving hollow stem auger techniques. Additional specific hollow stem auger drilling procedures and requirements will be provided in the project work plans.

2. References

ASTM Standard D6151 – 08, 1997, Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling, Subcommittee; D18-02.

SOP 1.1 - Sample Custody

SOP 1.2 - Field Activity Daily Log

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 3.2 - Subsurface Soil Sampling While Drilling

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 6.2 – Drilling, Development, and Heavy Equipment Decontamination

SOP 8.1 - Monitoring Well Installation

SOP 8.3 - Borehole and Well Abandonment

SOP 10.1 - Soil Organic Vapor Sampling

SOP 9.2 - Grab Groundwater Sampling

SOP 15.1 – Borehole Lithologic Logging

SOP 23.1 - Land Surveying

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Hollow Stem Auger Drilling - A drilling method using rotating auger flights (typically in 5-foot joints) with a bit on the bottom of the lead flight (sometimes called the "lead auger"). The flights consist of a hollow pipe and an outer spiral plate, which when rotated, forces soil cuttings upward along the borehole wall to the surface. The auger string is advanced by rotation, with pressure exerted by the rig, forcing the bit to cut the soil at the bottom and direct cuttings to the augers.

A retractable plug with a pilot bit is placed at the bottom of the auger string to prevent cuttings from entering the hollow stem. When the plug is retracted, a sampler may be sent through the hollow center to sample soil at the bottom of the borehole without requiring the augers to be removed. A wireline sampler may also be attached to the inside of the lead auger for coring as the borehole is advanced.

This method is commonly used for drilling and sampling of soil borings, collection of soil gas and screening-level water samples, and installation of some smaller diameter wells. The well casing string may be placed through the hollow stem.

The hollow stem auger drilling method has advantages over other drilling techniques in certain circumstances, and disadvantages in others. This method is highly suitable for unconsolidated and consolidated fine-grained soils. It is easy to detect and measure water level during drilling. Hollow-stem auger drilling can achieve the most rapid rates of penetration in soft sticky clay-dominated soils. However, coarse and consolidated gravels and hard bedrock may be too dense for adequate drill penetration. Soil cuttings are typically disaggregated and remolded, making bedding, fabric, and soil property determination difficult. The augers are likely to smear clays on the borehole wall, interfering with the flow of groundwater to the monitoring well.

The most reliable method for logging of soils during hollow stem auger drilling is collecting relatively intact samples through the hollow stem. An advantage of the hollow stem auger method is that soil samples can be readily obtained from the bottom of the hole without requiring the removal or pull back of the auger string (unlike air or mud rotary methods).

This drilling method may be used to install monitoring wells (limited by diameter), as there is good depth control, and the auger can be progressively pulled as well construction materials are added to the borehole. The methodology may also be used to drill out monitoring wells for destruction.

Another advantage of the hollow stem auger method is that air or mud are not required as circulating media. Therefore, there is limited potential for flushing of soil samples collected for chemical analyses and a reduction in volumes of investigated derived wastes requiring costly handling and management procedures. Auger-type rigs can be significantly smaller than other types of rigs, making them the most suitable for some jobs with significant space constraints, including overhead clearance.

Additional disadvantages of the hollow stem auger method include depth limitations of 100 to 250 feet (may be less depending on soil conditions). Hard soil horizons or very coarse gravel (cobbles and boulders) may be impenetrable with this method.

4. Procedure

This section contains responsibilities, procedures, and requirements for hollow stem auger drilling. The selection and implementation of hollow stem auger drilling techniques must incorporate site specific conditions and requirements. Consequently, the project work plans will identify the following:

- The purpose of each borehole (e.g., monitoring well installation, soil sampling, well abandonment, well destruction, etc.);
- Specific methodology for drilling, including equipment and cuttings/fluid containment;
- Specific locations, depths, and diameters of boreholes;
- Objectives and types of sampling and/or logging of borehole;
- Details of mobilization/demobilization and decontamination of equipment;
- Appropriate health and safety guidelines and personnel protective equipment; and
- Additional procedures or requirements beyond those covered in this SOP.

4.1 Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that all hollow stem auger drilling activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC). These responsibilities may be assigned to a Subcontractor Task Leader (STL)

The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of field generated documentation associated with this SOP. The SQAM is also responsible for the implementation of corrective action (e.g., retraining personnel, additional review of work plans, protocols, and SOPs, variances to hollow stem auger drilling requirements, issuing nonconformances, etc.) if problems occur.

Field personnel assigned to hollow stem auger drilling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the STL or the SQAM.

4.2 Rig Decontamination and Preparation

All drilling and sampling equipment should be decontaminated before drilling, per SOPs 6.2 and 6.1 and the project work plans.

The driller and rig geologist/engineer should inspect the drilling equipment for proper maintenance and appropriate decontamination prior to each time the rig is mobilized to a site. All clutches, brakes, and drive heads should be in proper working order. All cables and hydraulic hoses should be in good condition. All auger joints and bits should also be in good condition (e.g., no cracked or bent blades, bits are not excessively worn, etc.).

Any observed leakage of fluids from the rig should be immediately repaired and the rig decontaminated again before it is allowed to remobilize.

4.3 Site Preparation

The logistics of drilling, logging, sampling, cuttings/fluid containment, and/or well construction should be determined before mobilizing. The site should be prepared as per the project work plans.

Before mobilization, the STL and/or the rig geologist/engineer should assess the drilling site with the driller. This assessment should identify potential hazards (slip/trip/fall, overhead power lines, etc.), and determine how drilling operations may impact the environment (dust, debris, noise). Potential hazards should be evaluated and corrected, or the borehole location changed or shifted, as per the project work plans.

The STL or appropriate designee should ensure that all identifiable underground utilities around the drilling location have been marked, and the borehole location appropriately cleared per the project work plans and SOP 23.1. At a minimum, copies of the site clearance documents should be kept on-site.

4.4 Mobilization and Set-Up

Once the site is prepared, the rig is mobilized to the site and located over the borehole location. The rig is leveled with a set of hydraulic jacks attached to the front and rear of the rig. Wood jack blocks/pads should be placed on the ground surface under the leveling jacks. The driller should always raise the mast slowly and carefully to prevent tipping or damaging the rig and avoiding obstructions or hazards.

Appropriate barriers, delineators, and signs should be in place prior to drilling, per the site health and safety plan. Visqueen (plastic) may be required beneath the rig.

Appropriate cuttings and other investigation-derived waste containment should be set onsite prior to the start of drilling.

4.5 Health and Safety Requirements

Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan. All Contractor and subcontractor personnel at the site should have appropriate training and qualifications as per the health and safety plan.

During drilling, all personnel within the exclusion zone should pay close attention to rig operations. The rotating auger blades can snag or catch loose clothing, causing serious injury or death.

Establishing clear communication signals with the drilling crew is mandatory, since verbal communication may not be heard during the drilling process. The entire crew should be made aware to inform the rig geologist/engineer of any unforeseen hazard, or when anyone is approaching the exclusion zone.

4.6 Breaking Ground

Prior to the commencement of drilling, all safety sampling and monitoring equipment will be appropriately calibrated per the project work plans.

The rig geologist/engineer should inform the driller of the appropriate equipment (e.g., cookie cutter, etc.) to be used for penetration of the surface cover (e.g., asphalt, concrete, cement, etc.). In the event of breaking ground where a shallow subsurface hazard may exist (unidentifiable utility, trapped vapors, etc.), the driller should be informed of the potential hazard and drilling should commence slowly to allow continuous visual inspection and/or monitoring and, if necessary, stop for probing. Once the ground surface is exposed, the driller will hand auger to a depth of 5 feet or more to clear the location of shallow utility lines. Hand auger in various directions until it is confirmed that the location is clear of shallow utility lines.

4.7 Borehole Drilling

During drilling operations, and as the borehole is advanced, the rig geologist/engineer will generally:

- Observe and monitor rig operations;
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance;
- Prepare a lithologic log from soil samples or cuttings;
- Supervise the collection of, and prepare soil, soil vapor, and groundwater samples; and
- As drilling progresses the rig geologist/engineer should observe and be in frequent communication with the driller regarding drilling conditions. This includes relative rates of penetration (indicative of fast or slow drilling) and

chattering or bucking of the rig. These conditions, including the relative drilling rate, should be recorded on the boring log, per SOP 15.1. Drilling should not be allowed to progress faster than the rig geologist/engineer can adequately observe conditions, compile boring logs, and supervise safety and sampling activities.

The rig geologist/engineer should also observe the rig operations, including the make-up and tightening of connections as additional auger joints are added to the auger string. Any observed problems, including significant down time, and their causes are recorded on the Field Activity Daily Log (FADL) (SOP 1.2).

Cuttings and fluids containment during drilling should be observed and supervised by the rig geologist/engineer, per specifications in the project work plans.

The rig geologist/engineer will oversee or conduct appropriate health and safety sampling and monitoring. If any potentially unsafe conditions are evident from the above drilling observations and the health and safety sampling and monitoring, the rig geologist/engineer may suspend drilling operations at any time and take appropriate actions, per the health and safety plan. In the event suspension of drilling activities occur:

- The STL must be informed of the situation;
- Appropriate corrective action must be implemented before drilling may be continued; and
- The observed problem, suspension, and corrective action are entered on the FADL.

During drilling, the rig geologist/engineer will compile a boring log as per SOP 15.1. The log will be compiled, preferably from soil samples recovered while drilling, as directed in the project work plans. Observations of drilling conditions are also entered on the log, as discussed above and in SOP 15.1. If total depth was reached prematurely due to refusal, the cause of refusal should be noted on the boring log and the FADL.

Subsurface soil samples may be collected with a split spoon sampler or Shelby tube during drilling, per SOP 3.2. The sampling will be supervised by the rig geologist/engineer. Soil samples (drive samples) can be readily obtained at discrete intervals with these methods.

Soil organic vapor (SOV) sampling may be conducted at discrete intervals during hollow stem auger drilling. This is done by stopping at the desired depth and driving a sample probe through the hollow stem into the soil ahead of the bit and then collecting a vapor sample. The sampling should be supervised by the rig geologist/engineer following procedures in SOP 10.1.

Groundwater screening (grab) samples can be obtained at discrete intervals during drilling. One method is to auger to the bottom of the selected interval or zone and pull the auger back to the top of the interval, allowing groundwater through the open borehole. A water sample is then collected with a bailer run through the inside of the augers. Another method is to stop the augers at a selected interval or zone and advance a hydropunch sampler beyond the lead auger to retrieve a water sample. The groundwater screening sampling procedures should follow those described in SOP 9.2.

Borehole Abandonment: If the borehole is to be abandoned once drilling is completed, the abandonment will follow procedures outlined in SOP 8.3. The abandonment will be supervised by the rig geologist/engineer.

Monitoring Well Completion: If a monitoring well is to be installed in the borehole, the well completion will follow procedures outlined in SOP 8.1. The well installation activities will be supervised by the rig geologist/engineer.

4.8 Demobilization/Site Restoration

After drilling, sampling, well installation, or borehole abandonment is completed, the hollow stem rig is rigged down and removed from the borehole location. The demobilization/site restoration will be supervised by the rig geologist/engineer or appropriate designee.

All debris generated by the drilling operation will be appropriately disposed of.

The site should be cleaned (ground washed if necessary) and surface conditions restored, per the project work plans.

All abandoned borings should be topped off and completed, per the project work plans. All monitoring wells will also have their surface completions finished, per the project work plans.

Any remaining hazards as a result of drilling activities will be identified, and appropriate barriers and markers put in place, per the health and safety plan.

All soil cuttings and fluids will be properly contained, clearly labeled, and maintained, per the project work plans.

The STL or appropriate designee should inspect the site to make sure that post-drilling site conditions are in compliance with the project work plans.

5. Records

Records generated as a result of implementation of this SOP will be maintained in the Project Records file, in accordance with SQP 4.2 – Records Management. Well logs shall be drafted according to SOP 15.1, reviewed by a Professional Geologist, and submitted to any regulatory agencies in accordance with the borehole permit or other project requirements.

6. Attachments

None.

DIRECT PUSH TECHNOLOGY

STANDARD OPERATING PROCEDURE 14.5

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for field personnel to use during the supervision of drilling operations involving direct push technology. The details within this SOP should also be used in conjunction with project work plans.

2. References

United States Environmental Protection Agency (EPA), 1997. *Expedited Site Assessment Tools For Underground Storage Tank Sites: A Guide for Regulators*, EPA 510-B-97-001 – Released by the Office of Underground Storage Tanks.

EPA, 2005. *Groundwater Sampling and Monitoring with Direct Push Technologies*, OSWER No. 9200.1-51, EPA 540/R-04/005, August.

SOP 1.1 – Sample Custody

SOP 1.2 – Field Activity Daily Log

SOP 2.1 – Sample Handling, Packaging, and Shipping

SOP 3.2 – Subsurface Soil Sampling While Drilling

SOP 6.1 – Sampling Equipment and Well Material Decontamination

SOP 6.2 – Drilling, Development, and Heavy Equipment Decontamination

SOP 8.3 – Borehole and Well Abandonment

SOP 10.1 – Soil Organic Vapor Sampling

SOP 15.1 – Lithologic Logging

Standard Quality Procedure (SQP) 4.2 – Records Management

3. Definitions

Direct Push Technology - Direct Push Technology (DPT, also known as “direct drive,” “drive point,” or “push technology”) refers to a growing family of tools used for performing

subsurface investigations by driving, pushing, and/or vibrating small-diameter hollow steel rods into the ground. By attaching sampling tools to the end of the steel rods, they can be used to collect soil, soil-gas, and groundwater samples. Direct push technologies are a valuable tool for environmental and geotechnical investigations because they offer a number of advantages over conventional well installation, drilling boreholes, and sampling methods, and provide many other types of data (e.g., *in situ* detection of contaminants and real-time geotechnical data).

Some of the typical advantages of using DPT are:

- Faster sampling capability;
- In general, lower cost when greater data density is needed;
- The versatility of DPT units can be mounted on trucks, trailers, tracks, tractors or skid steers, as well as portable or floating platforms. This variety of platforms offers the ability to sample areas previously considered inaccessible, including the inside of buildings;
- Generates less investigation-derived waste during sampling and minimizes the potential for exposure to hazardous substances;
- Creation of small diameter boreholes to minimize surface and subsurface disturbance;
- Capability of diagonal drilling; and
- Capability of collecting depth-discrete groundwater samples to locate contaminated zones.

Some of the disadvantages of using DPT are:

- In some geologic and hydrogeologic settings, may have limited penetration depths (e.g., some caliches, bedrock, or unconsolidated layers with significant amounts of gravel or cobbles);
- Will have shallower depth limit than other drilling methods; and
- Smaller sample volume compared with other conventional drilling methods.

4. Procedure

This section contains responsibilities, requirements, and procedures for DPT. The selection and implementation of DPT techniques must incorporate site-specific conditions and requirements. Consequently, project work plans will identify the following:

- Testing and sampling objectives;
- The purpose of each borehole (e.g., monitoring well installation, groundwater sampling, coring or soil sampling, etc.);
- Locations and depths of DPT sampling points;
- Numbers and volumes of soil or ground water samples to be collected;

- Types of chemical analyses to be conducted for the samples;
- Specific quality control (QC) procedures and sampling required;
- Details of mobilization/demobilization and decontamination of equipment; and
- Specific procedures to be performed in addition to those covered in this SOP.

At a minimum, the procedures outlined below for DPT will be followed.

4.1 Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that all DPT activities are conducted and documented in accordance with this and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC). The SPM may assign these responsibilities to a Subcontractor Task Leader (STL).

The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of field activities and documentation associated with this SOP. The SQAM is also responsible for the implementation of corrective action (e.g., retraining personnel, additional review of work plans and SOPs, generation of variances to Cone Penetrometer Testing (CPT) and sampling requirements, issuing nonconformances, etc.) if problems occur.

Field personnel assigned to DPT and sample collection activities are responsible for completing their tasks in accordance with this and other applicable procedures. All staff are responsible for reporting deviations from applicable procedures to the STL or SQAM.

4.2 Preparation Procedures

Prior to the start of DPT activities, ensure that all DPT locations have been appropriately cleared of all identifiable and suspected underground utilities and buried objects, per the project work plans. Review all forms and diagrams documenting the location of the cleared DPT locations, as well as that of any underground utility lines or other buried objects. At a minimum, copies of the site clearance documents should be kept onsite in a common accessible location.

Perform a specific calibration of air monitoring equipment required for air space monitoring according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s), as specified in the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged, and the project manager will be notified.

Don the appropriate personal protective equipment specified in the project work plans and health and safety plan.

4.3 Direct Push Technology

The DPT uses a hydraulically powered percussion hammer and the static weight of the vehicle that the system is mounted on. Tools are pushed or punched into the ground by displacing soil to make a path for the tool. The depth of investigation will typically be less than 50 feet below ground surface (bgs). Lighter weight rigs can be utilized for shallow surveys up to approximately 15 feet bgs and in areas of limited access. DPT is often mounted on a rubber tracked platform for limited access and off-road terrain areas.

4.4 Rig Decontamination and Preparation

All drilling and sampling equipment should be decontaminated before drilling, per SOPs 6.1 and 6.2, and the project work plans.

The driller and the rig geologist/engineer should inspect the drilling equipment for proper maintenance and appropriate decontamination. All clutches, brakes, cables, hydraulic lines, hydraulic jacks, and the drive percussion hammer should be in proper working order. All pipe joints and bits should be in good condition with no worn threads, cracked tool joint connections, excessive wear, etc.

Any leakage of fluids from the DPT rig or fluid circulation system (e.g., hydraulic lines, etc.) should be immediately repaired, and the DPT rig or circulation equipment should be decontaminated again before it is allowed to remobilize to the site.

4.5 Site Preparation

The logistics of drilling, logging, sampling, containment, and/or well construction should be determined before mobilizing. The site should be prepared, per project work plans.

Before mobilization, the STL and/or the rig geologist/engineer should assess the drilling site. This assessment should identify potential hazards (slip/trip/fall, overhead, etc.) and should determine how drilling operations may impact the environment (dust, debris, noise). Potential hazards should be evaluated and corrected, or the borehole location changed or shifted, per the project work plans.

The STL or appropriate designee should ensure that all overhead utilities have adequate clearance between all portions of the DPT rig and maximally extended masts, towers, and drill rod holders, that identifiable and suspected underground utilities around the drilling location have been marked, and that the borehole location has been cleared, per project work plans. At a minimum, copies of the site clearance documents should be kept onsite in a commonly accessible location.

4.6 Mobilization and Set-up

Once site preparation is completed, the rig is mobilized to the site and positioned over the identified and cleared borehole location. The DPT rig is then leveled with a set of hydraulic jacks,

with pads at the rear of the equipment. Once the DPT rig is leveled, the mast with hydraulic percussion hammer should be raised slowly and carefully to prevent tipping or damaging the rig and to avoid hitting any obstructions or hazards.

Appropriate barriers and delineators should be in place prior to drilling, per the site health and safety plan.

Appropriate fluids and possible investigation-derived waste (i.e. concrete) containment should be set up on site prior to the commencement of drilling, per the work plan.

4.7 Health and Safety Requirements

Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan. All Contractor and subcontractor personnel at the site should have appropriate training and qualifications, per the health and safety plan. Documentation should be kept readily available in the project files onsite.

During drilling, all personnel within the exclusion zone should pay close attention to all DPT rig and equipment operations. Rapidly pushing drill tools can catch or snag loose clothing causing serious injury.

Establishing clear communication signals with the drilling crew is mandatory, since verbal communication may not be heard during the drilling process.

The entire crew should be made aware that they should inform the site supervisor of any unforeseen hazard, or when anyone is approaching the exclusion zone.

4.8 Direct Push Procedures

4.8.1 Breaking Ground and Surface Hole Drilling

Prior to the start of direct push, all safety sampling and monitoring equipment will be appropriately calibrated, per the project work plans. The rig geologist/engineer should inform the driller of the appropriate equipment (jack hammer) that will be used for penetrating the specific surface cover (asphalt, concrete, cement, etc.) at the drilling location.

In the event of direct push where a shallow subsurface hazard may exist (nearby suspected or known utilities, pipelines, tanks, structures, debris, trapped vapors, etc.), the driller will hand auger to a depth of 5 feet or more to clear the location of shallow utility lines. Hand auger in various directions to confirm the location is clear of shallow utility lines.

4.9 DPT Penetration

During DPT operations, as the borehole is advanced, the rig geologist/engineer will generally:

- Observe and monitor rig operations;
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance;
- Prepare a lithologic log from core or soil samples;
- Document drilling progress and other appropriate observations on the FADL (SOP 1.2);
- Supervise the collection and preparation of any soil, soil vapor, or groundwater samples; and
- Supervise groundwater sample collection.

As direct push progresses, the rig geologist/engineer should observe and be in frequent communication with the DPT operator regarding exploratory operations. Conditions noted should include relative rates of penetration (as indicated by fast or slow penetration), chattering and bucking of the rig, lost returns, hard penetration, refusal, etc. These conditions, including penetration rates, should be recorded on the boring log, per SOP 15.1. Penetration should not be allowed to progress faster than the rig geologist/engineer can adequately observe conditions, compile lithologic logs, and supervise safety and sampling activities.

The rig geologist/engineer should also observe the make-up and tightening of connections, as additional pipe joints are added to the rods. Any observed problems and causes, including significant down time, should be recorded on the FADL (SOP 1.2).

The rig geologist/engineer will continue to oversee or conduct appropriate health and safety sampling and monitoring during penetration. If any potentially unsafe conditions are evident from exploratory observations or health and safety monitoring, the rig geologist/engineer may suspend operations at any time and take appropriate actions, per the health and safety plan. In the event of a suspension of exploratory activities:

- The STL must be informed of the situation;
- Appropriate corrective action must be implemented before work may continue; and
- The observed problem, suspension and corrective action must be entered on the FADL (SOP 1.2).

During penetration, the rig geologist/engineer will compile a boring/well construction log following procedures outlined in SOP 15.1 Borehole Lithologic Logging.

Subsurface soil sampling is accomplished with a dual-tube system. The external drive tip (typically 2 1/8-inch diameter) and corresponding internal drive tip (typically 1 ½-inch diameter) with drive or piston sampler can be done at discrete intervals. This system leaves the outer extension

in place, providing a cased hole through which to sample with the internal drive. The dual-tube system pipe is four feet in length. Continuous soil coring uses the dual-tube system, with four-foot long clear plastic liner connected to the internal drive with a grabber.

4.10 Borehole Abandonment

If the borehole is to be abandoned once penetration is completed, the abandonment should follow the procedures outlined in SOP 8.3. The abandonment will be supervised by the rig geologist/engineer.

4.11 Monitoring Well Completion

DPT can be used for monitoring well installation. Depending on the outside diameter of the direct push tooling used, 1-inch and 2-inch polyvinyl chloride (PVC) casing wells can be installed. Also, 0.75-inch and 2-inch internal diameter pre-pack wells can be installed. If a monitoring well is to be installed in the borehole, the procedures outlined in SOP 8.1 should be followed. The well installation will be supervised by the rig geologist/engineer.

Grab groundwater samples are obtained using a hydropunch pipe and typically consist of a short (e.g., 4- to 5-foot) screen nested within a sealed, water-tight tool pipe. Because the screen is not exposed to the formation as the sampler is advanced into the subsurface, the screen does not become plugged or damaged. In addition, the potential for cross contamination is greatly reduced and a true depth-discrete sample that is representative of the target sampling zone can be collected. To collect the sample, the hydropunch pipe is advanced to the target sampling depth and the protective outer rod is retracted, exposing the screen to groundwater. Multi-level sampling in a single borehole can be accomplished with sealed-screen samplers by retrieving the sampler and decontaminating it or replacing it with a clean sampler before reentering the hole to collect another sample. Grab groundwater sampling procedures are outlined in SOP 9.2 should be followed.

4.12 Demobilization/Site Restoration

After penetrating, sampling, and well installation or borehole abandonment is completed, the drive pipe and tools are properly stored, the mast is lowered, and the rig is moved off of the location. Demobilization/site restoration will be supervised by the rig geologist/engineer or appropriate designee.

All debris generated by the exploratory operation should be appropriately disposed of.

The site should be cleaned, the ground washed as necessary, and the site conditions restored, per the project work plans.

All abandoned borings should be topped off and completed, per SOP 8.3 or the project work plans. All monitoring wells should also have their surface completions finished, per the project work plans.

Any hazards remaining as a result of exploratory activities should be clearly identified and reported to the STL. Before leaving, secure the hazard(s) with appropriate access controls and markers, per the site work plan and health and safety plan.

5. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

None.

BOREHOLE LITHOLOGIC LOGGING

STANDARD OPERATING PROCEDURE 15.1

1. Purpose

This Standard Operating Procedure (SOP) describes the basic methods for logging soil using the Unified Soil Classification System (USCS) visual method, as well as methods for describing rock core samples by standardized techniques. Use of visual examination and simple manual tests associated with the USCS procedure gives standardized criteria and processes for describing and identifying soils. The methods for describing rock core are also presented with the intent to standardize methods and terminology. Logging soil and rock samples according to the procedures outlined within this SOP assures that data, information, and descriptions generated from each borehole or excavation are properly collected and documented. Furthermore, proper documentation and logging of soil and rock samples allows direct comparison of lithology between different boreholes. This document describes:

- The methods for describing soil and rock samples and defines basic terminology to be used when describing soil and rock core samples;
- What information is necessary to complete the lithologic log;
- The required forms on which field observations are logged and defines the procedure for filling in individual sections of the form; and
- The tools and equipment necessary for logging and visual classification of soil samples.

2. References

American Society of Testing and Materials, 1999. *Standard Test Method for Penetration Test and Split Barrel Sampling of Soils*, ASTM D1586-99, Vol. 04.08

American Society for Testing and Materials, 2000. *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, ASTM D2488-00, Vol. 04.08.

American Society for Testing and Materials, 2006. *Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation*, ASTM D2113-06, Vol. 04.08.

U.S. Department of the Interior, Bureau of Reclamation (USBR), 1986. *Procedures for Determining Unified Soil Classification (Visual Method)*, USBR 5005-86

State of California Department of Transportation, 2007. *Soil and Rock Classification and Presentation Manual*.

LEHR Environmental Restoration Division, 1998. *SOP No. 15.1 Lithologic Logging*.

Department of Health and Human Services, Centers for Disease Control and Prevention, 2005. *NIOSH Pocket Guide to Chemical Hazards*, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Environmental Protection Agency, 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

Johnson, R. B., and DeGraff, J. V., 1988. *Principles of Engineering Geology*, John Wiley and Sons, New York.

Terzaghi, K., Peck, R. B., and Mesri, G., 1996. *Soil Mechanics in Engineering Practice*, 3rd ed., John Wiley and Sons, New York.

SOP 1.2 - Field Activity Daily Log

SOP 2.1 – Sample Handling, Packaging, and Shipping

SOP 3.2 – Subsurface Soil Sampling While Drilling

SOP 5.1 – Water-Level Measurements in Monitoring Wells

SOP 14.1 – Hollow Stem Auger Drilling

SOP 14.5 – Direct Push Technology

Standard Quality Procedure (SQP) 4.2 - Records Management

2.1 Abbreviations

Abbreviations Used for Lithologic Descriptions:

PC = punch core
RC = rock core
v = very
f = fine
m = medium
mod = moderate
c = coarse
min = mineralization
w/ = with
SA = subangular
SR = subrounded
R = rounded
A = angular
soft sed = soft sediment deformation
def'm = deformation
DF = drilling fluid (mud)
x-beds = cross beds

@ = at
RQD = rock quality designation
ppm = parts per million
rx w/HCl = reaction with hydrochloric acid
FeOx = iron oxide
MnO_2 = manganese oxide
P = plasticity

Abbreviations Used for Permeability Estimates:
1 K = primary conductivity
2 K = secondary conductivity due to fracturing, mineralization, etc.
H = high
L = low
E = estimated
K = Hydraulic conductivity

Core Fractures are Described as Follows:
(Depth/fracture type (see below)/angle w/mineralization or other characteristics)
CIF = coring induced fracture
HIF = handling induced fracture
NF = natural fracture
HF = healed fracture

General Abbreviations:
DA = Drill Ahead
NR = No Recovery
dk = dark
lt = light
ylw = yellow/yellowish
brn = brown/brownish
grn = green/greenish
gry = gray/grayish
blk = black
bl = blue
ind = indurated
cmt = cemented
calc = calcite
qtz = quartz
SS = split spoon
S = sub
//////// = Gradational Contact
------- = Approximate Contact
_____ = Definite Contact

3. Definitions

This section presents definitions required for proper borehole logging in two parts. The first part presents definitions of some of the common basic terminology utilized in soil and rock classification. These definitions do not substitute for the training and experience required in learning the multitude of definitions used in soil classification. The second section defines individual sections of the log sheet, outlines suggested procedures for filling in each section, and provides definitions for abbreviations commonly used in lithologic descriptions.

Gravel - Particles of rock that will pass a 3-inch sieve and be retained on a No. 4 sieve.

Sand - Particles of rock that will pass a No. 4 sieve and be retained on a No. 200 sieve.

Clay - Soil passing the No. 200 sieves that exhibits plasticity (putty-like properties) within a range of moisture contents, and which exhibits considerable dry strength when air-dry.

Silt - Material passing the No. 200 sieve that is non-plastic or very slightly plastic and exhibits little or no strength when air-dry.

Dry Strength - This is the resistance of a 1/4-inch air-dry ball made from the test material to crushing between the fingers. Dry strength is described with the terms None, Low, Medium, High, and Very High.

Penetration Resistance - Penetration resistance is based on blow counts recorded per foot while driving a Standard Penetration Sampler with a 140-pound hammer. A larger diameter sampler will have higher blow counts.

Dilatancy - This is a measure of the ability of a 1/2- to 1-inch-long pat made from the test material to yield water when shaken horizontally. Dilatancy is described with the terms None, Slow, and Rapid.

Toughness - This is a measure of the test material's ability to be rolled into a 1/8-inch-diameter thread. Toughness is described with the terms Low, Medium, and High.

Plasticity - This is a description of the test sample behavior derived during the performance of the toughness test. Plasticity is described with the terms Nonplastic, Low, Medium, and High.

Color - There are two approaches to identifying the color of samples. The Munsell Soil Color Chart can be used to describe soil and rock unit colors. Or the logger can subjectively judge the color using a set of standard colors. For this work plan the logger should subjectively judge the color using the following colors in combination:

- Brown
- Yellow
- Blue
- Orange
- Red
- Grey

- Olive

No more than two colors should be combined, with the more dominant color being preceded by the secondary color and separated by a hyphen, e.g. “brown-gray”. The color description may be additionally modified by the terms “light” and “dark” as appropriate. For brevity, and to also distinguish subjective color descriptions from those of the Rock Color Chart, the “ish” suffix should be avoided.

Frequently, a sample has spots or patches which are colored differently from the bulk of the sample. This is called mottling. Where it occurs, the proper description includes the color of the bulk sample followed by the word “mottled,” followed by one or more of the color descriptions, (e.g., “dark brown mottled tan”).

Moisture Content - The terms used to describe moisture content are dry, damp, moist, and wet. The moisture content is determined by feel. Dry is an unusual condition where the sample is completely desiccated as if it were baked in an oven. A damp sample will have enough moisture to keep the sample from being brittle, dusty, or cohesionless and is darker in color that the same material in the dry state. A moist sample will leave moisture on your hand but displays no free water. A wet sample is one which is saturated and displays free water.

Estimated Grain Size Percents - The method of determining the percent composition of various grain sizes is largely visual, except in distinguishing between silt and clay. When noting percentages, if all the fractions of all sizes in the sample are listed, they should total 100%. When estimating the percent of fines, because of the difficulties in distinguishing silt from clay, only the percent total fines should be estimated. When describing gravel, the size of the clasts should be noted in inches, using “in.” to symbolize inches. If the range of clasts begins just above coarse sand, then specify the largest size in a range of clasts (e.g. 20% gravel and cobbles to 5 inches). When describing sand sizes, the terms fine, medium, and coarse are to be used.

Estimated Relative Permeability - Relative permeabilities are given as very low, low, low to moderate, moderate, moderate to high, high, and very high. It is extremely difficult to estimate the hydraulic permeability visually. Very high permeability materials are rare and usually occur as very well sorted gravels and sands with very little fine sediment. Generally, permeability decreases with degree of consolidation and amount of clay.

Odor - Odor is not usually mentioned unless a particular odor is detected. The absence of odor is only reported where the lack of it is diagnostic.

4. Procedure

This section provides both the responsibilities and the procedures involved with soil logging. Field borehole logging is one aspect of drilling operations. Other aspects are covered in SOP 3.2 Subsurface Soil Sampling While Drilling, SOP 14.1 Hollow Stem Auger Drilling, and SOP 14.5 Direct Push Technology, . Every borehole should be logged, whether or not a well or piezometer is to be installed. If coring is not conducted while drilling, cuttings should be logged, while allowing for 1) lag time due to the travel time necessary to lift the cuttings to the surface and 2) the highly disturbed nature of the cuttings returned to the surface. Specific drilling methods control the validity

of logging drill cuttings and therefore, information presented from cuttings observations should be weighted appropriately. For example, cuttings collected while drilling with rotary (particularly air) methods generally allow for more trustworthy depth relationships to be determined than cuttings collected while using auger drilling methods.

4.1 Responsibilities

Field personnel assigned to borehole logging and sampling activities are responsible for completing their tasks according to the specifications outlined in this SOP and in accordance with the site-specific health and safety procedures outlined within the site safety plan.

The Subcontractor Task Leaders (STL) assigned to supervision and management of field activities associated with borehole logging will be responsible for developing work plans, ensuring that field personnel follow the procedures outlined within this SOP, coordinating and scheduling activities with field staff and subcontractors and reviewing field generated documentation. If problems occur in the field and the scope of the proposed drilling and lithologic logging work needs to be modified, project staff will also be responsible for notifying the STL and Subcontractor Quality Assurance Manager (SQAM), implementation of corrective action and client notification under their direction.

The Subcontractor Project Health and Safety Manager (SPHSPM) will be responsible for reviewing project health and safety plans and ensuring that the proposed tasks to be completed in the field are in agreement with corporate health and safety guidelines. Additionally, the SPHSPM will be responsible for ensuring that all staff receive appropriate training and certifications prior to field mobilization.

4.2 Prerequisites

Prior to beginning field borehole logging, review the project work plan to determine the drilling scope of work, intervals to be cored or sampled, specific lithologic logging requirements, and the overall data quality objectives of the project. Review the site health and safety plan to determine site specific hazards and necessary personal protective equipment (PPE) requirements.

Safety Considerations - Prior to conducting work in an uncharacterized area, or where high concentrations of contaminants are suspected that cannot be effectively monitored using a photoionization detector (PID) or flame ionization detector (FID), contact the SPHSPM to determine what equipment should be used. Regularly monitor drill cuttings and the work area for volatile organic compounds (VOCs). Cease drilling operations and contact the STL, and/or the Subcontractor Project Manager (SPM) when:

- Readings exceed the time-weighted average (TWA) values, or exceed half of the threshold limit values (TLV) for known or suspected chemicals;
- Breathing zone concentrations recorded by the field monitoring exceed twice background concentrations;

- Five ppm is measured in the absence of background concentrations; or
- There is evidence of contamination that could impact worker health and safety.

Obtain the materials and equipment listed in the Drilling Field Work Checklist (Attachment 7.1) and appropriate personal protective equipment, as required by the site health and safety plan.

5. Soil Boring Logs

The Borehole/Well Construction Log (BWCL) Form is included as Attachment 7.2 to this SOP. Field personnel recording lithologic information during drilling will use this form. The procedures that will be followed in completing the Borehole/Well Construction Log Form are outlined below.

As applicable, the following information will be filled in completely at the top of the first page of each boring log:

- Project Number;
- Project Name;
- Project Location;
- Rough Sketch with scale and north arrow depicting the approximate location of boring to structures, or other field landmarks;
- Boring Number;
- Name of Drilling Contractor;
- Name of Driller(s);
- Name of Field Geologist completing the form;
- Date and time drilling are started and completed;
- Drilling/Sampling Method;
- Type of Drill Rig used in collecting the samples;
- Driller's C57 License Number; and
- Borehole Diameter.

Each subsequent page of the Borehole/Well Construction Log should include:

- Photoionization (PID) or flame ionization detector (FID) readings recorded at the appropriate sample depth in units of parts per million (ppm);
- The instrument number of the PID used in the field;
- Borehole Completion and Sample Information (total borehole depth in feet, sample depth, sample description, blow counts, inches driven, inches recovered, and sample condition);

- Borehole abandonment/completion information, such as conductor casing(s) (interval and diameter), depth of sand pack and grout, well casing, and screen depth; and
- All depth or particle size numbers recorded as a decimal number to the appropriate significant digits.

A Field Activity Daily Log (FADL) will record the start of fieldwork and will be updated throughout the day by the field geologist/engineer, as described in SOP 1.2. The daily field activity log will include:

- Date/Time and field activity description;
- Hours spent on field activity; and
- A diary of daily activities, inspections, problems, conversations, visitors, weather conditions, and any other information relevant to the field activity.

Samples collected for purposes other than soil classification should be collected as per SOP 3.2, Subsurface Soil Sampling While Drilling, and are subject to handling, packaging, and shipping procedures described in SOP 2.1, Sample Handling, Packaging, and Shipping.

5.1 Borehole Logging Procedures

The BWCL Form (Attachment 7.2) will be filled out accurately for each soil boring drilled and/or each soil boring attempted. Sample depths, locations, and types will be recorded on the form. Boreholes that are logged entirely from cuttings and are not sampled must be indicated as such.

The BWCL will contain a detailed description of the soil strata encountered and all pertinent information regarding drilling operations and estimated soil and groundwater properties.

- Soil will be classified according to the USCS. The textural name for the soil will be written in the appropriate column using the USCS symbol.
- The format description for fine-grained sediments will include: textural classification (Silt, Sandy Silt, Clayey Silt, Sandy Clay, Silty Clay, Clay, Organic Silt, or Organic Clay), color, penetration resistance, moisture content, particle size distribution, estimated permeability, odor, and other miscellaneous classifications (cementation, geologic origin, formation name, etc.).
- The format description of coarse-grained sediments will include: textural classification (Sand, Clayey Sand, Silty Sand, Gravelly Sand, Gravel, Clayey Gravel, Sandy Gravel), color, penetration resistance, moisture content, particle size distribution, grain shape, grain size, estimated permeability, odor, and other miscellaneous classifications.
- A solid horizontal line and the appropriate depth in the USCS symbol column will mark abrupt soil changes. A dashed line will mark an apparent soil change. Diagonal lines will mark gradational changes. (Field personnel are best qualified to estimate the depth of changes. This task will not be delegated to office personnel, who have not observed the drilling operation).

- Abbreviations will be used on the logs to save space for editing purposes.
- If water was introduced into the borehole during drilling and/or into the well during initial development, notes should be added to identify the source (e.g., fire hydrant location, faucet, and number).
- If Bentonite Gel is used for drilling fluid, indicate the product name and manufacturer on the log or in the FADL. No polymer-bearing drilling fluid additives shall be used unless approved in advance by the Consulting Project Manager.

Comments on the BWCL are extremely important. Some important aspects of the drilling operation that will be recorded are:

- The organic content of the soil and the depth of topsoil and roots;
- Any sudden change in the speed, sound, or penetration rate of the drill rig;
- If sampling is not continuous, where drill cuttings were used to complete the log; and
- Any sample that is suspected of being disturbed, contaminated, or chemically or physically altered during the drilling process.

Suggested information to be included in each section of the BWCL (Attachment 7.2) is as follows:

1. Borehole Location - Indicate the borehole location on a map, with respect to permanent natural and man-made features and any existing nearby wells. When feasible, record the distance to at least two permanent locations or one location when directional (i.e., compass bearing) data are provided. Show a north arrow, preferably oriented toward the top of the page.
2. Project - Identify the project and site. In addition, include the general area in which the borehole is located (e.g., off site, Building 5, Lot E, etc.).
3. Borehole/Well Number – Provide the borehole/well number, as noted on the approved Drilling Work Plan and/or Sampling Plan.
4. Job Number - Identify the account number for the project.
5. Logged By - Identify the individual(s) responsible for logging the borehole, performing field measurements, and collecting samples.
6. Edited By - Identify the geologist who independently reviews and checks the boring/well log entries.
7. Project Manager - Identify the Consulting Project Manager.
8. Drill Rig - Identify the drill rig manufacturer and model.
9. Drilling Contractor - Identify the drilling company and its city of origin.
10. Driller/Helper - Identify drill rig operator and helper(s).
11. Drilling Method - Identify the method(s) used to drill the borehole.

12. Sample Method - Identify the method(s) used to collect lithologic and chemical samples.
13. Hammer Weight/Drop – Identify the drive sampler hammer weight in pounds and drop distance in inches for the hammer used to advance drive samplers. If a hammer is not used, enter NA (not applicable).
14. Borehole Diameter - Identify the diameter of the final borehole in inches and tenths of an inch. Also note diameter of any pilot boreholes drilled.
15. Borehole Started Time/Date – Identify the time using the 24-hour format (24 h) and date when drilling began.
16. Borehole Completed Time/Date – Identify the time (24 h) and date when pilot borehole is drilled to total depth.
17. Well Construction Started Time/Date - Identify the time (24 h) and date when well construction begins, including reaming the pilot borehole in preparation for well construction.
18. Well Construction Completion Time/Date - Identify the time (24 h) and date when well installation is complete (placement of first grout lift). If well is abandoned, note as such.
19. Well Head Completion - Identify the proposed type of well head completion (e.g., locking 9-in. diameter galvanized steel pipe [“stove pipe”] or Christy box).
20. Depth to Water - Water levels in boreholes should be recorded when water is first encountered during drilling, and then at least once after drilling has been completed or a piezometer and/or monitor well has been installed. Before taking water level measurements, review SOP 5.1 “Water-Level Measurements in Monitoring Wells.” Include borehole/casing depth, water depth, time, and date, using ground surface as the datum.
21. Total Depth - Record the total depth of borehole in feet.
22. Casing Depth - Record the total depth of well casing in feet.
23. Screened Interval - Include the depth interval of perforated casing section in feet.
24. Sandpack - List the depth interval of filter pack sand and fine grained transition sand (if used) in feet. Include the manufacturer name and designation of sand.
25. Well Development - Identifies the method(s), and time (24 h), date, and estimated flow rate in gallons per minute (gpm) when initial well development was completed.
26. Geophysical Logs - Identify the geophysical logging company, method(s), and date. If geophysical logging is not performed during initial drilling and well installation, enter NA (not applicable).
27. Circulation – Identify the volume of fluid losses and the interval over which they occur. When the column is left blank, it indicates that no fluid loss was observed. Complete fluid loss (CL) means that no fluid returned to the surface during pumping. If possible, give quantitative estimates of major fluid losses (rate in gpm, or estimate of total gallons lost). Although circulation loss applies primarily

to air and mud rotary systems, it can also be used during auger drilling to indicate quantity of return of cuttings at the surface.

28. OVA/PID Field Readings. Record Organic Vapor Analyzer (OVA) or PID readings - The work area (breathing zone) should be monitored with the OVA/PID for each core run. A portion of each soil/rock sample submitted for analysis should also be monitored with the OVA/PID after being containerized in a plastic bag for 15 minutes.

29. Sampler Type/Depth - Give sampler type by the letter code listed below and identify the depth at the top of the sampling interval in feet below ground surface (bgs). Example sampler types and descriptions are listed below:

    Standard penetrometer, 1.38" I.D. = SP

    Split-barrel (small), 2.0" I.D. = CM (California Modified Split Spoon)

    Split-barrel (large), 2.5" = SBL

    HQ wireline core, 2.3" I.D. = PC

30. Blows/6 inches – Identify the number of blows required to drive the sampler 6 in. by a 140-lb hammer falling 30 in. Fifty blow counts per 6-inch drive is considered "refusal," and sampling at this depth is usually terminated. In addition, a total of 100 blow counts per 18-in. drive, or no observed advance of the sampler during ten successive hammer blows, is also considered "refusal." During coring, leave this section blank. Normally, the second and third 6-inch intervals are recorded and added as the number of blows per feet.

31. Inches Recovered/Inches Driven - Identify the length in inches of sediment or rock recovered on a sampling or core run divided by the length in inches the sampler is advanced. For example, a recovery ratio for 10 in. of recovery on an 18-inch sampling interval for a core run would be 10/18".

32. Sample Condition/Rock Quality Designation (RQD) - Indicate the estimated quality of the sample for analysis: P = poor, F = fair, G = good, or E = excellent. When rock coring, the RQD is reported in the unreduced fraction form. The numerator is the length in inches of intact core 4 inches or greater in length, and the denominator is the length of the core run in inches.

33. Sample Identification (ID) - Record the depth or depth range of the sampling interval, given in feet and tenths of feet. The date and time of the sample is also given.

34. Analysis - Identify laboratory analysis to be performed on sample.

35. Well Annulus/Borehole Filler - Identify the type of material used to fill the annulus space between the well and borehole wall (e.g., Monterey #3 sand, 0/30 sand, bentonite pellets, Portland cement grout). Also identify the type of material used as borehole filler, either for backfill below the well bottom or for abandoning the borehole, if required (e.g., Portland cement grout, bentonite chips,

etc.). Material names are written vertically, and arrows are drawn from the material name to the upper and lower contacts with adjacent materials.

36. Well Casing - Identify the casing and screen used to construct the well. Casing and screen identification should include type of material (PVC, steel, etc.), schedule (Schedule 40, Schedule 80, etc.), and diameter. Screen identification should also include slot size (e.g., 0.02-inch) and screen type (e.g. machine slotted, continuously slotted, louvered, etc.). The well cap location and type should also be noted. Casing and screen descriptions are written vertically, and arrows are drawn from the description to the upper and lower contacts with adjacent descriptions.

37. Depth in Feet - Identify the depth in feet. The depth on all pages other than the first page should be filled out by the drilling geologist in the field.

38. Recovery/Sample Location – Show core recovery by an "x" in the recovery column on the log. The location of a sample collected for further evaluation is shown by a solid box. When partial sample loss occurs, it is often possible to determine why and where core loss has occurred. For example:

    1. Rock stuck in drive shoe.

    2. Coring from dense (stiff) material to soft material causing block-off.

    3. Loss of cohesionless material.

    4. Fell out during retrieval of core sampler.

    5. Mechanical failures.

    Note: If uncertain where sample loss has occurred, the recovered interval is assumed to be from the top of the sampling interval.

39. Contact - Lithologic contacts are drawn in the contact column and extended across the lithologic description field. If the contact is identified by the driller, specify this in the lithologic description field. Three types of contacts are used:

    1. Sharp. A sharp contact is indicated with a solid line.

    2. Gradational. A gradational contact is indicated with hatches.

    3. Approximate. An approximate contact is indicated by a dashed line and is used when the exact depth or nature of the lithologic contact is uncertain.

40. Lithologic Description - A continuous log of encountered geologic materials determined from borehole cuttings, samples, and core should be recorded on the BWCL. A system of description similar to the American Society for Testing and Materials (ASTM) method D 2488-90 (2000), Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) is used for sediment, and a similar description is used for rock.

- Lithologic descriptions record direct field observations - Any interpretations included with these descriptions should be clearly noted by placing the interpretation in parentheses. The format is outlined below:

A. Fine-Grained Sediment Description Format.

1. Contact depth in feet and tenths of a foot. For example, "(0'–5.1')."

2. Textural Classification. For example, Sandy Silt describes a soil sample that is predominantly silt with the next highest percentage being sand.

Fine-grained Group		**Coarse-grained Group**	
Group Symbol	Group Name	Group Symbol	Group Name
CL	Low to medium plasticity clays	GW	Well-graded gravel
ML	Non-plastic to medium plasticity silt	GP	Poorly graded gravel
OL	Organic clay or silt (lean)	GM	Silty gravel
CH	High plasticity clays	GC	Clayey gravel
MH	High plasticity silt	SW	Well-graded sand
OH	Organic clay or silt (fat)	SP	Poorly graded sand
PT	Peat	SM	Silty sand
		SC	Clayey sand

Fine grained examples - Gravelly silt, sandy silt, silt, clayey silt, sandy clay, silty clay, clay, organic silt, and organic clay.

Coarse grained examples - Sand, clayey sand, silty sand, gravelly sand, gravel, clayey gravel, silty gravel, and sandy gravel.

3. Group Symbol. The appropriate Unified Soil Classification System (USCS) sediment group symbol is written in parentheses after the textural classification. For example, silt would be (ML).

4. Color. Soil color is named and coded using the Munsell Soil Color chart. The code should be in parentheses immediately following the written description. For example, "reddish brn (5YR, 4/4)." Presence of mottling and banding is also recorded.

5. Consistency/Penetration Resistance. For fine sediments use very soft, soft, medium, stiff, very stiff, and hard. These are estimated from drive sample hammer blows or other field tests. Blow counts may also be used, if reliable.

6. Moisture Content. Dry, damp, moist, wet (saturated). Omit moisture terms below the saturated zone and when drilling with mud or air-mist rotary systems.

7. Size Distribution. Approximate percentage of gravel, sand, fines (if possible, distinguish between silt and clay). Percentages should add up to 100%. For example, "80% silt, 20% f-sand."

8. Estimated Permeability. Very low, low, moderate, or high. These are based primarily on grain size and sorting. For example, “LEK.”
9. Miscellaneous. Odor, contact, and/or bedding dip, bedding features, cementation, structures, fractures, fracture fillings, fossils, formation name, minerals, oxidation, etc.

- B. Coarse-Grained Sediment Description Format.

1. Contact depth in feet and tenths of a foot. For example, “(0'–5.1').”
2. Textural Classification. The appropriate textural classification. For example, “Silty Gravel.”
3. Group Symbol. The appropriate Unified Soil Classification System (USCS) sediment group symbol is written in parentheses after the textural classification. For example, “(GM).”
4. Color. Soil color is named and coded using the Munsell Soil Color chart. The code should be in parentheses, immediately following the written description. For example, “dk brn (7.5 YR, 3/4).” Presence of mottling and banding is also recorded.
5. Relative Density/Penetration Resistance. For cohesionless materials use very loose, loose, medium, dense, or very dense, estimated from drive sample hammer blows or other field tests. Blow counts may be used, if reliable.
6. Moisture Content. Dry, damp, moist, and wet (saturated). Omit moisture terms below the regional water table and when drilling with mud or air-mist rotary systems.
7. Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay). Percentages should add up to 100%. For example, “80% gravel, 20% silt.”
8. Grain Shape. Angular, subangular, subrounded, rounded, or well-rounded, for grains larger than sand size.
9. Grain Size. The largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
10. Estimated Permeability. Very low, low, moderate, or high. This is based primarily on grain size and sorting. For example, “HEK.”
11. Miscellaneous. Odor, contact, and/or bedding dip, bedding features, sorting, structures, fossils, cementation, geologic origin, formation name, minerals, oxidation, etc.

- C. Fine-Grained Rock Description Format

1. Contact depth in feet and tenths of a foot. For example, “(76.5'-80').”
2. Textural Classification. For example, “Sandy Siltstone.”

Fine grained examples - Sandy siltstone, siltstone, clayey siltstone, sandy claystone, silty claystone, claystone.

Coarse grained examples - Sandstone, clayey sandstone, silty sandstone, gravelly sandstone, conglomerate, clayey conglomerate, silty conglomerate, and sandy conglomerate.

3. Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. For example, "gry grn (5G, 5/2)." Presence of mottling and banding is also recorded.
4. Hardness. Very hard, hard, medium, soft, very soft.

Attachment G-1. Rock Hardness Classification

Hardness Descriptive Term	Defining Characteristics
Very hard	Cannot be scratched with knife; does not leave a groove on the rock surface when scratched.
Hard	Difficult to scratch with knife; leaves a faint groove with sharp edges.
Medium	Can be scratched with knife; leaves a well-defined groove with sharp edges.
Soft	Easily scratched with knife; leaves a deep groove with broken edges.

5. Moisture Content. Dry, damp, moist, wet (saturated). Omit moisture terms below the saturated zone and when drilling with mud or air-mist rotary systems.
6. Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay). Percentages should add up to 100%. For example, "80% silt, 20% f-sand."
7. Estimated Permeability. Very low, low, moderate, or high. This is primarily based on grain size, sorting, and cementation. Estimate secondary permeability due to natural rock fractures when applicable. For example, "LEK."
8. Miscellaneous. Odor, contact, and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.
9. Fractures are identified by depth, angle, width, and associated mineralization, if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]) should be stated. For example, "NF @90.8', 25 deg to axis, 0.1" wide, minor calcite."

6. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files, in accordance with SQP 4.2 - Records Management.

7. Attachments

7.1 - Drilling Field Work Checklist

7.2 - Borehole/Well Construction Log

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the CQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 7.1

DRILLING FIELD WORK CHECKLIST

Drilling Field Work Checklist

Upon Request for proposal

- Develop a scope of work and send out requests for quotes from multiple subcontractors. We usually try and get three quotes for each type of subcontractor (drillers, line locators, laboratories, and surveyors, as needed).
- Review quotes to make sure that they are accurate and reflect the scope of work.
- Prepare budget.
- Have accounting QC spreadsheet.

Upon contract award:

- Schedule the subcontractors;
- Prepare and submit PO or Work Order request to Gail McKay;
- Apply for necessary drilling permits;
- Apply for necessary encroachment permits;
- Prepare a traffic control plan, if required;
- Order the necessary sample containers from the laboratory;
- Order any necessary equipment;
- Prepare protocol and COC; and
- Prepare H&S Plan and have management review it and sign it.

The week before field work:

- Ensure that sample containers have arrived and that the order is correct;
- Rent any necessary equipment/meters to be delivered one to two days prior to field work;
- Mark boring locations and conduct line locating field work;
- Call USA five days prior to drilling; and
- Arrange for city/county inspector within 48 or 24 hours prior to field work.

Upon completion of field work:

- Finalize paperwork and submit to PM;
- Submit samples to lab or arrange for courier to pick up samples; and
- Submit any follow-up paperwork associated with the field work, like well completion forms or notice of completion of field work to the City/County.

ATTACHMENT 7.2

BOREHOLE/WELL CONSTRUCTION LOG

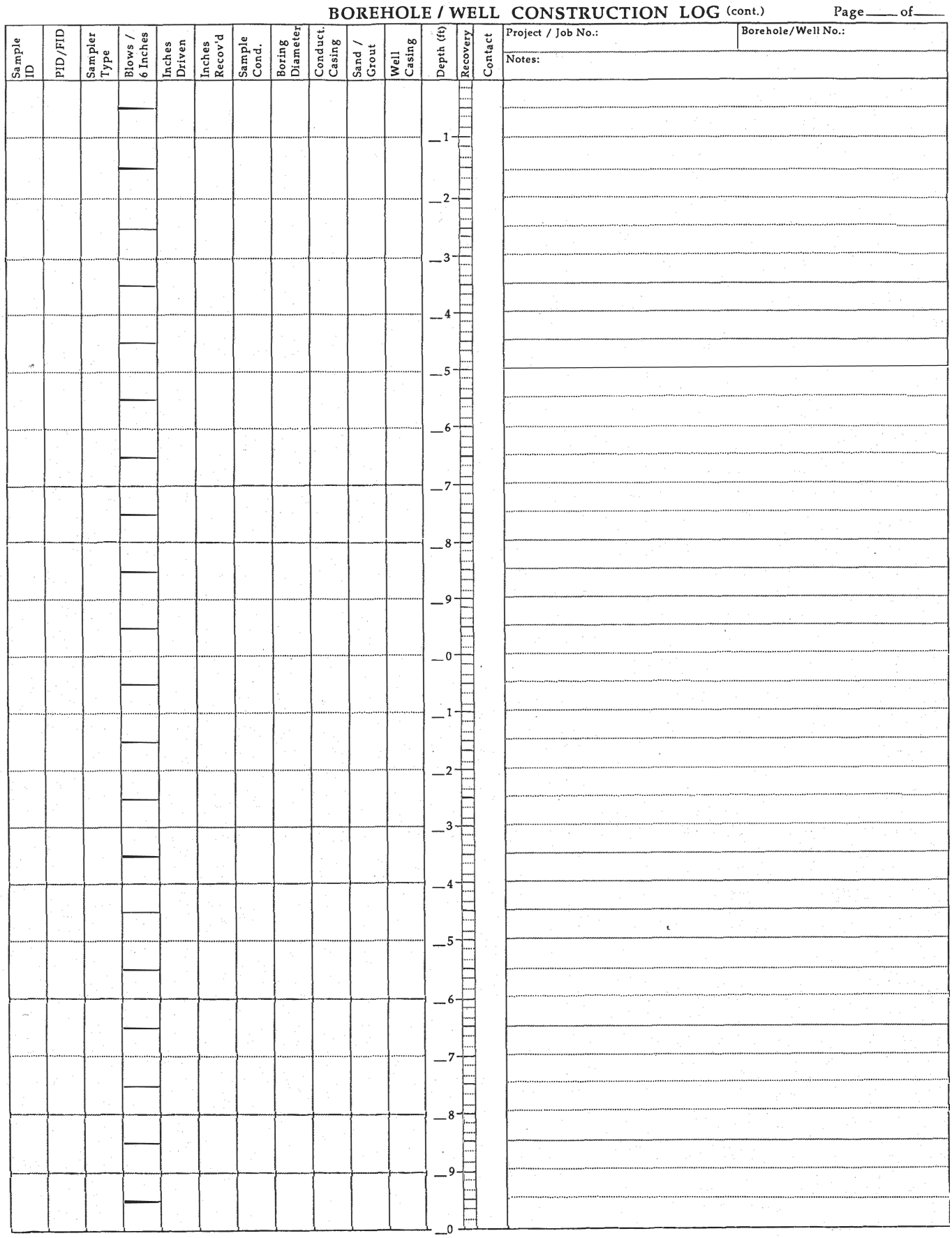
BOREHOLE / WELL CONSTRUCTION LOG

Page ____ of ____

BOREHOLE LOCATION	Project: (facility, address, city, state)	Borehole/Well No:
		Job No:
	Logged By:	Edited By:
	Project Manager:	Drill Rig:
	Drilling Contractor: (name, city, state)	
	Driller:	License # : C57-
	Drilling Method:	Sample Method:
	Well Head Completion:	Ground Surface Elevation:
	Hammer Weight/Drop:	Borehole Diameter:
	Started, Time:	Date:
	Completed, Time:	Date:
Approximate Scale:	Water Depth	
	Boring/Casing Depth	
Notes:	Time	
	Date	

Total Boring Depth:		Total Well Depth:
Screened Interval:		Well Diameter:
Sand Pack (Type and Interval):		
Well Development Method:		
Time:	Date:	Flow Rate:
Geophysical Logs, Type:		
By:		Date:

Sample ID	PID / FID (ppm)	Sampler Type / depth	Blows per 6 Inches	Inches Driven	Inches Recovered	Sample Condition	Boring Diameter	Diagram: Conductor Casing(s) Interval and Diameter	Diagram: Sand / Grout	Diagram: Well Casing / Screen	Depth in Feet	Recovery / Sample Loc.	Contact / Hyd. Conduct.	LITHOLOGIC DESCRIPTIONS
											1			
											2			
											3			
											4			
											5			
											6			
											7			
											8			
											9			
											10			


BOREHOLE / WELL CONSTRUCTION LOG (cont.)
Page ____ of ____
Sample ID
PID/FID
Sampler Type
Blows / 6 Inches
Inches Driven
Inches Recov'd
Sample Cond.
Boring Diameter
Conduct. Casing
Sand / Grout
Well Casing
Depth (ft)
Recovery
Contact
Project / Job No.:
Borehole/Well No.:
Notes:

SAMPLE LABELING

STANDARD OPERATING PROCEDURE 17.1

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for sample labeling. Sample labeling is required to identify, track, and trace samples from the time of collection until the time of disposal. Additional specific procedures and requirements will be provided in the project work plans.

A label must be completed and securely attached to every environmental sample collected for analysis. Sample labels include all forms of sample identification (labels or tags) that are physically attached to samples collected, and provide, at a minimum, the information required by this SOP and project work plans.

2. References

SOP 1.1 - Sample Custody

SOP 1.2 - Field Activity Daily Report

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 9.3– Low-Flow Sampling

SOP 17.2 - Sample Numbering

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

None.

4. Procedure

Sample labeling is required to identify, track, and trace samples from the time of collection until the time of disposal. The details within this SOP should be used in conjunction with the project work plans. The project work plans will commonly provide the following information:

- Sample collection objectives;
- Numbers, types, and locations of samples to be collected; and

- Any additional sample labeling requirements or procedures beyond those covered in this SOP, as necessary.

Document all of the information necessary on the sample label, and ensure that the label is physically attached to each respective sample. Each sample label must contain, at a minimum, the following information:

- Project number;
- Date and time of collection;
- Sample identification number;
- Analytical laboratory;
- Analysis;
- Analytic method;
- Preservative; and
- Collector's initials.

Additional information may also be required, per the project work plans, and must accordingly be included on all sample labels.

Indelible ink should be used in filling out all sample labels and tags.

Ensure that each sample collected has a sample label.

Ensure that the information documented on the sample label corresponds with the information documented on the Field Activity Daily Report and sampling data form (SOP 1.2), and Chain-of-Custody Record (SOP 1.1).

The Subcontractor Project Manager (SPM) is responsible for ensuring that all sample collection and labeling activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC). The SPM may delegate these responsibilities to a Subcontractor Task Leader (STL).

The SPM or their designee is responsible for periodic review of sample labels generated according to this sample labeling SOP. The SPM is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to sample labeling requirements, issuing nonconformances, etc.), if problems occur.

Field personnel assigned to sampling and sample labeling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the STL or SPM.

5. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files, in accordance with SQP 4.2 – Records Management.

6. Attachments

None.

SAMPLE NUMBERING

STANDARD OPERATING PROCEDURE 17.2

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for sample numbering. Sample numbering is required to identify, track, and trace samples from the time of collection until the sample results are no longer usable. Additional specific procedures and requirements will be provided in the project work plans.

A sample number (or sample ID) is a unique alphanumeric identification assigned to each and all physical samples collected as part of any given project. This SOP is the minimum standard for use every time an environmental sample (soil, water, soil gas, etc.) is to be collected.

2. References

SOP 1.1 - Sample Custody

SOP 1.2 - Field Activity Daily Report

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 9.3 – Low-Flow Sampling

SOP 17.1 - Sample Labeling

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

N - parent (normal) environmental sample

FD - field duplicate sample

EB - equipment blank sample

RB - rinseate blank sample

Sample ID - sample identification code

Sample Tracking table - table used to create and track unique Sample IDs

SO - soil

TB - travel blank sample

4. Procedure

The project work plans will generally provide the following information:

- Sample collection objectives;
- Quantities, types, and locations of samples to be collected;
- Project-specific character string to be used for the sample numbering;
- Sample data manager responsible for issuing sample numbers to field personnel conducting sampling activities; and
- Any additional sample numbering requirements or procedures beyond those covered in this SOP, as necessary.

Sample IDs will be determined on a project-specific basis and stated in the field work protocols. Sample IDs should be as simple, and preferably as short, as possible, and must be compatible with the laboratory analytical tracking system and the data management system to be used for the project sample data.

The Subcontractor Database Manager (SDM) will assign a unique sample ID for each sample to be submitted for analysis. Field personnel should not assign sample IDs unless extra samples become necessary on the day of collection and the sample data manager is unavailable to issue additional unique IDs from the Sample Tracking table. If Sample IDs are assigned by field personnel, the IDs should contain the string YYYYMMDD##, where YYYY is the numerical year, MM is the month, DD is the day, and ## is the sequential number of the sample collected that day. Note that GeoTracker has a sample ID character limitation of up to 25 characters which must not be exceeded when creating sample IDs. EQuIS has a limitation of 30 characters for its sample_name field and 40 characters for its sys_sample_code field, making GeoTracker the limiting database among the two databases currently used.

Parent environmental samples (soil, sediment, groundwater, air, etc.) and field duplicate samples will be assigned sample IDs with the same prefix, so that the laboratory will be unable to distinguish between the field duplicate and parent samples. For sampling events where travel blanks accompany volatile organic compound (VOC) samples, all travel blanks will be assigned a unique sample ID that begins with the letters TB.

The sample data manager will be responsible for updating a project specific Sample Tracking table with the following information:

- Unique sample ID;
- Associated location name;
- Sample type (N, FD, EB, RB, TB, etc.);
- Sample matrix (soil, water, soil gas, etc.);

- Sampling event description;
- Date stamp of sample ID generation; and
- Any other general information.

The sample ID must be recorded on the Sample Label (SOP 17.1), Field Sampling Data Sheet (SOP 1.2), and Chain-of-Custody Record (SOP 1.1).

The Subcontractor Project Manager (SPM) is responsible for ensuring that all sample collection and numbering activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC). The SPM may designate these responsibilities to a Subcontractor Task Leader (STL).

The SPM is also responsible for periodic review of field generated documentation associated with this SOP, and for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to sample numbering requirements, issuing nonconformances, etc.) if problems occur.

Field personnel assigned to sampling and sample data managers assigned to sample numbering activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the STL or the SPM.

4.1 Sample Numbering Examples

Example sample IDs containing a text prefix and numerical suffix are generated here for a fictitious site. The first example is a sample ID sequence whose prefix contains a five-character abbreviation that corresponds to the sample material and location of collection. A four-digit numerical suffix was generated to give the samples their unique identity and was issued in sequential order. For this example sampling event involving four shallow soil samples, the example Sample Tracking entries are:

Sample Name	Location Name	Sample Type	Matrix	Event	Date Stamp	Note
SSJLI7438	JLI382	N	SO	JLI Investigation	10/1/2018 13:01:05	
SSJLI7439	JLI122	N	SO	JLI Investigation	10/1/2018 13:02:08	
SSJLI7440	JLI122	FD	SO	JLI Investigation	10/1/2018 13:03:15	Parent sample SSJLI7439
SSJLI7441	JLI464	N	SO	JLI Investigation	10/1/2018 13:04:12	
SSJLI7442	JLI289	N	SO	JLI Investigation	10/1/2018 13:05:20	

The sample prefix "SSJLI" corresponds to shallow soil in the Jet Liner Incineration area. The sample ID contains an incrementing numerical four character suffix that can have up to 10,000 unique IDs for the ongoing JLI Investigation. Each sample ID is unique and the number of characters is unchanging for data sorting purposes.

Additional examples are:

- GWROD05 for a groundwater sample in the Remediated Oyster Drying area where samples are collected from one well on a five year frequency and are expected to require fewer than 100 sample IDs during the project lifetime.

- SSSGTF048 for a sub-slab soil gas sample collected in the Technology Fabrication building. In this case four characters were used in the prefix to distinguish sub-slab soil gas samples (SSSG) from soil gas (SG) samples collected outside the building footprint.

- SB2015012101 for an unplanned soil boring sample collected by field personnel. This sample ID contains the YYYYMMDD## character string that should be used to create unique sample IDs in the field.

5. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Sample Name Tracking

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the Subcontractor Quality Assurance Manager, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

SAMPLE NAME TRACKING

Sample Name Tracking

Sample Name	Location Name	Collection Date	Collection Time	Sample Type	Matrix	Depth	Event	Note

SAMPLING PROTOCOL

STANDARD OPERATING PROCEDURE 17.3

1. Purpose

This Standard Operating Procedure (SOP) establishes the method and responsibilities associated with the creation of sampling protocols. It outlines requirements necessary to produce effective work specification documents for the performance of environmental field sampling.

2. References

SOP 1.1 - Sample Custody

SOP 1.2 - Field Activity Daily Report

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 9.3 - Low-flow Groundwater Sampling

SOP 17.1 - Sample Labeling

SOP 17.2 - Sample Numbering

SOP 20.1 - Sample Containers, Preservation, and Holding Times

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

None.

4. Procedure

4.1 Scope

A sampling protocol is a work order that defines the specific work tasks, schedule, and budget, and contains all the information necessary to prepare for and complete environmental sampling as part of any given project. This SOP is the minimum standard for use every time an environmental sample (soil, water, soil gas, etc.) is to be collected.

4.2 Prerequisites

The project work plans will generally provide the following information:

- Sample collection objectives;
- Quantities, types, locations, sample collection methods, and frequency of samples to be collected, including quality control samples;
- Decontamination procedures;
- Project-specific character string to be used for the sample numbering;
- Sample Documentation requirements;
- Laboratories that are contracted to perform the analyses;
- Analytic methods to be used, specific analytes for each analytic method, and the appropriate bottle set for each analytic method;
- Preservation, filtering, holding time, and refrigeration requirements for each analytical method;
- Identification of SOPs necessary to perform required tasks;
- Health and Safety Documentation, as specified in the Project Health and Safety Plan, including tailgate safety meeting form and map to hospital; and
- Any additional requirements, procedures, or special instructions beyond those covered in this SOP, as necessary.

Generation of sample numbers (SOP 17.2) for normal environmental samples and quality control samples must precede creation of a sampling protocol.

4.3 Responsibilities

The Subcontractor Project Manager (SPM) is responsible for assuring that the work is done in accordance with applicable environmental, safety, and health regulations, and standard operating practices. The SPM either creates the sampling protocol and compiles the sampling protocol package or delegates these tasks to a Subcontractor Task Leader (STL). The SPM is also responsible for periodic review of field generated documentation associated with this SOP and for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to sampling protocol requirements, issuing nonconformances, etc.), if problems occur.

The designated STL is responsible for assembling/compiling the sampling protocol package.

Field personnel assigned to sampling activities are responsible for completing their tasks according to the protocols generated following this SOP. All staff are responsible for reporting deviations from the procedures to the STL or the SPM. At the conclusion of the sampling activities, field personnel are responsible for returning the completed field forms to the STL or SPM.

4.4 Procedure

The components of a sampling protocol are:

- Cover Sheet with general information;
- Sampling Protocol spreadsheet;

- Chain(s) of Custody Form(s);
- Field Sampling Data Sheet(s);
- Site maps;
- Field Activity Log;
- Equipment and supply forms;
- SOPs for all associated activities;
- Reference to the Project Health and Safety Plan; and
- Miscellaneous project specific forms (such as water level forms, well construction details, etc.).

The Cover Sheet must contain the following information:

- Name of the task to be performed;
- Date of the sampling event;
- Job name;
- Job address;
- Job number;
- SPM and STL names, mobile phone numbers, and office phone numbers;
- Backup contact name and phone number;
- Site contact name and phone number;
- Laboratory contact names and phone numbers;
- Estimated budget (number of people and number of days);
- Contents of protocol package;
- Checklist of tasks to be completed;
- Checklist of equipment to be brought to the site;
- Detailed descriptions of work to be performed in advance of the job and at the job site;
- Project Health and Safety Plan reference; and
- Instructions for documentation delivery.

The detailed description of tasks to be performed should include:

- Site access information;
- Health and safety meeting times, dates, and locations;
- Description of sample collection tasks;
- Instructions for special samples or procedures;
- Waste management instructions;

- Sample shipping contact information;
- Arranging for laboratory courier pick-up or delivery;
- Keeping the Field Activity Log up to date; and
- Notifying the SPM or STL of any procedural modifications.

The Cover Sheet should also state that a copy of the completed chain of custody record must be delivered to the SPM or STL within 24 hours of relinquishing the samples, and that completed protocol package documents, including equipment and supply billing forms, must be returned to the SPM within a specified time period. In addition, the cover sheet should also state that at the end of each field activity, all completed field documentation will be scanned into a portable document format (PDF) or similar file and emailed to the SPM for archiving. See Attachment 6.1 for a cover page template.

The Sampling Protocol spreadsheet must contain the following information:

- Sampling point (location identification);
- Sample number (a unique alias);
- Sample Type Identification (e.g., N for normal environmental sample, FD for Field Duplicate, FB for Field Blank, etc.);
- Laboratory contracted to perform analyses;
- Number of sample containers;
- Type of sample containers (e.g., G for glass, P for plastic, etc.);
- Volume of the container;
- Type of preservative in the container (e.g., HCl for hydrochloric acid, None, etc.);
- Whether or not the sample must be filtered (yes or no);
- Whether or not the sample requires refrigeration;
- Sample turnaround time (e.g., normal or rush with specified time);
- Sample matrix;
- Parameter to be analyzed (e.g., volatile organic compounds [VOCs], specific metals, pH, etc.);
- Specific analytic method; and
- Any special instructions (e.g., special hold time requirements, field filtering check box, etc.).

Sampling points, sample types, contracted laboratories, filtering requirements, sample containers, preservation requirements, holding times, and expected turnaround times should be found in the work plan for the project, and should be included in the protocol. Sample numbers are generated by the sample data manager (SOP 17.2). Sample containers, preservation requirements, and holding times can be found in SOP 20.1. See Attachment 6.2 for a sampling protocol template.

Chain-of-custody (COC) forms must be included in the sampling protocol package (SOP 1.1). At a minimum, the COC(s) must include the job name and number, SPM or STL's name, and the directory in which the sampling protocol can be found.

Field sampling data sheets, if applicable, should be included in the sampling protocol package (SOP 9.3).

Site maps must be included in the sampling protocol package, with each sampling location clearly identified.

Field activity logs must be included in the protocol package (SOP 1.2).

A completed draft protocol package should be reviewed by the SPM to ensure that the work is correct for the contract, meets regulatory compliance, meets health and safety directives, and is within the budget for the contract. Review by the Subcontractor Project Quality Assurance Manager (SPQAM), STL, and/or the field personnel may be undertaken for jobs with certain circumstances. After the final draft is approved by the SPM, the completed protocol is printed and distributed to the field staff.

Field operations staff maintain a copy of all field forms, logs, and notes produced in completing the work defined in the sampling protocol. The originals are distributed to the SPM or designated staff person. After collection of data and review of the work these originals are filed in the project record files.

5. Records

Records generated as a result of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 Protocol Cover Page Template

6.2 Sampling Protocol Template

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the SPQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

PROTOCOL COVER PAGE TEMPLATE

DOE Areas Groundwater Sampling: March 2019

GROUNDWATER SAMPLING FIELD WORK PROTOCOL PACKAGE
COVER SHEET
GENERAL INFORMATION

Job Name: DOE Areas GW sampling
Job Address: UC Davis Center for Health and the Environment
Job No.: **388-1856.18.1_3_2**

Office Contacts:
TRU 510-450-6193 office
925-768-3745 mobile
BPB 510-450-6145 office
415-342-2172 mobile

Site Contacts:
UC Davis
Chris Wright (Site) 530-681-1793
Gonzolo Barajas (Site) 530-752-4034 office

Rachel L Lauesen
rllauesen@ucdavis.edu
530-752-9184 office
530-312-4535 mobile
530-906-2425 alternative

Contents:
Instruction sheet
General Site information sheet
DOE Areas Well Location Map
Low-flow sampling procedure
Sampling protocol spreadsheet
Sampling schedule
Field Activity Log Sheets
Water Sampling Data Sheets
Chain-of-Custody forms
SQP 8.1 - Calibration and Maintenance of Measuring and Test Equipment
Vehicle Safety Checklist, Safety Meeting Form, Hospital Route Map

Lab Contacts:
Alan Kemp (925) 689-9022
Eurofins Calscience Laboratories

Heather Shaffer (843) 556-8171 xt 450
GEL Laboratories

Tasks to be Completed:

- ☐ Schedule Eurofins Calscience courier at least 48 hours in advance (contact Alan Kemp 925.689.9022)
- ☐ Collect groundwater samples as listed on the sampling protocol
- ☐ Relinquish chemical samples to Calscience couriers each day that Cr6 samples are collected (24 hr hold)
- ☐ Transfer wastewater to tank in Co-60 area
- ☐ Ship radiological samples to GEL, Charleston, SC

(see details below)

Advance Job Coordination:

1. **Read/QC** protocol. Please contact TRU if you have any questions.
2. **Print** sample labels from PDF file.
4 **Sample** containers were shipped to LEHR. Retrieve container shipments from main building receiving area if they are not already in field office.
5. **Bring**:

☐ Project Health and Safety Plan	☐ Graduated cylinder	☐ Cal Check Standards (in field office)
☐ COCs and Field Forms	☐ Packing tape, bubble wrap, absorbent	☐ well keys
☐ Sample labels	☐ coolers with ice	☐ cones, tools to access vaults
☐ Sample containers	☐ camera phone	☐ 5 gal bucket (in field office)
☐ Low-flow controller	☐ 1 gallon Ziploc bags	☐
☐ water level meter	☐ Filters (0.45um) (in field office)	☐

DOE Areas Groundwater Sampling: March 2019

GROUNDWATER SAMPLING FIELD WORK PROTOCOL PACKAGE
COVER SHEET
GENERAL INFORMATION

Work Description and Special Instructions:

1 **Review** the Site Health and Safety Plan each AM and fill out safety forms daily.

2 **Please Perform** calibration check on the multi-meter each day before collecting DOE samples. If multi-meter is not found in field office, contact Rachel Lauesen (contact info above) to obtain meter. Record cal-check on the log (SQP 8.1). Enter calibration checks on separate line of form each day.

3 **Collect** samples from wells UCD1-013, -021, -023, -068, -069, -070, -071, and -072 . Follow the attached sampling procedure. Complete the Water Sampling Data Sheets for each well (attached).

4 **Collect** samples according to the attached Sampling Schedule.

5 **Collect** field duplicate samples as shown on the sampling protocol spreadsheet. Collect MS/MSD extra containers for the field duplicates as shown on the sampling protocol.

6 **Collect** unfiltered samples from each well before attaching the filter and collecting filtered samples.

7 **Contain** and discharge purge water to tanks near Co-60 field. Pump water into tanks. Do not carry bucket up ladder to tank opening at top. Pour water into IRA system containment/drain if you cannot pump to tanks.

8 **Fill** out chain-of custody in the field and QC check against containers in afternoon before relinquishing. Number each COC.

9 **Pack** samples in coolers for appropriate laboratories. Place containers upright in coolers. Do not lay containers sideways in cooler or they will break during transport.

10 **Ship** C-14 samples via overnight air on ice to GEL. Ship all other radiological samples to GEL via ground without ice: General Engineering Labs, 2040 Savage Road, Charleston, SC 29407, Phone 843-556-8171. Use extra padding. Radiological sample shipping can be done the day after sampling is complete.

11 **Transfer** custody of all other chemical parameter samples over to Calscience courier.

Safety Requirements:

1. Level D protection is required at this site (work clothes, steel-toed & chemical resistant boots, vinyl gloves, safety glasses or goggles recommended, etc.).
2. Use traffic safety equipment when working around moving vehicles (e.g., barricades, cones, vest).
3. Review and bring to the Site the Site Health and Safety Plan and Hospital Map.

ATTACHMENT 6.2

SAMPLING PROTOCOL TEMPLATE

SAMPLING PROTOCOL

SITE: START DATE:
JOB NO.: Tech Lead:

Sampling Point	Sample Number	Sample Type (1)	Analyze for	Analytical Method	Sample Matrix (2)	Lab (3)	# of Con-tainers	Sample / Cont. Type (4)	Volume	Preser-vative? (5)	Filter? (Y/N)	Refrig? (Y/N)	Lab Turn (6)	Sampled By	Sample Date	Sample Time	Special Instructions

1. N = Normal environmental sample, FD = Field duplicate, EB = Equipment blank, TB = Trip blank
2. WG = Groundwater, WQ = Water Quality
3. CEL = Eurofins/Calscience Environmental Lab, GEL = GEL Laboratories, LLC
4. W = Water, S = Soil, V = Clear VOA, VB = Brown VOA, A = Amber, P = Plastic, G = Glass (Specify in Special Instructions)
5. N = None, specify any preservative desired
6. N = Normal, specify the laboratory turnaround time

GEOTRACKER ELECTRONIC REPORTING

STANDARD OPERATING PROCEDURE 17.4

1. Purpose

GeoTracker is a State of California database and geographic information system (GIS) public access repository of contaminant release information for leaking underground fuel tanks (LUFT), Department of Defense (DoD) sites, Spills-Leaks-Investigations-Cleanups (SLIC), and Landfill sites. U.S. Department of Energy may authorize a consultant as an agent to upload laboratory analytical data, well construction and location data, and electronic images of maps and complete reports to GeoTracker. In the case that a consultant is so authorized, it is the responsibility of the Consulting Project Manager to ensure that all data uploaded to GeoTracker are accurate and uploaded using the procedures described in this SOP.

2. References

State Water Resources Control Board (SWRCB), 2019, Electronic Submittal of Information (ESI), https://www.waterboards.ca.gov/ust/electronic_submittal/, Updated January 2, 2019.

http://geotracker.swrcb.ca.gov

3. Definitions

Global ID - This is the unique GeoTracker identifier for the Site (SL186272984).

Field Point Name (FPN) - This is the unique identifier assigned to a specific point (location) where measurements or samples are taken. Names uploaded to GeoTracker must be the same as the well names and borehole names used in the hard copy report submitted to the lead agency.

Electronic Deliverable File (EDF) - This is a comprehensive data standard designed to facilitate the transfer of electronic data files between data producers and data users. The format is specific to analytical laboratory data.

4. Procedure

GeoTracker requires a username and password to gain access to the secure portion of the GeoTracker website in order to claim sites and upload data. Consultants can obtain a user name and password from the State Water Resources Control Board, Electronic Submittal of Information (ESI) website (SWRCB, 2019).

Electronic submittal of laboratory analytical data must be preceded by uploading of field point names and well construction data. The FPNs uploaded to GeoTracker must be the same as the well names and borehole names used in the hard copy reports submitted to the regulatory agency. Well construction information is entered on a data entry screen on the GeoTracker website.

Analytical data are uploaded via laboratory-supplied, compressed EDFs. If the sample location data or Global ID are not included in the laboratory EDF, these data must be entered into the EDF either manually or via database queries, and re-compressed, or zipped, before the EDF can be uploaded. The global ID for the Laboratory for Energy-related Health Research/Old Campus Landfill Superfund Site is SL186272984.

Well location data are uploaded via GEO_XY files, which provide surveyed sub-meter accuracy horizontal field measurement data. Positions of fixed sampling locations [longitude (X) and latitude (Y)], such as groundwater monitoring wells, should be reported only once for a site, unless resurveyed. Consumer-grade GPS units do not meet GeoTracker's submeter accuracy requirements. Locations must be surveyed by a licensed surveyor. The GEO XY file is a text file and must always be named “GEO_XY.txt”. It must be compressed prior to uploading into GeoTracker.

Water level data are uploaded via GEO_Z files. Elevation data should be submitted every time a new survey is performed. The GEO Z file is a text file and must always be named “GEO_Z.txt”. It must be compressed prior to uploading into GeoTracker.

Field measurements, such as dissolved oxygen, pH, temperature, etc., are uploaded via GEO_WELL files. GEO_WELL data should be submitted after every sampling event. The GEO WELL file is a text file and must always be named “GEO_WELL.txt”. It must be compressed prior to uploading onto GeoTracker.

Site maps are uploaded via GEO_MAP files. The GEO_MAP file is an electronic image of the generalized site plan map and is most often created by electronically scanning the hard copy report’s site map. The GEO_MAP should display locations of existing and former underground storage tanks, buildings, streets bordering the Site, and sampling locations of all groundwater wells and soil samples. The GEO_MAP does not need to contain locations of composite samples (often collected from stockpiles or holding drums). The GEO_MAP file must always be named “GEO_MAP” and should have the applicable file extension (.gif, .jpeg, .jpg, .tiff, .tif, or .PDF) and should NOT be compressed prior to upload. Multiple GEO_MAP files can be submitted for a site.

Boring log data are uploaded via GEO_BORE files. The GEO_BORE file is an electronic image of the boring log for import into the GeoTracker system. Each boring log is associated with an individual sampling location where the borehole was drilled. The graphics of a boring log will vary, and may require more or less detail, depending on the specific project. The boring log image is to be submitted in portable document format (PDF). To submit a GEO_BORE file, select “GEO_BORE” from the “Upload EDD” menu page and follow the instructions. A GEO_BORE file contains the bore log of only one FPN and is uploaded to that FPN (i.e. GEO_BORE files cannot be uploaded to multiple FPNs at once).

Reports are uploaded via GEO_REPORT files. The GEO_REPORT file is an electronic image of the complete report being submitted for regulatory review. Each GEO_REPORT is associated with an individual document type and title that is entered during the electronic submission

process. A complete image of the report is to be submitted as a single PDF file. A complete electronic PDF version of the paper report shall include all text, graphs, diagrams, tables, maps, and figures that are included in the paper report, as well as a signature page.

An upload confirmation report will be generated upon successful upload of files. Print the upload confirmation report and save in the project files.

Check pending status to ensure that the uploaded files have been received.

In summary, in order to upload any data or report into the GeoTracker, you will need to:

- Log in with the correct user name and password to access the intended facility;
- Upload site Field Point Names;
- Prepare data/reports in the correct format;
- Quality check data using the "Check EDD" link;
- Upload data and/or reports, in no specific order;
- Record confirmation numbers; and
- Check uploaded data/reports shown under "Pending Status".

5. Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that the required data are uploaded to GeoTracker in accordance with this SOP and any other appropriate procedures.

The data are uploaded by the Subcontractor Project Chemist and if there is a manual data entry component, those data should be checked by the Subcontractor Task Leader or designee. The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of documentation associated with this GeoTracker SOP.

The SQAM is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of SOPs, issuing nonconformances, etc.) if problems occur. Personnel assigned to GeoTracker upload activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the SQAM.

6. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with Standard Quality Procedure (SQP) 4.2 – Records Management.

7. Attachments

None.

FIELD QC SAMPLING

STANDARD OPERATING PROCEDURE 18.1

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for conducting field quality control (QC) sampling. Field QC sampling is required to evaluate the quality and integrity of samples collected during a given sampling event. Additional specific field QC sampling procedures and requirements will be provided in the project work plans.

2. References

SOP 1.1 - Sample Custody

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 3.1 - Surface and Shallow Soil Sampling

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 17.1 - Sample Labeling

SOP 17.2 - Sample Numbering

SOP 20.1 - Sample Containers, Preservation, and Holding Times

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Field QC sample - A physical sample collected during a specific sampling event. The purpose of this sample is to evaluate the quality and integrity of primary samples collected during the specific sampling event.

4. Procedure

This section contains both responsibilities and requirements for field QC sampling. Field QC sampling is required to provide data to verify the quality and integrity of environmental samples collected during a given sampling event.

The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives;

- Quantities, types, and locations of environmental (non-QC) samples to be collected;
- Quantities and types of QC samples to be collected; and
- Any additional QC sampling requirements or procedures beyond those covered in this SOP, as necessary.

The Subcontractor Project Manager (SPM) is responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC). The SPM may assign these responsibilities to a Subcontractor Task Leader (STL).

The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of field generated documentation associated with this SOP. The SQAM is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

Field personnel assigned to environmental and QC sampling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the STL or the SQAM.

Typical QC samples are as follows:

- Trip blank (TB);
- Equipment blank (EB);
- Field blank (FB); and
- Field duplicate (FD).

Trip blanks are analyte-free water, shipped from and returned unopened to the laboratory in the shipping containers containing volatile organics samples. The blanks are prepared by a vendor or the laboratory using certified organic compound-free water, sent to the project location, carried with the sampling team(s) during sampling, and shipped to the laboratory for analysis with the environmental samples.

Trip blank samples are commonly collected and analyzed at a rate of one per sample cooler containing samples for volatile organic analyses. The number or rate of trip blanks to be collected and the specific analyses to be conducted for the trip blanks will be provided in the project work plans.

Equipment blank samples are collected from the final rinse water during decontamination of groundwater, soil, or waste sampling equipment. This type of equipment includes bailers, split spoon samplers, soil sample sleeves, hand augering equipment, surface soil sampling equipment, purge and sample pumps, etc.

Equipment blank samples are generally collected at a rate of one per sampling event. Equipment blanks are usually collected from re-usable sampling equipment only. The number or rate

of equipment blank samples to be collected for a particular project will be specifically developed and documented in the project work plans. The specific chemical analyses to be conducted for the equipment blank samples will also be developed and documented in the project work plans.

Field blanks are prepared from the source of water which is used for decontamination. Source water is poured into a sample container in the field, preserved and shipped to the laboratory with field samples. One sample from each sampling event and each water source or lot number is generally collected and analyzed for all parameters of interest for the project. Upon collection, a description of the water source for the field blank sample should be documented in the field sampling data sheet.

The number or rate of field blank samples to be collected for a particular project will be specifically developed and documented in the project work plans. The specific chemical analyses to be conducted for the field blank samples will also be developed and documented in the project work plans.

For soils, field duplicate samples are generally collected by co-located sampling (e.g., using successive sample tubes from the same split spoon sampling run) or by splitting samples. Field duplicate water samples are commonly collected by retaining consecutive samples from the sampling device (e.g., bailer or sample pump discharge line). Field duplicate water samples may also be generated by splitting a collected volume; except for volatile analyses.

Field duplicate samples are commonly collected at a rate of 10 percent per media sampled. However, the number or rate of field duplicate samples to be collected for a particular project will be specifically developed and documented in the project work plans. The specific chemical analyses to be conducted for the field duplicates will also be developed and documented in the project work plans.

All field QC samples will be collected in proper containers with appropriate preservation, per SOP 20.1 and the project work plans.

The collection of field QC samples consisting of various media (e.g., soil, groundwater, etc.) will follow procedures in sample collection SOPs for the respective media and any other applicable procedures in the project work plans. For example, the collection of a surface soil field duplicate QC sample will follow procedures specified in the Surface and Shallow Soil Sampling SOP 3.1. Equipment blank samples are collected directly while rinsing the sampling equipment following appropriate procedures in Sampling Equipment and Well Material Decontamination SOP 6.1 and the project work plans. Field blank samples are collected by pouring decontamination water directly into sample containers following the applicable sample collection SOP and the project work plans.

Field QC samples will be labeled and numbered as described in SOPs 17.1 and 17.2, respectively, and the project work plans.

The field QC samples will also be maintained under custody per SOP 1.1 and be appropriately stored, handled, and shipped per SOP 2.1.

5. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

None.

SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

STANDARD OPERATING PROCEDURE 20.1

1. Purpose

This standard operating procedure (SOP) provides guidance on the selection of suitable containers for samples, volume requirement, holding times, and recommended preservation techniques for water, wastes, sediments, sludges, soil, air, and soil gas samples.

2. References

Korte, N. and P. Kearl, 1985. *Protection for the Collection and Preservation of Ground Water and Surface Water Samples and for the Installation of Monitoring Wells, 2nd ed.,* U.S. Department of Energy, GJ/TMC-08, Technical Measurements Center, Grand Junction Projects Office.

RCRA, 1986. *Ground Water Monitoring Technical Enforcement Guidance Document, OSWER-9950.1*, September 1986

United States Environmental Protection Agency (EPA), 1985. *Practical Guide for Ground Water Sampling, EPA/600/2-85/104*, Washington, D.C

EPA, 2007. *Test Methods for Evaluation of Solid Waste, EPA-SW-846, 3rd ed.*, Washington, D.C.

EPA, 1983. *Manual of Ground Water Quality Sampling Procedures, EPA/600/2-85/104*, Washington, D.C.

EPA, 1983. *Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020*, Washington, D.C.

EPA, 1982. *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA-600/2-85/104, Washington, D.C.

EPA, 2014. *Sampler's Guide, Contract Laboratory Program Guidance for Field Samplers*, EPA-500-R-014-013, October.

SOP 1.1 - Sample Custody

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 17.1 - Sample Labeling

SOP 17.2 - Sample Numbering

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Field Sample: A sample that has been collected at a project site to meet the data quality objectives defined in the project work plans.

4. Procedure

As a general guide in choosing a sample container, the construction material should be non-reactive with the sample matrix (e.g., soil, water), and the analytical parameter(s) to be tested.

Sample containers will vary according to the matrix and nature of the sample to be collected. Glass or brass containers must be used when analyzing samples for semi-volatile organic compounds, pesticides, or polychlorinated biphenyl compounds to prevent introduction of extraneous organic compounds, such as those that might be leached from plastic containers. The rigid plastic screw caps for the bottles and polyethylene caps for brass core tubes must be Teflon-lined to prevent contamination. Pre-weighed and pre-preserved volatile organics analysis (VOA) vials or Encore (or equivalent) sampling devices are acceptable for volatile organic compound (VOC) soil sample containers per EPA-SW-846 Method 5035. Polyethylene or glass containers must be used when analyzing samples for metals, but polyethylene containers are preferred because they are less likely to break during shipment. Wide-mouth containers are generally used for wastes and sediments/soil and narrow-mouth vials or bottles for water. Summa canisters are recommended for vapor intrusion samples. Containers are typically obtained from the contract laboratory and are received pre-cleaned containing the specified preservative.

Once a sample has been collected, steps must be taken to preserve the sample's chemical and physical integrity during transport and storage prior to analysis. The type of sample preservation required will vary according to the sample type and the parameter to be measured.

The task-specific work plans will establish the quantity, type, and analyses of field samples. When ordering containers for a sampling activity, include primary field samples, field duplicates, blanks, and matrix spikes as specified in the task work plan. The volume of sample collected should be sufficient to perform all required analyses, plus an additional amount for any quality control needs, split/subcontract lab samples, or repeat examination. The container, volume, preservation, and holding time specifications presented in Attachments 6.1 through 6.3 are intended as general guidance and should be verified with the contracted laboratory before placing the container order. Arrangements should be made to deliver the samples to the laboratory within the holding time and temperature requirements (see SOP 2.1, Sample Handling, Packaging, and Shipping). If sample temperature and holding times are not an issue, then expensive overnight air shipment should be avoided (ex. radiological samples).

The Subcontractor Project Manager (SPM) is responsible for assuring that the proper containers are selected and ordered in accordance with applicable environmental, safety, and health regulations, and standard operating practices. The SPM or Subcontractor Task Leader (STL) will coordinate with the Subcontractor Project Chemist (SPC) to verify the containers and analyses requested follow the task-specific work plans.

The designated STL or the SPC are responsible for comparing the containers received from the laboratory to the original order of containers to verify that all containers and preservatives are correct.

Field personnel assigned to sampling activities are responsible for using the proper containers and preservatives. All staff are responsible for reporting deviations from the procedures to the STL or the SPM. At the conclusion of the sampling activities, field personnel are responsible for returning the completed field forms to the STL or SPM.

5. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

6.1 - Table 1. Recommendation for Sample Volumes, Containers, Preservation, and Holding Times of Water Samples

6.2 - Table 2. Recommendation for Sample Volumes, Containers, Preservation, and Holding Times of Sediment/Soil Samples

6.3 - Table 3. Recommendation for Sample Volumes, Containers, Preservation, and Holding Times of Air and Soil Gas Samples

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the CQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

TABLE 1. RECOMMENDATION FOR SAMPLE VOLUMES, CONTAINERS, PRESERVATION, AND HOLDING TIMES OF WATER SAMPLES

Table 1. Recommendation for Sampling Volumes, Containers, Preservation and Holding Times of Water Samples[1]

Measurement	Container Size / Min Volume (ml)	Container[2]	Preservative[3,4]	Holding Time
Organics				
Volatile organic compounds	3 x 40-ml vial / 40	G, Teflon-lined septum	Cool, 4ºC, HCl to pH<2 (no headspace)	14 Days
Benzene, toluene, ethylbenzene, and Xylenes	3 x 40-ml vial / 40	G, Teflon-lined septum	Cool, 4ºC, HCl to pH<2 (no headspace)	14 Days
Total petroleum hydrocarbons as gasoline	3 x 40-ml vial / 40	G, Teflon-lined septum	Cool, 4ºC, HCl to pH<2 (no headspace)	14 Days
Total petroleum hydrocarbons as diesel, jet, motor oil	1,000 / 500	A, Teflon-lined cap	Cool, 4ºC	7 Days until extraction 40 Days after extraction
Semi-volatile organic compounds	1,000 / 1,000	A, Teflon-lined cap	Cool, 4ºC	7 Days until extraction 40 Days after extraction
Polycyclic aromatic hydrocarbons	1,000 / 1,000	A, Teflon-lined cap	Cool, 4ºC	7 Days until extraction 40 Days after extraction
Pesticides	1,000 / 1,000	A, Teflon-lined cap	Cool, 4ºC	7 Days until extraction 40 Days after extraction
Polychlorinated biphenyls	1,000 / 1,000	A, Teflon-lined cap	Cool, 4ºC	7 Days until extraction 40 Days after extraction
Oil and Grease	1,000 / 1,000	A, Teflon-lined cap	Cool, 4ºC; H_2SO_4 to pH<2	28 Days
Organic Carbon	250 / 150	G	Cool, 4ºC; H_2SO_4 to pH<2	28 Days
Inorganics				
ICP and ICP/MS metals	250 / 100	P	HNO_3 to pH<2	6 Months
Mercury	250 / 100	P	HNO_3 to pH<2	28 Days
Low-level mercury	500 / 50	G, Teflon-lined cap	Preserved by Lab [5]	90 Days
Hexavalent chromium	250 / 200	P	Cool, 4ºC	24 Hours
Nitrate Plus Nitrite	125 / 50	P	Cool, 4ºC; H_2SO_4 to pH<2	28 Days
Nitrate	125 / 50	P	Cool, 4ºC	48 Hours
Chloride	125 / 50	P	Cool, 4ºC	28 Days
Chlorine	500 / 100	P	None Required	15 Minutes
Sulfate	125 / 50	P	Cool, 4ºC	28 Days
Alkalinity	250 / 100	P	Cool, 4ºC	14 Days
Dissolved Oxygen	500 / 300	A	no headspace	15 Minutes
Oxidation reduction potential	250 / 100	P, G	None Required	Analyze Immediately
Radiological Tests				
Gamma Spectrum	2,000 / 2,000	P	HNO_3 to pH<2	6 Months
Gross Alpha, Beta	1,000 / 500	P	HNO_3 to pH<2	6 Months
Carbon-14	1,000 / 500	P	Cool, 4ºC	6 Months
Tritium	1,000 / 250	P	none	6 Months
Alpha emitters [6]	1,000 / 500	P	HNO_3 to pH<2	6 Months

Table 1. Recommendation for Sampling Volumes, Containers, Preservation and Holding Times of Water Samples[1]

Measurement	Container Size / Min Volume (ml)	Container[2]	Preservative[3,4]	Holding Time
Physical Properties				
Conductance	125 / 50	P	Cool, 4ºC	28 Days
pH	125 / 50	P, G	None Required	15 Minutes
Total dissolved solids	1,000 / 1,000	P	Cool, 4ºC	7 Days
Total suspended solids	1,000 / 1,000	P	Cool, 4ºC	7 Days
Temperature	250 / 100	P, G	None Required	Analyze Immediately
Turbidity	125 / 100	P	Cool, 4ºC	48 Hours
Bacterial				
Coliform, Fecal and Total	250 / 250	P sterile, G sterile	Cool, 4ºC; 0.008% $Na_2S_2O_3$	6 Hours

Notes:

[1] More specific instructions for preservation and sampling are found in Code of Federal Regulations, 40, Part 136, 2013.
[2] Plastic (P) or Glass (G) or Amber glass (A).
[3] Sample preservation should be performed immediately upon sample collection.
[4] When any sample is to be shipped by common carrier (ex. FedEx) or sent through the United States Postal Service, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).
[5] Low-level mercury samples are preserved by the laboratory upon receipt.
[6] americium-241, plutonium-241, radium-226, thorium series, uranium series

Abbreviations:
HCl – hydrochloric acid
H_2SO_4 – sulfuric acid
HNO_3 – nitric acid
ICP/MS – inductively coupled plasma/mass spectrometry
ml – milliliter
$Na_2S_2O_3$ – sodium thiosulfate

ATTACHMENT 6.2

TABLE 2. RECOMMENDATION FOR SAMPLE VOLUMES, CONTAINERS, PRESERVATION, AND HOLDING TIMES OF SEDIMENT/SOIL SAMPLES

Table 2. Recommendation for Sampling Volumes, Containers, Preservation and Holding Times of Sediment/Soil Samples

Measurement	Container Size / Minimum Volume	Container[1]	Preservative[2]	Holding Time
Organics				
Volatile Organic Compounds (including BTEX[3])	three 40 ml / 5g; one 60 ml	Pre-weighed VOAs; 5-gram core sampler; 60 ml glass jar	Na metabisulfite (low level), methanol (high level), Cool, 4ºC	14 Days
Total Petroleum Hydrocarbons as Gasoline	three 40 ml / 5g; one 60 ml	Pre-weighed VOAs; 5-gram core sampler; 60 ml glass jar	Na metabisulfite (low level), methanol (high level), Cool, 4ºC	14 Days
Volatile Organic Compounds (including BTEX[3])	two 5g / 5g	Encore™ or equivalent	Cool, 4ºC	48 Hours until preservation[4], 14 days if preserved
Total Petroleum Hydrocarbons as Gasoline	two 5g / 5g	Encore™ or equivalent	Cool, 4ºC	48 Hours until preservation[4], 14 days if preserved
SVOCs, PAHs, TPH-D, TPH-jet, TPH-MO, organochlorine pesticides, PCBs [5]	4-oz, 20g each analysis	G, Teflon-lined caps	Cool, 4ºC	14 Days until extraction/ 40 Days after extraction
Total Organic Carbon	4-oz / 2g	G, Teflon-lined caps	Cool, 4ºC	28 Days
Inorganics				
ICP and ICP/MS Metals	4-oz / 2g	P, G, Teflon-lined caps	Cool, 4ºC	6 Months
Mercury	4-oz / 1g	P, G, Teflon-lined caps	Cool, 4ºC	28 Days
Hexavalent Chromium	4-oz / 10g	P, G, Teflon-lined caps	Cool, 4ºC	30 Days
Nitrate	4-oz / 10g	P, G, Teflon-lined caps	Cool, 4ºC	7 Days
Sulfate	4-oz / 20g	P, G, Teflon-lined caps	Cool, 4ºC	28 Days
Oil & Grease	4-oz / 30g	G, Teflon-lined caps	Cool, 4ºC	28 Days
pH	4-oz / 20g	P, G, Teflon-lined caps	Cool, 4ºC	24 Hours
Radiological Tests				
Gamma Spectrum	8-oz / 200g	P, Teflon-lined caps	None Required	6 Months
Gross Alpha, Beta	4-oz / 20g	P, Teflon-lined caps	None Required	6 Months
Carbon-14	4-oz / 20g	G, Teflon-lined caps	Cool, 4ºC	6 Months
Tritium	4-oz / 20g	P, Teflon-lined caps	None Required	6 Months
Alpha emitters[6]	4-oz / 20g ea	P, Teflon-lined caps	None Required	6 Months

Notes:

[1] Polyethylene (P) or Glass (G) or Volatile Organics Analysis vial (VOA).

[2] When any sample is to be shipped by common carrier (ex. FedEx) or sent through the United States Postal Service, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).

[3] benzene, toluene, ethylbenzene and xylenes (BTEX) typically included in volatile organic compounds analysis. Verify analyte suite provided by laboratory.

[4] Encore™ sample preservation should be done by offsite laboratory.

[5] Semi-volatile organic compounds (SVOCs) or polycyclic aromatic hydrocarbons (PAHs) or total petroleum hydrocarbons as diesel (TPH-G) or total petroleum hydrocarbons as jet fuel (TPH-jet) or total petroleum hydrocarbons as motor oil (TPH-MO) or polychlorinated biphenyls (PCBs).

[6] americium-241, plutonium-241, thorium series, uranium series

Abbreviations:

g – gram(s)
ICP/MS – inductively coupled plasma/mass spectrometry
ml – milliliter
oz – ounces

ATTACHMENT 6.3

TABLE 3. RECOMMENDATION FOR SAMPLE VOLUMES, CONTAINERS, PRESERVATION, AND HOLDING TIMES OF AIR AND SOIL GAS SAMPLES

Table 3. Recommendation for Sampling Volumes, Containers, Preservation, and Holding Times of Air and Soil Gas Samples

Measurement	Container Size / Min Volume	Container	Preservative	Holding Time
VOCs[1] in indoor air	6-Liter	SUMMA canister	NA	30 days
VOCs[1] in ambient air	6-Liter	SUMMA canister	NA	30 days
VOCs[1] in soil gas	1-Liter	SUMMA canister	NA	30 days
VOCs[1] in sub-slab soil gas	1-Liter	SUMMA canister	NA	30 days

Notes:

[1] EPA Method TO-15 analysis

Abbreviations:

NA – not applicable
EPA – United States Environmental Protection Agency
VOCs – volatile organic compounds

DATA VALIDATION

STANDARD OPERATING PROCEDURE 21.1

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for data validation. Data validation is required to assess if project data meet the data quality objectives (DQOs), and to ensure that data are accurate and dependable for project decisions. Additional specific procedures and requirements will be provided in the project work plans.

2. References

United States Environmental Protection Agency (EPA), 2015, *US EPA Guidance on Environmental Data Verification and Data Validation, EPA-QA/G-8,* June.

EPA, January 2017a, *National Functional Guidelines for Organic Superfund Methods Data Review (SOM02.4), EPA-540-R-2017-002*

EPA, January 2017b, *National Functional Guidelines for Inorganic Superfund Methods Data Review (ISM02.4), EPA 540-R-2017-001*

SOP 1.1 - Sample Custody

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 6.1 - Sampling Equipment and Well Material Decontamination

SOP 17.1 - Sample Labeling

SOP 17.2 - Sample Numbering

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Data validation is a systemic process for reviewing and qualifying data, to provide assurance that the data are adequate for their intended use. During the validation process, all results will be identified as either acceptable for use, estimated and acceptable for use, or rejected and unacceptable for use.

4. Procedure

The Subcontractor Project Manager (SPM) s responsible for ensuring that all data validation activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of documentation associated with this data validation SOP. The SQAM is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to data validation requirements, issuing nonconformances, etc.) if problems occur.

Personnel assigned to data validation activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the SQAM.

Data validation will be performed using checklists and referring to the guidance of the *National Functional Guidelines for Organic Superfund Methods Data Review* (EPA, 2017a) and *National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2017b). The checklist for Level II validation is provided in Attachment 1. Level II data validation consists of reviewing the laboratory report for holding times, reported weight basis, detection limits, detection below the reporting limit, surrogate spike recoveries, laboratory control sample recoveries, matrix spike recoveries (MS/MSD), blank contamination, and field duplicate precision. Checklists for Levels III and IV validation of organic, metals, general chemistry, and radiochemistry data are also provided in Attachment 1. Level III validation contains the following elements:

- The organic data will be reviewed for holding times, blank analysis results, gas chromatography/mass spectrometry (GC/MS) tuning, instrument calibrations, internal standard areas, laboratory control samples (LCS), matrix spike/matrix spike duplicate (MS/MSD), and surrogate recovery;
- The metals, general chemistry and radiochemistry data will be reviewed for holding times, blank analysis results, MS/MSD, LCS, and instrument calibrations; and,
- Analytical results will be qualified as a result of the data validation process in accordance with the qualifying conventions as listed in Attachment 2.

Level IV data validation involves reconstruction of some or all of the laboratory results in addition to all elements of Level III validation. The percentage of results requiring reconstruction of the laboratory results shall be as specified in the specific sampling and analysis plan.

All data qualified as a result of the validation process will be summarized on a Data Validation Summary sheet. The summary sheet must list the compound qualified, as well as the sample identification, qualification flag, and reason code. Reason codes must be defined (California GeoTracker codes).

5. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

Data Validation Checklists:

6.1 - Level II Data Review Summary

6.2 - Level III/IV Validation of Organic Data by GC/MS Analysis

6.3 - Level III/IV Validation of Organic Data by GC Analysis

6.4 - Level III/IV Validation of Radiochemistry Data

6.5 - Level III/IV Validation of Metals Data

6.6 - Level III/IV Validation of Wet Chemistry or Other Miscellaneous Analyses

Data Validation Qualifier Definitions and Summary forms:

6.7 - Data Validation Qualifier Definitions

6.8 - Data Validation Summary

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the SQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

LEVEL II DATA REVIEW SUMMARY

LEVEL II DATA REVIEW SUMMARY

Project Name: Project Number:

Analyses: Lab Order Number:

Sample Dates:

Laboratory QC Criteria	Yes	No	NA
Have all samples been extracted/analyzed within holding times?			
Did the laboratory report the correct weight basis?			
Are detection and reporting limits acceptable?			
Were all detected analytes above their reporting limit?			
Are all surrogate recoveries in all samples within QC limits?			
Are all LCS recoveries within QC limits?			
Are all MS/MSD recoveries and RPDs within QC limits?			
Are method blanks free of contamination?			
Are travel blanks free of contamination?			
Are field/equipment blanks free of contamination?			
Are all compounds present in either the sample or duplicate also present in the other?			
Are all RPDs between sample and duplicate acceptable (35% for water and air, 50% for soil)?			

Flags:

Sample ID	Compound	Det Flag	Lab Quals	Val Quals	Final Quals	Reportable Result?

Comments:

Reviewed by: Date:

ATTACHMENT 6.2

LEVEL III/IV VALIDATION OF ORGANIC DATA BY GC/MS ANALYSIS

LEVEL III/IV VALIDATION OF ORGANIC DATA BY GC/MS ANALYSIS

Lab: _____ Date: _____

Analysis: _____ SDG #: _____

HOLDING TIMES

Have all SVOC samples been extracted within holding times? **Yes** ☐ **No** ☐ **N/A** ☐

If any sample fails this criterion, apply qualifiers to all results in the sample according to the following guidelines:

Condition	Positives	Non-Detects
15 Days ≤ Soil Sampling → Extraction ≤ 28 Days	"J"	"UJ"
Soil Sampling → Extraction > 28 Days	"J"	"R"
8 Days ≤ Water Sampling → Extraction ≤ 14 Days	"J"	"UJ"
Water Sampling → Extraction > 14 Days	"J"	"R"

Have all samples been analyzed within holding times? **Yes** ☐ **No** ☐ **N/A** ☐

If any sample fails this criterion for the VOC fraction, apply qualifiers to all results in the sample according to the following guidelines (note: unpreserved soil sample holding time is 48 hours):

Condition	Positives	Non-Detects
15 Days ≤ VOC Sampling → Analysis ≤ 28 Days	"J"	"UJ"
VOC Sampling → Analysis > 28 Days	"J"	"R"

If any sample fails this criterion for the SVOC fraction, apply qualifiers to all results in the sample according to the following guidelines:

Condition	Positives	Non-Detects
41 Days ≤ BNA Extraction → Analysis ≤ 80 Days	"J"	"UJ"
BNA Extraction → Analysis > 80 Days	"J"	"R"

SYSTEM MONITORING COMPOUNDS (SURROGATES)

Are all surrogate recoveries in all samples within QC limits? Yes ☐ No ☐ N/A ☐

If any surrogate failures are observed in a sample for the VOC fraction, apply qualifiers to all results in the sample according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper Limit	"J"	No qualifiers
10% ≤ %R < Lower Limit	"J"	"UJ"
%R < 10%	"J"	"R"

If any surrogate failures are observed in a sample for either the Base/Neutral or Acid fractions, apply qualifiers to all results in the sample, for that fraction, according to the following guidelines:

Condition	Positives	Non-Detects
1 %R out & > 10%	No qualifiers	No qualifiers
2 or more %R out, > Upper Limit	"J"	No qualifiers
2 or more %R out, < Lower Limit and all > 10%	"J"	"UJ"
1 or more %R < 10%	"J"	"R"

QC CHECK SAMPLE (LCS)

Are all LCS recoveries within QC limits? Yes ☐ No ☐ N/A ☐

If any LCS compound fails this criterion, apply qualifiers to the failed compound in all samples associated with that LCS, according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper Limit	"J"	No qualifiers
30% ≤ %R < Lower Limit	"J"	"UJ"
%R < 30%	"J"	"R"

If failures are widespread and consistent in the direction of the failure, then an overall analytical bias can be determined for this fraction.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

	Yes	No	N/A
Are all MS/MSD recoveries and relative percent difference (RPD) within QC limits?	☐	☐	☐

MS/MSD data are used in conjunction with LCS data to identify and describe interferences. If LCS recoveries indicate a similar bias, then the bias can be determined to be analytical in nature. If LCS recoveries are in control, then the bias can be identified as a matrix effect.

BLANKS

Are the following free of contamination?	Yes	No	N/A
Method blanks	☐	☐	☐
Trip blanks (if present)	☐	☐	☐
Field/Rinseate blanks (if present)	☐	☐	☐

Use the following steps when qualifying data based on blank contamination.

- Identify all individual data points that are associated with a blank contaminant.
- For any data point associated with contamination from more than one blank, select the blank with the highest concentration of the contaminant. The sample data point will be compared to this contaminant for qualifying purposes.
- Convert the concentration of the selected contaminant to the actual contamination level. Divide the contamination concentration by the blank detection limit and multiply by the sample detection limit.
- Qualify all data points associated with a common laboratory contaminant (acetone, 2-butanone, methylene chloride, or common phthalates) according to the following guidelines:

Condition	Flag
No Positive Sample Result	None
Positive Sample Result < 10x Contamination Level	"UJ"
Positive Sample Result > 10x Contamination Level	None

- Qualify all data points associated with any other laboratory contaminant according to the following guidelines:

Condition	Flag
No Positive Sample Result	None
Positive Sample Result < 5x Contamination Level	"UJ"
Positive Sample Result > 5x Contamination Level	None

GC/MS INSTRUMENT PREFORMANCE CHECKS (TUNES)

Are all ion abundances within QC limits for each tune? Yes ☐ No ☐ N/A ☐

If any ion abundances do not fall within QC limits, qualify all results in all related samples "R".

INITIAL CALIBRATIONS (ICs)

Are all RRFs greater than 0.05? Yes ☐ No ☐ N/A ☐

If any compound fails this criterion, qualify the failed compound in all samples associated with that IC; qualify positive results "J" and non-detects "R".

Are all %RSDs less than 30%? Yes ☐ No ☐ N/A ☐

If any compound fails this criterion, apply qualifiers to that compound in all samples associated with that IC, according to the following guidelines:

Condition	Positives	Non-Detects
30% < %RSD < 80%	"J"	"UJ"
%RSD > 80%	"J"	"R"

CONTINUING CALIBRATIONS (CCs)

Are all RRFs greater than 0.05? Yes ☐ No ☐ N/A ☐

If any compound fails this criterion, qualify the failed compound in all samples associated with that CC; qualify positive results "J" and non-detects "R".

Are all %Ds less than 25%?	**Yes**	**No**	**N/A**
	☐	☐	☐

If any compound fails this criterion, apply qualifiers to that compound in all samples associated with that CC, according to the following guidelines:

Condition	**Positives**	**Non-Detects**
25% < %D ≤ 80%	"J"	"UJ(-)/No qualifiers(+)"
%D > 80% and the RF from CC > RRF from IC	"J"	"UJ"
%D > 80% and the RF from CC < RRF from IC	"J"	"R"

INTERNAL STANDARDS (ISs)

Are all IS retention times within 30 seconds of the retention times for the ISs in the associated CCs?	**Yes**	**No**	**N/A**
	☐	☐	☐

If any IS in a sample fails this criterion, qualify all compounds that are quantitated with that IS in that sample; qualify positive results "J" and non-detects "R".

Are all IS area counts > 50% and < 200% of the area count for the ISs in the associated CCs?	**Yes**	**No**	**N/A**
	☐	☐	☐

If any IS in a sample fails this criterion, qualify all compounds that are quantitated with that IS in that sample, according to the following guidelines:

Condition	**Positives**	**Non-Detects**
Sample Count > 200%	"J"	No qualifiers
25% ≤ Sample Count < 50%	"J"	"UJ"
Sample Count < 25%	"J"	"R"

FIELD DUPLICATES (IF APPLICABLE)

Are all compounds present in either the sample or duplicate also present in the other?	**Yes**	**No**	**N/A**
	☐	☐	☐

Data are not qualified based on field duplicate precision; rather, an overall assessment of whether or not the data is representative of field conditions is made. This assessment should be discussed in the final report. If several compounds are present in either the sample or the duplicate but not in the other, then data may be qualitatively questionable. Some guidelines for evaluation:

- Any sample or duplicate data point that is below the DL is considered to be a positive result if the other data point in the pair is a positive result.
- Any sample or duplicate data point that is below the DL is considered to be a non-detect if the other data point in the pair is a non-detect.
- If several discrepancies are noted, check to see if they are consistent (i.e., always present in the sample, but not detected in the duplicate).
- If discrepancies are consistent, compare DLs to see if there may be a large dilution factor for whichever sample consistently shows the non-detects.

Are all RPDs between sample and duplicate acceptable?	**Yes**	**No**	**N/A**
	☐	☐	☐

Make an overall assessment of the quantitative precision of the sample-duplicate data. All RPDs should be within 35% for water and air; 50% for soil. Calculate RPDs according to the following guidelines:

- If both data points for a compound are not detected, or are found below the RL, no calculation is necessary.
- Any data point that is found, but below the RL, can be considered a positive result at the RL for calculation purposes.
- The RPD for two data points is (Difference/Mean)×100.

Prepared By: _____ Date _____

ATTACHMENT 6.3

LEVEL III/IV VALIDATION OF ORGANIC DATA BY GC ANALYSIS

LEVEL III/IV VALIDATION OF ORGANIC DATA BY GC ANALYSIS

Lab: _____ Date: _____

Analysis: _____ SDG #: _____

HOLDING TIMES

Have all SVOC samples been extracted within holding times? **Yes** ☐ **No** ☐ **N/A** ☐

If any sample fails this criterion, apply qualifiers to all results in the sample, according to the following guidelines:

Condition	Positives	Non-Detects
15 Days ≤ Soil Sampling → Extraction ≤ 28 Days	"J"	"UJ"
Soil Sampling → Extraction > 28 Days	"J"	"R"
8 Days ≤ Water Sampling → Extraction ≤ 14 Days	"J"	"UJ"
Water Sampling → Extraction > 14 Days	"J"	"R"

Have all samples been analyzed within holding times? **Yes** ☐ **No** ☐ **N/A** ☐

If any sample fails this criterion for the VOC fraction, apply qualifiers to all results in the sample according to the following guidelines (note: unpreserved soil sample holding time is 48 hours):

Condition	Positives	Non-Detects
15 Days ≤ VOC Sampling → Analysis ≤ 28 Days	"J"	"UJ"
VOC Sampling → Analysis > 28 Days	"J"	"R"

If any sample fails this criterion for either the SVOC, Pesticide/PCB, or Herbicide fraction, apply qualifiers to all results in the sample, for that fraction, according to the following guidelines:

Condition	Positives	Non-Detects
41 Days ≤ Extraction → Analysis ≤ 80 Days	"J"	"UJ"
Extraction → Analysis > 80 Days	"J"	"R"

SYSTEM MONITORING COMPOUNDS (SURROGATES)

Are all surrogate recoveries in all samples within QC limits? **Yes** ☐ **No** ☐ **N/A** ☐

If any surrogate failures are observed in a sample for either the VOC, Pesticide/PCB, or Herbicide fraction, apply qualifiers to all results in the sample, for that fraction, according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper Limit	"J"	No qualifiers
10% ≤ %R < Lower Limit	"J"	"UJ"
%R < 10%	"J"	"R"

QC CHECK SAMPLE (LCS)

Are all LCS recoveries within QC limits? **Yes** ☐ **No** ☐ **N/A** ☐

If any LCS compound fails this criterion, apply qualifiers to the failed compound in all samples associated with that LCS, according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper Limit	"J"	No qualifiers
30% ≤ %R < Lower Limit	"J"	"UJ"
%R < 30%	"J"	"R"

If failures are widespread and consistent in the direction of the failure, then an overall analytical bias can be determined for this fraction.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

Yes ☐ **No** ☐ **N/A** ☐

Are all MS/MSD recoveries and relative percent difference (RPD) within QC limits?

MS/MSD data are used in conjunction with LCS data to identify and describe interferences. If LCS recoveries indicate a similar bias, then the bias can be determined to be analytical in nature. If LCS recoveries are in control, then the bias can be identified as a matrix effect.

BLANKS

Are the following free of contamination?	**Yes**	**No**	**N/A**
Method blanks	☐	☐	☐
Trip blanks (if present)	☐	☐	☐
Field/Rinseate blanks (if present)	☐	☐	☐

Use the following steps when qualifying data based on blank contamination.

- Identify all individual data points that are associated with a blank contaminant.
- For any data point associated with contamination from more than one blank, select the blank with the highest concentration of the contaminant. The sample data point will be compared to this contaminant for qualifying purposes.
- Convert the concentration of the selected contaminant to the actual contamination level. Divide the contamination concentration by the blank detection limit and multiply by the sample detection limit.
- Qualify all data points associated with a common laboratory contaminant (acetone, 2-butanone, or methylene chloride) according to the following guidelines:

Condition	**Flag**
No Positive Sample Result	None
Positive Sample Result < 10x Contamination Level	"UJ"
Positive Sample Result > 10x Contamination Level	None

- Qualify all data points associated with any other laboratory contaminant according to the following guidelines:

Condition	**Flag**
No Positive Sample Result	None
Positive Sample Result < 5x Contamination Level	"UJ"
Positive Sample Result > 5x Contamination Level	None

INITIAL CALIBRATIONS (ICs)

Are all %RSDs within QC limits for the quantitation column? **Yes** ☐ **No** ☐ **N/A** ☐

If any compound fails this criterion, apply qualifiers to that compound in all samples associated with that IC, according to the following guidelines:

Condition	Positives	Non-Detects
30% < %RSD < 80%	"J"	"UJ"
%RSD > 80%	"J"	"R"

CONTINUING CALIBRATIONS (CCs)

Are all %Ds within QC limits for the quantitation and confirmation columns? **Yes** ☐ **No** ☐ **N/A** ☐

If any compound fails this criterion, apply qualifiers to that compound in all samples associated with that CC, according to the following guidelines:

Condition	Positives	Non-Detects
25% < %D ≤ 80%	"J"	"UJ(-)/No Qualifiers(+)"
%D > 80% and the RF from the CC > RRF from IC	"J"	"UJ"
%D > 80% and the RF from the CC < RRF from IC	"J"	"R"

FIELD DUPLICATES (IF APPLICABLE)

Are all compounds present in either the sample or duplicate also present in the other?	**Yes** ☐	**No** ☐	**N/A** ☐

Data are not qualified based on field duplicate precision; rather, an overall assessment of whether or not the data is representative of field conditions is made. This assessment should be discussed in the final report. If several compounds are present in either the sample or the duplicate but not in the other, then data may be qualitatively questionable. Some guidelines for evaluation:

- Any sample or duplicate data point that is below the DL is considered to be a positive result if the other data point in the pair is a positive result.
- Any sample or duplicate data point that is below the DL is considered to be a non-detect if the other data point in the pair is a non-detect.
- If several discrepancies are noted, check to see if they are consistent (i.e., always present in the sample, but not detected in the duplicate).
- If discrepancies are consistent, compare DLs to see if there may be a large dilution factor for whichever sample consistently shows the non-detects.

Are all RPDs between sample and duplicate acceptable?	**Yes** ☐	**No** ☐	**N/A** ☐

Make an overall assessment of the quantitative precision of the sample-duplicate data. All RPDs should be within 35% for water and air; 50% for soil. Calculate RPDs according to the following guidelines:

- If both data points for a compound are not detected, or are found below the RL, no calculation is necessary.
- Any data point that is found, but below the RL, can be considered a positive result at the RL for calculation purposes.
- The RPD for two data points is (Difference/Mean)x100.

Prepared By: _____ Date _____

ATTACHMENT 6.4

LEVEL III/IV VALIDATION OF RADIOCHEMISTRY DATA

LEVEL III/IV VALIDATION OF RADIOCHEMISTRY DATA

Lab: _____ Date: _____

Analysis: _____ SDG #: _____

HOLDING TIMES

Have all samples been analyzed within 180 days? **Yes** ☐ **No** ☐ **N/A** ☐

If any sample fails this criterion, apply "J" qualifier to all sample results.

LABORATORY CONTROL SAMPLE (LCS)

Are all LCS recoveries within QC limits? **Yes** ☐ **No** ☐ **N/A** ☐

Gross Alpha, Beta: Recovery = ± 30%
All others: Recovery = ± 25%

If any LCS compound fails this criterion, apply qualifiers to the failed compound in all samples associated with that LCS, according to the following guidelines:

Condition	Positives	Non-Detects
Gross Alpha, Beta: ± 30% < %R ≤ ± 90%	"J"	"UJ"
%R > ± 90%	"J"	"R"
All others: ± 25% < %R ≤ ± 75%	"J"	"UJ"
%R > ± 75%	"J"	"R"

Out of acceptance criteria comments:

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

Are all MS/MSD recoveries within QC limits? **Yes** ☐ **No** ☐ **N/A** ☐

Gross Alpha, Beta: Recovery = ± 30%
All others: Recovery = ± 25%
(Except when sample concentration > 4x spike concentration)

Review MS recoveries and apply qualifiers to failed compounds in all associated samples.

Condition	Positives	Non-Detects
Gross Alpha, Beta: ± 30% < %R ≤ ± 90%	"J"	"UJ"
%R > ± 90%	"J"	"R"
All others: ± 25% < %R ≤ ± 75%	"J"	"UJ"
%R > ± 75%	"J"	"R"

Are all MS/MSD RPD within QC limits? **Yes** ☐ **No** ☐ **N/A** ☐

Gross Alpha, Beta: RPD = ± 30%
All others: RPD = ± 25%

Out of acceptance criteria comments:

BLANKS

Are all Reagent Blank results below Reporting Limits? **Yes** ☐ **No** ☐ **N/A** ☐

Are Field/Rinsate Blanks, if present, below Reporting Limits? ☐ ☐ ☐

If the blank results fall outside the appropriate limits, qualify the results for all associated samples that are less than 10 times the blank value as estimated, "J" or "UJ"

Out of acceptance criteria comments:

CALIBRATIONS

Are Continuing Calibrations within acceptable limits?

Yes	No	N/A
☐	☐	☐

Check Calibration QC information for each type of counter.

Gross Proportional Counter: Gross Alpha/Beta, Strontium-90
Gamma Spectroscopy
Liquid Scintillation Counter: Carbon-14, Tritium
Lucas Cell Counter: Radium-226

Check trends for HI and LOW flags. If any detector FAILED, check run logs to make sure no samples were counted on that day for a failed detector.

The LSC calibration sheet needs further explanation as to action limits. Until further clarification, make sure that H-3 and C-14 COR/AVG % Diff columns are < 1.0.

Out of acceptance criteria comments:

LAB DUPLICATES

Is the RER (Replicate Error Ratio) ≤1.0?

Yes	No	N/A
☐	☐	☐

If RER for a particular radionuclide is greater than 1, qualify the results for that radionuclide in all associated samples of the same matrix as estimated, "J."

$$RER = |S - D| / (2\sigma_S + 2\sigma_D)$$

Where S = Original sample value
D = Duplicate sample value
$2\sigma_S$ = Original sample uncertainty
$2\sigma_D$ = Duplicate sample uncertainty

Out of acceptance criteria comments:

FIELD DUPLICATES (IF APPLICABLE)

Do field duplicate values generally look similar?	**Yes**	**No**	**N/A**
	☐	☐	☐

Field duplicate samples may be taken and analyzed as an indication of overall precision. These analyses measure both field and lab precision; therefore, the results may have more variability than lab duplicates that measure only lab performance. It is expected that soil duplicate results will have a greater variance than water matrices due to difficulties associated with collecting identical field samples. Any evaluation of field duplicates shall be provided with the reviewer's comments. All RPDs should be generally within 50% for soil samples and 35% for water samples. Calculate RPDs according to the following guidelines:

- If both data points for a compound are not detected, or are found below the DL, no calculation is necessary.
- Any data point that is found, but below the DL, can be considered a positive result at the DL for calculation purposes.
- The RPD for two data points is (Difference/Mean)x100.

Field Duplicate comments:

COMMENTS:

Prepared By: _____ Date _____

ATTACHMENT 6.5

LEVEL III/IV VALIDATION OF METALS DATA

LEVEL III/IV VALIDATION OF METALS DATA

Lab: _____ Date: _____

Analysis: _____ SDG #: _____

HOLDING TIMES

Have all samples been analyzed within holding times? Yes ☐ No ☐ N/A ☐

28 Days for Mercury
180 Days for all other Metals

If any sample fails this criterion, apply qualifiers to all results in the sample according to the following guidelines:

Condition	Positives	Non-Detects
Mercury held 29-56 days	"J"	"UJ"
Mercury held > 56 days	"J"	"R"
Other metals held 181-360 days	"J"	"UJ"
Other metals held > 360 days	"J"	"R"

Out of acceptance criteria comments:

LABORATORY CONTROL SAMPLE (LCS)

Are all LCS recoveries within QC limits? Yes ☐ No ☐ N/A ☐

Water: %R should be between 80%-120%.
Soils: "Found" should be between the limits provided on Form 7 (65%-135% for solid LCS).

If any LCS compound fails this criterion (except for Silver or Antimony in water), apply qualifiers to the failed compound in all samples associated with that LCS, according to the following guidelines:

Condition		Positives	Non-Detects
Water:	%R > 120%	"J"	No Qualifiers
	50% ≤ %R < 80%	"J"	"UJ"
	%R < 50%	"J"	"R"
Soil:	%R > Upper Limit	"J"	No Qualifiers
	30% ≤ %R < Lower Limit	"J"	"UJ"
	%R < 30%	"J"	"R"

If failures are widespread and consistent in the direction of the failure, than an overall analytical bias can be determined for this fraction.

Out of acceptance criteria comments:

BLANKS

Are the following free of contamination?	**Yes**	**No**	**N/A**
Preparation Blanks	☐	☐	☐
Initial Calibration Blanks	☐	☐	☐
Continuing Calibration Blanks	☐	☐	☐
Field/Rinseate Blanks (if present)	☐	☐	☐

Use the following steps when qualifying data based on blank contamination.

- List all calibration blank contaminants, but do not flag data.
- Identify all individual data points that are associated with preparation blank contaminant.
- For any data point associated with contamination from more than one preparation blank, select the blank with the highest concentration of the contaminant. The sample data point will be compared to this contaminant for qualifying purposes.
- Convert the concentration of the selected contaminant to the actual contamination level. Divide the contamination concentration by the blank detection limit and multiply by the sample detection limit.
- Qualify all data points associated with a laboratory contaminant according to the following guidelines:

Condition	Qualifier
No Positive Sample Result	None
Positive Sample Result < 5x Contamination Level	"UJ"
Positive Sample Result > 5x Contamination Level	None

Out of acceptance criteria comments:

LAB DUPLICATES

Are all RPDs between the sample and duplicate acceptable? Yes ☐ No ☐ N/A ☐

If the sample values are ≥ 5x the CRDL, the RPDs for original and duplicate sample values should be within 20% (35% for soil).

If sample values are ≤ 5x the CRDL, the RPD should be ± the CRDL.

For Metals, the duplicate is usually run on the matrix spike sample.

If any compound fails the RPD criterion, qualify positive results for the failed compound "J" and qualify non-detects for the failed compound "UJ" in all samples of the same matrix and laboratory quality control batch.

Out of acceptance criteria comments:

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

Are all MS/MSD recoveries within 75%-125%? Yes ☐ No ☐ N/A ☐
(Except when sample concentration > 4x spike concentration)

MS/MSD data are used in conjunction with LCS data to identify and describe interferences. If LCS and MS/MSD recoveries indicate a similar bias, then the bias can be determined to be analytical in nature. If LCS recoveries are in control, then the bias can be identified as a matrix effect. A post-digestion spike (PDS) will be performed when spiked metals do not meet matrix spike control limits.

Condition	Positives	Non-Detects
MS %R > 125%	"J"	No Qualifiers
MS %R < 75% and ≥ 30%	"J"	"UJ"
MS %R < 30%, no PDS or PDS %R < 75%	"J"	"R"
MS %R < 30%, PDS %R ≥ 75%	"J"	"UJ"

These qualifications apply to all samples of the same matrix as the MS and/or PDS sample and of the same laboratory quality control batch.

Out of acceptance criteria comments:

INDUCTIVELY COUPLED PLASMA (ICP) - INTERFERENCE CHECK SAMPLE (ICS)

Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) and Inductively Coupled Plasma -Mass Spectrometry (ICP-MS)

Are ICS recoveries within 80%-120%? **Yes** ☐ **No** ☐ **N/A** ☐

If any ICS analyte fails this criterion, apply qualifiers to the failed analyte in all samples associated with that ICS, according to the following guidelines:

Condition	Positives	Non-Detects
ICP-AES: ICS %R > 120% (or > true value + CRQL)	"J"	No Qualifiers
50% ≤ %R < 80% (or < true value - CRQL)	"J"	"UJ"
%R < 50%	"J"	"R"
ICP-MS: ICS %R > 120% (or > true value + 2 x CRQL)	"J"	No Qualifiers
50% ≤ %R < 80% (or < true value – 2 x CRQL)	"J"	"UJ"
%R < 50%	"R"	"R"

Out of acceptance criteria comments:

INDUCTIVELY COUPLED PLASMA (ICP) – SERIAL DILUTIONS

Are serial dilution percent differences (%D) ≤ 10%? **Yes** ☐ **No** ☐ **N/A** ☐

Serial dilution is applicable to analytes with concentrations greater than 50 times (50x) the Method Detection Limit (MDL) in the original (undiluted) sample. If a serial dilution %D exceeds 10%, apply qualifiers to the failed analyte in the sample (and chemically similar samples within the same quality control batch) according to the following guidelines:

Condition	Positives	Non-Detects
Sample concentration > 50x MDL and %D > 10	"J"	"UJ"

Out of acceptance criteria comments:

CALIBRATIONS

Are all initial calibration correlation coefficients ≥ 0.995: **Yes** ☐ **No** ☐ **N/A** ☐

If any compound fails this criterion, qualify positive results for the failed compound "J" and qualify non-detects for the failed compound "UJ" in all samples associated with that initial calibration.

Are all ICV recoveries within QC limits: **Yes** ☐ **No** ☐ **N/A** ☐

Mercury:	%R between 80%-120%
All other Metals:	%R between 90%-110%

If any compound fails this criterion, qualify positive results for the failed compound "J" and qualify non-detects for the failed compound "UJ" in all samples associated with that ICV.

Are all CCV recoveries within QC limits: **Yes** ☐ **No** ☐ **N/A** ☐

Mercury:	%R between 80%-120%
All other Metals:	%R between 90%-110%

If any compound fails this criterion, qualify positive results for the failed compound "J" and qualify non-detects for the failed compound "UJ" in all samples associated with that CCV.

Out of acceptance criteria comments:

FIELD DUPLICATES (IF APPLICABLE)

Are all compounds present in either the sample or duplicate also present in the other? **Yes** ☐ **No** ☐ **N/A** ☐

Data are not qualified based on field duplicate precision; rather, an overall assessment of whether or not the data is representative of field conditions is made. This assessment should be discussed in the final report. If several compounds are present in either the sample or the duplicate but not in the other, then data may be qualitatively questionable. Some guidelines for evaluation:

- Any sample or duplicate data point that is below the DL is considered to be a positive result if the other data point in the pair is a positive result.
- Any sample or duplicate data point that is below the DL is considered to be non-detect if the other data point in the pair is a non-detect.

- If several discrepancies are noted, check to see if they are consistent (i.e., always present in the sample, but not detected in the duplicate).
- If discrepancies are consistent, compare DLs to see if there may be a large dilution factor for whichever sample consistently shows the non-detects.

Are all RPDs between sample and duplicate acceptable?

Yes	No	N/A
☐	☐	☐

Make an overall assessment of the quantitative precision of the sample-duplicate data. All RPDs should be generally within 50% for soil samples and 35% for water and air samples. Calculate RPDs according to the following guidelines:

- If both data points for a compound are not detected, or found below the DL, no calculation is necessary.
- Any data point that is found, but below the DL, can be considered a positive result at the DL for calculation purposes.
- The RPD for two data points is (Difference/Mean)x100.

Out of acceptance criteria comments:

Prepared By: _____ Date _____

ATTACHMENT 6.6

LEVEL III/IV VALIDATION OF WET CHEMISTRY OR OTHER MISCELLANEOUS ANALYSES

LEVEL III/IV VALIDATION OF WET CHEMISTRY OR OTHER MISCELLANEOUS ANALYSES

Lab: _____ Date: _____

Analysis: _____ SDG #: _____

HOLDING TIMES

	Yes	No	N/A
Have all samples been analyzed for all compounds within holding times?	☐	☐	☐

If any sample fails this criterion, apply qualifiers to all results in the sample according to the following guidelines:

Condition	Positives	Non-Detects
HT + 1 ≤ Analysis ≤ 2 x HT	"J"	"UJ"
Analysis > 2 x HT	"J"	"R"

LABORATORY CONTROL SAMPLE (LCS)

	Yes	No	N/A
Are all LCS recoveries within QC Limits?	☐	☐	☐

If any compound fails this criterion, apply qualifiers to the failed compound in all samples associated with that LCS, according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper Limit	"J"	No Qualifiers
30% ≤ %R < Lower Limit	"J"	"UJ"
%R < 30%	"J"	"R"

If failures are widespread and consistent in the direction of the failure, then an overall analytical bias can be determined for this fraction.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

	Yes	No	N/A
Are all MS/MSD recoveries within QC limits?	☐	☐	☐

MS/MSD data are used in conjunction with LCS data to identify and describe interferences. If LCS recoveries indicate a similar bias, then the bias can be determined to be analytical in nature. If LCS recoveries are in control, then the bias can be identified as a matrix effect.

BLANKS

Are the following free of contamination?	Yes	No	N/A
Laboratory Blanks	☐	☐	☐
Trip Blanks (if present)	☐	☐	☐
Field/Rinseate Blanks (if present)	☐	☐	☐

Use the following steps when qualifying data based on blank contamination.

- Identify all individual data points that are associated with a blank contaminant.
- For any data point associated with contamination from more than one blank, select the blank with the highest concentration of the contaminant. The sample data point will be compared to this contaminant for qualifying purposes.
- Convert the concentration of the selected contaminant to the actual contamination level. Divide the contamination concentration by the blank detection limit and multiply by the sample detection limit.
- Qualify all data points associated with a laboratory contaminant according to the following guidelines:

Condition	Qualifier
No Positive Sample Result	None
Positive Sample Result < 5x Contamination Level	"UJ"
Positive Sample Result > 5x Contamination Level	None

CALIBRATIONS

	Yes	No	N/A
Are all initial calibrations acceptable?			
%RSDs within QC limits? (If applicable)	☐	☐	☐
Correlation coefficients > 0.995? (If applicable)	☐	☐	☐
ICV recoveries within QC limits? (If applicable)	☐	☐	☐

If any compound fails applicable criterion, as specified in the QAPP and/or the method, qualify positive results for the failed compound "J" and non-detects for the failed compound "UJ" in all samples associated with that ICV.

	Yes	No	N/A
Are all continuing calibrations acceptable?			
%Ds within QC limits? (If applicable)	☐	☐	☐
CCV recoveries within QC limits? (If applicable)	☐	☐	☐

If any compound fails applicable criterion, as specified in the QAPP and/or the method, qualify positive results for the failed compound "J" and non-detects for the failed compound "UJ" in all samples associated with that CCV.

FIELD DUPLICATES (IF APPLICABLE)

	Yes	No	N/A
Are all compounds present in either the sample or duplicate also present in the other?	☐	☐	☐

Data are not qualified based on field duplicate precision; rather, an overall assessment of whether or not the data is representative of field conditions is made. This assessment should be discussed in the final report. If several compounds are present in either the sample or the duplicate, but not in the other, then data may be qualitatively questionable. Some guidelines for evaluation:

- Any sample or duplicate data point that is below the DL is considered to be a positive result if the other data point in the pair is a positive result.
- Any sample or duplicate data point that is below the DL is considered to be a non-detect if the other data point in the pair is a non-detect.
- If several discrepancies are noted, check to see if they are consistent (i.e., always present in the sample, but not detected in the duplicate).

- If discrepancies are consistent, compare DLs to see if there may be a large dilution factor for whichever sample consistently shows the non-detects.

Are all RPDs between sample and duplicate acceptable?

Yes	No	N/A
☐	☐	☐

Make an overall assessment of qualitatively precision of the sample duplicate data. All RPDs should be generally within 50% for soil samples and 35% for water samples. Calculate RPDs according to the following guidelines:

- If both data points for a compound are not detected, or found below the DL, no calculation is necessary.
- Any data point that is found, but below the DL, can be considered a positive result at the DL for calculation purposes.
- The RPD for two data points is (Difference/Mean)x100.

Prepared By: _____ Date _____

ATTACHMENT 6.7

DATA VALIDATION QUALIFIER DEFINITIONS

DATA VALIDATION QUALIFIER DEFINITIONS

The following definitions provide brief explanations of the data validation qualifiers assigned to results in the data review process.

Flag	Data Qualifier Definition
U	The analyte was analyzed for, but was not detected above, the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified," and the associated numerical value represents its approximate concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODE DESCRIPTIONS

The following descriptions provide brief explanation of the cause for qualification of the results determined in the data review process. These reason codes are used in combination with the data qualifier, i.e., "Uz" indicates the analyte is non-detect due to method blank contamination.

Flag	Reason Code Description
C	Calibration failure; poor or unstable response.
d	Matrix duplicate imprecision or matrix spike/matrix spike duplicate imprecision.
f	Field replicate or duplicate imprecision.
h	Holding time violation.
i	Internal standard failure.
k	Serial dilution imprecision.
l	Laboratory control sample (LCS) recovery failure.
m	Matrix spike/matrix spike duplicate (MS/MSD) recovery failure.
n	Interference check sample recovery failure.
q	Below CRQL/CRDL or above calibration range.
s	Surrogate spike recovery failure.
v	Detected concentrations > 25% difference between 2 GC columns (Pesticides).
z	Blank contamination.

ATTACHMENT 6.8

DATA VALIDATION SUMMARY

DATA VALIDATION SUMMARY

Project: Project Number:

Analyses: Lab ID:

Sample ID:

Comments:

Flags:

Compound	Sample ID	Flag	Reason Code	Reporting Limit	ParvqID	Result

Reviewed by: _____ Date: _____

DATA VERIFICATION

STANDARD OPERATING PROCEDURE 21.2

1. Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for verification of field and laboratory data. Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. The goal of data verification is to ensure and document that the data are what they purport to be, and that the reported results reflect what was expected to be done.

2. References

United States Environmental Protection Agency (EPA), 2014. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium, SW-846 Update V*, July.

EPA, 2015, *US EPA Guidance on Environmental Data Verification and Data Validation, EPA-QA/G-8*, June.

SOP 1.1 - Sample Custody

SOP 1.2 – Field Activity Daily Log

SOP 2.1 - Sample Handling, Packaging, and Shipping

SOP 21.1- Data Validation

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

Data verification is a systemic process for reviewing field data or laboratory data to provide assurance that the requested data are correct and complete and comply with procedural and contractual requirements. The laboratory data verification process is typically conducted concurrently with field data verification (SOP 1.1, SOP 1.2).Laboratory data verification is performed to ensure that the contract laboratory performed the requested analysis without errors and omissions, and to initiate any required follow-on analytical work including re-analysis or additional analyses so that impacts on the quality, schedule, and resources are minimized.

4. Responsibilities

The Subcontractor Project Manager (SPM) is responsible for ensuring that all data verification activities are conducted and documented in accordance with this SOP and any other appropriate procedures. The SPM shall ensure staff are adequately trained to perform assigned duties.

The Subcontractor Quality Assurance Manager (SQAM) is responsible for periodic review of documentation associated with this data verification SOP. The SQAM is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to data verification requirements, issuing nonconformances, etc.) if problems occur.

Personnel assigned to data verification activities are responsible for completing their tasks according to specifications outlined in this SOP and project planning documents. All staff are responsible for reporting deviations from these procedures and planning documents to the SQAM.

5. Procedure

Field and laboratory data verification will be performed according to the *US EPA Guidance on Environmental Data Verification and Data Validation* (EPA, 2015) or as otherwise stated in project plans or contracts. Before proceeding with data verification:

- The location and source of project planning documents, such as sampling and analysis plans, applicable methods (EPA, 2014), project plans, and quality assurance project plans will be determined.
- Applicable project requirements will be obtained from the planning documents.

Field and laboratory data will then be verified against the project planning documents. Data are verified as information is passed from one level to the next (e.g., at the chain of custody and field form stage per SOP 1.1 and SOP 1.2; then the laboratory sample receipt confirmation stage per SOP 2.1, then the laboratory report delivery stage per this SOP).Verification of laboratory data will include the following elements:

- Confirmation that the sample receipt documentation ("log-in") was reviewed to determine conformance with sample collection planning documents;
- All analytes and methods reported as requested on the chain of custody and specified in the sampling and analysis plan;
- Laboratory deliverable was received within contracted turn-around time;
- The delivered data are final or preliminary;
- The deliverable contains the requested level of information;
- The report contains a copy of the chain of custody and any modifications;
- All electronic deliverables have been received;
- All results are reported on the requested weight basis (along with moisture content when dry weight basis is requested);
- All results are reported to the correct detection limits as specified in the sampling and analysis plan or other planning documents;
- All project specific QC limits have been applied;
- Whether the laboratory narrative identifies any issues that affect the usability of the results (e.g., elevated cooler temperature, excessive headspace, etc.).
- For soil gas - Whether tracer gases (e.g., helium) were detected;

- For groundwater samples - Whether reported results appear anomalous, or consistent with historical results; and
- For soil - Whether any results exceed 10X Soluble Threshold Limit Concentration (STLC) or 20X Toxicity Characteristic Leaching Procedure (TCLP) and trigger re-analyses or -extractions.

The verification will be documented using form 6.1, Laboratory Report Verification Checklist. For data generated outside of an independent laboratory, and not addressed by existing procedures, the verification requirements will be specified in the planning documents.

6. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

7. Attachments

7.1 - Laboratory Report Verification Checklist.

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the SQAM provided that the substitute form contains equivalent information as the referenced form.

ATTACHMENT 7.1

LABORATORY REPORT VERIFICATION CHECKLIST

LABORATORY REPORT VERIFICATION CHECKLIST

Project Name: Lab Sample Delivery Group:

Weiss Project Number: Sample Collection Date(s):

Date of Log-In Confirmation: Date Lab Report received:

Laboratory Report Checks	**Yes**	**No**	**NA**
1. Was the laboratory SRC checked against COCs and applicable planning documents (e.g sampling and analysis plan and protocol)?			
2. Are results reported within the contracted turn-around-time?			
3. If late, do laboratory contract penalties apply?			
4. Are all analytes and methods reported as requested per the COC and project planning documents?			
5. Is the laboratory report final (not preliminary)?			
6. Does the report contain all information required per the project planning documents (e.g. level II, III, IV reporting)?			
7. Does the report contain copies of COCs and any modifications requested?			
8. Have all requested EDDs been delivered?			
9. Are the results reported on the weight basis specified in the work plan/protocol or other project planning documents (moisture content reported when dry weight is requested)?			
10. If not specified in a work plan, are all soil results reported on a dry weight basis?			
11. Are results reported at MDLs or RLs as requested on the COC and per project planning documents?			
12. Do detection and reporting limits meet work plan specifications?			
13. Are the project QC limits shown and applied in the laboratory report per the work plan or project planning documents?			
14. Are helium or other tracer gases detected in any samples (soil gas only)?			
15. Are the reported results consistent with historical site results?			
16. Do any results exceed 10X STLC or 20X TCLP?			
17. Is reanalysis or analysis per WET/TCLPs recommended? (add explanation below)			
18. Does the lab narrative raise any questions about the integrity of the data?			

Applicable work plan or protocol/date:

Applicable QA plan/date:

Comments:

Reviewed by: Date:

Approved by (PM or PIC): Date:

LAND SURVEYING

STANDARD OPERATING PROCEDURE 23.1

1. Purpose

This standard operating procedure (SOP) describes the methods for obtaining information through field surveys, property surveys, and surveys of monitoring wells. In performing these methods, other survey requirements may need to be fulfilled (e.g., monument construction, boundary surveys).

2. References

California State Water Resources Control Board (SWRCB), 2005, *Survey XYZ, Well Data, and Site Map Guidelines & Restrictions, Electronic Deliverable Format and Data Dictionary, Rev. 6.1,* April.

SOP 8.1 - Monitoring Well Installation

SOP 17.4 - GeoTracker Electronic Reporting

Standard Quality Procedure (SQP) 4.2 - Records Management

3. Definitions

The location of points and orientation of lines frequently depends upon measurement of angles and directions. Directions are given by bearings and azimuths.

Coordinate System - A coordinate system is a system which uses one or more numbers, or coordinates, to uniquely determine the position of a point or other geometric element.

Datum - Geodetic datums define the size and shape of the earth and the origin and orientation of the coordinate systems used to map the earth. Datums have evolved from those describing a spherical earth to ellipsoidal models derived from years of satellite measurements.

EDF - Electronic Deliverable Format, is a comprehensive data standard compatible with GeoTracker, designed to facilitate the transfer of electronic data files between data producers and data users.

GeoTracker – State Water Resources Control Board data management system for sites that impact, or have the potential to impact, water quality in California, with emphasis on groundwater.

GPS - Global Positioning System, a radio navigation system that uses signals from satellites to determine location, velocity, and time anywhere in the world with a precision and degree of accuracy dependent upon the GPS equipment used and the availability of satellite coverage at the time and position where the measurement occurs.

4. Procedure

4.1 Disclaimer

Most land survey work is expected to require the expertise, equipment, or licenses of a registered land surveyor to conduct surveys with the typical degree of accuracy required for most projects. The role for the Subcontractor Project Manager (SPM) or designee is to identify the survey requirements for a project, communicate the requirements to the licensed surveyor, prepare the site for survey, and ensure that the data collected meets the project specifications.

4.2 Responsibilities

The SPM is responsible for ensuring that the surveying is properly performed. This will be accomplished through staff training or by verifying the qualifications of survey subcontractors, and by maintaining quality assurance/quality control (QA/QC).

As a minimum, the SPM is responsible for seeing that the field personnel or survey team receive the following:

- Review of site specific work plans, which address this procedure (e.g., sampling and analysis plans, quality assurance plans, etc.); and
- Review of this SOP and associated SOPs listed in this section.

The SPM may assign these responsibilities to a Subcontractor Task Leader (STL).

The Subcontractor Quality Assurance Manager (SQAM) is responsible for the periodic review of documentation generated by the performance of this procedure. The SQAM may also perform audits and surveillances of field personnel or the survey team as they perform land surveys to assure compliance with specified procedures.

Field personnel or the Survey Team are responsible for conducting the land survey activities in accordance with acceptable industry standards and this SOP, and for the proper documentation of these activities and resulting measurements.

4.3 Procedures

All property surveys will be performed in accordance with good land surveying practices and conform to all pertinent federal and state laws and regulations governing land surveying in the area where the work is being accomplished.

For projects requiring GeoTracker submittal of land survey data, survey teams or contractors must provide an EDF that conforms with the GeoTracker standard. Well location data are uploaded via GEO_XY files, as described in the GeoTracker Guidance (SOP 17.4). Consumer-grade GPS units do not meet GeoTracker's submeter accuracy requirements.

Mark sampling locations or survey points with wooden lathe stakes, wooden survey pegs, or metal fenceposts. Write the location ID on the marker or survey flagging so that it is readily visible. Attach identification plaques to groundwater monitoring wells by riveting them to the vault lid and to the casing cap by cable attachment. Use a black marker for wooden stakes and flagging.

Upon completion of the location marking project, copies of field notebooks, and pertinent reference materials should be delivered to the SPM for retention in the project record files. All office entries in field notebooks should be made in a pen color different than the original.

Monitoring well locations are surveyed only after the installation of the tamper proof locking cap well casing cover, which is set in concrete. The horizontal plane survey accuracy is ±0.1 foot (unless greater accuracy is required) and is measured to any point on the well casing cover. The vertical plane survey must be accurate to ±0.01 foot. Four elevations are typically measured, including the following:

- Top of the inner well casing (on the lip);
- Top of the well cap’s water level measurement port when the well contains a dedicated pump;
- Top of the outer protective well vault casing (on the rim, not the lid); and
- Ground surface adjacent to the well vault.

The point on the casing where the elevation is to be measured will be scribed or notched so that water level measurements may be taken at the same location.

Note: The STL should ensure that the surveying party is given the keys to the locks before starting the survey.

Load all well survey data into the project database and GeoTracker (SWRCB, 2005) upon receipt of deliverables from the land surveyor. Replace data from previous well surveys so that survey data represent the current wellhead elevation. Well repairs or modifications can change casing, port, or rim elevations between surveys.

4.4 Utility Surveys

Utility Surveys use underground mapping technology to identify underground cables and pipes, which must be avoided when performing subsurface penetration activities. Ground Penetrating Radar Systems (GPRS) and electromagnetic detectors are typically used. Potential obstructions should be clearly identified on the ground with spray paint. At a minimum, clearing of sampling locations should consist of notifying Underground Service Alert North 811 at least 48 hours prior to any intrusive activities. It is recommended that obstructions be given a minimum berth of 15 feet.

5. Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2 – Records Management.

6. Attachments

None.

Appendix C

Contract Laboratory Quality Assurance Plans

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QUALITY ASSURANCE MANUAL FOR ENVIRONMENTAL ANALYTICAL SERVICES

Version 6.0
August 2017

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The NELAC Institute (TNI)
Management and Technical Requirements for Laboratories Performing Environmental Analysis
TNI Standard (EL-V1-2009) Effective September 09, 2009

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1. Introduction

1.1. This *Quality Assurance Manual* is based upon the overall business and management philosophies, mission, and goals of Eurofins Calscience, Inc. ("ECI", "the laboratory"). This manual is written to present the policies employed by the laboratory and the support departments that serve the environmental laboratory and to comply with the requirements of the National Environmental Laboratory Accreditation Program (NELAP), ISO/IEC 17025, and the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP). These policies define the "what" we do with emphasis on management's responsibilities and commitment to quality. Governing SOPs are in place within the organization, to ensure the proper execution of this policy document and are referenced throughout the document.

1.2. This manual is required reading for laboratory personnel. The appendices are available resources to all personnel but are not required reading for all employees. The most recent and up-to-date *Quality Assurance Manual* and all referenced documents are available to all laboratory personnel who work in or support the laboratory.

2. Normative References

2.1. *Environmental Laboratory Sector, Volume 1: Management and Technical Requirements for Laboratories Performing Environmental Analysis, Modules 1, 2 and 4,* The NELAC Institute, 2009 ("TNI 2009 V1")

2.2. *Department of Defense Quality Systems Manual for Environmental Laboratories,* Version 5.1 (2017). ("QSM")

2.3. *Department of Defense Quality Systems Manual for Environmental Laboratories,* Version 4.2 (2010).

2.4. *ISO/IEC 17025:2005.*

3. Definitions

3.1. Definitions generally applicable to the laboratory are contained in Appendix 1.

3.2. Some specific definitions may appear in SOPs where they are used.

4. Quality Management System

4.1. Organization

4.1.1. Eurofins Calscience, Inc. is a wholly-owned subsidiary of Eurofins Environment Testing US Holdings, Inc. It is a duly licensed business with its main office at 7440 Lincoln Way, Garden Grove, CA 92841-1427.

4.1.2. It is the intention of Eurofins Calscience, Inc. to conform to all requirements of its customers, the National Environmental Laboratory Accreditation Program (NELAP) and the current TNI Standard, the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) and the current Quality Systems Manual, the State of California SWRQCB ELAP; and other State and Client Programs as

accredited, certified, licensed or requested.

4.1.3. The laboratory performs its analytical work at its facility on Lincoln Way and at two satellite laboratory spaces in Garden Grove, CA. In addition, the laboratory maintains a Service Center in Concord, CA as well as an internal courier service. All of these facilities and services operate under the management system described in this manual. Full contact information for each is included in Appendix 3.

4.1.4. Eurofins Calscience, Inc. is a stand-alone business entity that operates under the Eurofins organization. Eurofins is an organization of testing laboratories and does not engage in other types of environmental activities in the USA. There are no potential conflicts of interest due to this structure.

4.1.5. The organization, structure and work assignments ensure the following:

4.1.5.1. The laboratory's managerial and technical personnel have the authority and resources needed to carry out their duties.

4.1.5.2. Personnel will not be subjected to undue internal, external, commercial, financial or other pressure that could adversely affect the quality of their work. "Undue pressure" is addressed in the annual Ethics and Data Integrity Training given to all employees of the laboratory. Instructions for managing undue pressure are included in that training. See also the relevant SOP, T065 *Data Integrity*, current revision. Employees may report to the following, as they feel comfortable:

- Their Chain of Command
- Laboratory QA Staff
- The corporate Quality Director
- The corporate ethics hotline through Lighthouse Services (posters are placed throughout the lab)

4.1.5.3. The laboratory protects confidential information and proprietary rights of its customers at all times through rules on data distribution, management of confidentiality during site visits and data security.

4.1.5.4. Management and staff are expected to conduct themselves in an ethical manner at all times. Laboratory employees do not engage in activities that would compromise their ability to generate legally defensible, high quality data. This is also addressed in the Ethics and Data Integrity training given in the laboratory.

4.1.5.5. The laboratory is overseen by the Business Unit Manager (BUMa). Technical operations, Support services, Quality Assurance and Customer services report to the BUMa. Additionally, QA has a "dotted line" relationship with Quality Assurance Director of Eurofins Environment Testing US. Full organizational charts detailing the management structure of Eurofins Calscience, Inc. can be found in Appendix 4. The QA Department keeps the most up to date organizational

chart.

4.1.5.6. This organizational chart shows the responsibility, authority and interrelationships of all personnel who manage, perform, or verify work. Through this organization, management provides adequate supervision of all employees and provides technical management with overall responsibility for the data produced in the laboratory.

4.1.5.7. The laboratory has a designated Quality Assurance (QA) Manager who, along with assigned staff, has responsibility and authority for ensuring that the management system related to quality is implemented and followed at all times. The QA Manager has direct access to the highest level of management in the local company. In addition, the QA Manager has support from the Eurofins Environment Testing Corporate Quality Director.

4.1.5.8. The laboratory appoints deputies for key personnel. These are included in a memo detailing Key Personnel Alternates that is updated regularly by the Laboratory Director and posted, among other places, outside the quality offices. Deputies are assigned for the following:

- Business Unit Manager
- Laboratory Director
- Quality Assurance Manager and other quality personnel
- Operations Manager
- Health and Safety Manager
- IT Manager
- All Project Management Personnel
- All Technical Group Leaders

4.1.5.9. The laboratory ensures that personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the objectives of the management system. This is mostly accomplished through initial and ongoing training, though additional communications may be used from time to time.

4.1.6. Top management ensures that appropriate communication processes are established with the laboratory and communication takes place regarding the effectiveness of the management system.

4.1.6.1. The laboratory uses a number of formal and informal mechanisms to provide this type of communication.

4.1.6.2. Meetings are held on a daily basis with operations management, quality assurance and project management personnel. While the primary purpose of these meetings is status updates, the venue is used to provide updates on management system issues, projects, technical issues, as well as training on a wide range of topics, including the management system. Group leaders are charged to carry

information from these meetings to personnel in their groups.

4.1.6.3. Training sessions are held as necessary to meet requirements for annual ethics, data integrity and computer security awareness as well as other important topics.

4.1.6.4. Laboratory management holds quarterly meetings with all staff to provide updates on laboratory status, goals, and issues important to personnel, including the management system.

4.1.7. The Quality Assurance Manager and quality staff are empowered and responsible for the following:

4.1.7.1. Serve as the focal point for QA/QC and be responsible for the oversight and/or review of quality control data;
4.1.7.2. Have functions independent from laboratory operations for which they have quality assurance oversight;
4.1.7.3. Be able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence;
4.1.7.4. Have documented training and/or experience in QA/QC procedures and the laboratory's quality system;
4.1.7.5. Have a general knowledge of the analytical methods for which data review is performed;
4.1.7.6. Maintain the currency of the quality assurance manual and review it at least annually
4.1.7.7. Arrange for or conduct internal audits as per Section 4.14 annually;
4.1.7.8. Notify laboratory management of deficiencies in the quality system;
4.1.7.9. Monitor corrective actions; and
4.1.7.10. Stop work if the system is deemed to be out of control.

4.1.8. The Laboratory Director, Operations Manager, technical Group Leaders and their designees:

4.1.8.1. Are members of the staff who exercise actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results;
4.1.8.2. Are experienced in the fields of accreditation for which the laboratory is accredited;
4.1.8.3. Have duties that include monitoring standards of performance in quality control and quality assurance, and monitoring the validity of the analyses performed and data generated in the laboratory to assure reliable data.
4.1.8.4. If absent for a period of time exceeding fifteen (15) consecutive calendar days, must designate another full-time staff member meeting the qualifications of the technical manager(s) to temporarily perform this function. If this absence exceeds thirty-five (35) consecutive calendar days, the primary accreditation body must be notified in writing;
4.1.8.5. Meet the qualification requirements of the standard.

4.1.8.5.1. Have a bachelor's degree in the chemical, environmental, biological sciences, physical

sciences, or engineering, with at least 24 college semester hours of chemistry.

4.1.8.5.2. Have at least two years of experience in the environmental analysis of representative inorganic and organic analytes for which the laboratory is accredited.

4.1.8.5.3. Other options are available and are fully described in the standard (TNI 2009 V1M2, Section 5.2.6.1)

4.1.8.6. All personnel in these positions are full-time personnel who do not work in other accredited laboratories.

4.2. Management

4.2.1. Beginning with this quality assurance manual, the laboratory has established a management system appropriate to its activities. The system is described in this quality assurance manual, which includes the laboratory policies and includes or references descriptions of its systems and programs and its procedures and instructions.

4.2.1.1. The management system is designed to assure the quality of the laboratory's tests are known and documented. Further, the system describes how these documents are made available to laboratory personnel and requires that personnel understand and implement the requirements contained in them.

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4.2.1.2. The system is designed to support the ECI Mission Statement: **ECI strives to be the leading full-service environmental testing laboratory in the Western United States by having unsurpassed capacity, exceptional customer service, continual quality improvement and consistently superior TAT.**

4.2.2. Management's Quality Policy Statement

4.2.2.1. Eurofins Calscience, Inc. (ECI) is committed to providing its customers with environmental data that is reliable, defensible, and of known and documented quality. We continually strive to meet our customer's requirements and exceed their expectations.

4.2.2.2. This Quality Assurance Manual and related documentation describes the policies and procedures used to meet that commitment. The Manual is designed to meet the Standards used in the NELAP, the DoD ELAP, the State of California ELAP and other government and customer requirements. Laboratory management is committed to the quality improvement processes described in these standards and to providing the resources to ensure laboratory personnel can honor that commitment.

4.2.2.3. Laboratory personnel whose responsibilities include any aspect of testing activities are required to familiarize themselves with all of the quality documentation associated with their job function and to implement the policies and

procedures described in that documentation into all of their work in the laboratory. Laboratory personnel acknowledge this responsibility by signing the Quality Policy contained in the Employee Handbook.

4.2.2.4. Management reviews this Quality Policy and the objectives listed below during the annual Management Review. The signatures of management personnel on this Quality Assurance Manual indicate their concurrence and support of this Policy.

4.2.2.5. Quality Objectives

4.2.2.5.1. Laboratory Management Personnel

- Commit to a quality improvement approach to management that focuses on problem solving through system improvement.
- Provide the resources necessary to allow laboratory personnel to successfully meet customer requirements while maintaining all quality standards.
- Provide a work environment that ensures accessibility to all levels of management and encourages personnel to raise questions, voice concerns, and participate in system development.

4.2.2.5.2. Laboratory Analytical Personnel

- Perform all analyses and related tasks according to documented procedures.
- Record all required and relevant observations completely, accurately, honestly and in “real time”.
- Respond immediately to indications of questionable data, equipment malfunctions, and quality control failures by taking appropriate actions as governed by laboratory procedures and communicating the issues to supervisory personnel.
- Work diligently to meet client needs, including turn-around times, while always keeping quality requirements as the most important objective.

4.2.3. Top management is committed to development and implementation of the management system and to continually improving its effectiveness through consistent internal audits, management reviews, corrective and preventive action and on-going training of personnel. Records of these activities provide evidence of that commitment.

4.2.4. Top management communicates to the organization the importance of meeting customer as well as statutory and regulatory requirements through the quality system as well as on-going meetings and other communications. See 4.1.6 above.

4.2.5. This quality assurance manual includes or references all procedures and outlines the documentation structure of the management system. The Standards under which the laboratory operates include specific

requirements for the quality assurance manual and for technical SOPs, as well as for laboratory operations. The documentation system of the laboratory is designed to capture the requirements contained in these normative documents and provide them to laboratory personnel as applicable.

4.2.5.1. The quality assurance manual is the over-arching, primary document in the system.

4.2.5.2. Standard Operating Procedures are referenced by the quality assurance manual and describe how to perform required procedures.

4.2.5.3. Data is captured using forms that are referenced by the SOPs. Quality Assurance Manager, including compliance with the Standard, are defined in this manual (See Section 4.1), in job descriptions, and where specific responsibilities are required for particular processes, in the SOPs governing those processes.

4.2.6. Top management ensures the integrity when changes are planned and implemented.

4.2.6.1. A “Management of Change” process is used to monitor changes made to computer systems.

4.2.6.2. Method changes require demonstration and governing document updates prior to implementation.

4.2.6.3. Preventive action processes are used to develop and implement changes to the management system.

4.2.7. Additional Requirements

4.2.7.1. Data Integrity-The laboratory maintains a Data Integrity Program as a part of its Ethics requirements. The program is described in Section 4.16 of this quality assurance manual and in the SOP referenced in that section.

4.2.7.2. Approved Signatories-The Business Unit Manager, Laboratory Director and all project managers are authorized to sign reports. Certain Quality Assurance personnel are authorized to sign reports that are for internal use. Additionally, some project manager assistants are authorized to sign preliminary reports and final reports under certain conditions. The Quality Assurance group keeps a current list of approved signatories.

4.2.7.3. The laboratory uses electronic signatures on reports for customers. The IT group collects electronic facsimiles of the authorized user’s actual signature. They are stored securely and attached to the authorized user’s login, where they are made available for use on reports.

4.2.7.4. The laboratory’s lists of approved methods are included on the applicable scopes of accreditation. These are available electronically in the quality department files.

4.3. Document Control

4.3.1. General

The laboratory has established and maintains procedures to control all documents that form part of its management system (internally generated or from external sources), such as regulations, standards, other normative documents, test and/or calibration methods, as well as drawings, software, specifications, instructions and manuals. The procedures are detailed in Calscience SOPs T002 *Document Control* and T001 *SOP Preparation.* The former document details the overall document control program while the latter provides specific instructions and templates for writing Standard Operating Procedures and related documents.

4.3.2. Document Approval and Issue

4.3.2.1. All documents issued to personnel in the laboratory as part of the management system are reviewed and approved for use by appropriate management and QA personnel prior to issue.

4.3.2.1.1. In general, approval by the group leader and a QA representative is required. Some variations may occur for analyst aids and for higher-level documents such as this Quality Assurance Manual, which must be approved by top management and the QA Manager. The requirements and specifics, including specific responsibilities, are included in T002 *Document Control.*

4.3.2.1.2. Instrument manuals are tacitly approved for use through the purchase of the instrument and are kept in the laboratory near the instrument or in a designated area in the East QA Office.

4.3.2.2. Master lists are used to identify the current revision status and distribution of documents in the management system. A database system is used for all ECI SOPs. Other document types are kept in lists grouped by type of document. These lists are maintained and made readily available to preclude the use of invalid and/or obsolete documents.

4.3.2.3. The procedure(s) adopted ensure the following:

4.3.2.3.1. Authorized editions of appropriate documents are available at all locations where operations essential to the effective functioning of the laboratory are performed.

4.3.2.3.1.1. Hard copies are maintained in binders in laboratory areas

4.3.2.3.1.2. Electronic copies are available to be viewed on the company intranet.

4.3.2.3.2. Documents are periodically reviewed and, where necessary, revised to ensure continuing suitability

and compliance with applicable requirements.

4.3.2.3.2.1. Method SOPs are reviewed as part of the internal audits and at least annually.

4.3.2.3.2.2. This Quality assurance manual will be reviewed at least annually.

4.3.2.3.2.3. Other documents written internally will be reviewed at least every two years.

4.3.2.3.2.4. External documents that may change are verified at least annually.

4.3.2.3.2.5. External documents that do not change, such as manufacturers' instrument manuals, are not reviewed.

4.3.2.3.3. Invalid or obsolete documents are promptly removed from all points of issue or use to prevent unintended use.

4.3.2.3.4. All documents removed from use or replaced are marked as obsolete. Paper documents are shredded with the exception of the master copy, which is marked in permanent ink and placed in an "Obsolete" file. Electronic documents are removed from the active directory and placed into a document archive file.

4.3.2.4. Management system documents generated by the laboratory are uniquely identified. The identification system is detailed in T002 *Document Control.*

4.3.3. Document Changes

4.3.3.1. Changes to documents are reviewed and approved by the same laboratory positions as approved the original document, or their designee. See Section 4.3.2.1 above. The requirements and specifics, including specific responsibilities, are included in T002 *Document Control.*

4.3.3.2. Altered or new text, when practical, is identified in by the use of a bolded font in the finished version of the document. Use of a bolded font is considered not practical when a significant rewrite of a document is performed.

4.3.3.3. Amendment of documents by hand is not allowed.

4.3.3.4. Changes in documents maintained in electronic systems are identical to changes in hard-copy documents, except that the final copy (in .pdf) is placed in the current SOP directory.

4.4. Review of Requests, Tenders and Contracts

4.4.1. The laboratory has established and maintains procedures for the review of requests, tenders and contracts. The policies and procedures adopted for these reviews leading to a contract are intended to ensure the following:

4.4.1.1. The requirements, including the methods to be used, are adequately defined, documented and understood.

4.4.1.2. The laboratory has the capability and resources to meet the requirements.

4.4.1.3. The appropriate test and/or calibration method is selected and is capable of meeting the customers' requirements. Any deviations from the published test method must be communicated to the customer. See Section 5.4.1.5.

4.4.1.4. Any differences between the request or tender and the contract must be resolved before any work commences. Each contract must be acceptable both to the laboratory and to the customer.

4.4.1.5. A contract may be any written or oral agreement to provide a customer with testing services.

4.4.2. Records of reviews, including any significant changes, are maintained. Records are also maintained of pertinent discussions with a customer relating to the customer's requirements or the results of the work during the period of execution of the contract. A more detailed explanation of the processes used to meet these requirements are contained in the ECI SOP *Project Management and Business Development,* T062, current version.

4.4.2.1. The method of recording the review depends on the type of review required.

4.4.2.2. For large sample contracts, the client usually contacts the laboratory prior to bringing samples to the laboratory. Any telephone conversations will be confirmed by e-mail to the client stating the expected samples, the methods that will be used, etc. These electronic communications are maintained as a record of the review. In addition, checklists are developed for review of RFPs and associated project plans or sampling and analysis plans (SAPs). For ongoing projects, this review only needs to be performed at the outset and if any changes are made.

4.4.2.3. For walk-in clients, a chain of custody is required. If clients do not bring one in with their samples, the laboratory provides one and requests that it be filled out. The laboratory reviews the COC as part of the login process and ensures the specific methods to be used are listed. A laboratory representative signs the COC and provides a copy to the client. This becomes the record of the review.

4.4.2.4. If samples are shipped in without prior notice, the same procedures as for walk-in clients are followed, but the copy of the COC is provided to the client by mail or electronic mail.

4.4.3. The review must also cover any work that is subcontracted by the laboratory. Subcontracting is detailed in the Section 4.5 of this Quality Assurance Manual.

4.4.4. The customer must be informed of any deviation from the contract. Usually, this communication is made by electronic mail. If made by other means, *e.g.,* telephone call, e-mail confirmation will be performed to provide a written record.

4.4.5. If a contract needs to be amended after work has commenced, the same contract review process must be repeated and any amendments are communicated to all affected personnel.

4.5. Subcontracting of Environmental Tests

4.5.1. When the laboratory subcontracts work, whether because of unforeseen reasons (e.g. workload, need for further expertise or temporary incapacity) or on a continuing basis (e.g. through permanent subcontracting, agency or franchising arrangements), this work shall be placed with a competent subcontractor. A competent subcontractor is one that holds an appropriate accreditation for the work in question

4.5.1.1. Work requiring NELAP accreditation must be placed with a NELAP-accredited laboratory.
4.5.1.2. Work requiring drinking water certification must be placed with a certified drinking water laboratory.
4.5.1.3. Work requiring DoD accreditation must be placed with a DoD-accredited laboratory. Additionally, the sub-contract must have project-specific approval by the DoD customer before samples are analyzed.

4.5.2. Proper accreditation is confirmed by initial and then by at least annual review of the subcontract laboratory's accreditation certificate(s). Additionally, ECI sends instructions with each subcontracted job requiring the subcontract laboratory to notify ECI of the following:

4.5.2.1. Any changes or loss of accreditation or certification for the applicable analyses,
4.5.2.2. Any analyses for which the laboratory has had unacceptable PT results that are not able to be addressed through corrective action, and
4.5.2.3. Need to further subcontract the sample analyses to a different subcontracting laboratory, including any "in-network" laboratory operating under a different accreditation or certification.

4.5.3. The laboratory advises the customer of the arrangement in writing and, when appropriate, gains the approval of the customer, preferably in writing. Personnel from ECI's Project Management group are tasked with management of subcontracting.

4.5.3.1. In the case of large contract work, notification is done as part of the contracting procedure described in the previous section. (Section 4.4)

4.5.3.2. In the case of walk-in or other individual lot type of work, the need to subcontract will be included on the COC that is copied and given to the customer or in an e-mail to the customer. If by e-mail, it is the project manager's responsibility to maintain the e-mail as a record of notification.

4.5.3.3. In some cases, customers may give a standing order to subcontract their samples. Records of such an order must be maintained by the project manager.

4.5.4. The laboratory is responsible to the customer for the subcontractor's work, except in the case where the customer or a regulatory authority specifies which subcontractor is to be used.

4.5.5. The Project Management group maintains a list of all subcontractors that it uses for tests and a record of having reviewed the appropriate accreditation certificate(s) for the tests that are subcontracted.

4.5.6. The laboratory performing the subcontracted work is indicated in the final report. The laboratory will make a copy of the subcontractor's report available to the client when requested.

4.5.7. Procedure:

4.5.7.1. The ECI project manager generates a separate chain of custody to accompany the subcontracted samples to the designated laboratory.

4.5.7.2. The ECI PM gathers the sample containers to be shipped and places them in a designated area in the sample receiving walk-in cooler. If samples are required to be split, PM personnel ensure that the proper splits are prepared.

4.5.7.3. PM or sample management personnel attach a sheet to the CoC noting the requirements listed in 4.5.2 above.

4.5.7.4. Sample management personnel load the cooler and ship the samples to the subcontract laboratory.

4.6. Purchasing Services and Supplies

4.6.1. The laboratory has a policy and procedure(s) for the selection and purchasing of services and supplies it uses that affect the quality of the tests. The policy of the laboratory is to purchase items that will be of sufficient quality to complete testing in compliance and to not adversely affect the processes. Procedures exist for the purchase, reception and storage of reagents and laboratory consumable materials relevant for the tests as described below.

4.6.2. The laboratory ensures that purchased supplies and reagents and consumable materials that affect the quality of analyses are not used until they have been inspected or otherwise verified as complying with

standard specifications or requirements defined in the methods for the analyses concerned. These services and supplies used are selected to comply with specified requirements. Records of actions taken to check compliance are maintained.

4.6.2.1. In general, supplies, reagents and consumable materials are purchased so that no additional testing is required prior to use. In this case, the initials of the person receiving the material state that the correct material was received, based on the ordering information, and it is, therefore, compliant.

4.6.2.2. In cases where there is no history with a vendor or where a particular supply has been shown to require testing, the testing is performed and records of the results tied to the lot of material tested, are maintained by the Group Leader where the supplies are used.

4.6.2.3. Reagents and standards used in analysis have some more specific requirements for inspection and testing. These requirements are included in the ECI SOP T003, *Standards and Reagents*, current version.

4.6.2.4. Equipment that may affect quality is calibrated or otherwise demonstrated to be suitable prior to use. Requirements and records are maintained as described in the related technical documents; such as method SOPs, support equipment SOPs, etc.

4.6.3. Purchasing documents for items affecting the quality of laboratory output are required to contain data describing the services and supplies ordered. Review and approval for technical content is performed prior to release. The manner in which this is performed depends on the type of supply or service.

4.6.3.1. Many routine consumable supplies are included in a stockroom supply contract. The specific items to be stocked are approved by the Group Leader who prepares the list for their area on an annual basis.

4.6.3.2. Items such as solvents and acids are ordered in bulk after consultation with Group Leaders. Specific grades are specified in the ECI SOP T003, *Standards and Reagents*.

4.6.3.3. Large equipment purchases are approved by laboratory (technical) management or corporate technical areas.

4.6.3.4. Other supplies or services are approved on an individual basis by Group Leaders or designees as part of their sign-off in the routine ordering process.

4.6.4. The laboratory evaluates suppliers of critical consumables, supplies and services that affect the quality of testing and calibration, and maintains records of these evaluations and list those approved.

4.6.4.1. Large supply houses, such as Fisher Scientific and VWR, supplying consumable materials that do not require

traceability are considered to be approved for use unless proven otherwise.

4.6.4.2. Vendors providing calibration services and reference materials used for calibration must be able to provide certificates of accreditation for the specific services or materials provided through an internationally-recognized ISO Accreditation Body and must be able to provide endorsed certificates of calibration under the appropriate ISO or national standard in order to be considered approved. Where accredited reference materials are not available, other requirements apply. See the ECI SOPs T003, *Reagents and Standards*, and T043, *Support Equipment*, current versions, for further information.

4.6.4.3. Consultants are approved based on evaluation of their work history and, if deemed necessary by the Laboratory Director or designee, by reference.

4.6.4.4. The corporate purchasing system does not include technical vendor approval. ECI maintains a list of approved vendors in the Laboratory Operations office. Quality critical items and services must be purchased from vendors that are included on the list maintained locally. Other vendors, though available on the purchasing system, must not be used.

4.7. Service to the Client

4.7.1. The laboratory is willing to cooperate with customers or their representatives in clarifying the customer's request and in monitoring the laboratory's performance in relation to the work performed, provided that the laboratory can ensure confidentiality to other customers.

4.7.1.1. The laboratory will provide the customer or the customer's representative reasonable access to relevant areas of the laboratory for the witnessing of tests performed for the customer, provided this can be done while ensuring confidentiality to other customers.

4.7.1.2. Customers wishing to perform on-site audits of the laboratory must commit to maintaining confidentiality. The laboratory maintains an SOP and confidentiality agreement for external audits, ECI SOP *Customer and Regulatory Audits,* T-027, current version. Note: Assessors representing State and Third Party Accreditation Bodies or similar agencies bound by their own confidentiality policies are not included under this clause.

4.7.1.3. If requested, the laboratory will help with preparation, packaging, and dispatch of samples needed by the customer for verification purposes.

4.7.1.4. The laboratory will take other such reasonable actions requested by the customer.

4.7.2. The laboratory seeks feedback, both positive and negative, from its customers. The feedback is used and analyzed to improve the management system, testing and calibration activities and customer service.

4.7.2.1. Feedback is solicited with each electronic report sent to the customer.

4.7.2.2. Feedback is also solicited on an annual survey coordinated through Eurofins corporate office. The project management group provides a list of customers to the corporate office, which sends surveys to selected customers on the list. Results are compiled and returned to the laboratory.

4.7.2.3. Feedback collected is included for review in the annual Management Review.

4.8. Complaints

4.8.1. The laboratory has a policy and procedure for the resolution of complaints received from customers or other parties. Records are maintained of all complaints and of the investigations and corrective actions taken by the laboratory.

4.8.2. All complaints must be recorded and investigated at least sufficiently enough to determine whether they are with or without merit.

4.8.2.1. Complaints are recorded in the eJira system by the person who receives the complaint. The “issue” screen is filled out down through the “Description” section of the screen.

4.8.2.2. That individual either investigates the complaint or assigns the investigation to another individual using the eJira system.

4.8.3. Complaints are initially evaluated as with merit, *e.g.,* complaints about missed turn-around times or results that are found to have been reported erroneously, or as without merit, *e.g.,* complaints about results that, while not desired, are in fact correct or about pricing that was previously accepted.

4.8.3.1. Record the investigation in the “Investigation” field

4.8.3.2. Conclude that that investigation is with merit or without merit.

4.8.4. Complaints that are found to be with merit are placed into the corrective action system for disposition. In eJira, an ICAR is created, the issues are further investigated, root cause is determined, actions are taken and all of these steps are recorded as described in the corrective action procedures.

4.9. Control of Nonconforming Environmental Testing Work

4.9.1. The laboratory has a policy and procedures that must be implemented when any aspect of its testing work, or the results of this work, do not conform to its own procedures or the agreed requirements of the customer. The policy of the laboratory is that non-conforming work must be addressed as defined below or in pertinent SOPs so that the needs of

the customer are met. Examples of places non-conforming work could occur include customer complaints, quality control, instrument calibration, checking of consumable materials, staff observations or supervision, test report checking, management reviews and internal or external audits.

4.9.1.1. The responsibilities and authorities for the management of nonconforming work are as follows.

4.9.1.1.1. All laboratory personnel are responsible for taking appropriate action when non-conforming work is identified, including notification of the Laboratory Director, if needed. In many cases, the appropriate action is defined in the analytical SOPs.

4.9.1.1.2. All personnel may stop work when non-conforming work is identified, but the Group Leader, Operations Manager, Laboratory Director, QA representative or QA manager must be notified of a stoppage as soon as is feasible.

4.9.1.1.3. The Laboratory Director, QA Manager, Operations Manager or their designees, are authorized to recall work or withhold analytical reports, if necessary.

4.9.1.2. An evaluation of the significance of the nonconforming work is made. Exceptions are first evaluated by the analyst or other personnel performing the work and their group leader.

4.9.1.3. Correction is taken immediately, together with any decision about the acceptability of the nonconforming work. “Corrections” are things done to continue working, report the data, and fix the immediate problem. Note that this is different than corrective action, which is described in Section 4.11.

4.9.1.4. Where necessary, the customer is notified and work is recalled. The responsibility for authorizing the resumption of work given to the Laboratory Director, or designee, in consultation with the QA manager and following the review of root cause(s) and corrective action.

4.9.2. Where the evaluation indicates that the nonconforming work could recur or that there is doubt about the compliance of the laboratory's operations with its own policies and procedures, the corrective action procedures given in 4.11 shall be promptly followed.

4.9.3. For projects under DoD ELAP Accreditation, the laboratory shall notify all affected clients of potential data quality issues resulting from nonconforming work within 15 business days, even if corrective action has not been completed. Notification shall be performed according to documented procedures. Documentation of corrective actions taken to resolve the nonconformance shall be submitted to the client(s) in a timely and responsive manner. See ECI SOP T062, *Project Management.*

4.10. Improvement

4.10.1. The laboratory strives to continually improve the effectiveness of its management system through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review.

4.10.2. Personnel are encouraged to bring to the attention of management items that may improve the functioning of the laboratory and its management system.

4.10.3. Improvements must be vetted and follow the change control procedures used in the laboratory to ensure continuing compliance with policies, Standards, regulations, methods, etc.

4.11. Corrective Action

4.11.1. General

4.11.1.1. The laboratory policy is to take appropriate corrective action whenever departures from the laboratory's policies and procedures are identified in the management system or the laboratory's technical operations. This is done using the procedures described below. For quality control outliers that do not appear to be systematic, appropriate actions are defined in the analytical SOPs and this formal corrective action process is not required.

4.11.1.2. A non-conformance with the management system or with the technical operations of the laboratory may be identified through a variety of activities, such as control of nonconforming work, internal or external audits, proficiency test failures, management reviews, and feedback from customers and from staff observations.

4.11.1.3. All personnel in the laboratory are responsible to initiate corrective action when indicated by SOPs, observance of departures from documented systems, or simply good scientific judgment or common sense. When bench analysts believe corrective action is needed, they must notify their group leader as soon as possible so the group leader can review and assign responsibilities.

4.11.1.4. The eJira system is used to record all steps of the corrective action process.

4.11.1.5. The issue must be defined with adequate detail to allow further investigation. Typically, the important elements to include are: what event(s) occurred, in what process did the event(s) occur, who witnessed the event(s) or performed the process, when (date/time) did the event(s) occur, where did the event(s) occur, what other processes were or may be impacted. Record this information in the "Description" section of the eJira system.

4.11.1.6. Once the problem or failure is defined, responsibility for investigation is assigned to one or more laboratory personnel by the Group Leader, Operations Director, Laboratory Director, or Quality Assurance personnel. The eJira system sends an email to those assigned to notify them of the responsibility.

4.11.1.7. If sample data are affected, provide as much information as possible about which data and how it was affected in the "Impact on Sample Data" section of the eJira system.

4.11.2. Cause Analysis

4.11.2.1. For failures that appear to be systematic, the procedure for corrective action starts with an investigation to determine the root cause(s) of the problem. Cause analysis is key to the corrective action procedure.

4.11.2.2. Root cause analysis is the most challenging aspect of the corrective action process. When correctly applied, root cause analysis leads to more effective solutions, continuous improvement, and a reduced likelihood of further deficiencies. In some cases, the root cause is singular and easily discerned. In other cases, determination of the root cause or causes may require more effort to identify. For this reason, there is no single 'recipe' that can be followed. There is no singe procedure that will be applicable to all scenarios, but there are guiding principles, the most important of which is addressing the question: "Why did this deficiency occur?"

4.11.2.3. Root Cause Analysis seeks to identify the origin of a problem. It assumes that systems and events are interrelated. One event leads to another, which leads to another. By tracing back these actions, you can discover the original source of the problem.

4.11.2.4. Adequate data must be collected to allow effective Root Cause Analysis. In addition to the information required in the definition of the problem, investigations must also attempt to determine the duration, frequency, and/or pervasiveness of the problem and identify any other areas where the same or similar problems could occur.

4.11.2.5. Root causes are specific underlying causes that can be reasonably identified, that management has control to fix and for which effective recommendations for preventing recurrences can be generated.

4.11.2.6. Potential causes could include, but are not limited to, issues related to customer requirements, sample matrix, methods and procedures, staff skills and training, consumables, equipment calibration and maintenance, environmental conditions.

4.11.2.7. Record the Root Cause(s) determined in detail in eJira Section "Detailed Explanation of the Root Cause". At the

same time, select the best option in the "Root Cause Category" drop down. This is used for category tracking purposes. If more than one root cause is identified, choose the category that has a greater impact on the laboratory.

4.11.3. Selection and Implementation of Corrective Actions

4.11.3.1. If possible, generate several potential solutions to the root cause(s) of the problem.

4.11.3.2. Rank the potential solutions according to their likelihood of eliminating the problem, preventing its recurrence, the cost vs benefit, and the risk of unintended negative impacts.

4.11.3.3. Select one or more actions appropriate to the magnitude of the problem and the risk of recurrence.

4.11.3.4. List the potential corrective action(s) and note those selected for implementation in the "Corrective Action Plan" section in the eJira

4.11.3.5. Assign personnel responsible for implementation in eJira. The system will email the person(s) assigned to notify them of the responsibility.

4.11.3.6. Assign a completion date for implementation. Standard completion time is targeted at two weeks, but this may not be appropriate and may be changed depending on the nature of the actions and the needs of the laboratory and its customers.

4.11.4. Monitoring of Corrective Actions

4.11.4.1. Routine monitoring of corrective actions is combined with internal auditing. . When ICARs are closed by a member of QA, that person will enter the issue into the "QA Issue Follow Ups" Excel. On the first business day of the month, the Quality Assurance Manager or their designee will query this document for issues that have not been followed-up on. These issues will be checked to ensure activities are proceeding in a timely way and implemented corrective actions appear to be effective.

4.11.4.2. Additionally, during preparation for internal audits, the eJira system is queried for corrective actions related to the area to be audited. Verification of the continued effectiveness of these corrective actions are then included in the scope of the internal audit. Records of the verification are maintained in the audit record.

4.11.5. Additional Audits--Where the review of corrective actions shows clusters of similar root causes, or where monitoring of implementation of corrective actions shows continued or significant non-conformances, the laboratory ensures that the appropriate areas of activity are audited in accordance with 4.14 as soon as possible.

4.12. Preventive Action

4.12.1. Needed improvements and potential sources of nonconformities, either technical or concerning the management system, must be identified. When improvement opportunities are identified or if preventive action is required, action plans are developed, implemented and monitored to reduce the likelihood of the occurrence of such nonconformities and to take advantage of the opportunities for improvement.

4.12.2. As noted in the Standard, preventive action is a pro-active process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints. Performing appropriate preventive action requires a mindset of looking at laboratory operations with an eye toward seeing what could go wrong. Often, this will be based on what types of problems have been solved in the past. Preventive actions may come as a result of the management review process or through attempts to improve the efficiency of the laboratory, including LEAN initiatives.

4.12.3. The preventive action process is as follows

- Identify the needed preventive action
- Develop an action plan to implement the action
- Implement the action, with changes as necessary
- Monitor the results of the action to verify that the action taken is achieving the desired results and has not caused unanticipated negative impacts

4.12.4. Preventive actions should be recorded. Unless another mechanism is indicated, such as the Management of Change (MOC) system or LEAN records, use the eJira system. Identification of a root cause is not part of the preventive action system. Fields in the eJira system relating to root cause should be listed as “NA”.

4.13. Control of Records

4.13.1. General

4.13.1.1. The laboratory has established and maintains procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. Quality records maintained include reports from internal audits and management reviews as well as records of corrective and preventive actions.

4.13.1.2. All records must be legible and stored in such a way that they are readily retrievable. ECI maintains records in both hard copy and electronic formats. Both types of records must be stored so as to prevent damage and deterioration. All records are maintained for a minimum of five years after last use.

4.13.1.3. All records are held secure and in confidence.

4.13.1.4. The laboratory maintains procedures to protect and back up electronic records and to prevent unauthorized amendments

to these records.

4.13.2. Technical records

4.13.2.1. The laboratory is required to retain records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for the time period defined above or longer, if required by the customer. The records for each test or calibration must contain sufficient information to facilitate, if possible, identification of factors affecting the uncertainty and to enable the test or calibration to be repeated under conditions as close as possible to the original. The records must include the identity of personnel responsible for the sampling, performance of each test and/or calibration and checking of results.

4.13.2.2. Observations, data and calculations must be recorded at the time they are made and must be identifiable to the specific task. For example, it is not acceptable to record a number without identifying what the number means.

4.13.2.3. When mistakes occur in records, each mistake shall be crossed out with a single line; not erased, made illegible or deleted; and the correct value entered alongside. All such alterations to records shall be dated and signed or initialed by the person making the correction. Additionally, corrections due to reasons other than transcription errors must specify the reason for the correction. In the case of records stored electronically, equivalent measures shall be taken to avoid loss or change of original data.

4.13.3. Additional Requirements

4.13.3.1. The laboratory's record keeping system is designed to allow the history of the sample and associated data to be readily understood through the documentation. This system must produce unequivocal, accurate records that document all laboratory activities such as laboratory facilities, equipment, analytical methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification, and inter-laboratory transfers of samples and/or extracts.

4.13.3.2. Records are made available to the accreditation body. Records concerning a customer's samples will be made available to that customer if it can be done without compromising the confidentiality of other customer's data.

4.13.3.3. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval for the full retention time required for the record type.

4.13.3.4. Access to archived information must be documented with an access log. Electronic access is tracked through the electronic storage systems. Hard copy archive access is

documented with a log.

4.13.3.5. All information necessary for the historical reconstruction of data shall be maintained by the laboratory, including the items listed below. Instructions for how each item is maintained are found in the SOPs governing those activities and in the technical SOPs for each method.

4.13.3.5.1. All raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' worksheets and data output records (chromatograms, strip charts, and other instrument response readout records).
4.13.3.5.2. A written description or reference to the specific method used, which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value.
4.13.3.5.3. The laboratory sample ID code.
4.13.3.5.4. The date of analysis.
4.13.3.5.5. The time of analysis is required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., extractions and incubations).
4.13.3.5.6. Instrumentation identification and instrument operating conditions/parameters (or reference to such data).
4.13.3.5.7. All manual calculations.
4.13.3.5.8. Analyst's or operator's initials/signature or electronic identification.
4.13.3.5.9. Sample preparation including cleanup, separation protocols, volumes, weights, instrument printouts, meter readings, calculations, and reagents.
4.13.3.5.10. Test results.
4.13.3.5.11. Standard and reagent origin, receipt, preparation and use.
4.13.3.5.12. Calibration criteria, frequency and acceptance criteria.

4.13.3.6. All generated data, except those that are generated by automated data collection systems, are recorded legibly in permanent ink.

4.13.3.7. If the laboratory transfers ownership or goes out of business, ECI will ensure that the records are maintained or transferred according to customer instruction.

4.13.3.7.1. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives will be clearly established. In cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records will be followed.
4.13.3.7.2. If the laboratory goes out of business, all records will revert to the control of the client or regulatory agency, as applicable. As much notice as

possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

4.13.4. Analytical Record-Keeping System Design

4.13.4.1. Analyses in the laboratory are either performed on analytical instrumentation that provides the required records electronically, usually using vendor-supplied software, or there is an analytical "bench sheet" designed for the analysis to capture all required information.

4.13.4.2. Where electronic systems do not capture all of the required information, they may be augmented with a bench sheet or batch sheet to provide information missing from the electronic files.

4.13.4.3. Some of the required analytical information is recorded on the "worksheet", a collection of sample tracking information printed for each sample group at log-in and carried through the laboratory process with the samples.

4.13.4.4. Signature log: The laboratory keeps a log of each employee's name, signature and initials. The laboratory also assigns each employee a numerical "Analyst ID". Technical personnel generally use this number rather than their signature or initials on analytical records. The log is kept on file in the QA offices.

4.14. Internal Audits

4.14.1. The laboratory periodically, and in accordance with a predetermined schedule and procedure, conducts internal audits of its activities to verify that its operations continue to comply with the requirements of the management system and with all applicable Standards. The internal audit program addresses all elements of the management system and laboratory process. Additional detail on auditing requirements and qualification of internal auditors is found in the ECI SOP *Internal Audit Procedures,* T028, current revision.

4.14.1.1. It is the responsibility of the Quality Assurance Manager to plan and organize audits as required by the schedule and requested by management. Auits are performed so that the entire management system is audited annually.

4.14.1.2. Internal audits are performed by trained and qualified personnel who are independent of the activity to be audited.

4.14.1.3. Checklists are used to assist the audit procedure. This ensures that there is documentation of what items were checked and what the results of the checks were.

4.14.2. If audit findings cast doubt on the correctness or validity of calibrations or analytical results, immediate corrective action must be taken. Deficiencies discovered during the auditing process are rectified and documented

using the corrective action process described in Section 4.11 of this manual. Records are maintained in the eJira system.

4.14.3. The area of activity audited, the audit findings and corrective actions that arise from them are recorded in an audit report.

4.14.4. Follow-up audit activities verify and record the implementation and effectiveness of the corrective action taken. Follow up is a part of the corrective action procedure and is documented in the corrective action system.

4.14.5. Additional Items

4.14.5.1. If the laboratory identifies events that cast doubt on the validity of test results, the laboratory is required to notify clients with affected data within seven calendar days of the discovery. Notification must be recorded in the eJira system.

4.14.5.2. The laboratory management must ensure that these actions taken as a result of internal audits are discharged within the agreed time frame.

4.15. Management Review

4.15.1. The Laboratory Management is responsible for performing an annual management review of the laboratory. The focus of the management review is on the sufficiency of the Quality Assurance Manual and system to meet the standards of NELAP.

4.15.1.1. The review is performed in multiple stages. First, the quality department personnel and the BUMa collect information to fill out the Eurofins Environment form “Management Review Meeting Agenda”.

4.15.1.2. Then, a local meeting is held with the BUMa, the quality department staff, the production manager and other parties as decided by the BUMa.

4.15.1.3. The output of the meeting is the completed “Management Review Meeting Agenda” form with proposed action items.

4.15.1.4. The final step is for the BUMa and the quality staff to review the information and proposed action items with the [Insert Paul Wise’s Title here] and the Corporate Quality Director to finalize action items.

4.15.2. The review will include but is not limited to the following items:

4.15.2.1. The suitability of policies and procedures, including data integrity procedures
4.15.2.2. Results of the annual assessment
4.15.2.3. Results of proficiency testing samples
4.15.2.4. Corrective and preventive actions
4.15.2.5. Results of any external assessments, *e.g.*, certification assessments
4.15.2.6. Any changes in the volume or type of work, particularly

anticipated changes

4.15.2.7. Review of client complaints or other client feedback

4.15.2.8. Any other relevant factors, such as quality control activities, resources, and staff training.

4.15.3. A record of the discussions included in the review will be kept on file in the laboratory.

4.15.3.1. The record must include determinations as to whether the management system is meeting the needs of the laboratory and where improvements will be made.

4.15.3.2. Action items resulting from the review will be entered into the eJira system, where they will be assigned to specific personnel and given a timeline for implementation.

4.16. Data Integrity

4.16.1. It is the policy of the laboratory to produce data which are sound, correct and complete. The laboratory maintains a documented data integrity system which is reviewed annually and approved by management. The program in place in the laboratory includes the following elements which are detailed in the ECI SOP T065, *Data Integrity*, current version.

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4.16.1.1. Data Integrity Training

4.16.1.2. Documentation signed by each employee

4.16.1.3. In-depth, periodic monitoring of data integrity

4.16.1.4. Documentation of data integrity procedures.

4.16.2. Laboratory management will uphold the spirit of the laboratory's data integrity program and will work to effectively implement the requirements of these procedures.

4.16.3. Employees undergo Data Integrity training and sign statements that they agree to abide by the requirements of the Data Integrity Program at orientation and annually.

4.16.4. The laboratory maintains a no-fault reporting policy for data integrity issues.

4.16.5. If a report is received of a potential violation of the laboratory's data integrity procedures or if the laboratory's auditing program reveals evidence of inappropriate actions or vulnerabilities related to data integrity, further review is required. All investigations will be handled in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and the issues clarified.

4.16.6. All investigations that result in finding of inappropriate activity must be recorded and the records must include any disciplinary actions involved, corrective actions taken, and all notifications of clients. All records must be kept for at least five years.

5. Technical Requirements

5.1. General

5.1.1. Many factors determine the correctness and reliability of the tests performed by a laboratory including human factors, accommodation and environmental conditions, test and calibration methods and method validation, equipment, measurement traceability, sampling, handling of test items, as well as others.

5.1.2. The extent to which the factors contribute to the total uncertainty of measurement differs considerably between different types of test. The laboratory takes these factors into consideration in developing test methods and procedures, in training and qualifying personnel and in the selection and calibration of the equipment it uses.

5.2. Personnel

5.2.1. The laboratory management must ensure the competence of all who operate specific equipment, perform tests, evaluate results, and sign test reports. When using staff in training, appropriate supervision must be provided. Personnel performing specific tasks are qualified on the basis of appropriate education, training, experience and/or demonstrated skills, as required.

5.2.2. The management of the laboratory formulates goals with respect to the education, training and skills of the laboratory personnel. The laboratory policy and procedures for identifying training needs and providing training of personnel are outlined below. The training program is intended to be relevant to the present and anticipated tasks of the laboratory. The overall goals of the training program are to ensure that all personnel have the skills to perform their work in compliance with the management system and the Standard, are trained in the parts of the management system that affect their specific job, and have demonstrated competency to perform the tests, parts of tests or other functions for which they are responsible. Details of the training program, including records requirements, are contained in the ECI SOP *Employee Training*, T010 (current version).

5.2.2.1. Training needs are identified through evaluation of current skills by management. Initially, individuals are trained to perform specific methods or support procedures as defined by their initial job description. After initial training in specific job functions, annual evaluations include identification of other training needs. Training on basic laboratory techniques is performed along with method training that uses those techniques.

5.2.2.2. Initial training is designed to provide a new employee with the information required to perform their job in compliance with the overall management system. Additional training needs are determined during employee evaluations and may include additional method training, training in additional tasks such as sample management, refresher training, or, in some cases, retraining on particular parts of the management system.

5.2.2.3. Training effectiveness is evaluated initially through observation of the employee's performance of tasks and/or through evaluations of Demonstrations of Capability. Continuing evaluations are made through additional observation, through evaluation of quality control data and proficiency testing data as well as review of reports and records generated by the employee in the performance of their duties.

5.2.3. The laboratory routinely uses personnel who are employed by the laboratory. However, new employees are often brought in through a temporary agency and may be converted to full-time company employees after a trial period. Regardless of whether company employees or contracted personnel are used, the laboratory ensures that such personnel are supervised and competent and that they work in accordance with the laboratory's management system.

5.2.4. The laboratory maintains current job descriptions for managerial, technical and key support personnel involved in tests and/or calibrations. Minimum job descriptions (as required by the Standard) for key managerial personnel are found in Appendix 2 of this Quality Manual. Job descriptions for analytical ("bench") personnel are maintained by the Operations Manager and/or Group Leaders. Information in job description may include, for example, the following items.

5.2.4.1. Responsibilities with respect to performing tests.
5.2.4.2. Responsibilities with respect to the planning of tests and evaluation of results
5.2.4.3. Responsibilities with respect to method modification and development and validation of new methods
5.2.4.4. Expertise and experience required
5.2.4.5. Qualifications and any required training programs
5.2.4.6. Managerial duties.

5.2.5. Laboratory management authorizes specific personnel to perform particular types of sampling and testing, to issue test reports, and to operate particular types of equipment. The laboratory maintains records of the relevant authorization(s), competence, educational and professional qualifications, training, skills and experience of all technical personnel, including contracted personnel. This information is maintained by the QA office and kept readily available. It must include the date on which authorization and/or competence is confirmed.

5.2.5.1. Authorization to perform tests is given by the approval of the Initial Demonstration of Capability. Authorization to operate specific types of equipment is included with the method authorization that uses that equipment.

5.2.5.2. Each analyst must demonstrate capability for each test method used in the laboratory initially, prior to reporting samples using the method, and on an annual basis thereafter. Records of these demonstrations must be maintained.

5.2.5.3. For processes that do not include an analytical method, authorization is indicated by one of several methods:

5.2.5.3.1. For processes that require specific LIMS or other electronic permissions, the authorization is indicated by the supervisor's e-mail to QA requesting that the permission be given to the employee.

5.2.5.3.2. For analytical processes that do not lend themselves to a demonstration of capability, authorization is indicated through inclusion by the supervisor of the method on the employee's "Method Proficiency List and Demonstration of Capability Certification Statement" form along with the record of having read and understood the governing SOP(s).

5.2.5.4. This laboratory does not offer opinions or interpretations, so there is no authorization procedure for them.

5.2.5.5. All records of training are included in the employees' training files.

5.2.6. Group Leader responsibilities

5.2.6.1. Group leaders are responsible for ensuring that training requirements are met for assigned personnel, and

5.2.6.2. Ensuring that training records are maintained and up to date for assigned personnel.

5.2.7. Data Integrity Training

5.2.7.1. Data integrity training is required as a part of the initial new employee orientation and annually thereafter.

5.2.7.2. The Data Integrity Program, including training requirements, is described in Section 4.16 above and in the SOP referenced there.

5.3. Accommodation and Environmental Conditions

5.3.1. The laboratory facilities for testing, including but not limited to energy sources, lighting and environmental conditions, must facilitate correct performance of the tests. The laboratory will ensure that the environmental conditions do not invalidate the results or adversely affect the required quality of any measurement. The technical requirements for accommodation and environmental conditions that can affect the results of test and calibration are required to be documented.

5.3.2. Most of the laboratory is amenable to normal industrial building controls. There are few areas in the laboratory where temperature requirements are prescribed. Where test methods make specific requirements, these are incorporated into the testing areas. The following environmental conditions are considered essential to obtaining accurate results:

5.3.2.1. Leaching tumblers (*e.g.,* TCLP) are kept in a room that is controlled and monitored during tumbling and meets the

requirements of the test methods.

5.3.2.2. Biomonitoring (Whole Effluent Toxicity Testing, "WETT") is performed in a room that is controlled and monitored during testing to meet the requirements of the test methods.

5.3.3. The laboratory maintains an effective separation between areas in which there are incompatible activities. Measures are taken to prevent cross-contamination.

5.3.3.1. Volatile organic analyses and air analyses are performed in a building that is separated from the main building, where organic extractions and semivolatile organic analyses are performed.

5.3.3.2. Other analyses with a potential for cross-contamination from preparation (e.g., metals) are performed in separate rooms.

5.3.4. Laboratory access is controlled. Only authorized individuals are allowed in the laboratory area. Guests may be allowed in the laboratory only with an authorized escort. Detailed protocols for managing customer visits and external audits are included in the ECI SOP *Customer and Regulatory Audits,* T-027, current version.

5.3.4.1. Customer information must be kept confidential when visitors are in the laboratory area. Do not allow visitors, particularly customers, to view worksheets from other customers' samples.

5.3.4.2. Do not leave visitors unescorted in the laboratory areas.

5.3.5. Laboratory personnel are required to practice appropriate good housekeeping.

5.3.5.1. In general, no specific laboratory protocols are required for the types of analyses performed at ECI. Where specific protocols are required for specific tests, they are documented in the applicable test method SOPs.

5.3.5.2. The laboratory LEAN program seeks to minimize clutter while maximizing accessibility of appropriate apparatus, reagents, and standards. Laboratory personnel are required to maintain their work spaces as indicated in the LEAN 5S Standards.

5.3.5.3. The laboratory employs a contractor to provide basic custodial services. The contractor has been instructed to not use cleaning chemicals in the areas where volatile organic analyses are performed.

5.4. Environmental Methods and Method Validation

5.4.1. The laboratory is required to use appropriate methods and procedures for all tests within its scope and all calibrations and verifications of equipment.

5.4.1.1. These include sampling, handling, transport, storage and preparation of samples to be analyzed and, and, where

appropriate, an estimation of the measurement uncertainty as well as statistical techniques for analysis of quality control data.

5.4.1.2. The laboratory has instructions on the use and operation of all relevant equipment, and on the handling and preparation of samples for analysis, or both, where the absence of such instructions could jeopardize the results of tests and/or calibrations.

5.4.1.2.1. These instructions are included in the laboratory's SOPs for specific methods and in the instrument manufacturer's manuals.

5.4.1.2.2. Additional instructions may be included in SOPs specific to a particular task or instrument.

5.4.1.3. All instructions, standards, manuals and reference data relevant to the work of the laboratory are required to be kept up to date and made readily available to personnel (see 4.3). Deviation from test and calibration methods may occur only if the deviation has been documented, technically justified, authorized, and accepted by the customer.

5.4.1.4. The laboratory maintains specific SOPs for each environmental test method used in the laboratory.

5.4.1.5. Deviations from the published method are listed in a specific section in the SOP along with their technical justification. Data supporting the validity of listed deviations, if required, is kept on file in the laboratory. Listed deviations are collated by the QA department and then provided to project management.

5.4.2. The laboratory must ensure it uses test methods, including methods for sampling, which meet the needs of the customer and which are appropriate for the tests and/or calibrations it undertakes.

5.4.2.1. Methods published in international, regional or national standards are preferably used.

5.4.2.1.1. Sources include methods that have been published either in international, regional or national standards, or by reputable technical organizations, or in relevant scientific texts or journals, or as specified by the manufacturer of the equipment. Specific sources of methods used at ECI include the EPA, *Standard Methods for the Examination of Water and Wastewater*, ASTM, the State of California and local municipalities, and scientific journals.

5.4.2.1.2. The laboratory must use the latest valid edition of a standard unless it is not appropriate or possible to do so. Note: Some accreditations and some contracts held by the laboratory require the use of

earlier editions of methods.

5.4.2.1.3. When necessary, the method is supplemented with additional details to ensure consistent application.

5.4.2.2. When the customer does not specify the method to be used, the laboratory selects what it deems the most appropriate method.

5.4.2.3. Laboratory-developed methods or methods adopted by the laboratory may also be used if they are appropriate for the intended use and if they are validated. The customer must be informed as to the method chosen. See clause 5.4.3 below.

5.4.2.4. The laboratory is required to confirm that it can properly operate standard methods before introducing the tests or calibrations. If the standard method changes, in such a way that the detection system, the chemistry, or the sensitivity of the method may be affected, the confirmation must be repeated. This is accomplished by performing a Demonstration of Capability and, where applicable, a determination of detection limits study.

5.4.2.5. The laboratory must inform the customer when the method proposed by the customer is considered to be inappropriate or out of date.

5.4.2.6. All customer notifications are performed as part of the request, tenders, and contracts procedure. (See Section 4.4)

5.4.3. Laboratory-Developed methods. It is not likely that the laboratory will develop any in-house methods. If the need arises, the laboratory will develop validation plans in line with the requirements of the Standards.

5.4.4. Non-Standard methods, if used, will be validated using the procedures included in the Eurofins Calscience, Inc. SOP *Method Validation and Demonstration of Analytical Capability,* T046, current version.

5.4.5. Validation of the implementation of analytical methods will be performed using the procedures included in the Eurofins Calscience, Inc. SOP *Method Validation and Demonstration of Analytical Capability* T046, current version.

5.4.6. Estimation of Analytical Uncertainty

5.4.6.1. The laboratory maintains procedures for determining the uncertainty associated with analysis. Determination of total uncertainty, including sampling, transport, etc. is beyond the scope of the laboratory and will not be determined.

5.4.6.1.1. The exact nature of some test methods may preclude rigorous, statistically valid estimation of analytical uncertainty. In these cases the laboratory will attempt to identify all components of analytical uncertainty and make a reasonable

estimation and shall ensure that the form of data reporting does not give a wrong impression of the uncertainty. A reasonable estimation is based on knowledge of method performance and previous experience. When estimating the analytical uncertainty, all uncertainty components which are of importance in the given situation must be taken into account.

5.4.6.1.2. In those cases where a well-recognized test method specifies limits to the values of the major source of uncertainty of measurement and specifies the form of presentation of calculated results, the laboratory is considered to have satisfied the requirements on analytical uncertainty by following the test method and reporting instructions.

5.4.6.1.3. The laboratory is only responsible for estimating the portion of measurement uncertainty that is under its control. As stated in Section 5.10.3.1.c, test reports will include a statement of the estimated analytical uncertainty only when required by the customer.

5.4.6.2. Analytical uncertainty will not be routinely reported to the customer. Uncertainty will only be reported when requested by the customer or when the uncertainty affects compliance to a specification limit, if known by the laboratory. The laboratory uses no methods where the uncertainty is routinely relevant to the validity or application of the test results.

5.4.6.2.1. If a project requires analytical uncertainty to be reported, the laboratory shall report the estimated uncertainty based on project-specific procedures or, if not available, an internal procedure based on results of Laboratory Control Samples will be used.

5.4.6.2.2. The estimated analytical uncertainty can be expressed as a range (±) around the reported analytical results at a specified confidence level. A laboratory may report the in-house, statistically-derived LCS control limits based on historical LCS recovery data as an estimate of the minimum laboratory contribution to analytical uncertainty at a 99% confidence level.

5.4.6.3. For testing laboratories, the laboratory shall ensure that the equipment used can provide the analytical portion of measurement uncertainty needed by the customer.

5.4.6.4. For further information and procedures for determining analytical uncertainty, see the ECI SOP *Uncertainty in Measurement*, T045, current version.

5.4.7. Control of Data

5.4.7.1. Calculations and data transfers shall be subject to appropriate checks in a systematic manner.

5.4.7.2. When computers or automated equipment are used for the acquisition, processing, recording, reporting, storage or retrieval of test or calibration data, the laboratory ensures that:

5.4.7.2.1. Computer software developed by the user is documented in sufficient detail and is suitably validated as being adequate for use;

5.4.7.2.2. Procedures are established and implemented for protecting the data; such procedures shall include, but not be limited to, integrity and confidentiality of data entry or collection, data storage, data transmission and data processing;

5.4.7.2.3. Computers and automated equipment are maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of test and calibration data.

5.4.7.2.4. Commercial off-the-shelf software (e.g. word processing, database and statistical programs) in general use within their designed application range may be considered to be sufficiently validated. However, laboratory software configuration/ modifications should be validated as in 5.4.7.2.1.

5.4.7.2.5. User names and passwords are required for all information system access. Passwords are changed at least every six months.

5.4.7.2.6. Employees are trained at hiring and annually thereafter on computer security awareness. This training is combined with Ethics and Data Integrity Training for ease of implementation.

5.4.7.2.7. The Quality Assurance Manager or designee is responsible for annual inspection of the LIMS. At a minimum, archived reports are compared to re-generated reports to verify data and calculation integrity. Records are kept and laboratory management is notified of any problems identified and any corrective actions taken.

5.4.7.2.8. If the laboratory develops information systems that allow electronic customer interaction, the laboratory must also develop a procedure to

provide prior notification to customers of software or hardware changes that will adversely affect customer electronic data.

5.4.7.3. The validation procedures for computer software vary depending on the source and use.

5.4.7.3.1. Instrument software provided by the instrument vendor or by a recognized third-party vendor is considered to be validated by the vendor under the NELAP standard, but calculation algorithms are required to be validated under the DoD ELAP. Specific configurations installed by the vendor are also considered validated unless changed significantly by the laboratory.

5.4.7.3.2. Office software applications such as Word and Excel are considered to be validated by the vendor, including specific functions included in those applications.

5.4.7.3.3. Any software applications designed in the laboratory must be validated by the laboratory, including spreadsheets used to perform quality-critical calculations. See the next section for specific validation requirements.

5.4.7.3.4. All software, including user-defined software such as spreadsheet applications must be protected from unauthorized changes. Calculation cells in spreadsheets must be locked to prevent alterations of the formulae.

5.4.7.4. Some analyses and processes in the laboratory have spreadsheets that have been designed to perform the calculations necessary to generate the reportable results. All spreadsheets created for the laboratory will be validated for use prior to implementation. Vendor software that requires validation will also be validated using one of these methods.

5.4.7.4.1. One method of validation consists of a manual confirmation of the calculations performed by the spreadsheet. This verification will be kept on file in the laboratory.

5.4.7.4.2. Other methods of validation may include comparison of data generated by the old validated sheet to the data generated by the new sheet, or comparison of a set of new software calculations against calculations of the same data from the old, validated software.

5.4.7.4.3. Validation is only required when changes are made to calculation cells but not when changes are made to cells that look up sample description data (non-numerical) in LIMS, or when the

changes are purely cosmetic (font, column width etc).

5.5. Equipment

5.5.1. The laboratory is furnished with all items of sampling, measurement and test equipment required for the correct performance of the tests and/or calibrations (including sampling, preparation of test and/or calibration items, processing and analysis of test and/or calibration data). The laboratory does not use equipment that is outside its permanent control

5.5.2. Equipment and its software used for testing, calibration and sampling are capable of achieving the accuracy required and procedures ensure that the equipment complies with specifications relevant to the tests and/or calibrations concerned.

5.5.2.1. Calibration programs are established for key quantities or values of the instruments where these properties have a significant effect on the results. General equipment requirements are described in this section. Specific requirements are described in pertinent SOPs.

5.5.2.1.1. Calibration of analytical instrumentation is generally described the ECI SOP *Internal Quality Control Checks*, T020, current version. Specific requirements are contained in the test method SOPs governing the equipment.

5.5.2.1.2. Calibration and verification of support equipment is described ECI SOP *Support Equipment Calibration, Verification, and Monitoring*, T043, current version.

5.5.2.2. Before being placed into service, equipment (including that used for sampling) must be calibrated or checked to establish that it meets the laboratory's specification requirements and complies with the relevant standard specifications. It shall be checked and/or calibrated before use as required by the analytical methods or the SOPs.

5.5.3. Equipment is operated only by authorized personnel. Up-to-date instructions on the use and maintenance of equipment (including any relevant manuals provided by the manufacturer of the equipment) are readily available for use by the appropriate laboratory personnel. See the ECI SOPs *Routine Instrument Maintenance*, T066, current version, *Support Equipment Calibration, Verification, and Monitoring*, T043, current version, instrument manuals or the specific test method SOPs for these instructions.

5.5.4. Each item of equipment and its software used for testing and significant to the result is, when practical, be uniquely identified.

5.5.5. Records are maintained of each item of equipment and its software significant to the tests performed. The records shall include at least the following:

5.5.5.1. the identity of the item of equipment and its software;

5.5.5.2. the manufacturer's name, type identification, and serial number or other unique identification;

5.5.5.3. checks that equipment complies with the specification (see 5.5.2);

5.5.5.4. the current location, where appropriate;

5.5.5.5. the manufacturer's instructions, if available, or reference to their location;

5.5.5.6. dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and the due date of next calibration;

5.5.5.7. the maintenance plan, where appropriate, and maintenance carried out to date;

5.5.5.8. any damage, malfunction, modification or repair to the equipment.

Items 1, 2 and 4 are kept in spreadsheets by the QA Department. Items required in item 5 are kept in the QA Department. Maintenance plans are kept in the ECI SOP *Routine Instrument Maintenance*, T066, current version. Records of calibration/verification of analytical equipment are kept in the analytical data. Records of calibration/verification of support equipment are kept by the QA Department. Records of maintenance are kept in maintenance logs with the equipment.

5.5.6. The laboratory has procedures for safe handling, transport, storage, use and planned maintenance of measuring equipment to ensure proper functioning and in order to prevent contamination or deterioration. Additional procedures may be necessary when measuring equipment is used outside the permanent laboratory for tests, calibrations or sampling. See the ECI SOPs *Routine Instrument Maintenance*, T-066, current version, *Support Equipment Calibration, Verification, and Monitoring*, T043, current version, or the specific test method SOPs for these instructions.

5.5.7. Equipment that has been subjected to overloading or mishandling, gives suspect results, or has been shown to be defective or outside specified limits, must be taken out of service.

5.5.7.1. The equipment is isolated to prevent its use or clearly labeled or marked as being out of service until it has been repaired and shown by calibration or test to perform correctly. The laboratory has “Out of Service” signs available to place on instrumentation and requirements to include the out of service notification in logbooks associated with the equipment.

5.5.7.2. The laboratory must examine the effect of the defect or departure from specified limits on previous tests and/or calibrations and institute the "Control of nonconforming work" procedure (see 4.9). This is particularly important if support equipment is found to be out of tolerance during routine calibration cycles or if analytical equipment or reporting systems are found to have errors that may have been missed when used to generate earlier data.

5.5.8. Whenever possible, all equipment under the control of the laboratory and requiring calibration shall be labeled, coded or otherwise identified to indicate the status of calibration, including the date when last calibrated and the date or expiration criteria when recalibration is due.

5.5.8.1. Support equipment is labeled with its calibration status whenever possible.

5.5.8.2. Analytical instrumentation is calibrated according to test method requirements and requires some sort of calibration or calibration verification with every use. Therefore, the calibration status is generally maintained in and inferred from the instrument data.

5.5.9. When, for whatever reason, equipment goes outside the direct control of the laboratory, the laboratory shall ensure that the function and calibration status of the equipment are checked and shown to be satisfactory before the equipment is returned to service.

5.5.9.1. Analytical Instrumentation must pass method calibration requirements prior to return to use. If the instrumentation has been subject to repairs or alterations, new detection limit studies and an IDOC may be required. When in doubt, check with QA personnel.

5.5.9.2. Support equipment must be calibrated or verified as required before use.

5.5.9.3. Calibration Standards, such as Class 2 weights and traceable thermometers require verification upon return from calibration. See the ECI SOP *Support Equipment Calibration, Verification, and Monitoring.* T043, current version, for more information.

5.5.10. When intermediate checks are needed to maintain confidence in the calibration status of the equipment, these checks are carried out according to the procedures in the governing SOPs.

5.5.11. Where calibrations give rise to a set of correction factors, the laboratory procedures ensure that copies (e.g. in computer software, on calibration records, etc.) are correctly updated.

5.5.11.1. Interelement correction factors used in metals analysis, for example, must be updated through the software and saved appropriately.

5.5.11.2. Correction factors used on thermometers, for example, are listed on the thermometer.

5.5.12. Test and calibration equipment, including both hardware and software, must be safeguarded from adjustments which would invalidate the test and/or calibration results.

5.5.13. Support Equipment

5.5.13.1. In addition to analytical instruments, requirements for calibration apply to all devices that may not be the actual test

instrument, but are necessary to support laboratory operations. These include, but are not limited to; balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices (including thermometers and thermistors), thermal/pressure sample preparation devices and volumetric dispensing devices (such as Eppendorf® or automatic dilutor/dispensing devices), if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. Detailed requirements and procedures are contained in the ECI SOP *Support Equipment Calibration, Verification, and Monitoring*, T043, current version.

5.5.13.1.1. All support equipment shall be maintained in proper working order. The records of all repair and maintenance activities, including service calls, shall be kept.

5.5.13.1.2. All support equipment must be calibrated or verified at least annually, using references traceable to recognized a National Metrology Institute, such as NIST, when available, and bracketing the range of use.

The results of such calibration or verification are required to be within the specifications required of the application for which this equipment is used or the equipment is removed from service until repaired.

The laboratory must maintain records of established correction factors arising from these calibrations or verifications to correct all measurements.

5.5.13.1.3. Raw data records are retained to document equipment performance.

5.5.13.1.4. On each day the equipment is used, balances, ovens, refrigerators, freezers and water baths shall be checked and the results recorded. The acceptability for use or continued use is set according to the needs of the analysis or application for which the equipment is being used.

5.5.13.1.5. Volumetric dispensing devices (except Class A glassware and glass microliter syringes) used for quality-affecting measurements are checked for accuracy on a quarterly basis.

5.5.14. Instrument Calibration

5.5.14.1. Calibration of analytical instrumentation is addressed in general in the ECI SOP *Internal Quality Control Checks*, T020, current version.

5.5.14.2. Specifics of instrument calibration, including acceptance criteria, are contained in the technical SOP governing the analysis.

5.6. Measurement Traceability

5.6.1. All equipment used for tests and/or calibrations, including equipment for subsidiary measurements (e.g. for environmental conditions) having a significant effect on the accuracy or validity of the result of the test, calibration or sampling shall be calibrated before being put into service. The laboratory's program and procedures for the calibration of its equipment as well as traceability of standards and reagents is described in this section.

5.6.2. Measuring and test equipment with measuring functions used must be calibrated on at least an annual basis. Whenever possible, calibration is performed using reference standards or reference materials that are traceable to a national standard or other standard acceptable to the NELAP, DoD or customer, as applicable, unless it has been established that the associated contribution from the calibration contributes little to the total uncertainty of the test result. When this situation arises, the laboratory ensures that the equipment used can provide the uncertainty of measurement needed.

5.6.3. Reference Standards and Reference Materials

5.6.3.1. Reference Standards –The laboratory has a program and procedure for the calibration of its reference standards. Reference standards, such as weights used for checking balances and reference thermometers, must be calibrated by a calibration laboratory accredited to ISO 17025 for the particular calibration provided. Reference standards of measurement held by the laboratory are used for calibration or verification only and for no other purpose. The specifics of the calibration program are contained in the ECI SOP *Support Equipment Calibration, Verification, and Monitoring*, T043, current version.

5.6.3.2. Reference Materials – Reference materials, where possible, are traceable to SI units of measurement, to certified reference materials, or to national or international standard reference materials. Internal reference materials are checked as far as is technically and economically practicable.

5.6.3.3. Intermediate Checks – Checks needed to maintain confidence in the calibration status of reference, primary, transfer or working standards and reference materials are carried out according to procedures and schedules defined in the appropriate technical SOPs.

5.6.3.4. The laboratory shall have procedures for safe handling, transport, storage and use of reference standards and reference materials in order to prevent contamination or deterioration and in order to protect their integrity.

5.6.4. Documentation and Labeling of Standards, Reagents, and Reference Materials -- Documented procedures are in place for the purchase, receipt and storage of consumable materials used for the technical operations of the laboratory.

5.6.4.1. The laboratory retains records for all standards, reagents, reference materials, and media, including the manufacturer/vendor, the manufacturer's Certificate of Analysis or purity (if available), the date of receipt, and recommended storage conditions.

5.6.4.2. For original containers, if an expiration date is provided by the manufacturer or vendor it shall be recorded on the container. If an expiration date is not provided by the manufacturer or vendor it is not required.

5.6.4.3. Records are maintained on standard, reference material, and reagent preparation. These records shall indicate traceability to purchased stocks or neat compounds, reference to the method of preparation, date of preparation, expiration date and preparer's initials.

5.6.4.4. All containers of prepared standards, reference materials, and reagents are labeled with a unique identifier and expiration date.

5.6.4.5. Procedures are in place to ensure prepared reagents meet the requirements of the method.

5.6.4.6. Standards, reference materials, and reagents shall not be used after their expiration dates unless their reliability is verified by the laboratory.

5.7. Sampling

5.7.1. The laboratory performs some sampling for customers, virtually all of it related to wastewater treatment. Additionally, the laboratory performs subsampling of samples provided by customers to provide aliquots for specific analyses.

5.7.1.1. For external sampling, the procedures are described in detail in the ECI SOP *Industrial Wastewater Sampling*, T101, current version. Customers provide sampling plans to the laboratory. The SOP describes the specifics of the processes and factors to be controlled or monitored.

5.7.1.2. Subsampling, as in obtaining a representative sample for analysis from a sample container, is described in technical SOPs that deal with sample preparation.

5.7.2. Where the customer requires deviations, additions or exclusions from the documented sampling procedure, these are recorded in detail with the appropriate sampling data and are included in all documents containing test and/or calibration results, and are communicated to the appropriate personnel.

5.7.3. The laboratory maintains procedures for recording relevant data and operations relating to sampling that forms part of the testing or calibration that is undertaken. These records include the sampling procedure used, the identification of the sampler, environmental conditions (if relevant) and diagrams or other equivalent means to identify the sampling location as necessary and, if appropriate, the statistics the sampling procedures are based upon.

5.7.4. Sampling records for external sampling include the date and time of sampling and any deviations from the sampling procedures that were requested or required.

5.8. Handling Samples and Test Items

5.8.1. The laboratory has procedures for the transportation, receipt, handling, protection, storage, retention and/or disposal of test and/or calibration items, including all provisions necessary to protect the integrity of the test or calibration item, and to protect the interests of the laboratory and the customer. The procedures used to meet the requirements of this section are included in the ECI SOP T100 *Sample Receipt and Log-in Procedures*, current version.

5.8.2. The laboratory has a system for identifying test and/or calibration items. The identification shall be retained throughout the life of the item in the laboratory. The system is designed and operated so as to ensure that items cannot be confused physically or when referred to in records or other documents. The system accommodates a sub-division of groups of items and the transfer of items within and from the laboratory, including all samples, sub-samples, preservations, sample containers, tests, and subsequent extracts and/or digestates.

5.8.2.1. The system generates a laboratory code, which maintains an unequivocal link with the unique field ID code assigned to each sample.

5.8.2.2. The laboratory ID code is placed as a durable label on the sample container.

5.8.2.3. The laboratory ID code is entered into LIMS and is the link that associates the sample with related laboratory activities such as sample preparation.

5.8.3. Upon receipt of the test or calibration item, abnormalities or departures from normal or specified conditions, as described in the test or calibration method, shall be recorded. When there is doubt as to the suitability of an item for test or calibration, or when an item does not conform to the description provided, or the test or calibration required is not specified in sufficient detail, the laboratory consults the customer for further instructions before proceeding and shall record the discussion.

5.8.3.1. The laboratory maintains procedures to be used when samples show signs of damage, contamination, inadequate preservation, or other exceptions to the sample receipt policy.

5.8.3.2. If the sample does not meet the sample receipt acceptance criteria listed, sample receiving personnel notify the

appropriate project manager of the exceptions or questions, who, in turn, confer with the customer. The laboratory shall either:

5.8.3.2.1. Retain correspondence and/or records of conversations concerning the final disposition of rejected samples; or,

5.8.3.2.2. Fully document any decision to proceed with the analysis of samples not meeting acceptance criteria.

5.8.3.2.3. The condition of these samples shall be noted on the chain of custody or transmittal form and in LIMS.

5.8.3.2.4. The analysis data shall be appropriately qualified on the final report.

5.8.4. The laboratory has procedures and appropriate facilities for avoiding deterioration, loss or damage to the test or calibration item during storage, handling and preparation. Handling instructions provided with the item shall be followed. When items have to be stored or conditioned under specified environmental conditions, these conditions shall be maintained, monitored and recorded. These procedures are contained in the ECI SOP T100 *Sample Receipt and Log-in Procedures*, current version.

Note: Eurofins Calscience, Inc. does not provide secure, legal chain-of-custody procedures.

5.8.5. Additional Requirements – Sample Receipt Protocols

5.8.5.1. The laboratory has implemented procedures for verifying and documenting preservation.

5.8.5.2. The laboratory uses LIMS to create a permanent chronological record to document receipt of all sample containers. This record contains the following required information:

5.8.5.2.1. Client/project name,
5.8.5.2.2. Date and time of laboratory receipt,
5.8.5.2.3. Unique laboratory ID code, and,
5.8.5.2.4. The identification of the person making the entries.

5.8.5.3. During the login process, the following information shall be unequivocally linked to the log record using the LIMS.

5.8.5.3.1. The field ID code, which identifies each sample, shall be linked to the laboratory ID code in the sample receipt log.

5.8.5.3.2. The date and time of sample collection shall be linked to the sample and to the date and time of receipt in the laboratory.

5.8.5.3.3. The requested analyses (including applicable approved method numbers), linked to the laboratory ID code.

5.8.5.3.4. Any comments resulting from inspection for sample rejection shall be linked to the laboratory ID code.

5.8.5.4. All documentation, such as memos, chain of custody, or transmittal forms that are transmitted to the laboratory by the sample transmitter, is retained.

5.8.5.5. A complete chain of custody record form, if utilized, is maintained to document transfer of the sample to the laboratory.

5.8.5.5.1. For most samples, once the sample is inside the laboratory and the receiving process is completed, sample movement within the laboratory is not recorded, but can be inferred from documentation of analytical processes.

5.8.5.5.2. An internal chain-of-custody is available upon customer request.

5.8.6. The laboratory has a written sample acceptance policy, which is available to customers of the laboratory and other sampling personnel. This policy requires the following information be provided with each sample. The policy is included as an appendix in the ECI SOP T100 *Sample Receipt and Log-in Procedures*, current version.

5.8.6.1. Proper, full, and complete documentation, which includes sample identification; the location, date and time of collection; collector's name, preservation type, sample type and any special remarks concerning the sample;

5.8.6.2. Proper sample labeling to include unique identification and a labeling system for the samples with requirements concerning the durability of the labels (water resistant) and the use of indelible ink;

5.8.6.3. Use of appropriate sample containers;

5.8.6.4. Adherence to specified holding times;

5.8.6.5. Sufficient sample volume to perform the necessary tests;

5.8.7. Additional Requirements – Sample Storage and Disposal

5.8.7.1. Samples shall be stored according to the conditions specified by preservation protocols. For most samples, this means that samples are refrigerated.

5.8.7.1.1. Samples that require thermal preservation shall be stored under refrigeration that is +/- 2°C of the specified preservation temperature unless

regulatory or method specific criteria exist. For samples with a specified storage temperature of 4°C, storage at a temperature above the freezing point of water to 6°C shall be acceptable.

5.8.7.1.2. In practice, most samples are kept in the refrigerators for ease of retrieval.

5.8.7.1.3. Samples must be stored away from all standards, reagents, and food. Samples must be stored in such a manner to prevent cross contamination.

5.8.7.2. Sample fractions, extracts, leachates and other sample preparation products are stored according to specifications in the method and the requirements listed above.

5.8.7.3. The laboratory addresses disposal of samples, digestates, leachates and extracts and other sample preparation products in SOP T005, *Disposal of Laboratory Samples and Wastes*.

5.9. Quality Control for Environmental Testing

5.9.1. The laboratory has implemented quality control procedures for monitoring the validity of tests and calibrations undertaken. The resulting data are recorded in such a way that trends are detectable and, where possible, statistical techniques are applied to the reviewing of the results. This monitoring is planned and reviewed and includes, but may not be limited to, the following:

5.9.1.1. regular use of certified reference materials and/or internal quality control using secondary reference materials;

5.9.1.2. participation in proficiency-testing programs;

5.9.1.3. replicate testing;

5.9.1.4. retesting or recalibration of retained items;

5.9.1.5. correlation of results for different characteristics of an item.

5.9.2. Quality control data are analyzed as soon as is feasible after analysis and, where they are found to be outside pre-defined criteria, planned action is taken to correct the problem and to prevent incorrect results from being reported.

5.9.3. Essential Quality Control Procedures

5.9.3.1. The laboratory has written protocols in place to monitor the following quality controls. The specific controls and their evaluations are contained in ECI SOP T020, *Internal Quality Control Checks*, current version, and in the appropriate test method SOPs.

5.9.3.1.1. positive and negative controls, as applicable to the test type, to monitor tests such as blanks,

LCSs, and matrix spikes;

5.9.3.1.2. tests to define the variability and/or repeatability of the laboratory results such as replicates, laboratory duplicates, and spiked duplicates;

5.9.3.1.3. measures to assure the accuracy of the method including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples, or other measures;

5.9.3.1.4. measures to evaluate method capability, such as limit of detection and limit of quantitation or range of applicability such as linearity;

5.9.3.1.5. selection of appropriate formulae to reduce raw data to final results such as regression analysis, comparison to internal/external standard calculations, and statistical analyses;

5.9.3.1.6. selection and use of reagents and standards of appropriate quality;

5.9.3.1.7. measures to assure the selectivity of the test for its intended purpose; and

5.9.3.1.8. measures to assure constant and consistent test conditions (both instrumental and environmental) where required by the method such as temperature, humidity, light or specific instrument conditions.

5.9.3.2. All quality control measures are assessed and evaluated on an on-going basis and quality control acceptance criteria are used.

5.9.3.3. The laboratory has procedures for the development of acceptance/rejection criteria where no method or regulatory criteria exist.

5.9.3.4. The quality control protocols specified by the laboratory's SOP shall be followed. The laboratory ensures that the essential standards outlined in the Technical Module of the Standards (TNI or DOD V1M4, as applicable) or mandated methods or regulations (whichever are more stringent) are incorporated into their test method SOPs. When it is not apparent which is more stringent, the QC in the mandated method or regulations is to be followed.

5.9.4. Instruments are calibrated as described in Section 5.5 of this QAM and detailed in ECI SOP T020, *Internal Quality Control Checks*, current version, and the laboratory method SOPs.

5.9.5. Batch QC samples are prepared with each preparation batch prepared in the laboratory. A preparation batch is a batch of samples of the same quality system matrix not to exceed a total of 20 field samples. QC

samples are not counted as part of the twenty. Unless otherwise specified and justified in the test method SOP, the following QC samples are required. The test method SOP may reduce or increase this requirement.

5.9.5.1. Each batch must contain, where applicable; a Laboratory Control Sample, a Method Blank, a Matrix Spike sample and a Matrix Spike Duplicate or Matrix Duplicate sample. The preparation and specific evaluation criteria for each of these QC sample types are detailed in the laboratory method SOPs.

5.9.5.2. All quality control measures must be assessed and evaluated while analyses are on-going. Laboratory personnel use bench sheets or instrument software to record all raw data. These systems include the recording and evaluating of QC data at the same time as the sample data. QC data is used to determine the usability of sample data as described later in this section.

5.9.5.3. Specific requirements for QC samples and their evaluation are included in the ECI SOP T020, *Internal Quality Control Checks*, current version

5.9.6. Limits of Detection and Limits of Quantitation

The laboratory uses a combination of Limits of Detection and Limits of Quantitation ("Reporting Limits") to convey sensitivity for each analysis performed in the laboratory. Specific requirements and instructions for the determination of these limits are contained in the ECI SOP T006, *Determination of Detection Limits*, current version.

5.10. Reporting of Results

5.10.1. General Considerations

5.10.1.1. The result of each environmental test must be reported accurately, clearly, unambiguously and objectively as well as in accordance with any specific instructions included in the test method.

5.10.1.2. The results shall be reported in a test report and shall include all the information requested by the customer and necessary for the interpretation of the test results and all information required by the method used. This information is normally that required by 5.10.2, and 5.10.3 or 5.10.4, below.

5.10.1.3. Instructions for generating test reports are located in the ECI SOP-T063, *LIMS*, current revision. See also SOP-T009, *Significant Figures, Rounding, and Reporting of Results*; SOP-T025, *Reporting of Tentatively Identified Compounds (TICs)*; and T-026, *Reporting of Data Qualifiers*.

5.10.2. Test Reports

Each test report shall include at least the following information. An exception is taken when "Preliminary Results" are provided to meet customer's rush turn-

around time requests. Preliminary reports are labeled as such on the cover and are always followed by the complete final report.

5.10.2.1. A Title. This laboratory titles its reports “Analytical Report”
5.10.2.2. The name and address of the laboratory;
5.10.2.3. The Work Order number is the unique identification of the test report. It is displayed on each page in order to ensure that the page is recognized as a part of the test report. Report pages are numbered as 1 of *n,* where “n” is the total number of pages.
5.10.2.4. The name and address of the customer;
5.10.2.5. identification of the test method used;
5.10.2.6. description of, the condition of, and unambiguous identification of the samples tested;
5.10.2.7. the date of receipt of the samples where this is critical to the validity and application of the results (See 5.10.11 below), and the date(s) of performance of the analysis or different analytical steps, as applicable;
5.10.2.8. reference to the sampling plan and procedures used by the laboratory or other bodies where these are relevant to the validity or application of the results (this is rare in this laboratory);
5.10.2.9. the analytical results with the units of measurement;
5.10.2.10. the name(s), function(s) and signature(s) or equivalent identification of person(s) authorizing the test report or calibration certificate;
5.10.2.11. where relevant, a statement to the effect that the results relate only to the samples tested;
5.10.2.12. a statement specifying that the client is specifically prohibited from making material changes to the report and, to the extent that such changes are made, Calscience is not responsible, legally or otherwise.

5.10.3. Test Reports

5.10.3.1. In addition to the requirements listed in 5.10.2, test reports shall, where necessary for the interpretation of the test results, include the following:

5.10.3.1.1. Deviations from, additions to, or exclusions from the test method, and information on specific test conditions, such as environmental conditions;
5.10.3.1.2. Where relevant, a statement of compliance/non-compliance with requirements and/or specifications;
5.10.3.1.3. Where applicable, a statement on the estimated uncertainty of measurement. (Note: estimation of uncertainty in measurement is addressed in Section 5.6 of this document); information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer's instruction so requires, or when the uncertainty affects compliance to a specification limit;
5.10.3.1.4. Wdditional information which may be required by specific methods, customers or groups of

customers.

5.10.3.2. In addition to the requirements listed in 5.10.2 and 5.10.3.1, test reports containing the results of sampling shall include the following, where necessary for the interpretation of test results:

5.10.3.2.1. The date of sampling
5.10.3.2.2. The customer's reference to the sampling site and other information as noted on the Chain of Custody.

5.10.4. The TNI standard notes that the section in ISO 17025 regarding Calibration Certificates (ISO/IEC 17025:2005(E), Clause 5.10.4) does not apply to environmental testing activities.

5.10.5. Opinions and interpretations

The laboratory does not offer opinions or interpretations of the data reported.

5.10.6. Testing and calibration results obtained from subcontractors

When the analytical report contains results of tests performed by subcontractors, these results are clearly identified. The subcontractor must report the results either in writing or electronically.

5.10.7. Electronic transmission of results

5.10.7.1. In the case of transmission of test or calibration results by telephone, e-mail, facsimile or other electronic or electromagnetic means, the requirements of this section (see also Section 5.4.7).

5.10.7.2. Most reports are submitted by electronic mail to the person requesting the analysis. Results may not be submitted to any other entities without the approval of the original requestor. A record of this approval must be maintained by the laboratory.

5.10.7.3. Electronic mail transmissions are accompanied by statements regarding confidentiality and privacy of information.

5.10.8. Format of reports

The format of the reports is designed to accommodate each type of test carried out and to minimize the possibility of misunderstanding or misuse.

5.10.9. Amendments to test reports and calibration certificates,

5.10.9.1. When required, amendments are made by regenerating the entire report. Amended reports are labeled on the cover as "Supplemental Report #" where "#" is a sequential number, starting with 1. The Work Order number is also listed and the electronic file name is incremented with "_s#" to clearly identify the revision.

5.10.9.2. Such amendments are designed to meet all the requirements of this International Standard.

5.10.10. While rare, it is possible that ECI may be requested to produce abbreviated report at some times. If the request arises, ECI will maintain all of the information that would be required for the full report.

5.10.11. Additional Requirements

Reports must also include the following information, when applicable.

5.10.11.1. Time of sample preparation and/or analysis if the required holding time for either activity is less than or equal to seventy-two (72) hours.

5.10.11.2. Results that are reported on a basis other than as received (*e. g.*, dry weight).

5.10.11.3. Any non-accredited tests shall be clearly identified as such to the client when claims of accreditation to this Standard are made in the analytical report or in the supporting electronic or hardcopy deliverables.

5.10.11.4. Clear identification of numerical results with values outside the calibration range.

End of Quality Manual

APPENDIX 1 - Definitions

The following definitions are used in the text of Quality Systems. In writing this document, the following hierarchy of definition references was used: ISO 8402, ANSI/ASQC E-4, EPA's Quality Assurance Division Glossary of Terms, and finally definitions developed by TNI. The source of each definition, unless otherwise identified, is the TNI Quality Systems Committee.

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. (TNI)

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

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

Analyte: A substance, organism, physical parameter, property or chemical constituent(s) for which an environmental sample is being analyzed. (TNI)

Analytical Uncertainty: A subset of Uncertainty in Measurement that includes all laboratory activities performed as part of the analysis. (TNI)

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (*e.g.*, to the standards and requirements of TNI NELAP, DoD ELAP, others as necessary). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples, which are prepared and/or analyzed together with the same process and personnel using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same TNI-defined matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples. (TNI Quality Systems Committee)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). (TNI)

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

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

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards.

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications. (TNI)

Calibration Curve: The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)

Calibration Standard: A substance or reference material used to calibrate an instrument. (QAMS)

Certified Reference Material (CRM): A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30 - 2.2)

Chain of Custody Form: A record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; collector; time of collection; preservation; and requested analyses. (TNI)

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to:

- Second column confirmation;
- Alternate wavelength;
- Derivatization;
- Mass spectral interpretation;
- Alternative detectors; or
- Additional cleanup procedures. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ ASQC E4-1994)

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Integrity: The condition that exists when data are sound, correct and complete, and accurately reflect activities and requirements. (TNI)

Data Reduction: The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate acceptable accuracy. (TNI)

Detection Limit: The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (TNI)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed. (ASQC)

Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised. (40 CFR Part 136)

In-depth Data Monitoring: When used in the context of data integrity activities, a review and evaluation of documentation related to all aspects of the data generation process that includes items such as preparation, equipment, software, calculations, and quality controls. Such monitoring shall determine if the laboratory uses appropriate data handling, data use and data reduction activities to support the laboratory's data integrity policies and procedures.

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. (TNI)

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system. (TNI)

Legal Chain of Custody Protocols: Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain of Custody Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory. (TNI)

Limit of Detection (LOD): Limit of Detection (LOD): The smallest concentration of a substance that must be present in a sample in order to be detected at the DL with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. (TNI)

Limit of Quantitation (LOQ): The smallest concentration that produces a quantitative result with known and recorded precision and bias. (TNI)

Matrix: The substrate of a test sample. (TNI)

Matrix Duplicate: A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. (QAMS)

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte. (QAMS)

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

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136 Appendix B)

National Environmental Laboratory Accreditation Program (NELAP): A Program of TNI through which recognized State Accreditation Bodies and Non-Governmental Accreditation Bodies accredit laboratories using the TNI Standards. (TNI)

National Institute of Standards and Technology (NIST): A federal agency of the US Department
of Commerce's Technology Administration that is designed as the United States national metrology institute (NMI). (TNI)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (TNI)

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (TNI)

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (TNI)

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

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI) [2.1]

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (QAMS)

Protocol: A detailed written procedure for field and/or laboratory operation (e.g., sampling, and analysis) which must be strictly followed. (EPA- QAD)

Quality Assurance: An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS)

Quality Assurance (Project) Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EPA-QAD)

Quality Control: The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users. (QAMS)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)
Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (TNI)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC. (ANSI/ ASQC E-41994)

Quality System Matrix: These matrix definitions are to be used for purposes of batch and quality control requirements:
Air and Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device.
Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.
Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.
Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.
Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.
Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.
Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.

Quantitation Limits: Levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported at a specific degree of confidence. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, printouts of chromatograms, instrument outputs and handwritten records. (TNI)

Reagent Blank (method reagent blank): A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)

Reagent Water: Water in which no target analytes or interferences are detected as required by the analytical method. (TNI)

Reference Material: A material or substance with one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30- 2.1)

Reference Standard: A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM-6.08)

Reference Toxicant: The toxicant used in performing toxicity tests to indicate the sensitivity of a test organism and to demonstrate the laboratory's ability to perform the test correctly and obtain consistent results (see Chapter 5, Appendix D, Section 2.1.f). (TNI)

Replicate Analyses: The measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (TNI)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure. (TNI)

Sampling Media: Material used to collect and concentrate the target analytes(s) during air sampling such as solid sorbents, filters, or impinger solutions. (TNI)

Selectivity: (Analytical chemistry) The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. (EPA-QAD)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (TNI)

Spike: A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes. (TNI)

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of TNI and meets the approval requirements of TNI procedures and policies. (ASQC)

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

Standard Reference Material (SRM): A certified reference material produced by the U.S. National Institute of Standards and Technology or other National Metrology Institute (NMI) and characterized for absolute content, independent of analytical method. (EPA-QAD)

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes. (QAMS)

TNI: The NELAC Institute. www.nelac-institute.org

Traceability: The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM - 6.12), or, The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Uncertainty of Measurement (Measurement Uncertainty, Uncertainty): Non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used. (VIM 2-26) A more colloquial (but less exact) definition could be "The range of values in which the true value would be statistically likely to occur due to variability within the test system." (ECI)

Validation: The process of substantiating specified performance criteria. (EPA- QAD)

Verification: Confirmation by examination and provision of evidence that specified requirements have been met. (TNI)

NOTE: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.

The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

Sources:

American Society for Quality Control (ASQC), Definitions of Environmental Quality Assurance Terms, 1996

American National Standards Institute (ANSI), Style Manual for Preparation of Proposed American National Standards, Eighth Edition, March 1991

ANSI/ASQC E4, 1994

International Standards Organization (ISO) Guides 2, 30, 8402

International Vocabulary of Basic and General Terms in Metrology (VIM): 1984. Issued by BIPM, IEC, ISO and OIML

National Institute of Standards and Technology (NIST)

National Environmental Laboratory Accreditation Conference (TNI), July 1998 Standards

U.S. EPA Quality Assurance Management Section (QAMS), Glossary of Terms of Quality Assurance Terms, 8/31/92 and 12/6/95

U.S. EPA Quality Assurance Division (QAD)

40 CFR, Part 136

Appendix 2 – Job Descriptions of Key Personnel

Business Unit Manager:

ECI's Business Unit Manager represents ECI to the Eurofins US and Global Corporate entities.

- ⇨ Ensures that ECI's financial and production performance meets assigned metrics.
- ⇨ Determines need for capital and employee resources and allocates as appropriate.
- ⇨ Serves as the legal representative for ECI.
- ⇨ Responsible for yearly budget and overruns.
- ⇨ Point person for major new initiatives

Laboratory Director:

ECI's Laboratory Director, through its Business Unit Manager, is the final authority on all issues dealing with data quality and has the authority to require that procedures be amended or discontinued, or analytical results voided or repeated. He or she also has the authority to suspend or terminate employees on the grounds of non-compliance with QA/QC procedures. In addition, the Laboratory Director:

Ensures that ECI remains current with all regulations which affect operations and disseminate all such changes in regulatory requirements to the Operations Director, QA Manager, and Technical Managers (at ECI known as Group Leaders):

- ⇨ Ensures that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented;
- ⇨ Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work;
- ⇨ Oversees the development and implementation of the QA Program which assures that all data generated will be scientifically sound, legally defensible, and of known quality;
- ⇨ In conjunction with the QA Manager, conducts annual reviews of the QA Program;
- ⇨ Oversees the implementation of new and revised QA procedures to improve data quality;
- ⇨ Ensures that appropriate corrective actions are taken to address analyses Identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director;
- ⇨ Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to;
- ⇨ Oversees all laboratory accreditation efforts

Operations Director:

The Operations Director manages and directs the analytical production sections of the laboratory. He or she reports directly to the Laboratory Director and assists in determining the most efficient instrument utilization. More specifically, he/she:

- ⇨ Evaluate the level of internal/external non-conformances for all departments;
- ⇨ Continuously evaluate production capacity and improves capacity utilization;
- ⇨ Continuously evaluate turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments;

- ⇨ Develop and improve the training of all analysts in cooperation with the Laboratory Director, QA Director, QA Manager and Group Leaders, and in compliance with regulatory requirements;
- ⇨ Ensure that scheduled instrument maintenance is completed;
- ⇨ Are responsible for efficient utilization of supplies;
- ⇨ Constantly monitor and modify the processing of samples through the departments; and
- ⇨ Maintain sufficient personnel, equipment and supplies to achieve production goals.

Quality Assurance Manager:

The Quality Assurance (QA) Manager has full authority through the Business Unit Manager in all matters relating to quality assurance and quality control systems. The QA Manager can make recommendations to the Business Unit Manager and/or Laboratory Director regarding the suspension analytical activities or the suspension or termination of employees on the grounds of non-compliance with QA/QC systems or procedures. An alternate QA Manager is always assigned. In the absence of the primary designate, the alternate will act in the QA Manager's capacity with the full authority of the position as allowed by ECI governing documents. In addition, the QA Manager performs the following:

- ⇨ Oversight and monitoring of and compliance with ECI's QA program;
- ⇨ Ensuring continuous improvement in all aspects of ECI's QA program such as:
  - o accreditations/certifications;
  - o analytical method management;
  - o internal and external audits;
  - o documentation;
  - o training;
  - o proficiency evaluation studies;
- ⇨ Ensuring ECI's QA program remains up-to-date consistent with current regulatory requirements and ECI's QA policies;
- ⇨ Supervision and direction of all QA staff; and
- ⇨ Serving as a technical resource for analytical chemistry or QA matters;
- ⇨ Provide support and oversight to QA staff with regard to external audit responses. Provide input on, and define appropriate corrective actions for the laboratory. Document corrective action responses, and monitor the required audit response time frames, as needed.
- ⇨ Oversees in-house training on quality assurance and control.

Quality Assurance Specialist:

The Quality Assurance Specialist has full authority through the QA Manager in matters dealing within the laboratory. The Quality Assurance Specialist can make recommendations to the QA Manager and regarding the suspension or termination of employees on the grounds of non-compliance with QA/QC procedures. An alternate Quality Assurance Specialist is always assigned. In the absence of the primary designate, the alternate will act in the Quality Assurance Specialist's capacity with the full authority of the position as allowed by ECI governing documents. In addition, the Quality Assurance Specialist performs the following:

- ⇨ Maintains and updates the QAM on an annual basis;
- ⇨ Implements ECI's QA Program;
- ⇨ Monitors the QA Program within the laboratory to ensure complete compliance with its objectives, QC procedures, holding times, and compliance with client or project specific data quality objectives;
- ⇨ Distributes performance evaluation (PE) samples on a routine basis to ensure the production of data that meets the objectives of its QA Program;

- ⇨ Maintains all SOPs used at ECI;
- ⇨ Maintains records and archives of all PE results, audit comments, and customer inquiries concerning the QA program;
- ⇨ Performs statistical analyses of QC data and establish controls that accurately reflect the performance of the laboratory;
- ⇨ Conducts periodic performance and system audits to ensure compliance with the elements of ECI's QA Program;
- ⇨ Prescribes and monitors corrective action;
- ⇨ Serves as in-house client representative on all project inquiries involving data quality issues;
- ⇨ Coordinates data review process to ensure that thorough reviews are conducted on all project files;
- ⇨ Develops revisions to existing SOPs;
- ⇨ Reports the status of in-house QA/QC to the Laboratory Director;
- ⇨ Maintains records and archives of all QA/QC data including but not limited to method detection limit (MDL) studies, accuracy and precision control charts, and completed log books; and
- ⇨ Conducts and/or otherwise ensures that an adequate level of QA/QC training is conducted within the laboratory.

Quality Assurance Assistant:

The Quality Assurance (QA) Assistant reports to the QA Specialist and performs the following functions:

- ⇨ Assists the Quality Specialists and lab staff with internal audits, corrective action review, test method assessments and overall implementation of the QA program;
- ⇨ Performs daily balance checks and periodic thermometer checks;
- ⇨ Generates and reviews, in conjunction with the Quality Specialists, Control Charts and Method Detection Limit (MDL) studies;
- ⇨ Prepares logbooks for use in the laboratory;
- ⇨ Reviews and revises SOPs as needed;
- ⇨ Distributes new SOPs to all applicable lab areas.
- ⇨ Writes and promulgates QA Directives.

Director of Business Development:

The Director of Business Development reports to the Laboratory Director and serves as the interface between the laboratory's technical departments and the laboratory's clients. The staff consists of the Project Management team, Business Development team and satellite office Operations Manager. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- ⇨ Technical training and growth of the Project Management team;
- ⇨ Business liaison for the Project Management team;
- ⇨ Human resource management of the Project Management team;
- ⇨ Responsible for the review and negotiation of client contracts and terms and conditions;
- ⇨ Responsible for establishing standard fee schedules for the laboratory;
- ⇨ Responsible for preparation of proposals and quotes for clients and client prospects;
- ⇨ Accountable for response to client inquiries concerning sample status;
- ⇨ Responsible for assistance to clients regarding the resolution of problems concerning Chains-of-Custody;
- ⇨ Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory;

- ⇨ Notifying the department managers of incoming projects and sample delivery schedules;
- ⇨ Accountable to clients for communicating sample progress in daily status meeting with agreed-upon due dates;
- ⇨ Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff;
- ⇨ Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness; and
- ⇨ Ensure that all non-conformance conditions are reported to the QA Manager, Operations Manager, and/or Laboratory Director via the Corrective Action process.

Technical Managers (at ECI known as Group Leaders):

The Group Leaders report directly to the Operations Director. They have the authority to accept or reject data based on pre-defined QC criteria. In addition, with the approval of the QA Manager, the Group Leaders may accept data that falls outside of normal QC limits if, in his or her professional judgment, there are technical justifications for the acceptance of such data. The circumstances must be well documented and any need for corrective action identified must be defined and initiated. The authority of the Group Leaders in QC related matters results directly from the QA Manager. The Group Leaders also

- ⇨ Coordinating, writing, and reviewing test methods and SOPs, with regard to quality, integrity, regulatory requirements and efficient production techniques;
- ⇨ Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process and providing technical and troubleshooting expertise on routine and unusual or complex problems;
- ⇨ Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis; and
- ⇨ Coordinates audit responses with supervisors and QA Manager.
- ⇨ Actively support the implementation of ECI's QA Program;
- ⇨ Ensure that their employees are in full compliance with ECI's QA Program;
- ⇨ Maintain accurate SOPs (by reviewing and implementing updates) and enforce routine compliance with SOPs;
- ⇨ Conduct technical training of new staff and when modifications are made to existing procedures;
- ⇨ Maintain a work environment which emphasizes the importance of data quality;
- ⇨ Ensure all logbooks are current, reviewed and properly labeled or archived;
- ⇨ Ensure that all non-conformance conditions are reported to the QA Manager, Operations Manager, and/or Laboratory Director via Corrective Action reports;
- ⇨ Provide guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Operations Manager, and/or QA Manager. Each is responsible for 100% of the data review and documentation, nonconformance issues, and the timely and accurate completion of performance evaluation samples and MDLs, for his/her department;.
- ⇨ Encourage the development of analysts to become cross-trained in various methods and/or operate multiple instruments efficiently while performing maintenance and using appropriate documentation techniques;.
- ⇨ Ensure that preventive maintenance is performed on instrumentation as detailed in the QA Manual or SOPs. He or she is responsible for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments;
- ⇨ Provide written responses to external and internal audit issues; and

- ⇨ Provide support to all levels of ECI Management.

Technical Managers (Sample Control Group Leader):

The Sample Control Group Leader reports to the Operations Manager. The responsibilities are outlined below:

- ⇨ Direct the receipt, handling, labeling and proper storage of samples in compliance with laboratory procedures and policies;
- ⇨ Oversee the training of Sample Control Technicians regarding the above items;
- ⇨ Direct the logging of incoming samples into the LIMS and ensure the verification of data entry from login;
- ⇨ Oversee all sample courier operations;
- ⇨ Acts as a liaison between Project Managers and Analytical departments in respect to handling rush orders and resolving inconsistencies and problems with chain-of-custody forms, and routing of subcontracted analyses; and
- ⇨ Oversees the handling of samples in accordance with the Waste Disposal SOP, the Hazardous Waste Contingency Plan in the Chemical Hygiene/Safety Manual, and the U. S. Department of Agriculture requirements.

Laboratory Analysts

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or supervisor. The responsibilities of the analysts are listed below:

- ⇨ Perform analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, the Data Integrity Policy, and project-specific QA plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- ⇨ Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on work sheets, bench sheets, preparation logbook, and/or a Non-Conformance report;
- ⇨ Report all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to the Group Leader and/or the QA Manager;
- ⇨ Perform 100% review of the data generated prior to entering and submitting for secondary level review; and
- ⇨ Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

Laboratory Technicians:

- ⇨ Prepare samples for analysis by weighing, extracting or digesting, filtering, or concentrating samples; and
- ⇨ Prepare method specific QC Samples with each preparation batch. All personnel must adhere to all QC procedures specified in the analytical method and in accordance to procedures or policies and are responsible for the full documentation of these procedures.

Project Managers:

The Project Manager normally reports to the Senior Project Manager and/or Business Development Director. Typical responsibilities include:

- ⇨ Serving as the laboratories' primary point of contact for assigned clients;

- ⇨ Working with laboratory chemists to resolve questions on data;
- ⇨ Scheduling of courier deliveries and pick-ups;
- ⇨ Tracking the progress of all laboratory production efforts;
- ⇨ Advising clients of any scheduling conflicts, possible delays, or other problems which may arise;
- ⇨ Resolving any questions or issues that clients may have with regard to our services, especially our reports;
- ⇨ Preparation of bottle kits for use by clients in their sampling efforts (as necessary);
- ⇨ Reviewing of reports/EDDs (Electronic Data Deliverables) as necessary prior to release;
- ⇨ Invoice preparation and review prior to release to client;
- ⇨ Serving as back-up contact person for other Project Managers in the event of his/her absence;
- ⇨ Coordination of all subcontracting efforts for projects assigned;
- ⇨ Preparation and implementation of program QAPPs (Quality Assurance Project Plans), if needed;
- ⇨ Preparation of project Case Narratives, as needed; and
- ⇨ Assembly of full data packages in accordance with company or client protocol, as needed.

Project Management Assistant:

The Project Management Assistant normally receives direction from the Project Manager(s) for which he/she is assigned. Typical responsibilities include:

- ⇨ Working with laboratory chemists to resolve questions on data;
- ⇨ Scheduling of courier deliveries and pick-ups;
- ⇨ Tracking the progress of all laboratory production efforts;
- ⇨ Advising clients of any scheduling conflicts, possible delays, or other problems which may arise;
- ⇨ Resolving any questions or issues that clients may have with regard to our services, especially our reports;
- ⇨ Preparation of bottle kits for use by clients in their sampling efforts;
- ⇨ Reviewing of reports/EDDs (Electronic Data Deliverables) prior to release;
- ⇨ Invoice preparation and review prior to release to client;
- ⇨ Serving as back-up contact person for the project managers in the event of his/her absence;
- ⇨ Coordination of all subcontracting efforts for projects assigned; and
- ⇨ Preparation and implementation of program QAPPs (Quality Assurance Project Plans), if needed.
- ⇨ As part of the administrative staff, this person may also be required to answer phones, do occasional filing, mailing, etc.

Health, Safety, and Respiration Protection Manager:

The Health and Safety Manager reports to the Laboratory Director and ensures that systems are maintained for the safe operation of the laboratory. The EHS Manager is responsible for:

- ⇨ Conducting ongoing, necessary safety training and conducting new employee safety orientations;
- ⇨ Assisting in developing and maintaining the Chemical Hygiene/Safety Manual;
- ⇨ Oversees the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed; and
- ⇨ Completes accident reports, follows up on root causes and defines corrective actions.

Hazardous Waste Coordinator:

The Hazardous Waste Coordinator reports directly to the Environmental Health & Safety Manager. The duties of the HWC consist of:

- ⇨ Staying current with the hazardous waste regulations and continuing training on hazardous waste issues;
- ⇨ Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste;
- ⇨ Supervise the recording of the transfer of samples from refrigerated conditions to ambient conditions [in the sample disposal log sheets (SDLS)];
- ⇨ Check the records in SDLS against the logbook (LIMS) records;
- ⇨ Coordinate the collection of waste throughout the laboratory that will be disposed of through “Lab Packs”;
- ⇨ Coordinate and supervise Hazardous Waste Technician(s);
- ⇨ Dispose of solid waste to an assigned Tote;
- ⇨ Supervise the recording and disposal of acid and soil with methylene chloride extracts into appropriate drums;
- ⇨ Prepare and discharge treated wastewater to the sewer system;
- ⇨ Maintain Uniform Hazardous Waste Manifest files;
- ⇨ Prepare weekly sample disposal schedules;
- ⇨ Coordinate and schedule waste pick-up;
- ⇨ Check all waste containers for appropriate labels; and
- ⇨ Maintain safe housekeeping and practices.

APPENDIX 3 – LIST OF PHYSICAL LOCATIONS

Main Laboratory

- 7440 Lincoln Way, Garden Grove, CA 92841-1427
- 714-895-5494 Fax 714-894-7501

Satellite Laboratory 1 "Lampson"

- 7445 Lampson Avenue, Garden Grove, CA 92841-2903
- Fax 714-898-2036

Satellite Laboratory 2 "Knott"

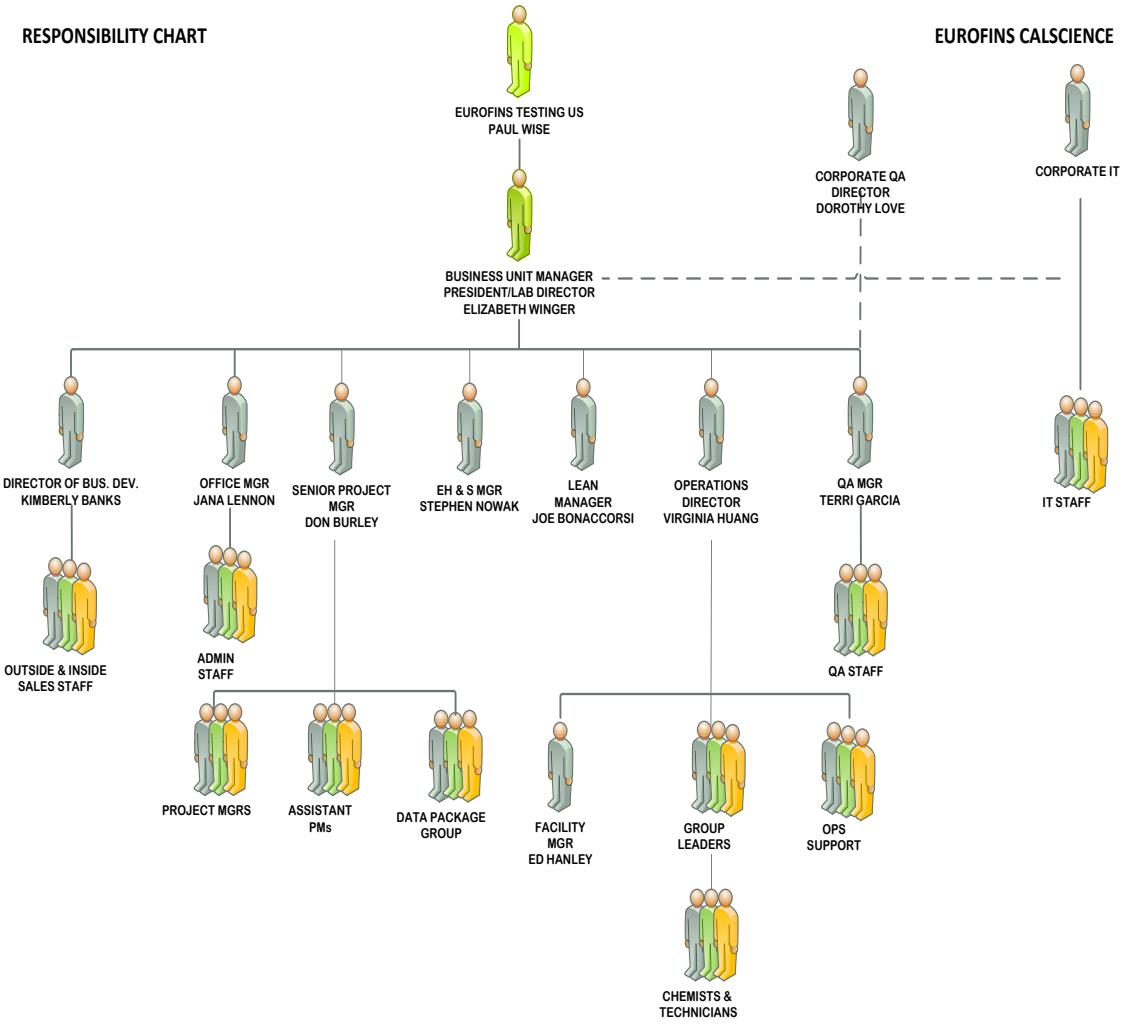
- 11380 Knott Street, Garden Grove, CA 92841-1400

Concord, CA Service Center

- 5063 Commercial Circle, Suite H, Concord, CA 94520-8577
- 925-689-9022 Fax 925-689-9023

APPENDIX 4 – ORGANIZATIONAL CHART

The organizational chart included in this manual was correct at the time of publication and shows the structure of the laboratory. The chart is kept current by the administrative office and can be obtained from the QA Department.



VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE

GEL LABORATORIES, LLC

QUALITY ASSURANCE PLAN

(GL-QS-B-001 REVISION 34)

GEL

GEL'S
DOCUMENT CONTROL OFFICER
CERTIFIES THIS DOCUMENT TO BE
A TRUE COPY OF THE FULLY
EXECUTED ORIGINAL.

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TABLE OF CONTENTS

SECTION 1
INTRODUCTION

Section 1 - Introduction

GEL Laboratories, LLC (GEL) is a privately owned environmental laboratory dedicated to providing personalized client services of the highest quality. Our mission is to be the "Analytical Firm of First Choice."

GEL was established as an analytical testing laboratory in 1981. Now a full service lab, our analytical divisions use state of the art equipment and methods to provide a comprehensive array of organic, inorganic, radiochemical, and bioassay analyses and related support services to meet the needs of our clients.

This Quality Assurance Plan provides an overview of our quality assurance program for analytical services. Outlined in this plan are the responsibilities, policies, and processes essential to maintaining client satisfaction and our high quality of performance. The Director of Quality Systems is responsible for revising, controlling, and distributing the QAP. It is updated/reviewed at least annually.

Everyone on our staff is expected to understand the policies, objectives, and procedures that are described in this plan and to fully appreciate our commitment to quality and their respective roles and responsibilities with regard to quality. We also expect any analytical subcontractors we employ to perform in accordance with the quality assurance requirements delineated in this plan. All GEL employees are required to participate in Annual Quality Systems training.

This Quality Assurance Plan (QAP) has been prepared according to the standards and requirements of the US Environmental Protection Agency (EPA), ANSI/ISO/IEC 17025-2017, and the TNI (The NELAP Institute) Standards adopted in August, 2009.

1.1 Quality Policy

GEL's policy is "to provide high quality, personalized analytical services that enable our clients to meet their environmental needs cost effectively."

We define quality as "consistently meeting the needs and exceeding the expectations of our clients." As such, we consistently strive to:

- meet or exceed client and regulatory requirements
- be technically correct and accurate
- be defensible within contract specifications
- provide services in a cost-effective, timely and efficient manner

At GEL, quality is emphasized at every level—from the Chairman and CEO to the newest of employees. Management's ongoing commitment to good professional practice and to the quality of our testing services to our customers is demonstrated by their dedication of personnel and resources to develop, implement, assess, and improve our technical and management operations.

The purpose of GEL's quality assurance program is to establish policies, procedures, and processes to meet or exceed the expectations of our clients. To achieve this, all personnel that support these services to our clients are introduced to the program and policies during their initial orientation, and annually thereafter during company-wide training sessions.

GEL's management is committed to compliance with and continual improvement of our quality assurance program. The program is designed to comply with the guidelines and specifications outlined in the following:

- TNI 2009
- ASME/NQA-1
- ISO/IEC 17025-2017
- QAPPs, U.S. EPA QA/R5
- Department of Energy Order 414.1B, 414.1C and 414.D
- ANSI N42.23-1996 Measurement and Associated Instrument Quality Assurance for Radioassay Laboratories
- ANSI N13.30-2011 Performance Criteria for Radiobioassay
- DOE STD 2019

- Performance Criteria for Radiobioassay- ANSI N13.30-1996.
- Energy Reorganization Act, 1974, Section 206, 10 CFR, Part 21
- MARLAP
- U.S. Department of Defense (DoD), Department of Energy (DOE) Consolidated Quality System Manual (QSM) for Environmental Laboratories, Revision 5.3, May 2019
- 10 CFR Part 21- Reporting of Defects and Noncompliance
- 10 CFR Part 61- Licensing Requirements for Land Disposal of Radioactive Waste
- NRC REG Guide 4.8
- NRC REG Guide 4.15

1.2 Quality Goals

GEL's primary goals are to:

- Ensure that all measurement data generated are scientifically and legally defensible, of known and acceptable quality per the data quality objectives (DQOs), and thoroughly documented to provide sound support for environmental decisions.
- Ensure compliance with all contractual requirements, environmental standards, and regulations established by local, state and federal authorities.

Additional goals include:

- A comprehensive quality assurance program to ensure the timely and effective completion of each measurement effort.
- A commitment to excellence and improvement at all levels of the organization.
- Early detection of deficiencies that might adversely affect data quality.
- Adequate document control.
- Effective quality assurance objectives for measurement systems and for quality data in terms of accuracy, precision, completeness, and comparability through the use of proven methods.
- The establishment of procedures that demonstrate that the analytical systems are in a state of statistical control.
- The implementation of corrective actions and improvements to ensure the integrity of data.
- Reduction of data entry errors through comprehensive automated data handling procedures.
- The development and implementation of good laboratory and standard operating procedures (SOPs).
- Ability to customize quality assurance procedures to meet a client's specific requirements for data quality.
- Good control of instruments, services, and chemical procurement.
- A continuously capable laboratory information management system (AlphaLIMS).
- Validated and documented computer hardware and software.
- All employees who have access to the AlphaLIMS system are required to participate in computer security awareness training annually.

1.3 Key Quality Elements

A sound quality assurance program is essential to our ability to provide data and services that consistently meet our high standards of integrity. The key features of our program are:

- An independent quality assurance (QA) validation and Quality Systems Department.
- A formal quality policy and QAP.
- Management review.
- Stated data quality objectives.
- A comprehensive employee training program.
- Ethics policy and education program.
- Internal audits and self-evaluations.
- A closed-loop corrective action program.
- State-of-the-art facilities and instruments.
- Adherence to standard operating procedures.
- EPA/NIST traceable reference materials.
- Electronically based document control.
- Chain of custody and electronic sample tracking.
- Inter-laboratory comparison programs.
- Formal laboratory accreditations.
- The evaluation of subcontractor laboratories.

- Statistical controls for analytical precision and accuracy.
- Replicate, method blank, matrix spike, tracer yield, internal standards, and surrogate measurements.
- The preventive maintenance of instrumentation and equipment.
- Independently prepared blind standard reference materials.
- Multi-level review processes.
- Focus on client satisfaction.
- Electronic tracking of client commitments, nonconformance's and corrective actions.
- Trend analysis of nonconforming items.

1.4 Management Reviews

The effectiveness of the Quality System is reviewed at least annually by Senior Management. These reviews address issues that impact quality, and the results of the reviews are used to develop and implement improvements to the system. Records of the review meetings are maintained as quality documents.

1.5 Disposition of Client Records

In the event that the laboratory should change ownership, the responsibility for the maintenance and disposition of client records shall transfer to the new owners. In the unlikely event that the laboratory ceases to conduct business, clients shall be notified and asked to provide instructions as to how their records should be returned or disposed. If a client does not provide instructions, those records will be maintained and disposed in a manner consistent with regulations and good laboratory practices for quality records.

1.6 Supporting Documents

Our laboratory operations and the quality of our analytical data comply with the specifications described in the documents listed in Appendix A.

1.7 Definitions

Applicable definitions are listed in Appendix B.

SECTION 2

ORGANIZATION, MANAGEMENT, AND PERSONNEL

Section 2 - Organization, Management, and Personnel

The chart found in Appendix C depicts our corporate organization, chain of command and flow of responsibility. The illustration in this appendix is designed to ensure the overall quality and cost efficiency of our company's analytical products and services.

Our structure is based on customer-focused divisions that follow a project from the point of initial contact to the final invoicing of work. These divisions include expertise in project management, sample receipt and custody, sample preparation and analysis, data review, and data packaging. An independent Quality Systems Management Department monitors the adherence of these divisions to the Quality Assurance Program.

The general responsibilities associated with the following position levels are discussed in this section:

- Chairman and Chief Executive Officer (CEO)
- President
- Chief Operating Officer (COO)
- Chief Financial Officer (CFO)
- Quality Systems Director
- Laboratory Directors
- Project Managers
- Group Leaders
- Laboratory and Technical Staff
- Information Systems Manager
- Environmental Manager
- Radiation Safety Officer
- Director of Human Resources

An overview of GEL's employee training protocol is also provided at Section 2.12.

2.1 Chairman and CEO, President, Chief Financial Officer and Chief Operating Officer

Operational responsibility rests with GEL's owners, CFO and COO. James M. Stelling and Joseph M. Hodgson Jr. are owners and serve respectively as Chairman and CEO, and President. Carey J. Bocklet occupies the position of COO. Laurie Herrington occupies the position of CFO. As the highest level executives, their philosophical approach to quality, technology and customer service keeps GEL unique. They are also part of a Leadership Team that works to create a workplace environment that attracts and retains highly qualified professionals.

As Chairman and CEO, Mr. Stelling oversees the Executive Committee and leads management in implementing total quality initiatives that ensure quality services that meet stringent criteria of excellence. He holds a Bachelor of Science in Commerce from the University of Virginia.

Joseph M. Hodgson Jr. is GEL's President. He has overall operational responsibility and operates the laboratory according to corporate policies, applicable licenses and regulations. He is also responsible for Strategic Planning, Marketing and Business Development. In addition, he has primary responsibility for the development and administration of our analytical testing and environmental consulting services. Mr. Hodgson Jr. holds a Bachelor of Science in Business from Wake Forest University.

The Chief Operating Officer is Carey J. Bocklet. Ms. Bocklet is responsible for the daily operations of the laboratories and client services. Ms. Bocklet holds a Bachelor of Science in Chemical Engineering, and a Master of Science in Business Administration, both from Clemson University.

Laurie Herrington is GEL's Chief Financial Officer and oversees GEL's financial management. She is responsible for contracts administration, invoicing, purchasing, payroll, accounts payable, and receivable, inventory control, property control and financial forecasting. Ms. Herrington holds a Bachelor of Science in Accounting and Business Administration from the College of Charleston. Ms. Herrington also has her licenses as a Certified Public Accountant and a Certified Fraud Examiner.

Together, the Chairman and CEO, President, COO and CFO form GEL's Executive Committee. Their responsibilities include the following:

- Ensuring that the individuals who staff our technical and quality positions have the necessary education, training, and experience to competently perform their jobs.
- Ensuring that all staff members receive ancillary training, as needed, to enhance performance in assigned positions.
- Budgeting, staffing, managing, and equipping the laboratory to meet current and future analytical program requirements.
- Overseeing the implementation and overall effectiveness of our Quality Assurance Plan, health and safety initiatives, and environmental programs.
- Managing production and cost control activities.
- Ensuring development of capabilities in response to new or revised regulations, instrumentation and procedures, and quality assurance initiatives.

2.2 Technical Laboratory Co-Directors

To enhance our responsiveness to clients through dedicated expertise and teamwork, our laboratory is divided into two major divisions, Chemistry and Radiochemistry, each with its own Technical Laboratory Director.

The Technical Directors report to the Executive Committee and are ultimately responsible for the technical content and quality of work performed within each division. They are also responsible for strategic planning, profitability and growth, personnel management and business development. Other responsibilities include:

- Monitoring and meeting profitability and growth objectives of the division.
- Establishing and implementing short and long range objectives and policies that support GEL's goals.
- Defining the minimum level of qualification, experience, and skills necessary for positions in their divisions.
- Establishing and implementing policies and procedures that support our quality standards.
- Ensuring that technical laboratory staff demonstrates initial and continuing proficiency in the activities for which they are responsible.
- Documenting all analytical and operational activities of the laboratory.
- Supervising all personnel employed in the division.
- Ensuring that all sample acceptance criteria are verified and that samples are logged into the sample tracking system, properly labeled, and stored.
- Documenting the quality of all data reported by the division.
- Developing internal mechanisms and measurements to improve efficiency.
- Overseeing activities designed to ensure compliance with laboratory health and safety requirements.
- Allocating the resources necessary to support an effective and ongoing quality assurance program.
- Representing the company to the public and to clients.
- Ensuring the appropriate delegation of authorities during periods of absence.
- Ensuring compliance to the ISO 17025:2017 Standard.

2.3 Quality Systems Director

Our Quality Systems Director (QSD) reports directly to the CEO. The QSD manages the design, implementation and maintenance of our quality systems in a timely, accurate, and consistent manner.

In addition to having responsibility for the initiation and recommendation of corrective and preventive actions, the QSD is responsible for:

- Establishing, documenting, and maintaining comprehensive and effective quality systems.
- Developing and evaluating quality assurance policies and procedures pertinent to our laboratory functions, and communicating these with the division directors and managers.

- Ensuring that the operations of the lab are in conformance with the Quality Assurance Plan and meet the quality requirements specific to each analytical method.
- Ensuring that laboratory activities are in compliance with local, state, and federal environmental laws and regulations.
- Reviewing project-specific quality assurance plans.
- Ensuring that quality control limits are established and followed for critical points in all measurement processes.
- Initiating internal performance evaluation studies using commercially purchased certified, high-purity standard reference materials.
- Performing independent quality reviews of randomly selected data reports.
- Conducting periodic audits to ensure method compliance.
- Conducting or arranging periodic technical system evaluations of facilities, instruments and operations.
- Overseeing and monitoring the progress of nonconformance's and corrective actions.
- Communicating system deficiencies, recommending corrective action to improve the system, and defining the validity of data generated during out of control situations.
- Preparing and updating quality assurance documents and reports to management.
- Coordinating inter-laboratory reviews and comparison studies.
- Overseeing Stop Work Orders in out-of-control situations.
- Administering accreditation and licensing.
- Administering our document control system.
- Providing guidance and training to laboratory staff as requested.
- Evaluating subcontractors and vendors that provide analytical and calibration services.
- Designating quality systems authorities in times of absence to one or more appropriately knowledgeable individuals.
- Overseeing notification if required for compliance with Energy Reorganization Act, 1974, 10 CFR, Part 21, should data recall be necessary.
- Ensuring that the laboratory has policies to avoid involvement in activities or relationships which might negatively affect confidence in the laboratory's competence, impartiality, judgement or operational integrity.
- Ensuring that management and personnel are free from undue internal and external pressures and influences that may adversely affect their impartiality, affecting the quality of their work, by mitigating pressures.
- Ensuring that employee competence measurements are established and monitored.

2.4 Quality Systems Review

The effectiveness of the Quality System is reviewed on a regular basis during meetings of the Leadership Team, which may be as often as weekly, but not less than quarterly. These meetings address issues that impact quality, and the subsequent discussions are used to design and implement improvements to the system. At least annually, a management assessment of GEL's Quality System is conducted and reported. The QSD maintains records of these assessments.

2.5 Manager of Client and Support Services

Project Managers (PMs) serve as primary liaisons to our clients. PMs, under the guidance of the Manager of Client and Support Services, manage the company's interaction with clients. They are the client's first point of contact and have responsibility for client satisfaction and for communicating project specifications and changes to the appropriate laboratory areas.

Additional responsibilities include:

- Retaining clients and soliciting new work.
- Managing multiple sample delivery orders and preparing quotes.
- Working with clients to define analytical methodologies, quality assurance requirements, reports, deliverables, and pricing.

- Overseeing sample management and informing laboratory staff of the anticipated arrival of samples for analysis.
- Conducting a review of client documents (i.e. quotes, invoices, routine and specialized reports).
- Working with the accounting team on invoicing and collection issues.
- Working with the Laboratory Directors, Production Manager, and Group Leaders to project workloads and determine schedules.

2.6 Group Leaders

Group Leaders are a critical link between project management, lab personnel, and support staff. They report to the Technical Directors and have the following responsibilities:

- Planning and coordinating the operations of their groups to meet client expectations.
- Scheduling sample preparation and analyses according to holding times, quality criteria, and client due dates.
- Ensuring a multi-level review of 100% of data generated by their groups.
- Coordinating nonconformances and corrective actions in conjunction with the Quality Systems Management team.
- Serving as technical resources to their groups, including data review.
- Managing special projects, reviewing new work proposals, and overseeing the successful implementation of new methods.
- Monitoring and controlling expenses incurred within their groups such as overtime and consumables.
- Providing performance and career development feedback to their group members.

2.7 Laboratory and Technical Staff - General Requirements

At GEL, every effort is made to ensure that the laboratory is sufficiently staffed with personnel who have the training, education, and skills to perform their assigned jobs competently.

Depending upon the specific position, laboratory personnel are responsible for:

- Complying with quality assurance and quality control requirements that pertain to their group and/or technical function.
- Demonstrating a specific knowledge of their particular function and a general knowledge of laboratory operations.
- Understanding analytical test methods and standard operating procedures that are applicable to their job function.
- Documenting their activities and sample interactions in accordance with analytical methods and standard operating procedures.
- Implementing the quality assurance program as it pertains to their respective job functions.
- Identifying potential sources of error and reporting any observed substandard conditions or practices.
- Identifying and correcting any problems affecting the quality of analytical data.
- Identifying and performing all client specific requirements outlined in the special requirements on the pull sheet of every batch.

2.8 Information Systems Manager

The Information Systems Manager reports directly to the COO. The responsibilities of this position include management of the Computer Services Team and AlphaLIMS, our laboratory information management system.

The combined responsibilities of the Information Systems Team, performing under the leadership of the Information Systems Manager, include the:

- Development and maintenance of all software and hardware.
- Translation and interpretation of routines for special projects.
- Interpretation of general data and quality control routines.
- Optimization of processes through better software and hardware utilization.

- Customization, testing and modification of data base applications.
- Maintenance and modification of our computer modeling, bar coding, CAD, statistical process control, project management, and data packaging systems.
- Development and maintenance of client and internal electronic data deliverables.
- Validation and documentation of software used in processing analytical data.

2.9 Environmental Manager

The Environmental Manager oversees our physical facility, laboratory and radiation safety programs, and instrumentation. This position reports to the COO, and manages and supervises the functions and staff assigned to these areas.

Responsibilities of the Environmental Manager include:

- Planning, evaluating, and making recommendations for facility maintenance, additions and renovations.
- Overseeing building renovations and new construction activities.
- Implementation of the Chemical Hygiene and Radiation Safety programs.
- Installing, maintaining, repairing, and modifying analytical instrumentation.
- Providing technical expertise and training in instrumentation operation, calibration, and maintenance.
- Monitoring and ensuring regulatory compliance for waste management operations and off-site disposal.

2.10 Radiation Safety Officer

The Radiation Safety Officer (RSO) reports to the COO. The RSO is responsible for the administration and execution of GEL's Radiation Protection Program. This person provides technical guidance and leadership for all issues concerning radiation health and safety as well as direct operations to ensure compliance with South Carolina Department of Health and Environmental Control (SCDHEC) regulations for radioactive materials.

Responsibilities of the RSO include:

- Establishing and enforcing policies consistent with the principles and practices designated to maintain all exposure to ionizing radiation "As Low As Reasonably Achievable" (ALARA).
- Supervising Radiation Protection Specialists in the execution of radiological surveys and maintenance of the Radioactive Material License inventory.
- Executing the Personal Dosimetry, Air Effluent Monitoring, and Sealed Radioactive Source Leak Test Programs.
- Developing procedures and protocols to establish and maintain compliance.
- Providing training for staff in proper radiation protection practices.

2.11 Director of Human Resources

The Director of Human Resources reports directly to the CEO. The DHR manages the design, implementation, and ongoing development of our Human Resources. Responsibilities of the DHR include:

- Administration, orientation, and indoctrination of all new employees.
- Administration and compliance with Federal, State, and Local employment regulations.
- Sourcing candidates for all functional positions to maintain and strengthen the technical services provided by GEL.
- Management of occupational health and safety as it relates to Federal, State, and OSHA regulations.

2.12 Employee Training

To ensure that our clients receive the highest quality services possible, we train our employees in the general policies and practices of the company, as well as the specific operating procedures relative to their positions. We conduct and document this training

according to GL-HR-E-002 for Employee Training and GL-QS-E-017 for Maintaining Technical Training Records.

New employees participate in a company orientation shortly after they are hired. During orientation they receive information on quality systems, ethics/data integrity, laboratory safety, and employment practices. Each new employee is also provided a manual that reiterates our policies on equal opportunity, benefits, leave, conflicts of interest, employee performance, and disciplinary action. Employees can access standard operating procedures, the Quality Assurance Plan, Safety, Health, and Chemical Hygiene Plan, and the Laboratory Waste Management Plan on GEL's Intranet.

Other training provided on an ongoing basis may include:

- Demonstration of initial proficiency in analytical methods and training to SOPs conducted by a trainer who has been documented as qualified and proficient in the process for which training is being provided.
- Demonstration of continued analyst proficiency is updated continuously, using the most recent data available in AlphaLIMS. Proficiency is demonstrated using the same processes as those used for initial Demonstration of Capability. (Refer to Section 8.3.1.)
- Company-wide, onsite training.
- Courses or workshops on specific equipment and analytical techniques.
- University courses.
- Professional and trade association conferences, seminars, and courses.

Documentation of employee training is the joint responsibility of the employee and the applicable Group Leader. If an SOP is revised during the course of the year, training to the revised SOP must be documented.

2.13 Ethics and Data Integrity

As our corporate vision statement explains, "We are a company that values: Excellence as a way of life, Quality Service, a Can-Do attitude, and a fundamental commitment to Ethical Standards." Employees attend ethics education programs that focus on the high standards of data integrity and ethical behavior mandated by our company and expected by our clients.

The annual ethics training includes:

- Specific examples of unethical behaviors for the industry and for the laboratory.
- Explanation of Internal Auditing for unethical behaviors and practices.
- GEL use of electronic audit functions using instrument and AlphaLIMS software.
- Explanation of GEL's Ombudsman policy for reporting inappropriate activities.
- Examples of consequences of inappropriate or unethical behaviors/practices.
- Examples of impartiality from commercial, financial or other pressures, both external and internal.

All employees sign an Ethics and Data Integrity Agreement that reflects their commitment to always perform their duties with these high standards. (Refer to Appendix F.) During the initial and continuing Ethics and Data Integrity training, GEL's policy on confidential reporting of potential integrity issues is thoroughly discussed. Potential business or data integrity issues are handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. All investigations are confidentially processed by GEL's QSD, or other members of GEL's Laboratory Management staff under the direction of the QSD. All investigations that result in finding of inappropriate activity are properly documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. The QSD is responsible for updating GEL's Executive Committee on the progress of integrity investigations during regularly scheduled meetings.

2.14 Confidentiality

The laboratory maintains the confidentiality and proprietary rights of information including the type of work performed and results of analysis. Laboratory personnel and staff are informed of this policy and sign a confidentiality agreement.

A confidentiality statement accompanies the electronic transfer of data from GEL via telefacsimile (fax) or electronic mail systems (email). Government affiliated auditing agencies have access to pertinent laboratory records. However, contract, third party, and client auditors have access only to those records that may be applicable to their inspection and shall not be granted access to client records that may be considered in conflict with their interests, unless prior authorization has been given by the submitting client. Confidential information may be purged of references to client identity, project and/or sample identity by the laboratory so that records may be provided to other entities (e.g. auditors) for review.

2.15 Impartiality

The laboratory is committed to Impartiality in producing valid results derived under its range of activities or scope of work. Results are provided accurately, objectively, clearly and in a report format which includes all the information necessary for the interpretation of the results. All information required by the method used and agreed with the customer is reported. The laboratory strives to maintain impartiality from commercial, financial or other pressures which might compromise impartiality. In addition to internal management structure mitigating undue pressures on employees, the laboratory reviews requests and tenders for possible risks to impartiality prior to bidding on work.

Our Core Values, along with procedures, plans, and policies outlined in this Quality Assurance Plan, scheduled management meetings, and monitoring of key performance indicators help in the management of risks on an on-going basis.

SECTION 3
QUALITY SYSTEMS

Section 3 - Quality Systems

Our Quality Systems include all quality assurance (QA) policies and quality control (QC) procedures necessary to plan, implement, and assess the work we perform. GEL's QA Program establishes a quality management system (QMS) that governs all of the activities of our organization.

GEL's quality management system is designed to conform to the requirements specified in the standards referenced in Appendix A. Essential elements of our quality management system are described in this section and Appendix E.

3.1 Quality Systems Team

The Quality Systems Team monitors risks to impartiality, confidentiality and other undue influences which could adversely affect confidence in the laboratory's competence, judgement or operational integrity. This team monitors conformity to the range of activity under which it performs. Risks which may affect the validity of results are identified, monitored and assessed as to the potential impact on the validity of the results. This group is responsible for recording and managing customer complaints through the laboratory non-conformance reporting system. .

Following is a summary of the responsibilities of each position, in addition to the duties discussed in section 2.3

3.1.1 Quality Systems Director

- Reports to the CEO
- Demonstrates strict adherence to and support of the company ethics policy
- Serves as management's representative for quality
- Responsible for the implementation and maintenance of the QMS
- Supervises the Quality Systems Team and their functions
- Initiates and recommends preventive action and solutions to quality problems
- Implements appropriate action to control quality problems until solutions are implemented and verified to be effective
- Verifies that effective solutions are implemented
- Demonstrates knowledge of the Quality System as defined by NELAC, TNI, NUPIC, ISO/IEC 17025, DOECAP DoD ELAP, and DOELAP.

3.1.2 Quality Systems Lead Auditor

- Reports to the Quality Systems Director
- Demonstrates strict adherence to and support of the company ethics policy.
- Demonstrates knowledge of the Quality System defined under NELAC, TNI, DOECAP,DoD ELAP, DOELAP, NUPIC and other quality standards such as ISO/IEC 17025-2017.
- Plans, schedules and participates in GEL's client audits, internal audits, and subcontractor audits
- Conducts conformance audits as necessary to verify implementation and closure of audit action items
- Serves as liaison to client and third party auditors
- Coordinates laboratory responses to audit reports and prepares final response
- Monitors progress of corrective actions
- Prepares and monitors progress of internal and subcontractor audit reports

3.1.3 Quality Assurance Officers

- Report to the Quality Systems Director
- Demonstrate strict adherence to and support of the company ethics policy.
- Demonstrate the ability to evaluate data objectively without outside influence
- Have documented training and/or experience in QA/QC procedures and knowledge of the Quality system as defined under NELAC, TNI and ISO 17025.
- Have knowledge of analytical methods

- Assist in the conduct of internal and supplier audits and requests for pricing reviews
- Administer corrective actions and nonconformances
- Monitor and respond to client -identified nonconformances and technical inquiries
- Implement and maintain statistical process control (SPC) system
- Ensure the monitoring of balances and weights, and temperature regulation of ovens, water baths, and refrigerators
- Coordinate the monitoring of DI water system and volatile organics storage coolers
- Maintain Method Detection Limit studies
- Write or review quality documents and standard operating procedures under the direction of the QS Director
- Provide training in quality systems and good laboratory practices.
- Manage laboratory certification processes
- Coordinate the receipt and disposition of external and internal performance evaluation samples.

NOTE: Once PE samples have been prepared in accordance with the instructions provided by the PE vendor, they are managed and analyzed in the same manner as environmental samples from clients. The analytical and reporting processes for PE samples are not specially handled.

3.1.4 Quality Systems Specialists/Document Control Officer

- Reports to the Quality Systems Director
- Demonstrates strict adherence to and support of the company ethics policy.
- Assist the team as directed with respect to Records Management, Document Control, Laboratory Certification, temperature and weight calibrations, logbook review, training documentation, and nonconformances, etc.

3.2 Quality Documents

Our Quality Systems policies and procedures are documented in this and other supporting documents. GEL's management approves all company quality documents. Pre-approval is secured for any departures from such documents that may affect quality.

In addition, to the QA Plan, Quality Systems allows for QA Project Plans (QAPjP) and includes standard operating procedures and any other quality assurance program requirements defined by individual contracts. The QA Plan describes the quality standards that we apply to our laboratory operations. We use Quality Assurance Project Plans to specify individual project requirements. The QA Plan and supporting documents are verified to be understood and are implemented throughout the laboratory fractions to which they apply.

Finally, our Standard Operating Procedures (SOPs) are used to describe in detail those activities that affect quality. SOPs are prepared, authorized, changed, revised released, and retired in accordance with GL-ADM-E-001. SOPs are accessible electronically via GEL's Intranet.

3.3 Document Control

The control of quality documents is critical to the effective implementation of our Quality Program. We define and control this process in accordance with GL-DC-E-001 for Document Control. Responsibilities for document control are divided between the Group Leaders and the Document Control Officer (DCO).

Group Leaders are responsible for:

- Supporting the development and maintenance of controlled documents that apply to their respective departments.
- Reviewing all quality documents annually for continued validity.
- Ensuring documentation that the affected employees are aware of revisions to documents or manuals.

The Computer Services Team is responsible for:

- Electronic maintenance of all records required for control, re-creation, and maintenance of analytical documentation.
- Maintenance of electronic copies of archived data and the electronic log of how they were determined.

The DCO is responsible for:

- Demonstrating strict adherence to and support of the company ethics policy.
- Managing the system for the preparation, authorization, change, revision, release, and retirement of the Quality Manual, QAP, project plans, and standard operating procedures.

- Ensuring that current controlled documents are accessible via GEL's Intranet.
- Managing a system to document current revision numbers and revision dates for all distributed documents and manuals.
- Managing a system to identify the nature of document revisions.
- Maintaining hard or electronic copies of obsolete documents.
- Maintaining electronic or hard copy originals of all controlled documents.

Revisions to controlled quality documents are made by replacing individual sections or the entire document, as determined by the DCO.

3.4 Controlled Document Review

Internally generated controlled documents undergo a multi-level review and approval process before they are issued. These levels include a procedural review, technical and/or quality review and final authorization of the appropriate manager or director if necessary. To ensure that new or revised standard operating procedures are not implemented prematurely, SOPs are effective upon the date of the final approval signature.

3.5 Quality Records

Quality records provide evidence that specified quality requirements have been met and documented. We generate them in accordance with applicable procedures, programs, and contracts. Quality records include but are not limited to:

- Observations
- Calculations
- Calibration data
- Certificates of analysis
- Certification records
- Chains of custody
- Audit records
- Run logs, instrument data, and analytical logbooks
- Instrument, equipment, and building maintenance logs
- Material requisition forms
- Monitoring logs
- Nonconformance reports and corrective actions
- Method development and start-up procedures including method detection limit studies
- Technical training records
- Waste management records
- Standard logs
- Software validation documentation
- Standard Operating Procedures (SOPs)
- Sample collection and field data

Our quality records are:

- Documented in a legible manner.
- Indexed and filed in a manner conducive to ready retrieval.
- Stored in a manner that protects them from loss, damage, and unauthorized alterations.
- Accessible to the client for whom the record was generated.
- Retained and disposed in the identified time period.

The generation, validation, indexing, storage, retrieval, and disposition of our quality records are detailed in GL-QS-E-008 for Quality Records Management and Disposition. The quality records of subcontracted services are also required to meet the conditions established in this SOP.

3.6 Internal and Supplier Quality Audits

We conduct internal audits annually to verify that our operations comply with the requirements of our QA program and those of our clients. We perform supplier audits as necessary to ensure that they too meet the requirements of these programs. Both internal and supplier audits are conducted in accordance with GL-QS-E-001 for the Conduct of Quality Audits.

3.6.1 Audit Frequency

Internal audits are conducted at least annually in accordance with a schedule approved by the Quality Systems Director. Supplier audits are contingent upon the categorization of the supplier, and may or may not be conducted prior to the use of a supplier or subcontractor (Refer to GL-QS-E-001.) Type I suppliers and subcontractors, regardless of how they were initially qualified, are re-evaluated at least once every three years.

Additional internal and supplier audits may be scheduled if deemed necessary.

3.6.2 Audit Team Responsibilities

Internal and supplier audits are conducted by qualified staff under the direction of the Lead Auditor or Quality Systems Director. A qualified audit team member shall have the technical expertise to examine the assigned activities.

We do not allow staff to audit activities for which they are responsible or in which they are directly involved. It is the responsibility of the Lead Auditor to ensure that such conflicts of interest are avoided when the audit team is assembled.

The Leadership Team has a significant role in the internal audit process, including:

- Provision of audit personnel
- Empowerment of the audit team with authority to make the audit effective
- Development and implementation of timely corrective action plans

3.6.3 Identification and verification of OFIs

Opportunities for Improvement are identified conditions that have potential to improve the quality of products or services. Several examples of objective evidence are used to support an OFI, which might be classified as an, observation, and/or recommendation.

The Lead Auditor may initiate an OFI and may reference a Nonconformance Report (NCR) or Corrective Action Request and Report (CARR) The OFI, is then entered into the NCR system per GL-QS-E-012 for NCR Database Operation.

Implementation of any changes or action is verified as effective prior to implementation. The OFI may be verified for continued effective implementation during the next scheduled audit.

3.7 Managerial and Audit Review

Our Leadership Team reviews the audit process at least annually. This ensures the effectiveness of the corrective action plan and provides the opportunity to introduce changes and improvements.

We document all review findings and corrective actions. Implementation plans and schedules are monitored by the Quality Systems Team.

3.8 Nonconformances

Processes, materials, and services that do not meet specifications or requirements are defined as nonconforming. Such nonconformances can include items developed in-house or purchased from vendors, samples received from clients, work in progress, and client reports.

At GEL, we have a nonconformance reporting system (NCR) that helps us prevent the entry of defective goods and services into our processes and the release of nonconforming goods and services to our clients. Our NCR system provides a means for documenting the disposition of nonconforming items and for communicating these to the persons involved in the process affected by the adverse condition(s).

Nonconformances are documented according to GL-QS-E-004 for the Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items. We regularly review SOPs, client complaints, and quality records, including completed NCRs, to promptly identify conditions that might result in situations or services that do not conform to specified quality requirements.

Our Quality Group processes, categorizes and trends nonconformances. Trending information may be provided to the Leadership Team and Group Leaders of the affected areas.

3.9 Corrective Action

There are two categories of corrective action at GEL. One is corrective action implemented at the analytical and data review level in accordance with the analytical SOP. The other is formal corrective action documented by the Quality Systems Team in accordance with GL-QS-E-002. Formal corrective action is initiated when a nonconformance reoccurs or is so significant that permanent elimination or prevention of the problem is required.

We include quality requirements in most analytical SOPs to ensure that data are reported only if the quality control criteria are met or the quality control measures that did not meet the acceptance criteria are documented.

Formal corrective action is implemented according to GL-QS-E-002 for Conducting Corrective/Preventive Action and Identifying Opportunities for Improvement

and documented according to GL-QS-E-012 for NCR Database Operation.

Any employee at GEL can identify and report a nonconformance and request that corrective action be taken. Any GEL employee can participate on a corrective action team as requested by the QS team or Group Leaders. The steps for conducting corrective action are detailed in GL-QS-E-002.

In the event that correctness or validity of the laboratory's test results is doubted, the laboratory will take corrective action. If investigations show that the results have been impacted, affected clients will be informed of the issue in writing within 5 calendar days of the discovery.

GEL will notify all affected customers of any data quality issues resulting from nonconforming work within 15 business days of discovery. GEL will provide and submit records of the corrective actions to resolve the nonconformance(s) to the customer(s) with 30 business days. This procedure will also be followed to notify GEL's accrediting body if the laboratory experiences any instances of inappropriate and prohibited laboratory practices. GEL will perform these procedures in accordance with SOP GL-QS-E-002 Conducting Corrective/Preventative Action and Identifying Opportunities for Improvement.

3.10 Performance Audits

In addition to internal and client audits, our laboratory participates in annual performance evaluation studies conducted by independent providers. We routinely participate in the following types of performance audits:

- Proficiency testing and other inter-laboratory comparisons.
- Performance requirements necessary to retain certification (Appendix D).
- Evaluation of recoveries of certified reference and in-house secondary reference materials using statistical process control data.
- Evaluation of relative percent difference between measurements through SPC data.

We also participate in a number of proficiency testing programs for federal and state agencies and as required by contracts. It is our policy that no proficiency evaluation samples be analyzed in any special manner.

Our annual performance evaluation participation generally includes a combination of studies that support the following:

- US Environmental Protection Agency Discharge Monitoring Report, Quality Assurance Program (DMR-QA). Annual national program sponsored by EPA for laboratories engaged in the analysis of samples associated with the NPDES monitoring program. Participation is mandatory for all holders of NPDES permits. The permit holder must analyze for all of the parameters listed on the discharge permit. Parameters include general chemistry, metals, BOD/COD, oil and grease, ammonia, nitrates, etc.
- Department of Energy Mixed Analyte Performance Evaluation Program (MAPEP). A semiannual program developed by DOE in support of DOE contractors performing waste analyses.
- ERA's MRAD-Multimedia Radiochemistry Proficiency test program. This program is for labs seeking certification for radionuclides in wastewater and solid waste. The program is conducted in strict compliance with USEPA National Standards for Water Proficiency study.
- ERA's InterLaB RadCheM Proficiency Testing Program for radiological analyses. This program completes the process of replacing the USEPA EMSL-LV Nuclear Radiation Assessment Division program discontinued in 1998. Laboratories seeking certification for radionuclide analysis in drinking water also use the study. This program is conducted in strict compliance with the USEPA National Standards for Water Proficiency Testing Studies.
- Water Pollution (WP). Biannual program for waste methodologies. Parameters include both organic and inorganic analytes.
- Water Supply (WS): Biannual program for drinking water methodologies. Both organic and inorganic parameters are included.

At GEL, we also evaluate our analytical performance on a regular basis through statistical process control acceptance criteria. Where feasible, this criterion is applied to both measures of precision and accuracy and is specific to sample matrix.

We establish environmental process control limits at least annually. In Radiochemistry, quality control

evaluation is based on static limits rather than those that are statistically derived, unless specified by regulatory programs such as Drinking Water. Our current process control limits are maintained in AlphaLIMS. GEL maintains client-specific and program-specific control limits and reporting requirements in the LIMS. Examples of client or program specific limits may be found in documents such as the DoD QSM tables in Appendices B and C of DOD-DOE QSM version 5.2, and in the HASQARD Standard which are available as Quality Systems documents.

We also measure precision through the use of matrix duplicates and/or matrix spike duplicates. The upper and lower control limits (UCL and LCL respectively) for precision are plus or minus three times the standard deviation from the mean of a series of relative percent differences. The static precision criteria for radiochemical analyses are 0 – 20% for activity levels exceeding the contract required detection limit (CRDL).

Accuracy is measured through laboratory control samples and/or matrix spikes, as well as surrogates and internal standards. The UCLs and LCLs for accuracy are plus or minus three times the standard deviation from the mean of a series of recoveries. The static limit for radiochemical analyses is 75 – 125%, except as specified by the Drinking Water regulations. Specific Instructions for out-of-control situations are provided in the applicable analytical SOP.

3.11 Control Charts

Per the U.S. Department of Energy, Quality Systems for Analytical Services (DOE QSAS): Control charts are a graphical representation of data taken from a repetitive measurement or process. Control charts may be developed for various characteristics, (e.g. mean, standard deviation, range, etc.) of the data. Per MARLAP "A control chart has two basic uses:

- As a tool to judge if a process was in control.
- As an aid in achieving and maintaining statistical control.

For applications related to radiation detection instrumentation or radiochemical processes, the mean (center line) value of a historical characteristic (e.g. mean detector response), subsequent data values and control limits placed symmetrically above and below the center line are displayed on a control chart."

For GEL's Chemistry, Radiochemistry, and Bioassay laboratories, the Computer Services Team (CST) developed a program where Group Leaders are sent email notifications that provide LCS failures by compound/analyte name. This assists the Group Leader with monitoring out of control situations due to laboratory contamination or analyst error. This program sends notifications once a week.

Each Group Leader may utilize programs in LIMS where they can review trending data as control charts by work order or by the SPC program.

GEL's QA Officer or designee shall review control charts during the period when the LIMS SPC program queries data points for analyses that require dynamic SPC limits for quality control parameters. This is performed on a biannual basis. At this time, any out of control conditions will be identified and a corrective action initiated. The QA Officer shall be able to stop unsatisfactory work or prevent the reporting of results generated from this program.

Dynamic SPC limits for control parameters are generally developed when more than 20 data points are available for review. Data points may be determined as outliers based on the process knowledge of the procedure being evaluated and the professional opinion of the data reviewer.

During their annual system review, management will evaluate the need to consolidate any redundant procedures and/or policies to help eliminate any confusion for work processes.

3.12 Essential Quality Control Measures

Some quality control measures are method-specific. There are, however, general quality control measures that are essential to our quality system. These quality measures include:

- Monitoring of negative and positive controls
- Defining variability and reproducibility through duplicates
- Ensuring the accuracy of test data including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples, etc.
- Evaluating test performance using method detection limits and quantitation limits or range of applicability such as linearity
- Selecting the appropriate method of data reduction

- A copy of GEL's Ethics and Integrity Agreement is provided in Appendix F.

SECTION 4
FACILITIES

Section 4 – Facilities

Our laboratory is designed with a full-service approach to handling environmental needs. The layout provides dedicated space for radiochemical analyses, bioassay analysis, organic extractions, semi-volatile organic analyses, volatile organic analyses, metals analyses, general chemistry analyses, and air analyses.

The laboratory and support offices occupy approximately 85,000 square feet engineered to meet the stringent quality control and utility requirements of the modern environmental laboratory. Records are temporarily stored on-site then warehoused in a climate-controlled building off-site. The diagram in Appendix H depicts the layout of the laboratories.

Discussed in this section are:

- Facility security
- Utility services and deionized water
- Prevention of contamination
- Assessment of contamination

4.1 Facility Security

Our facility features secured laboratory and storage areas. Restricted entry assures sample integrity and client confidentiality, which satisfies clients and potential national security interests.

Visitors cannot gain entry without being escorted through the laboratory by authorized personnel. A designated sample custodian and a bar-coded chain-of-custody provide a second level of security.

4.2 Utility Services

Each defined laboratory area is equipped with the following utilities:

- Cold water
- Hot water
- Deionized water
- Compressed air
- Natural gas
- Vacuum
- 110 Volt AC
- 208 Volt AC (at selected stations)
- Specialty gases (as required)

4.2.1 Deionized Water

We have two independent deionized water (DI) systems. One serves radiochemistry while the other serves the remaining laboratories. DI water is made from city water flowing through a reverse osmosis system and a deionization system capable of producing 5 gallons per minute of Type I laboratory water.

We monitor compliance according to GL-LB-E-016 for The Collection and Monitoring of the DI Water Systems. Our monitoring activities and frequencies can be found in Table 1 of the SOP.

4.2.2 Specialty Gasses

The specialty compressed gasses may be required by specific analytical systems. Each specialty compressed gas system is monitored for background contamination that would negatively impact the efficiency of the operating system. Monitoring is generally conducted through use of routine instrument control samples which are introduced to the operating system prior to instrument calibrations and throughout the analytical process. Requirements for the purity of the gasses are identified in the instrument operating manuals and standard operating procedures.

4.3 Prevention of Contamination

Work areas that are free of sample contaminants, constituents and measurement interferences are important to the generation of quality data. With this in mind, we designed our laboratories to prevent contamination and reinforce this design with good laboratory practices.

In addition to keeping our work areas free of dust and dirt accumulations, policies and features that prevent or minimize contamination include:

- An air conditioning system that controls the environment of individual laboratories for optimum performance of sensitive instruments and to eliminate potential cross contamination.
- Segregation of volatile and semi-volatile laboratories to minimize potential contamination associated with the use of commonly required solvents.

- Negative and positive pressure air locks to isolate selected laboratories to prevent the entry of airborne contaminants.
- Fume hoods to remove fumes and reduce the risk of aerosol and airborne contaminants and personal safety hazards are monitored in accordance with GL-FC-E-003 for Local Exhaust Ventilation Systems.
- Restricted access to the volatiles laboratory (authorized personnel only).
- Designated area for glassware preparation wherein all glassware used in sample prep and analysis is cleaned according to GL-LB-E-003 for Glassware Preparation.
- Segregated storage areas for volatiles and radioactive samples.
- Production, use, and monitoring of Type I DI water.
- Tracking and trending of any significant sample and/or reagent spills using the AlphaLIMS NCR system, allowing efficient analysis of any potential contamination.

4.4 Assessment of Contamination Levels

We evaluate contamination resulting from the following sources on the basis of quality assurance and quality control data derived from the analytical method and method blanks.

- Sample containers
- Reagent water
- Reagents and solvents
- Sample storage
- Chemical and physical interference
- Constituent carryover during analysis

Contamination in each of the volatile storage coolers is monitored by the weekly analysis of water blanks. Two DI water blanks are placed in each monitored cooler at the beginning of each month with one being analyzed each week. If the concentration of any target analyte exceeds the PQL, this is verified (with the second blank for that week) and corrective action is implemented to eliminate the source of contamination, evaluate the effect of samples stored in the cooler, and to notify clients. SOP GL-OA-E-058 discusses these practices in detail.

SECTION 5
EQUIPMENT AND REFERENCE MATERIALS

Section 5 – Equipment and Reference Materials

GEL's ability to efficiently generate data that are reproducible, accurate, and legally defensible is attributable to our use of high-quality instruments, equipment, and reference materials.

Provided in this section are:

- GEL's policies governing instruments, equipment, and reference materials
- Identification of instrumentation and support equipment
- Procurement protocol

5.1 General Policies

It is our policy to purchase instrumentation, equipment and high-quality reference materials that meet or exceed the method and regulatory requirements for the analyses for which we are accredited. If we need to use instruments or equipment not under our permanent control, we ensure that it also meets these standards.

Instrumentation and equipment are placed into service on the basis of ability to meet method or regulatory specified operating conditions such as range and accuracy. All laboratory instrumentation and testing equipment is maintained in accordance with standard operating procedures (SOPs).

Instrumentation and equipment is used in a manner that assures, where possible, that measurement uncertainty is known and consistent with specified quality requirements. Instruments and equipment are taken out of service and segregated or labeled as such under the following conditions:

- Mishandling and/or overloading
- Results produced are suspect
- Demonstrated defect or malfunction

Tagged or segregated instruments and equipment remain out of service until repaired and shown by test, calibration, or verification to perform satisfactorily. Instruments that are in service and normally calibrated prior to and during use are not tagged.

Each item of equipment, including reference materials is, if appropriate, labeled, marked or otherwise identified to indicate its calibration status. We maintain records for each major item of equipment, instrumentation, and all reference materials significant to quality performance. These records are often in the form of maintenance logs, which are kept in accordance with GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Recordkeeping Devices.

Documentation included in these records may include but is not limited to:

- Equipment name
- Manufacturer's name
- Type identification
- Serial number or other unique identification
- Date received and date placed in service (if pertinent)
- Current location
- Condition when received (if known)
- Manufacturer's instruction, where available
- Dates and results of calibrations and or verifications
- Date of next calibration and/or verification, where written procedures do not specify frequency
- Details of maintenance carried out to date and planned for the future
- History of any damage, malfunction, modification or repair

5.2 Instrumentation and Support Equipment

Appendix G lists the instruments we use for the analysis of environmental, radiochemical and bioassay samples. Where feasible, our instruments are equipped with autosamplers that improve efficiency and facilitate consistent sample introduction to the sample detector. They are also connected to an area network to facilitate data transfer.

Devices that may not be the actual test instrument but are necessary to support laboratory operations are referred to as support equipment. We also maintain this equipment in proper working order. Support equipment utilized at GEL includes:

- balances
- ovens
- refrigerators
- freezers
- incubators
- water baths
- temperature measuring devices
- volumetric dispensing devices
- muffle furnaces
- distillation apparatus
- grinders and homogenizers
- hot plates and heating mantles
- ultraviolet sterilizers.

Guidelines for the required calibration and evaluation of this equipment are discussed in Section 7.

We perform radiochemical and bioassay analytical services in accordance with the instrumentation and reference methods approved by the Department of Energy (DOE), the Environmental Measurements Lab (EML), the Environmental Protection Agency (EPA), ASTM, and Los Alamos Health and Environmental Chemistry (LAHEC). Modifications to these methods may be appropriate as a result of Performance Based Measurement Systems (PBMS).

SOPs are used to describe our procedures for all routine analyses performed by our labs. These procedures include step-by-step instructions for sample collection, storage, preparation, analysis, instrument calibration, quality control, disposal, and data reporting.

5.3 Procurement and Control of Purchased Items

Materials, equipment, and services that affect the quality of our products are designated as Quality Materials, Equipment, and Services and are only purchased from approved suppliers. We approve and document suppliers according to GL-QS-E-001 for the Conduct of Quality Audits.

At GEL, we maintain documentation of specific quality requirements for Quality Materials and Services. Records that document the quality of a product or service may include:

- certificates of analysis and traceability
- verifications of chemical quality
- inspections of equipment or materials
- verifications or inspections of vendor product specifications

Our procedure for requisitioning supplies, instruments, equipment and other common use material is described in GL-RC-E-002 for Material Requisition. These requests typically include:

- The date and name of person(s) requesting materials
- Account, department, project number to which the material is to be billed
- Recommended supplier or vendor
- Additional information necessary to expedite the purchase request
- Specifications that could affect the quality of products and services
- Vendor's material part number
- Amount of material needed
- Description of material
- Cost per unit
- Person(s) authorizing the purchase
- Time frame in which the material is needed

The equipment, instruments, and reference materials we purchase are inspected upon receipt in accordance with GL-RC-E-001 for the Receipt and Inspection of Material and Services. This inspection is to verify that procured items meet the acceptance criteria defined in the procurement documentation. Staff performing initial inspection routinely:

- Open and inspect all items for damage
- Compare the items with the issued purchase order or contract for catalog or part number, description or procurement specification, quality requirement, and acceptance criteria
- Label items with a limited shelf life with the date received
- Determine if the items conform to the specifications agreed to by the vendor.

The individual responsible for the technical acceptance of the item provides procurement and receiving staff with the proper acceptance documentation. Items found not to conform to quality standards are returned to the supplier, identified as nonconforming or disposed according to the established procedures in GL-

QS-E-004 for AlphaLIMS Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items. These nonconforming items may also include those identified as suspect/counterfeit items as identified in DOE guide DOE G 414.-3 for use with DOE 414.1B, C and D.

SECTION 6
HEALTH AND SAFETY

Section 6 – Health and Safety

GEL maintains a safe work environment and promotes healthy work practices. Our corporate Safety, Health, and Chemical Hygiene Plan was developed by a resident certified industrial hygienist. Procedures outlined in the plan are consistent with Occupational Safety and Health Administration, CERCLA, the Environmental Protection Agency, and SCDHEC.

All employees are trained in the safety practices applicable to their job functions. This training is conducted in accordance with GL-HR-E-002 for Employee Training.

Discussed in the section are:

- Fire safety and safety equipment
- Safety equipment and procedures related to handling radioactive samples

6.1 Fire Safety

Our facility is equipped with a fire alarm system designed to detect smoke in all areas of the facility. Certain high-risk areas, such as, the cold and ambient storage areas, organic sample preparation lab, hazardous waste lab, and solvent storage are additionally equipped with automatic halon systems. Fire blankets and dry chemical extinguishers are located at strategic points throughout the lab. We routinely inspect these extinguishers in accordance with GL-FC-E-004. Lab personnel are trained in the proper use and selection of fire extinguishers.

In order to decrease the risk of fire, bulk solvents are stored in a halon-protected storage room.

6.2 Evacuation

In the unlikely event of a fire (or other emergency), we have defined evacuation routes depicted in Appendix H. This diagram is posted in pertinent areas of the facility and designated staff members serve as evacuation leaders for the work groups.

6.3 Safety Equipment

Safety equipment, including safety glasses, lab coats, safety goggles, protective gloves, hard hats, and coveralls, is available to all employees as needed. We also provide respirators when needed to those who have completed training in the use of this specialized equipment.

Eyewashes and overhead showers are located throughout the laboratory. We routinely inspect these as directed in GL-FC-E-002 for Testing Emergency Eyewash and Shower Equipment.

6.4 Radiation Safety

Since GEL specializes in the handling of radioactive material, we have health physics procedures to ensure its safe handling. While lab personnel do not encounter significant levels of radiation requiring personal monitoring, a Dosimetry Program is in effect utilizing personal dosimeters for designated personnel. These dosimeters are exchanged quarterly and records of exposure are maintained. Instructions for the proper use of dosimeters are addressed in GL-RAD-S-009 for Personnel Dosimetry.

We take special precautions to ensure that samples are safely processed. Upon receipt, trained personnel use a survey meter to screen all samples for the presence of radioactivity. Protocols for the receipt of radioactive samples and for surveying suspected or known radioactive samples are detailed in GL-RAD-S-007 for Receiving Radioactive Packages and GL-RAD-S-001 for Radiological Surveys. This process is described in Section 9.

Upon leaving a radiologically controlled area, personnel check their hands and feet for potential contamination. This is done utilizing detection instrumentation that employs Geiger-Mueller or scintillation technologies. In addition, stations with portable detection instruments are set up for personnel frisking and in-process contamination surveys.

Key areas throughout the facility are surveyed:

- Laboratory analytical areas (Monthly smears)

- Radioactive Sample Storage Areas (Monthly smears and exposure rate)
- Sample Receipt and Waste Handling Areas (Monthly smears and exposure rate)
- Unrestricted and Radioactive Material Prohibited Areas (Quarterly smears)

SECTION 7
MEASUREMENT, TRACEABILITY, AND CALIBRATION

Section 7 – Traceability and Calibration

Traceability of measurements and the calibration of testing equipment are imperative to our ability to produce accurate and legally defensible data. As such, we have implemented procedures to ensure that equipment calibration and measurement verification are traceable to nationally recognized standards obtained from the National Institute of Standards and Technology (NIST) or accredited reference material producer (RMP) with traceability to NIST. Reference materials purchased outside the United States must be traceable back to each country's national standards laboratory or another national or international reference organization such as ILAC, APLAC and/or IAAC. The RMP may also have established acceptability by its approval as an ISO Guide 34 RMP. Commercial suppliers of radiochemistry reference standards/sources must conform to ANSI N42.22 and must be accompanied by a certificate of calibration consistent with ANSI N42.22-1995, section 8.

Where possible, calibration certificates provide traceability to national and/or international standards of measurement.

Calibration certificates provide measurement results and any associated uncertainty of measurement, and/or a statement of compliance with the identified specification. Calibration certifications are maintained as quality records.

When traceability to a national standard is not applicable, verification of measurement is achieved through inter-laboratory comparisons, proficiency tests, or independent analyses.

The following measurement and traceability practices are described in this section:

- Calibration criteria for support equipment
- General requirements
- Balances
- Temperature-sensitive devices and temperature monitoring
- Air displacement pipets
- Calibration criteria for instruments
- Calibration verification
- Initial calibration verification
- Continuing calibration verification

7.1 Calibration Criteria for Support Equipment

This section addresses calibration protocols for support equipment, including balances, temperature – sensitive equipment, and air displacement pipets. The general criteria applicable to the calibration of support equipment are as follows:

- Equipment is maintained in proper working order. Records of all maintenance activities including service calls are kept.
- Calibrations or re-verifications over the entire range of use, using NIST-traceable references when available, are conducted either quarterly, annually or biennially.
- The laboratory is allowed to re-verify some standards, sources and reagents to extend their expiration dates. However these reverifications must meet method acceptance criteria for their specific method and intended use. This has been GEL's process for numerous years and the laboratory has established a track record for both the reference materials and the producers. The reference materials verified/re-verified by the process have been subjected to numerous interlaboratory comparisons and cross-checked by use of different methods over a period of many years.
- If results of calibration and verification are not within the specifications for the equipment's application, then:
  1. The equipment is removed from service until repaired
  2. Under certain conditions, a deviation curve may be prepared. All measurements are corrected for the deviation, recorded and maintained.

- Prior to use each day, balances, ovens, freezers, refrigerators, incubators, and water baths are checked with NIST-traceable references (where possible) in the expected range of use.
- If prescribed by the test method, additional monitoring is performed for a device used in a critical test (such as an incubator or water bath).
- Support equipment is used only if the reference standard specifications (provided by the supplier or described in the analytical method) are met.
- Reference standards of measurement such as Class S or equivalent weights or traceable thermometers may be used for calibration when demonstrated that their performance as reference standards will not be invalidated.
- Reference standards of measurement are calibrated by a body that can provide, where possible, traceability to a national standard.
- Reference standards and measuring and testing equipment are, subject to in-service checks between calibrations and verifications, in accordance with ANSI/ISO/IEC 17025-2017.
- Reference materials, where possible, are traceable to national or international standards of measurement, or to national or international standard reference materials.
- Mechanical volumetric dispensing devices, except Class A glassware, are checked monthly for accuracy.

7.1.1 Balances

Our balances are under a service contract for annual calibration, maintenance, and cleaning. Each balance is labeled with a serial number, service date, date of next service, and signature or initials of the service technician.

Balances are set up, calibrated, and operated in the range required by the analytical method in accordance with GL-LB-E-002 for Balances. Prior to using a balance, the analyst is responsible for checking its calibration.

Calibration and calibration verification are performed using weights that are or have been calibrated against Class S or equivalent weights. These weights are traceable to NIST and calibrated biennially by a calibration service provider that meets the requirements of the ANSI/ISO/IEC 17025-2017 standard.

Calibration and calibration verification are recorded in the electronic balance calibration logbook. If the calibration or calibration verification does not meet the specified acceptance criteria, the balance is recalibrated. If the calibration criteria are still not met, the balance is removed from service and tagged as such.

7.1.2 Refrigerators, Freezers, Incubators, Ovens, Water Baths, and Similar Devices

Careful control of temperature is often central to the production of acceptable data. Temperature excursions beyond the established limits may invalidate a procedure and the associated data. Constant monitoring in accordance with GL-LB-E-004 for Temperature Monitoring and Documentation Requirements for Refrigerators, Freezers, Ovens, Incubators, and Other Similar Devices assures us that regulatory and/or method temperature requirements are being met.

We measure temperatures with thermometers that are verified either quarterly or annually against a NIST-traceable thermometer. The NIST traceable thermometers are independently verified at least annually by a verification service that meets the requirements of the ANSI/ISO/IEC 17025-2017 standard. The protocol for thermometer verification is described in GL-QS-E-007. We monitor the temperature of the following equipment according to GL-LB-E-004:

- Refrigerators and freezers used to store samples, standards, and other temperature-sensitive materials
- Incubators
- Ovens
- Water baths

We monitor the temperatures of refrigerators and freezers prior to use on each working day. The temperatures of ovens, water baths, and other devices used as part of an analytical process must be

monitored prior to, during, and immediately after use. Incubators and other devices used for other specialized analytical methods may require more frequent monitoring as specified in the corresponding SOP.

Temperature measurements are documented on logs specific to each piece of equipment. These logs may be paper or recorded electronically in LIMS. The logs may be posted on or near each refrigerator, freezer, water bath, oven, or other temperature control device. Electronic monitoring logbooks for refrigerators, freezers, and coolers with temperature probes are found in AlphaLIMS. Each log includes the following information:

- Date and time of each measurement
- Acceptance limits for device being monitored
- Whether device conforms with specifications at time of measurement
- Name, location, and number of device being monitored
- Notation of any out-of-control condition
- Any corrective action

When the process to maintain and document temperatures within acceptance limits does not conform to specifications appropriate action is then taken to document the nonconformance. According to GL-QS-E-004 for AlphaLIMS Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items. Any corrective action taken to bring the equipment back into acceptable use is discussed.

Examples of nonconformances are:

- Failure to maintain process temperature within acceptance limits
- Failure of device to achieve calibration
- Total failure of temperature control device
- Failure to monitor the temperature as required

7.1.3 Air Displacement Pipets

We calibrate air displacement pipets in accordance with GL-LB-E-010 for Maintenance and Use of Air Displacement Pipets. As specified in the SOP, the calibration of an air displacement pipet is verified daily prior to use, based on a single point measurement.

The acceptance criteria for each measurement are based on the standard deviation of the calibration measurements. Tolerance limits for commonly used verification volumes and accuracy and precision checks are included in the pipet calibration logbook. Calibrations and daily calibration verifications are traceable to each pipet using the unique identification found on its label.

If a pipet does not meet the calibration tolerance limits, it is removed from service until it again demonstrates compliance after being cleaned and/or repaired. Analysts whose jobs may require the use of air displacement pipets are trained in their proper use and calibration.

7.2 Instrument Calibrations

To ensure that the data generated by an instrument are accurate, we calibrate the instrument using standards containing known concentrations of target analytes. We verify the accuracy of calibration standards by analyzing an additional standard containing the target analytes. This initial calibration verification standard (ICV) originates from a second source. Verification that the instrument response is reliable and has not changed significantly from the current calibration curve is accomplished by the analysis of a continuing calibration verification (CCV) standard. Some analytical methods employ the use of CCVs at varying concentrations.

Traceability of calibration, calibration verification, and other quality control standards to the recognized standard is documented per GL-LB-E-007 for Laboratory Standards Documentation. Preparation and Verification of Radioactive Standards is described in GL-RAD-M-001. Individual identification numbers are assigned to each source standard and each subsequent intermediate and working standard prepared.

The identification number makes it possible to trace a standard to a parent standard and ultimately to the source standard. The date each standard is prepared, the protocol used in the preparation, the person preparing the standard, and the standard's expiration date are documented in the appropriate standards log, usually maintained in AlphaLIMS. The information is accessible via the standard ID number.

We record standard and reagent ID numbers on instrument run logs, analytical logbooks, sample preparation logs, and instrument raw data. Calibration standards that are used in the analysis of a particular sample or group of samples can be traced to NIST, US EPA, or other nationally recognized standards.

Calibration procedures for specific instruments, and the frequencies of performance for defined methods, are described in the applicable operating or analytical SOP. Calibration is discussed in general terms in GL-QS-E-014 and includes standard laboratory practices and formulas used for determinations made by these practices. General guidelines include:

- Verification of initial calibrations with a standard obtained from a second source (unless one is not available).
- Analysis of verification standards (ICV and CCV) with each initial calibration within 15% of the true value unless historical data have demonstrated that wider limits are applicable.
- Preparation of calibration curves as specified in the reference method.

If a test method does not specify the number of calibration standards, the minimum number is two, not including blanks, with one at the lowest quantitation limit. The reference SOP must establish the initial calibration requirements.

7.3 Calibration Verification

Unless otherwise specified by the method, regulatory program or demonstrated through historical data, the recovery of target analyte(s) in calibration verification standards shall be between 85 – 115%. We discuss additional requirements below.

7.3.1 Initial Calibration Verification (ICV)

- If an initial calibration curve is not established on the day of analysis, the integrity of the curve should be verified each day of use or every 24-hour period. Verification requires the initial analysis of a blank and standard from a second source. The standard concentration should be at the method-defined level. If not specified, a standard at a mid-level concentration may be used.
- If the initial calibration verification does not meet acceptance criteria, the analytical procedure is stopped and evaluated, and appropriate corrective measures are taken. Initial calibration verification must be acceptable before any samples are analyzed.

7.3.2 Continuing Calibration Verification (CCV)

Additional standards called CCVs are analyzed after the initial calibration curve or the integrity of the initial calibration curve is accepted. CCVs are analyzed at a frequency of 5% or every 12 hours, whichever is more frequent. If an instrument consistently drifts outside the acceptance criteria before the next calibration, the frequency is increased.

CCVs may be from the same source as the calibration standards or from a second source. The concentration is determined by the anticipated or known concentration of the samples and/or method-specified levels. At least one CCV shall be at a low-level concentration.

To the extent possible, we bracket the samples in each interval (every 20 samples or every 12 hours) with CCV concentrations closely representing the lower and middle range of reported sample concentrations. If this is not possible, the standard calibration checks should vary in concentration throughout the range of the data being acquired.

If the recovery of a CCV does not meet the acceptance criteria and routine corrective actions fail to produce a second consecutive check within acceptance criteria, a new initial calibration curve should be constructed. Analytes of interest found in corresponding environmental samples may be reported, however, only if all of these criteria are met:

1. CCV recovery for target analyte exceeds the acceptance criteria (biased high)
2. Target analyte in the environmental sample is not detected at a concentration exceeding the level required by client contract (i.e., MDL, PQL).

   Non-detects that meet these criteria are also referred to as “passable non-detects.”

If samples are found to contain target analytes that exceed the associated quantitation limits, and the CCV recovery does not meet the acceptance criteria, the

affected samples are re-analyzed. This occurs only after a new calibration curve has been established, evaluated, and accepted.

7.4 Bioassay Instrument Calibration and Frequency

Our Bioassay instruments are calibrated at the frequency of the instrument's use, stability, and method requirements. The calibration procedure for each instrument is described in the corresponding analytical SOP and is performed by those individuals proficient in the analyses described in the SOP.

SECTION 8
ANALYTICAL METHODS AND STANDARD OPERATING PROCEDURES

Section 8 – Analytical Methods and Standard Operating Procedures (SOPs)

We provide a wide array of parameters including volatile organics, extractable organics, metals, general inorganic/wet chemistry, radiochemistry, and radiobioassay. The procedures we use to determine these parameters are consistently executed due to our extensive system of SOPs and our training requirements for analytical staff.

A list of our SOPs and the analytical methods they represent (if applicable) is provided in Appendix I. Discussed here are:

- Selection of analytical methods
- Standard operating procedures
- Method validation and initial demonstration of capability
- Sample aliquots
- Data verifications
- Standard and reagent documentation and labeling (Refer to Section 10.1)
- Computers and data requirements

8.1 Selection of Analytical Method

Project Managers are ultimately responsible for selecting the test codes and methods assigned to a client based on client requirements and sample collection techniques. In selecting methods, our goal is to meet the specific needs and requirements of the client while providing data that are scientifically valid.

When the use of a specific test method is mandated, only that method is used. If the analysis cannot be performed by the client-requested method, we notify the client. We do not perform method substitutions without the client's consent. We recommend that clients who submit data to regulatory agencies also obtain the agency's approval of method modifications.

When clients have specific process or reporting deviations from GEL's standard practices, the laboratory may document the deviations in contracts, case narratives and/or with specific work instructions from the Project Management Team to the laboratory. Approval of the deviations is made after consideration of all safety and quality concerns have been resolved by GEL's management.

A Project Management AlphaLIMS Manual (GL-CS-M-001) is available to assist PMs and PMAs in selecting test codes and methods and communicating the client's analytical and data reporting specifications.

8.2 Standard Operating Procedures (SOPs)

We determine each parameter by the protocol detailed in the corresponding SOP. The defined protocol originates from the analytical method or methods referenced in the SOP and may incorporate regulatory and client requirements. Descriptions of the methods we employ can be found in:

- EPA SW-846
- EPA/600/479/020
- Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC)
- American Society for Testing and Materials (ASTM)
- Standard Methods for the Examination of Water and Wastewater (SM)
- South Carolina Department of Health and Environmental Control (SCDHEC)
- Code of Federal Regulations (CFR) Titles 40 and 49
- Department of Energy Environmental Measurements Laboratory (EML)
- Los Alamos Health and Environmental Chemistry (LAHEC)
- DOE
- DoD
- HASL

In addition to these references, a number of our radiochemistry procedures were developed in conjunction with Florida State University (FSU) under the guidance of Dr. Bill Burnett.

Laboratory sections have access to GEL's SOPs to ensure that each operational system and analytical procedure is performed in a uniform manner. SOPs are controlled according to GL-DC-E-001 for Document Control and are posted on the Intranet by the Document Control Officer.

We write and issue SOPs in accordance with GL-ADM-E-001 for the Preparation, Authorization, Change, Revision, and Release of Standard Operating Procedures. A technical and/or quality review is made of each new or revised SOP prior to its implementation.

Technical reviews ensure that procedures are technically sound and method-compliant, and are conducted by a senior analyst, group leader, or data reviewer. The quality review is an independent review by a member of the Quality Systems team and ensures that the quality requirements of the method, regulatory agencies, and GEL are adequately and accurately identified.

SOPs are modified when:

- Instruments or equipment change
- An error is identified
- Improvements in technology and/or reagents need to be incorporated
- Reference methods are revised or discontinued

Proposed revisions are submitted for review on Documentation Initiation and Revision Request (DIRR) forms. Changes are not implemented without a technical and quality review.

We review our technical SOPs annually and revise them as necessary. Analytical SOPs either contain or reference other SOPs that contain:

- reference method
- applicable matrix or matrices
- method detection limit
- scope and application including parameters to be analyzed
- method summary
- definitions
- interferences and limitations
- specific safety requirements
- required equipment and supplies
- reagents and standards
- sample collection, preservation, shipment, and storage
- quality control
- calibration and standardization
- procedure
- calculations
- method performance
- pollution prevention
- data assessment and acceptance criteria for quality control measures
- corrective actions for out of control or unacceptable data
- waste management
- references
- tables, diagrams, flowcharts, validation data
- identification of any modifications we have made to the published procedure

8.3 Method Validation and Initial Demonstration of Capability

Method validation requirements for Radiochemistry are documented and maintained in accordance with GL-RAD-D-002, Analytical Methods Validation for Radiochemistry.

An initial demonstration of method performance is required before a new analytical method is implemented and any time that there is a significant change in instrumentation or methodology. Exempted from this requirement are any tests for which spiking solutions are not available. Analyses that are exempt include those for determining:

- total dissolved, total suspended, total volatile, and total solids
- pH
- color
- free liquids
- temperature
- dissolved oxygen
- turbidity

We conduct the initial demonstration as described in Section 8.3.1. Records of initial demonstration are maintained in accordance with GL-QS-E-008 for Quality Records Management and Disposition. These records are available upon request.

After we demonstrate our ability to perform a specific analysis, we continue to demonstrate method performance through the analysis of laboratory control samples and performance evaluation samples.

If spiking solutions or quality control samples are not available, an analyst is trained by a qualified trainer to conduct the analysis. Analyst capability and proficiency is evaluated by the appropriate Group Leader before the

analyst is qualified to perform the analysis on client samples. The evaluation is documented and maintained according to GL-QS-E-017 for Maintaining Technical Training Records.

Method Validation must also occur when substantive modifications are made to stoichiometry, technology, mass tuning acceptance criteria, quantitation ions, compressing digestion or extraction timeframes, reducing reagent or solvent volumes, changing solvents or compressing instrument.

8.3.1 Procedure for Initial and Continuing Demonstrations of Capability (IDOC and CDOC)

We conduct initial demonstrations of capability for mandated analytical or EPA reference test methods following the procedure outlined below. This procedure is adapted from the EPA test method published in 40 CFR part 136, Appendix A and the 2003 NELAC and 2009 TNI Standards. IDOCs are completed whenever there is a change in instrument type, method or personnel. CDOCs are updated constantly in the laboratory AlphaLIMS.

Step 1: A quality control sample is obtained from an outside source (if possible). If one is not available, the sample may be prepared internally using stock standards that are prepared independently from those used in instrument calibration. The concentration is not known to the analyst.

Step 2: The QC sample is diluted in a volume of clean matrix. Sufficient volume of the diluted QC sample is prepared so that at least four aliquots of the required method are analyzed. Alternatively, four matrix spike samples may be evaluated for levels of precision and accuracy.

Step 3: Four aliquots of the diluted quality control sample are prepared and analyzed according to the analytical test method. This may occur concurrently or over a period of days.

Step 4: With the results obtained from the analysis of the diluted QC sample, the average recovery (x) in the appropriate reporting units (such as µg/L) and the standard deviation of the population sample (n-1) (in the same units) are calculated for each parameter of interest.

Step 5: For each parameter, the standard deviation (s) and the average recovery (x) are compared to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria. If "s" and "x" for all parameters meet the acceptance criteria, analysis of samples may begin. If any one parameter exceeds the acceptance range, the performance is unacceptable for that parameter.

Step 6: When one or more tested parameters fail one or more of the acceptance criteria, we locate and correct the source of the problem and repeat the test for every parameter of interest.

Other options for successful IDOCs are the following:

- PT Study- successful analysis of a PT Sample. If 4 LCSs cannot be performed, successful analysis of a PT sample may be used to demonstrate capability to perform a test. The PT sample may be single-blind to the analyst or double blind to the laboratory.
- Supervised Analysis- where other options are not practical, supervised analysis of a procedure may be used to demonstrate capability.
- Analysis of authentic sample with results statistically matching those obtained by another trained analyst.
- Other – this option may be used for certain personnel having sufficient analytical skills to develop a new procedure, as deemed appropriate by the supervisor or Quality Assurance personnel.

8.4 Sample Aliquots

When obtaining aliquots from a sample, it is imperative that the subsamples be representative of the parent sample. This ensures that the results obtained from the analysis of the aliquots are representative of the entire parent sample, not just the subsample. We employ different techniques to obtain subsamples. GEL's SOP for subsampling is GL-LB-E-029.

We can obtain representative aliquots of soil samples for the determination of metals through quartering. This involves the repeated quartering of the sample until the resulting quarter is equivalent to the amount of sample needed for analysis. Quartering may not be appropriate for obtaining subsamples for volatiles or other analyses where potential contamination or loss of target analytes is a concern.

Water samples are inverted several times prior to the collection of a subsample. This ensures a thorough mix and is absolutely required for the accurate

determination of analytes like total and total suspended solids.

The appropriate techniques for obtaining sample aliquots for designated analyses are discussed in the applicable SOPs.

8.5 Data Verification

All of the data we include in final reports to our clients undergoes extensive data verification. At GEL, we have a multi-level review process that takes place in all areas of the laboratory beginning with sample login. This process and the responsibilities of each level of review are delineated in a number of procedures, including GL-GC-E-092 for General Chemistry Data Review and Packaging, GL-MA-E-017 for Metals Data Validation, and GL-RAD-D-003 for Data Review, Validation, and Data Package Assembly.

8.5.1 Sample Login:

Samples are analyzed by the methods and for the target analytes identified when samples are logged into our database. If there is an error in this entry that is not promptly identified, the incorrect analytical method may be used or certain analytes may not be determined.

To prevent this, the person who enters the information into the database is generally the client's assigned Project Manager or PM Assistant. This entered information is reviewed against the client confirmation letter and/or chain of custody. If errors are identified, they are immediately corrected.

8.5.2 Data Validation in the Laboratory

The multi-level review process in our laboratory includes initial review by the analyst, a second review by a peer, and a final review by a group leader or data reviewer. Where appropriate based on personnel and client needs, the industrial division institutes two levels of review.

Our analytical data reviews ensure that:

- The analytical procedures comply with current SOPs.
- Quality control samples are analyzed at the frequency specified in the SOP or client specifications.
- The acceptance criteria for quality control samples are met, including recoveries of matrix spikes and laboratory control samples, the relative percent difference for matrix duplicates, matrix spike duplicates, laboratory control sample duplicates, and concentrations of target analytes in the method blank.
- Instrument data, run logs, and logbooks are reviewed to ensure that all method quality control criteria were met (e.g., calibration, initial calibration verifications, and continuing calibration verifications).
- Documentation is sufficient to reconstruct the analytical procedure.
- Data are maintained according to GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Recordkeeping Devices.
- Raw data are in agreement with the computer generated batch sheets and data reports.
- The calculations, dilution factors, concentration reported, and nominal concentrations are verified.
- Comments, qualifiers, or nonconformances for noncompliant or questionable data are documented.
- Data generated when the analytical process appears to be out of statistical control are not reported.

8.5.3 Validation of Data Reports and Packages

Before we report data to the client, we review the requested data report for package accuracy, completeness, and client-specifications. Responsibilities for review are dependent upon the type of report or package being generated. (Refer to Section 11 for Laboratory Report Formats.)

When a client is receiving a certificate of analysis or certificate of analysis and Quality Control Summary Report, the Project Manager (PM) or Project Manager Assistant (PMA) reviews the information for accuracy, completeness and the addition of pertinent comments made by the laboratory about the analysis or sample. The PM or PMA also reviews data for consistency as described in the Project Management AlphaLIMS Manual, GL-CS-M-001. For Bioassay results, the package is then reviewed for completeness by validator, team or group leader as described in GL-RAD-B-026.

If a client requests a case narrative, our data validators review the analyst-prepared case narrative for

accuracy and to assure its consistency with the information included on the certificate of analysis and Quality Control Summary Report. If a client requests a more detailed level of data package up to and including a CLP-like package, every laboratory fraction of data is reviewed by that fraction's data validator. The data are then compiled into a final data package. The Quality manager or designee will review a minimum of 10% of all data packages for technical completeness and accuracy on a quarterly basis and if data quality issues are discovered during the review, the client will be notified with fifteen (15) business days of the discovery of the issue.

8.6 Standard and Reagent Documentation and Labeling

The documentation and labeling of standards and reagents is addressed in GL-LB-E-007 and GL-RAD-M-001 for Laboratory Standards Documentation, and in Section 10.1 of the QAP, Recordkeeping System and Design.

8.7 Computer and Electronic Data Related Requirements

Our Information Management System (IT) SOPs describe the way in which we manage our software programs and hardware systems. Control of software development and modification activities is described in GL-IT-E-003 for Requirements, Design, Operation, Validation, and Removal of Hardware and Software Systems Used by the GEL Group, Inc. All development and revision activities are validated, and revision activities are validated, verified, and controlled with revision software or other procedures prior to production use.

Analytical software that is purchased from a vendor is validated and verified in accordance with GL-IT-E-005 for Requirements, Design, Operation, Validation, and Removal of Applications Used by The GEL Group, Inc. Documentation requirements are also described in this SOP.

Electronic signature requirements for confidentiality of records are described in GL-IT-E-001 for Instrument Technology Program for Good Laboratory and Good Manufacturing Practices.

SECTION 9
SAMPLE HANDLING, ACCEPTANCE, RECEIPT, AND INTERNAL CHAIN OF CUSTODY

Section 9 – Sample Handling, Acceptance, Receipt, And Internal Chain of Custody

The way we receive and handle samples is critical to providing our clients with data that are of the highest quality and are legally defensible. We have strict policies that govern the acceptance and receipt of a sample, sample handling and integrity, maintenance of the internal chain of custody, and storage of the sample upon completion of the required analytical processes. This section describes the policies and practices that we employ, including the following:

- Agreements to perform analysis
- Proper labeling of submitted samples
- Chains of custody
- Sample receipt procedures
- Sample receipt procedures for radioactive samples
- Sample tracking
- Sample storage
- Sample disposal

9.1 Agreement to Perform Analysis

Before we accept samples, we should have an agreement with the client that specifies the analytical methods, the number of samples to be analyzed, the price for the analysis, the date by which the client must receive results, and the reporting format. Any special requirements the client may have, such as non-routine methods and reporting limits, should be part of that agreement.

An agreement to perform analysis should be in one of three forms, further detailed in our Analytical Services Reference Manual and the SOPs for Delegated Authority to Commit the Company and Request for Proposal (RFP) and Contract Review (GL-CO-E-002 and GL-CO-E-003):

- Client confirmation letter (CCL) between the client and project manager for a specific group of samples. This letter includes the cost, turn-around time, requested analysis, sample matrix, number of samples, and type of client report.
- Sample acceptance by the Project Manager from an established client based on previously agreed conditions and confirmed by the client's submission of the sample(s).
- Contractual agreement for analytical services over a designated time period or project that delineates the specifications agreed upon.
- When the laboratory agrees to perform analyses with exceptional departures from normal processes, these exceptions are clearly defined in the client-laboratory agreement.

9.2 Sample Labels and Chain of Custody Forms

Once an agreement is established, we assume joint responsibility with the client to ensure that the samples submitted are properly labeled and accompanied by full and complete documentation that includes chain of custody and, where possible, material safety data sheets. Samples that are submitted without proper documentation may be refused.

Sample labels should include the:

- client's sample identification
- location, date, and time of collection
- collector's name
- chemical preservatives used
- constituents of interest (if space permits)

When requested, we ship labeled sample containers with appropriate preservatives and a chain of custody to the client for use during sample collection. There are several advantages to using these containers, including:

- Dedication of appropriate type sample container for the intended analyte or analytical method.
- Proper sample preservation for analytical test
- Traceability of bottle lot number to the manufacturer's certification that the containers are clean and show no signs of contamination.
- If a manufacturer cannot provide a certificate of cleanliness for radiochemistry parameters, a gross alpha-beta screen can be performed on the lot of containers being used. This is mandatory for containers used in support for SDWA programs.

Chain of custody forms include the following information and are initiated at the time of sample collection:

- name and address of client
- client sample identification
- date and time of sample collection
- sample matrix
- description of sampling site location
- number of containers
- methods, chemical and physical constituents for which the analyses are to be conducted
- preservatives
- date and signature of person who collected the sample
- date of transfer and signature of person relinquishing sample to the laboratory.

When our Field Services personnel collect samples, our standard chain of custody form and certified containers are automatically used. Our standard chain of custody forms are also available to our clients and are included with each shipment of pre-labeled and preserved containers. GEL chain of custody forms should always be used unless otherwise agreed to by contract.

9.3 Sample Conditions

In addition to properly documenting sample container labels and the chain of custody form, we need to make sure that samples meet the established requirements for analytical testing. This is particularly critical for samples that are being analyzed to meet regulatory requirements.

Samples should be collected in the appropriate type of container, preserved as directed, and stored in the conditions specified in the analytical method or established regulatory guidelines. In addition, samples should be submitted with sufficient time to conduct the specified analysis within the regulatory or method holding time. Aliquots should be of sufficient volume to perform the requested analyses. A summary of these conditions and holding times for routine analyses can be found in Appendix J.

9.4 Sample Receipt

Samples submitted to us are received in a central sample receiving area by our sample custodian or login clerk. Every sample is subject to the protocols established in GL-SR-E-001 for Sample Receipt, Login and Storage.

Our sample custodian acknowledges receipt of a sample by signing the chain of custody and recording the date and time custody was transferred from the client to the laboratory. The date, time, and person receiving the sample are also recorded on a standard or client-specific Sample Receipt Review (SRR) form.

The sample custodian is also responsible for noting the condition of a sample upon its arrival. This information may be recorded on both the sample chain of custody and the Sample Review Receipt form. As detailed in GL-SR-E-001, the sample custodian should:

- Inspect all sample containers for integrity.
- Document any unusual physical damage or signs of tampering with custody seals.
- Place any samples that appear to be leaking or have unusual odor under the fume hood while notifying the responsible project manager.
- Review the chain of custody submitted by the client for completeness.
- Compare descriptions and other information on the sample container labels to that listed on the chain of custody.
- Verify the sample is within the regulatory holding time for the analyses.
- Measure and record the temperature of sample aliquots that are to be used for analyses requiring thermal preservation.
- Measure and record the pH of all sample aliquots submitted for analyses that require chemical preservation to a specific pH.
- Verify that there are adequate sample aliquots for the requested analyses.
- Verify that appropriate sample containers were used for requested analyses.

If the sample custodian discovers any abnormalities or departures from standard conditions, the PM is

informed immediately. The PM will then notify the client as quickly as possible so that a decision can be made to proceed with the analysis or submit another sample or additional sample aliquots.

Common abnormalities or departures from standard conditions include:

- Sample containers with signs of damage, leaking, or tampering.
- Incomplete/missing chain of custody.

NOTE: If a nonradioactive sample has no chain of custody, the sample custodian should initiate one. "INITIATED ON RECEIPT" should be documented on the chain of custody.

- Discrepancies between the information on the chain of custody and the sample container labels.
- Method or regulatory holding time is exceeded.
- Sample is not preserved to the method or regulatory-required pH.
- The sample container does not meet method or regulatory criteria.
- The sample temperature exceeds or falls below the thermal preservation regulation or method requirement of 0° $\leq$ 6° C.

NOTE: If a sample is hand delivered to the laboratory immediately after collection with evidence that the chilling process has begun (arrival on ice), the sample shall be deemed acceptable.

- Radioactivity that exceeds that allowed by our radioactive license. (The handling of radioactive samples is discussed in 9.5.)

Samples that are not appropriate for the requested analyses or have no full test specifications require:

- Retention of all correspondence and records of conversations concerning the final disposition of the sample.
- Full documentation on the chain of custody and Sample Receipt Review form of the nonconforming condition and a decision to proceed with analysis.
- Documentation that the analysis is qualified appropriately on the final report.

9.5 Receipt of Radioactive Samples

The radioactive samples we receive are subject to the same monitoring identified in 9.4 when radioactivity levels do not exceed the level permitted by our license. Special procedures governing the receipt of radioactive samples are described in the GL-RAD-S-007 for the Receiving Radioactive Packages. These procedures prevent the inadvertent spread of radioactive contamination.

Because we cannot exceed the limits of our radioactive license, it is imperative that our clients notify us of impending shipments of radioactive samples. We reserve the right to refuse and return any radioactive sample where the radioactivity:

- Exceeds our permitted level by itself or in combination with other samples already on site; or
- Exceeds our administrative level of 25 mrem/hr.

The following special requirements for receiving radioactive samples are applicable:

- Only designated staff trained in the proper handling of radioactive materials handle radioactive samples.
- If a sample is labeled as radioactive, the custodian will immediately inform the Radiation Safety Officer (RSO) before opening the sample.
- The radioactivity of the sample will be measured by scanning the exterior surface of the cooler using a survey meter calibrated in Mr/hr. Refer to GL-RAD-S-001 for our Radiological Survey Procedures.
- If the radioactive level of the exterior of the cooler exceeds 0.5 Mr/hr, the RSO will be notified before the cooler is opened.
- If the radioactivity level of a sample or group of samples is found to exceed 25 mrem/hr, the RSO will be notified immediately. The client will be contacted and arrangements will be made to return the sample(s) or reduce the per sample exposure.
- If a chain of custody is not submitted with a sample, it will be placed on hold until a chain of custody is submitted.
- The inside of the cooler will be surveyed to ensure that no leakage or contamination has occurred.

- Each sample container will be surveyed and the highest reading will be documented on the Radioactive Shipment Inventory.

9.6 Sample Tracking

We track the samples we receive by a unique laboratory identification number that is automatically assigned when information pertaining to the sample is first entered into our database. Pursuant to GL-SR-E-001, the following information is entered for each sample received:

- client and/or project code
- client sample ID
- sample matrix
- equivalent laboratory sample matrix
- type of report format specified by client
- date and time of collection
- date received
- initials of person making entries
- number of containers submitted for the sample
- requested analyses
- pertinent observations or comments affecting the sample analysis or rejection

As soon as this information is entered, AlphaLIMS automatically assigns a unique number to the sample and its containers. We use the number to track the location of a sample container and to link to any subsamples and subsequent digestates and extracts.

The unique laboratory identification number is printed on a durable barcode label that contains the client identification, sample date and time. Once labeled, the sample container's identification number is uploaded into the database by scanning the barcode. Information included in the database at the time of sample scanning is the container's storage location, bottle type and volume, physical characteristics of the bottle, preservative, and the initials of the person entering this information. Entering of this information into the database is an important part of initiating our electronic internal chain of custody.

9.7 Internal Chain of Custody

Chain of custody procedures ensure traceability and sample integrity. Our legal and evidentiary chain of custody protocol establishes a continuous record of the physical possession, storage, and disposal of sample containers, collected samples and aliquots, and sample digestates or extracts.

The internal chain of custody starts with the scanning of a container's barcode label into an electronic database while identifying the location of the sample and the person having custody, or placing the sample in a secured storage area. If we supply the containers, the chain of custody may begin when the containers are provided to the client.

With regard to the internal chain of custody, a sample is defined as being in someone's custody if:

- It is in one's actual physical possession
- It is in one's view after being in one's physical possession
- It is in one's possession and then is locked up so that no tampering may occur
- It is kept in a secured area restricted to authorized personnel only

The protocol for ensuring sample integrity using the internal chain of custody is detailed in GL-LB-E-012 for Verifying the Maintenance of Sample Integrity. The electronic internal chain of custody works in conjunction with the chain of custody submitted by the client with a sample to:

- Account for all time associated with a sample, its subsamples, and extracts or digestates from the time the sample is received at GEL to its disposal
- Identify all individuals who physically handled the sample
- Provide evidence that the sample was stored in accordance with method and regulatory protocols

The electronic internal chain of custody is stored in AlphaLIMS so that information demonstrating the proper maintenance of custody can be provided to the client on the data reports or electronic data deliverables.

9.8 Sample Storage

In order to ensure the maintenance of sample integrity, all aliquots are stored in secured areas designated for sample storage. The storage location of

each sample aliquot can be tracked using the internal chain of custody. Areas designated for sample storage include:

- Main cooler where most samples requiring maintenance at a temperature range of 0° ≤ 6° C are stored.
- Volatile coolers for samples to be analyzed for volatile contaminants.
- Radioactive cooler for segregation of radioactive sample aliquots requiring refrigeration.
- Ambient storage for non-radioactive samples not requiring refrigeration.
- Ambient storage for radioactive samples.

The temperature of each refrigerated storage unit is monitored daily and documented per GL-LB-E-004 for Temperature Monitoring and Documentation Requirements for Refrigerators Freezers, Ovens Incubators, and Other Similar Devices. In addition, the main and radioactive coolers are monitored twenty-four hours a day by temperature sensors that are connected to our main security system. If the temperatures exceed the required range, the security system notifies the facilities manager or his designee immediately. This allows corrective actions to be initiated promptly.

Prior to and immediately after analysis, samples and their digestates and extracts are stored in compliance with the requirements of the requested analytical methods and GL-SR-E-001 for Sample Receipt, Login, and Storage. If a single aliquot is supplied for analyses by several methods, the most stringent analytical storage requirements are applied to the sample.

If samples are to be analyzed for volatile organic compounds, they are stored in designated volatile coolers that are maintained at a temperature range of 0° ≤ 6° C. No sample aliquots are stored in these refrigerators unless they are to be analyzed for volatiles. These storage units are monitored on a weekly basis for contamination by the analysis of volatile cooler storage blanks.

At the beginning of each month, two 40 mL vials are filled with treated deionized water, which is used for volatile method blanks and placed in each monitored cooler. Each week, two vials may be analyzed by EPA 8260B and the data are reported to the Quality Department. If the analysis reveals evidence of potential contamination, appropriate corrective actions are immediately implemented. SOP GL-OA-E-058 discusses the laboratory practices pertaining to monitoring and testing for VOA contamination.

Sample aliquots for non-volatile analysis, which also should be maintained at 0° ≤ 6° C, are stored in the main cooler unless they are radioactive. In order to reduce the chance of contamination, radioactive samples are stored in a designated cooler.

Sample aliquots to be analyzed for biochemical oxygen demand (BOD) are also delivered to the bacteriology laboratory and stored in the designated BOD cooler. This cooler is also maintained at 0° ≤ 6° C. After initiation of this analysis, the sample aliquots are returned to the main cooler.

After all analyses are complete and results are submitted to the client, sample aliquots are transferred to the sample archive area. They are stored in this area until they are disposed.

Radioactive and non-radioactive samples remain segregated in archive to reduce the risk of contamination.

9.9 Sample Disposal

Our policies concerning sample disposal are described in the Laboratory Waste Management Plan, GL-LB-G-001 and can be divided into two categories: those governing the disposal of sample laboratory waste, and those governing the disposal of residual client sample after the completion of all analyses.

9.9.1 Sample Laboratory Waste

Unless otherwise requested by contract, laboratory waste is collected in designated satellite containers found in sample collection and accumulation areas. These areas are monitored by both the waste department and analysts trained in waste collection. Wastes are segregated based on the type of hazard they present. I.e. radioactive, acid, base solvent, etc. when containers are full, the waste department is notified and the containers are removed from the laboratory for disposal. Direction for disposal activities, such as

packaging, shipping, and disposal site selection are provided in the Laboratory Waste Management Plan (GL-LB-G-001).

9.9.2 Residual Client Sample

Unused client sample material that is not consumed during the sample preparation or analytical procedures is either disposed of in accordance with the Laboratory Waste Management Plan (GL-LB-G-001) or at the client's request, returned in accordance with GEL's SOP GL-SR-E-002 for Transportation and Shipping of Samples and Pre-preserved Sample Containers.

It is our policy to hold samples for a minimum of sixty days after invoicing and before disposal, unless otherwise specified by contract or if the sample is part of litigation. If the sample is part of litigation, disposal of the physical sample shall occur only with concurrence of the affected legal authority, sample data user, and/or client.

When sample analyses are complete and regulatory and/or contractual holding times have expired, samples are moved from their storage locations to the radioactive or non-radioactive archives. Samples that are to be returned to the client or held for an extended time period are segregated from the other samples. Radioactive and non-radioactive samples remain segregated.

When internal or client-specified storage time expires, samples with like matrices are composited into appropriate containers. The composites are then subject to the same treatment and disposal protocol. Samples that are approved for disposal are scanned into our LIMS and assigned the status of "Disposed."

SECTION 10
RECORDS

Section 10 – Records

Our quality records provide the documentation we need to support analytical results and conclusions. Documented evidence that quality assurance and quality control requirements have been met is critical to providing data that fulfill the specifications of applicable procedures, programs, and contracts.

As described in Section 3 of this Quality Assurance Plan (QAP), quality records include but are not limited to:

- Observations
- Calculations
- Calibration data
- Certificates of analysis
- Certification records
- Chains of custody
- External, supplier, and internal audits
- Run logs
- Instrument data and analytical logbooks
- Instrument, equipment and building maintenance logs
- Material requisition forms
- Monitoring logs
- Nonconformance reports
- Corrective actions
- Method development and start-up procedures including MDL studies
- Training records
- Waste management records
- Standard logs
- Software validation
- Standard operating procedures (SOPs)
- Sample collection and field data

Our procedures provide a legal and evidentiary chain of custody and are described in Section 9 of this QAP. Described in this section are:

- Record keeping system and design
- Records management and storage
- Sample handling records
- Records of support activities
- Analytical records
- Administrative records

10.1 Recordkeeping System and Design

We manage, maintain and store our quality records according to GL-QS-E-008 for Quality Records Management and Disposition. The protocols established in this document work in conjunction with those for specific types of records addressed in other SOPs to govern our record keeping system. Our record keeping system allows the historical reconstruction of all laboratory activities that produced analytical data.

We facilitate historical reconstruction by maintaining the following records and information, from the time a sample is received until it is disposed.

- A master list of all employee signatures and initials is maintained in Human Resources. This allows the identification of any GEL personnel who accept, handle, analyze, prepare, review, store, or dispose of a sample, its subsamples, associated data and reports, and other related documentation.
- If we provide bottles and containers to a client or sampling personnel, these records are kept in accordance with GL-SR-E-002 Transportation and Shipping of Sample and Pre-preserved Sample Containers. These electronic and paper records include:
  - Supplier and lot numbers of containers and/or bottles provided
  - Certifications that the containers are free of contaminates that may bias the analyses
  - Addition of preservatives and identity of person responsible for this preservation.
  - Barcode of containers supplied to a particular client or for a specific field-sampling event.

The person or agency responsible for collecting a sample is documented on the chain of custody and entered into AlphaLIMS. Other records supporting the acceptance of a sample include:

- Date and time of sample receipt

- Person accepting sample
- Condition of sample upon receipt
- Client-confirmation letter and/or sample quote
- Client chain of custody
- Electronically generated sample ID numbers specific to each sample aliquot and linked to the client's sample description, sample collection and receipt information, and analyses to be performed.
- Identification of each person who has custody of a sample, its subsamples, extracts, or digestates. (This is provided through the internal chain of custody procedures described in Section 9.)

Documentation that materials purchased for use in the analysis or preparation of samples meet specifications is maintained in accordance with GL-RC-E-001 for Receipt and Inspection of Material and Services.

Records of equipment calibrations are maintained and traceable by date and ID number to a specific analysis. These records include certifications of calibration and service that have been initialed or signed.

Our thermometers are verified against a NIST traceable thermometer and records of this verification are maintained as described in GL-QS-E-007 for Thermometer Verification. Records of the daily and monthly calibration verifications of our analytical balances are kept in accordance with GL-LB-E-002 for Balances. The calibration records for our air-displacement pipets are maintained in pipet calibration logs specific to each pipet according to GL-LB-E-010 for Maintenance and Use of Air Displacement Pipets.

When methods and/or regulations specify that samples, subsamples, extracts, and/or digestates be stored at designated temperatures, or when the method, itself, has temperature sensitive steps, we document those temperatures on monitoring logs at the frequency defined in the corresponding SOPs. We can trace the specific storage location of a sample through the internal chain of custody.

We require that the initials of all personnel responsible for monitoring temperatures be recorded in the temperature monitoring logs pursuant to GL-LB-E-004 for Temperature Monitoring and Documentation Requirements for Refrigerators, Freezers, Ovens, Incubators and Other Similar Devices. The logs are reviewed for completeness in accordance with GL-QS-E-005 for Review of Monitoring Device Logs.

Documentation on the instruments and equipment used for the analysis of samples is recorded in run logs, laboratory logbooks, instrument data and/or sample preparation logs. Routine or corrective maintenance that is performed on equipment or instruments is recorded in the maintenance log specific to the instrument. We document these records in accordance with GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms and Other Recordkeeping Devices.

The standards containing known quantities of target analytes that we use in instrument calibration, calibration verification, and as quality control samples, such as matrix spikes and laboratory control samples, are documented according to GL-LB-E-007 and GL-RAD-M-001 for Laboratory Standards Documentation. These records contain the following information.

- Protocol by which each standard was prepared
- Traceability of each child standard to its parent
- Date each standard was prepared
- Initials of person preparing the standard
- Expiration dates
- Concentration of each standard

This information allows us to document that the standards used were prepared in accordance with the established protocol, produced using source standards that meet the method and regulatory criteria, and used prior to their expiration date.

If required, reagents used in the preparation, dilution, and analysis of samples are verified to be free of interferences or target analytes. We record these verifications in the Reference Material in LIMS in accordance with GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms and Other Recordkeeping Devices.

Analytical and sample preparation methods applied to each sample aliquot are documented via the internal chain of custody, method information, and information recorded in lab notebooks, sample preparation logs, run logs, and instrument data. The laboratory protocol we employ during analysis is dictated by the SOP in effect at the time the sample was analyzed or prepared by a specific method.

Run logs, laboratory notebooks, instrument data and sample preparation logs are used to document the preparation and analysis of samples and the associated instrument calibrations. These logs and notebooks are governed by GL-LB-E-009 for Run Logs and GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Recordkeeping Devices. As stated in these SOPs, sample preparation and analytical records that are not electronically generated should be:

- Legible
- Recorded in permanent ink
- Corrected using one line marked through the error, initialed and dated
- Initialed by the responsible party

We maintain electronic records for each analytical batch. These records include the ID numbers of each client and quality control sample prepared and/or analyzed together, the method of preparation and analysis, and the matrix of the samples included in the batch.

Through our electronic statistical process control system (SPC), the acceptance criteria applied for all quality control (QC) samples are stored and maintained. The acceptance limits for target analytes are method, matrix, and time-period specific, which allow us to regenerate the criteria applied to QC samples associated with identified client samples.

Our Quality Systems Team maintains the records of nonconformances and corrective actions associated with specific samples, batches, and processes. We maintain these records according to GL-QS-E-004 for the Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items; and GL-QS-E-002 for Conducting Corrective/Preventative Action and Identifying Opportunities for Improvement.

Electronic data records are maintained in a secured database designed to protect the integrity of the data. Data that are uploaded directly from instruments and that are manually entered are backed up by a second system.

Permanent records of electronic data deliverables are maintained along with the corresponding sample preparation and analytical data review records. This documentation includes the initials of the reviewer and date of the review.

Records of the data we report to our clients are maintained in a manner that protects client confidentiality, as well as any potential national security concerns. These records include copies of certificates of analysis, quality control summary reports, case narratives, CLP forms, and other information we provided to the client. The copies may be paper or electronic. The majority of the data packages submitted to Federal clients are stored electronically prior to being submitted to the client.

Records of samples being disposed or returned to the client are documented in accordance with GL-SR-E-002 for Transportation and Shipping of Samples and Pre-Preserved Sample Containers. Such records include the date samples are returned or disposed, the destination of the samples, and name of the person transferring the samples.

10.2 Record Storage

We store quality records in compliance with GL-QS-E-008 for Quality Records Management and Disposition. The records are:

- Stored in a secured area to maintain data integrity and protect client confidentiality, including any national security concerns.
- Kept in areas where they are protected from fire loss, environmental deterioration, and, in the case of electronic records, electronic or magnetic sources.
- Indexed and filed in a manner allowing for ready retrieval.

- Accessible to the client for whom the record was generated.
- Retained for an identified period of time that equals or exceeds ten years as determined by applicable law and client contract requirements.

Electronic data records are stored on compact disks.

All of the hardware and software we need to reconstruct data is maintained according to GL-IT-E-003 for Requirements, Design, Operation, Validation and Removal of Hardware and Software Systems Used by the GEL Group, Inc. Records that are stored or generated by network or personal computers have either hard copy or write-protected backup.

10.3 Sample Handling Policy

Records of all procedures applicable to samples are maintained in our possession. These records include documents that pertain to:

- Preservation, including sample container and holding time
- Sample identification, receipt, acceptance or rejection, and login
- Sample storage and tracking including shipping receipts, transmittal forms, routing and assignment records
- Sample preparation (ID codes, cleanup and separation protocols, volumes, weights, instrument printouts, meter readings, calculations, reagents)
- Sample analysis
- Standard and reagent origin, receipt, preparation, and use
- Equipment receipt, use, specification, operating conditions and preventative maintenance
- Instrument calibration frequency and acceptance criteria
- Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions
- Method performance criteria including expected quality control requirements
- Quality control protocols
- Electronic data security, software documentation and verification, software and hardware audits, backups and records of any changes to automated data entries
- Automated sample handling systems
- Disposal of hazardous samples

10.4 Records of Laboratory Support Activities

In addition to sample handling records, we maintain the following:

- Original raw data for calibrations, samples and quality control measures, including worksheets and data output records (chromatograms, strip charts, and other instrument readout records)
- A written description of or reference to the specific method used, including the computational steps used to translate parameter observations into a reportable analytical value
- Copies of final reports
- Archived standard operating procedures
- Correspondence relating to project-specific laboratory activities
- Corrective action reports, audits and audit responses
- Proficiency test results

10.5 Analytical Records

We document and maintain analytical records, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs according to GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Recordkeeping Devices, and GL-LB-E-009 for Run Logs.

The information that is documented in analytical records includes:

- Laboratory sample ID code
- Date and time of analysis
- Instrument ID and operating conditions/parameter (or reference to such data)

- Method of analysis
- All calculations
- Dilutions
- Initials of analyst or operator
- Units of measurement

Our policy is to produce and maintain analytical records that are:

- Accurate
- Reviewed and verified
- Legible and understandable
- Traceable and authentic to their source
- Grouped in a contemporary manner with data entered and information recorded as it is obtained

10.6 Administrative Records

A number of pertinent records are maintained by Human Resources or Quality Systems, including:

- Staff qualifications and experience.
- Training records, including initial demonstrations of proficiency. (Refer to procedure GL-HR-E-002 for Employee Training.)
- A log of names, initials and signatures for individuals having responsibility for initialing laboratory records.

We monitor continuing demonstrations of proficiency through AlphaLIMS per GL-HR-E-002 for Employee Training.

SECTION 11
LABORATORY REPORT FORMAT AND CONTENTS

Section 11 – Laboratory Report Format and Contents

Accurate data are of little benefit to a client unless they are reported in a format that is easy to interpret and provides all pertinent information relating to the analysis of a sample. At GEL, we have developed certificate of analysis report formats that meet the different needs of our clients, yet provide all of the information necessary to satisfy regulatory requirements while allowing for the interpretation of the data. Each format provides accurate, clear, unambiguous and objective data.

In addition to a certificate of analysis, a client can request and receive an extended data package. This package may include any of the following: certificates of analysis; summaries of quality control; case narratives; instrument data; sample preparation data; measurement traceability and calibration information; and electronic data deliverables. If clients require the reporting of data following the established contract laboratory protocol (CLP), we can provide a CLP-like data package that will meet their needs.

It is important that the certificate of analysis format and data package requirements be discussed with the client prior to our acceptance of the samples. Project Managers and contract staff are responsible for establishing an agreement with the client concerning data reporting and the potential cost to the client for data packages and/or specialized reporting. Our analytical data are reported to three significant figures unless otherwise required by client contract.

Laboratory reports and data packages are stored and transmitted in a manner that protects client confidentiality and potential matters of national security. No reports or data packages are released to persons or organizations outside GEL without the expressed consent of the client. If directed by a regulatory agency or subpoenaed to submit documents to a court of law, we will notify the client of the demand and the records being released.

The following elements of report formats and data packages are described in this section:

- Certificates of analysis (C of A)
- Quality control summary reports (QCSR)
- Analytical case narratives
- Electronic data deliverables (EDDs)
- Types of data packages and reporting formats
- Review of data packages and reports

11.1 Certificates of Analysis

We have two primary C of A report formats, Level 1 and Level 2. Both contain the following information when applicable:

- Title
- GEL address and phone number
- Name of PM or person serving as the primary client contact
- Barcode identification of the C of A
- Number of page and total number of pages
- Name and address of client, where appropriate
- Project name or code if applicable
- Client-provided sample description
- Unique laboratory ID number for the sample
- Sample matrix
- Characterization and condition of the sample where relevant
- Date of receipt of sample
- Date and time of sample collection, if provided
- Date and time of sample analysis, reanalysis, and/or sample preparation
- Initials of analyst and person responsible for sample prep
- Analytical batch number
- Sample analysis and preparation methods (or unambiguous description of any non-standard method used)
- Reference to sampling procedure
- Additions to or deviations or exclusions from the test method, and other information relevant to a specific test, such as environmental conditions and the use and meaning of data qualifiers
- Nonconformances that affect the data
- Whether data are calculated on a dry weight or wet weight basis

- Identification of the reporting units, such as µg/L or mg/kg
- Statement of the estimated uncertainty of the test result, if applicable
- Signature and title of the person(s) accepting responsibility for the content of the C of A
- Date C of A was issued
- Clear identification of data provided by outside sources, such as air temperature or ambient water temperature
- Identification of the reporting detection limit (RDL) or practical quantitation limit (PQL) for each analyte, if applicable.

If a portion of the sample analysis is subcontracted, the C of A will identify the subcontractor or applicable accreditation number, and the data that was determined by the subcontracting laboratory

Level 2 Certificates of analysis contain the following additional information:

- Dilution factors
- Method detection limits
- Surrogate recoveries and the acceptance criteria for all organic analyses
- Estimated concentrations determined for nondetects and appropriate "U" and "J" qualifiers for nondetects and concentrations that fall between the MDL and PQL respectively.

Once issued, a C of A is not altered unless a subsequent C of A is identified as a revised report.

11.2 Quality Control Summary Report (QCSR)

We prepare and analyze samples in groups of twenty or less. The quality control data that demonstrate the sample preparation and/or analytical efficiency of the batch are summarized on a QCSR. The data reported on the QCSR may be limited to a sample delivery group contained in the batch or may include all quality control for the batch. Information reported on QCSR includes:

- Quality control sample ID number
- Type of quality control sample
- Concentrations determined, where applicable, for method blanks, matrix spikes, matrix spike duplicates, matrix duplicates, laboratory control samples, serial dilutions, and laboratory control sample duplicates
- Acceptance criteria for matrix spikes, matrix spike duplicates, matrix duplicates, laboratory control samples, and laboratory control sample duplicates
- Nominal concentrations of matrix spikes, matrix spike duplicates, LCSs, and LCS duplicates
- Concentration of parent sample for the matrix spikes, matrix spike duplicates, or sample duplicates
- Percent recoveries for LCS and matrix spikes
- Relative percent differences for the matrix spike duplicates, matrix duplicates, and LCS duplicates
- Analytical batch number with which the quality control data is associated
- Parent sample numbers for matrix spikes, matrix duplicates, and matrix spike duplicates
- Sample or sample delivery group ID
- Project code
- Date issued, page numbers/total number of pages
- Identification of recoveries or relative percent differences that do not meet the acceptance criteria

11.3 Analytical Case Narratives

Analytical case narratives are written by an analyst or data validator to describe the overall conditions affecting the analysis of a batch or a specific sample in the batch. Case narratives usually include:

- Sample delivery group ID number
- Analytical batch number
- Methods of preparation and analysis
- Sample matrix
- Initial of person preparing and/or reviewing the narrative
- Specific sample ID numbers
- Identification and description of batch quality control samples including parent sample identification
- Affirmation that all sample preparation conditions specified by the method or regulatory agencies were met or identification of specific deviations
- Affirmation that all analysis criteria specified by the method or regulatory agencies were met or identification of specific deviations

- Instrumentation employed if applicable and verification of its calibration
- Summary of batch quality control as compared to acceptance criteria
- Identification of nonconformances
- Pertinent comments and observations of factors that affect sample data quality

11.4 Electronic Data Deliverables (EDDs)

Electronic data deliverables are generated according to client specifications. EDDs use programs supplied by the client or created internally by our EDD team. Internally generated EDDs are usually written in Perl and/or PL/SQL.

11.5 Types of Data Packages and Reports

We offer three levels of data reports and the ability to design packages to meet the needs of our clients. The levels of data reports are summarized in Table 1.

Table 1: Data Report Formats

Level	Contents
1	Level 1 C of A
2	Level 2 C of A plus QCSR
3	Level 2 plus Case Narrative

If a client so requests, the above reports can be accompanied by EDDs, case narratives, copies of associated nonconformance reports, and other support documentation. The client's specific requirements are communicated to the laboratory and data reviewers through AlphaLIMS.

GEL's SOP GL-CS-E-002 for The Internal Review of Contractually Required Quality Criteria for Client Package Delivery defines preparation and review of the package.

If a client requests a CLP-like data package, and we agree to provide one, it is compiled in accordance with GL-LB-E-013 for CLP-Like/DOE Data Package Assembly and Revision. If a client does not request a full CLP-like data package but asks for data to be provided on CLP forms generated from software, we follow the applicable procedures in GL-LB-E-013.

11.6 Review of Data Reports, EDDs, and Data Packages

Level 1 and Level 2 data reports are reviewed for accuracy and completeness by the PM or PMA. Level 3 and CLP-like data packages are reviewed in the laboratory by a data reviewer, who is responsible for reviewing specific fractions of the data package for accuracy, consistency, and completeness in accordance with the SOP for that lab area.

No data package fraction is to be provided to the data packaging team without the approval of the appropriate data reviewer.

CLP-like data packages are reviewed in compliance with the basic protocol. Specific requirements are described in GL-LB-E-013 for the CLP-Like/DOE Data Package Assembly and Revision.

11.7 State Specific Reporting Criteria

Some state agencies require laboratories who perform drinking water analyses in support of Clean Water Act programs to communicate specific results to clients and/or agencies in some circumstances. If samples are found to contain concentrations of target analytes above those required by Federal or State regulations, the state must be informed. Please see Appendix K for state specific reporting criteria for drinking water programs.

SECTION 12
SUBCONTRACTING ANALYTICAL SAMPLES AND OUTSIDE SUPPORT SERVICES

Section 12 – Subcontracting Analytical Samples and Outside Support Services

We provide a full array of organic, inorganic, and radiochemical analyses. The subcontracting of samples to other facilities, while infrequent, may occur when:

- The client has requested analytical services for which we are not certified or do not offer as a routine product.
- The regulatory or method holding times and/or client due dates are in danger of not being met as the result of instrument malfunction or the unexpected influx of a large group of samples.

No samples are subcontracted without the client's consent. The laboratories selected to receive subcontracted samples are expected to meet the following criteria:

- Demonstrated technical capability to provide data that meet and conform to our quality standards.
- Established certification, if available, for the requested analyses.
- Successful proficiency evaluation results, if available.
- Commitment to meet time requirements for delivery of results to the client.
- Agreement to provide all documentation requested in conjunction with the analysis.
- NELAP, or ISO/IEC 17025 accreditation for the analysis if required by the client.

We audit potential subcontractors for technical and administrative compliance as directed in GL-QS-E-001 for Conduct of Quality Audits. An audit may be in the form of a book audit or an on-site review.

If there is evidence of a technical, administrative, or quality deterioration, the laboratory is removed from our list of approved subcontractor laboratories pending further evaluation, which may include an on-site audit. Once the laboratory again demonstrates compliance with GEL's standards, it can be reclassified as an approved subcontractor laboratory.

At GEL, we have a multi-faceted and trained staff. There are occasions, however, when it may be necessary to obtain the services of professionals outside of GEL. This may be due to such things as sample workload, introduction of a new instrument or method requiring special knowledge, or employee leaves of absence.

Any outside support services or service personnel are subject to the same scrutiny as a subcontract laboratory. If a service fails to meet our standards for excellence, the appropriate parties are promptly notified. If immediate corrections are not implemented and services are not of adequate quality to maintain confidence, the contract is canceled.

SECTION 13
CLIENT SATISFACTION

Section 13 – Client Satisfaction

Meeting the needs and expectations of our clients is essential to meeting our commitment to be the environmental laboratory of first choice. An important part of meeting this commitment involves receiving and resolving client concerns and complaints.

Client complaints that question the quality of laboratory data or data deliverables are directed to Quality Systems. These concerns are responded to with input from the laboratory, EDD team or data packaging group as may be needed.

The types of complaints, area(s) affected, and any impacts on quality are trended on a quarterly basis. This information is available to members of the Leadership Team and other managers and group leaders.

We use AlphaLIMS to monitor client complaints, nonconformances and corrective actions. Every complaint is entered into the system upon receipt and assigned an internal and external due date. The external due date is often established by client contract. The internal due date allows time for the Quality Systems Team to review the response and transmit it to the client on or before the due date.

If we notice a trend that significantly affects the quality of our data, a corrective action is initiated following GL-QS-E-002 for Conducting Corrective/Preventive Action and Identifying Opportunities for Improvement. The implementation and verification of the corrective action affirms an effective and permanent solution.

The Quality Systems Team promptly audits those areas of activity or responsibility for which a complaint or concern has been stated.

APPENDIX A: REFERENCES

- The NELAC Institute, TNI Standard, 2016.
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- 40 CFR Part 136, August 19, 2014 Guidelines Establishing Test Procedures for the Analyses of Pollutants.
- 40 CFR Part 141- National Primary Drinking Water Regulations, July 1, 2009, Subpart C-Monitoring and Analytical Requirements
- DOE Orders 414.1B 414.1C, and 414.D Quality Assurance, U.S. Department of Energy.
- EPA Requirements for Quality Assurance Project Plans (QAPPs), US EPA QA/R5.
- EPA 815-R-05-004 EPA Manual for the Certification of Laboratories Analyzing Drinking Water.
- Model Statement of Work for Analytical Laboratories, Prepared for Department of Energy NNSA Service Center by Analytical Quality Associates, Rev 7, November 2006.
- Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, American National Standard ANSI/ASQC E4-2004.
- Measurement Associated Instrument Quality Assurance for Radiobioassay Laboratories ANSI N42.23-1995.
- US Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD/DOE QSM Version, 5.3, May 2019.
- MARLAP- Multi-Agency Radiological Laboratory Analytical Protocols
- 10 CFR Part 21- Reporting of Defects and Noncompliance
- 10 CFR Part 61- Licensing Requirements for Land Disposal and Radioactive Waste
- NRC REG Guide 4.15 and NRC REG Guide 4.8
- ISO/IEC 17025-2017
- DOE G 414/1-3, 11-3-04, Suspect/ Counterfeit Items Guide for use with 10 CFR 830 Subpart A. Quality Assurance Requirements, and DOE O 414.B, Quality Assurance.

APPENDIX B: DEFINITIONS

The following definitions are used throughout the text of our Quality Systems Plan. These definitions were reprinted from "Definitions for Quality Systems," NELAC, July 1, 1999. For most entries, the original source of each definition is provided.

AlphaLIMS: GEL's Laboratory Information Management System.

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in the requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a program of study or an institution as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Aliquot: A discrete, measured, representative portion of sample taken for analysis. (DoD, EPA QAD Glossary)

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

Analyte: The specific chemicals or components for which a sample is analyzed; may be a group of chemicals that belong to the same chemical family, and are analyzed together. (EPA Risk Assessment Guide for Superfund, OSHA Glossary)

Analytical Detection Limit: The smallest amount of an analyte that can be distinguished in a sample by a given measurement procedure throughout a given confidence interval. (NELAC Quality Systems Committee)

Analytical Reagent (AR) Grade: Designation for the high purity of certain chemical reagents and solvents given by the American Chemical Society. (NELAC Quality Systems Committee)

Analytical Sample: Any solution of media introduced into an instrument on which an analysis is performed excluding instrument calibration, initial calibration verification (ICV), initial calibration blank (ICB), continuing calibration verification (CCV), and continuing calibration blank (CCB)

ANSI: American National Standards Institute–this consensus standards body approves standards as a guide to aid the manufacturer, the consumer and the general public who may be concerned with its scope and provisions.

Audit: A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity. (EPA-QAD)

Batch: Environmental samples prepared and/or analyzed together with the same process and personnel using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) that are analyzed together as a group using the same calibration curve or factor. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subject to the usual analytical and measurement process to

establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Blind Sample: A subsample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process. (NELAC)

Calibrate: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device, or the correct value for each setting of a control knob. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration: The set of operations that establish, under specified conditions, the relationship between values indicated by a measuring device, or the correct value of each setting of a control knob. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration Curve: The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their analytical response. (NELAC)

Calibration Standard: A substance or reference material used to calibrate an instrument. (QAMS)

Certified Reference Material (CRM): A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying body. (ISO Guide 30 – 2.2)

Chain of Custody: A record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number of and types of containers; the mode of collection; collector; time of collection; preservation; and requested analyses. (NELAC Quality Systems Committee)

Commercial Grade Items: When applied to analytical services provided to nuclear power plants licensed pursuant to 10 CFR Part 50, commercial grade item means a structure, system, or component, or part there of that affects its safety function, that was not designed and manufactured as a basic component. In the laboratory operations, commercial grade items may include calibration standards, quality control standards, reagents, instrument software conducting calculations, calibration services for support instrumentation, and other process controls, verifying their acceptability by inspections, tests, validation, or analyses by the purchaser or third-party dedicating entity (such as NIST, A2LA, NPL and TNI). This activity assures that a critical characteristic is acceptable. Commercial grade items do not include items where the design and manufacturing process require in-process inspections and verifications to ensure that defects or failures to comply are identified and corrected. These types of items are considered Consumables.

When applied to facilities and activities licensed pursuant to 10 CFR Parts 50, commercial grade item means an item that is:

(245) Not subject to design or specification requirements that are unique to those facilities or activities;

(ii) Used in applications other than those facilities or activities; and

(iii) To be ordered from the manufacturer/supplier on the basis of specifications set forth in the manufacturer's published product description (for example, a catalog).

It is the responsibility of the purchaser to identify the vendor type, grade, and use of the purchased item
Confirmation: Verification of the presence of a component through the use of an analytical technique that differs from the original test method. These may include: (NELAC)

Second column confirmation
Alternate wavelength
Derivatization
Mass spectral interpretation
Alternative detectors or
Additional cleanup procedures

Continuing Calibration Blank (CCB): Aliquot of reagent water or other blank matrix that is analyzed after each CCV. The CCB is used to determine whether the analytical sequence is in control during sample analysis.

Continuing Calibration Verification Standard (CCV): An aliquot of reagent water or to the blank matrix to which known quantities of the method analytes are added in the laboratory. The CCV is analyzed exactly like a sample periodically throughout the sequence. Its purpose is to determine whether the analytical sequence is in control during the sample analysis. It may be prepared from the same source as the calibration standards and is usually of varied concentrations.

Control Limits: A range within which specified measurement results must fall to be compliant.

Corrective Action: Action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e., that they meet specified acceptance criteria). (NELAC)

Data Reduction: The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useful form. (EPA-QAD)

Detection Limit: The lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated degree of confidence. Refer to Method Detection Limit. (NELAC)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity is performed. (ASQC)

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

Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid. (40 CFR Part 136)

Initial and Continuing Demonstrations of Capability: Procedures to establish the ability of the laboratory to generate acceptable accuracy and precision which is included in many of the EPA's analytical test methods. In general, the procedure includes the addition of a specified concentration of each analyte in each of four separate aliquots of laboratory pure water or authentic samples. These are carried through the analytical procedure and the percentage recovery and the standard deviation are compared to specified limits. (40 CFR Part 136, 2003 NELAC)

Internal Standard: A known amount of standard added to a test portion of a sample and carried through the entire measurement process as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (NELAC)

Initial Calibration Blank (ICB): An aliquot of reagent water or other blank matrix that is analyzed after each ICV. The ICB is used to determine whether there is carryover contamination after injection of the mid-level ICV.

Initial Calibration Verification (ICV): A solution of method analytes of known concentrations that is used to fortify an aliquot of blank or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

Instrument Performance Check Solution (IPC): A solution of one or more method analytes, surrogates, internal standards, internal standards, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

Internal Standard (ISTD): A known amount of standard added to a portion of the sample extract as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Interferents: Substances that affect the analysis for the element of interest.

ISO/IEC 17025: The International Organization for Standardization and International

Ectrotechnical Commission form this specialized system for worldwide standardization. Members of ISO or IEC participate in the development of International Standards through technical committees established by their organization to deal with particular fields of activity. Other international organizations, government and non-government, also take part in development of these standards. The ANSI/ISO/IEC 17025-2017 is approved as an American National Standard and covers general requirements for the competence of testing and calibration laboratories.

Laboratory: A body that calibrates and/or tests.

1. In cases where a laboratory forms part of an organization that carries out other activities besides calibration and testing, the term "laboratory" refers only to those parts of that organization that are involved in the calibration and testing process.
2. As used herein, the term "laboratory" refers to a body that carries out calibration or testing at or from a permanent location, from a temporary facility, or a mobile facility. (ISO 25)

Laboratory Control Sample (LCS): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes from a source independent of the calibration standards or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias to assess the performance of all or a portion of the measurement system. (NELAC)

Laboratory Duplicate: Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC Quality Systems)

Limit of Detection (LOD): The lowest concentration level that can be determined by a single analysis and with a defined level of confidence to be statistically different from a blank. See also Method Detection Limit. (Analytical Chemistry, 55, p.2217, Dec. 1983, modified)

Limit of Quantitation (LOQ): The lowest concentration level of the initial calibration curve used to quantitate an analyte. (DoD clarification) The LOQ must be $\geq$ 3X the LOD, and is usually not more than 10X the LOD.

Lower Limit of Quantitation (LLOQ): The lowest concentration at which a target analyte can be reliably measured and reported. The LLOQ is ≥ the lowest point in the calibration curve and represents a concentration at which both quantitative and qualitative requirements can be consistently demonstrated. The LLOQ is verified at least annually, by typically quarterly, as the LOQ verification. The verifications are performed by extracting and analyzing an LCS spiked at 0.5 to 2 times the LOQ. The LLOQ verification is carried through the same preparation and analytical procedures as environmental samples and QC.

Linear Calibration Range: The concentration range over which the instrument response is linear.

Matrix: The component or substrate that contains the analyte of interest. For purposes of batch determination, the following matrix types shall be used:

- ◊ Aqueous: Any aqueous sample excluded from the definition of a drinking water matrix or saline/estuarine source. Includes surface water, groundwater, and effluents.
- ◊ Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.
- ◊ Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt-water source.
- ◊ Non-aqueous liquid: Any organic liquid with <15% settleable solids.
- ◊ Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
- ◊ Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.
- ◊ Chemical Waste: A product or by-product of an industrial process.
- ◊ Air Samples: Media used to retain the analyte of interest from an air sample such as sorbent tubes or summa canisters. Each medium shall be considered as a distinct matrix. (Quality Systems)

Matrix Spike (MS): Prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Matrix Spike Duplicate (spiked sample/fortified sample duplicate): A second replicate matrix spike is prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

May: Denotes permitted action, but not required action. (NELAC)

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

Method Detection Limit (MDL): The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136 Appendix B)

Must: Denotes a requirement that is required to be met. (Random House College Dictionary)

Negative Control: Measures taken to ensure that a test, its components, or the environment does not cause undesired effects, or produce incorrect test results. (NELAC)

NELAC: National Environmental Laboratory Accreditation Conference. A voluntary organization of state and federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. A subset of National Environmental Laboratory Accreditation Program (NELAP).

Performance Audit: the routine comparison of independently obtained quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory. (NELAC)

Performance Based Measurement System (PBMS): A set of processes wherein the data quality needs, mandates, or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner. (NELAC)

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (NELAC)

Practical Quantitation Limit (PQL): The lowest level in the calibration curve. With the prep factor applied, the PQL is referred to as the effective PQL.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms. (NELAC)

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

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (NELAC, Section 2.1)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results in comparison to peer laboratories and the collective demographics and results summary of all participating laboratories. (NELAC)

Protocol: A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed. (EPA-QAD)

Pure Reagent Water: Shall be water in which no target analytes or interferences are present at a concentration that would impact the results when using a particular analytical test method. (NELAC)

Quality Assurance: An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality within a stated level of confidence. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Quality Control: The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the need of users. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Quality Manual: A document stating the quality policy, quality system and quality practices of an organization. This may also be called a Quality Assurance Plan or a Quality Plan. **NOTE:** The quality manual may call up other documentation relating to the laboratory's quality arrangements. (Quality Systems Committee)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC. (ANSI/ASQC E-41994)

Quantitation Limits: The value at which an instrument can accurately measure an analyte at a specific concentration that includes the maximum or minimum levels, concentrations, or quantities of a target that can be quantified with the accuracy required by the data user. These values establish the upper and lower limits of the calibration range. (NELAC with DoD clarification)

Range: The difference between the minimum and the maximum set of values. (EPA_QAD)

Raw Data: Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies,

computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes that have been transcribed verbatim, dated and verified accurate by signature), the exact copy or exact transcript may be submitted. (EPA-QAD)

Reagent Blank (method reagent blank): A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Reference Material: A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30 -2.1)

Reference Standard: A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM – 6.08)

Relative Percent Difference (RPD): The difference between two duplicate samples, such as a MS/MSD/, LCS/LCSD, or sample/sample DUP. It is determined by taking the difference between the two results and dividing by the average.

Reporting Limit (RL): The level at which a target analyte would meet the data quality objectives of the laboratory and/or a project, which may include establishing compliance with a regulatory and/or action limit. The RL may be equal to the laboratory practical quantitation limit (PQL)

Requirement: Denotes mandatory specification; often designated by the term "shall." (NELAC)

Sample: Portion of material collected for chemical analysis, identified by a single, unique term. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis. (DoD)

Safety Related Procured Items: As specified in 10 CFR Part 50 and other Nuclear Power related activities, a basic component includes safety-related analytical services that are associated with the component information in support of an early site permit application or other safety related services identified by the client, whether the services are performed by the laboratory or others. GEL has identified the primary safety related basic component item for these services as:

- ◊ Calibration Standards for Radiochemical Analyses used in the direct issuance of analytical data reported to a Nuclear Facility. These standards are the primary sources (critical characteristic) of calibration for instruments that will provide the analytical results to our client. All Safety Related Procured Items are considered Type I procurement and must meet all specifications as identified in SOP GL-RC-E-002.

Standard Operating Procedure (SOP): A written document that details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and is accepted as the method for performing certain routine or repetitive tasks. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Standard Reference Material (SRM): A certified reference material produced by the U.S. National Institute of Standards and Technology and characterized for absolute content, independent of analytical test method. (NELAC)

Statistical Process Control (SPC): Statistically derived limits that establish acceptable ranges for recoveries of analytes of interest, including LCS, MS, MSD, PS, PSD and internal standards.

Stock Standard Solution: A concentrated solution containing one or more method analytes prepared in the laboratory using certified reference materials or purchased from a reputable commercial source.

Selectivity: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. (NELAC Quality Systems)

Sensitivity: The capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC Quality Systems)

Serial Dilution: The dilution of a sample by a known factor. When corrected by the dilution factor, the diluted sample should agree with the original undiluted sample within the specified limits. Serial dilution may reflect the influence of interferents.

Shall: Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there will be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled. (ANSI)

Should: Denotes a guideline or recommendation whenever noncompliance with the specification is permissible. (ANSI)

Spike: A known mass of target analyte added to a blank sample or subsample; used to determine recovery efficiency or for other quality control purposes.

Subsample: A portion of the entire sample randomly collected and composited to create weight used for the solvent extraction process. The subsample should be representative of the entire sample.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Test: A technical operation that consists of the determination of one or more characteristics or performance of a given product, material equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate. (ISO/IEC Guide 2 – 12.4)

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

Tolerance Chart: A chart in which the plotted quality control data is assessed via a tolerance level (e.g. ± 10% of a mean) based on the precision level judged acceptable to meet overall quality/data use requirements instead of a statistical acceptance criteria (e.g. ± 3 sigma). (ANSI N42.23-1995, Measurement and Associated Instrument Quality Assurance for Radiochemistry Laboratories)

Traceability: The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM-6.12)

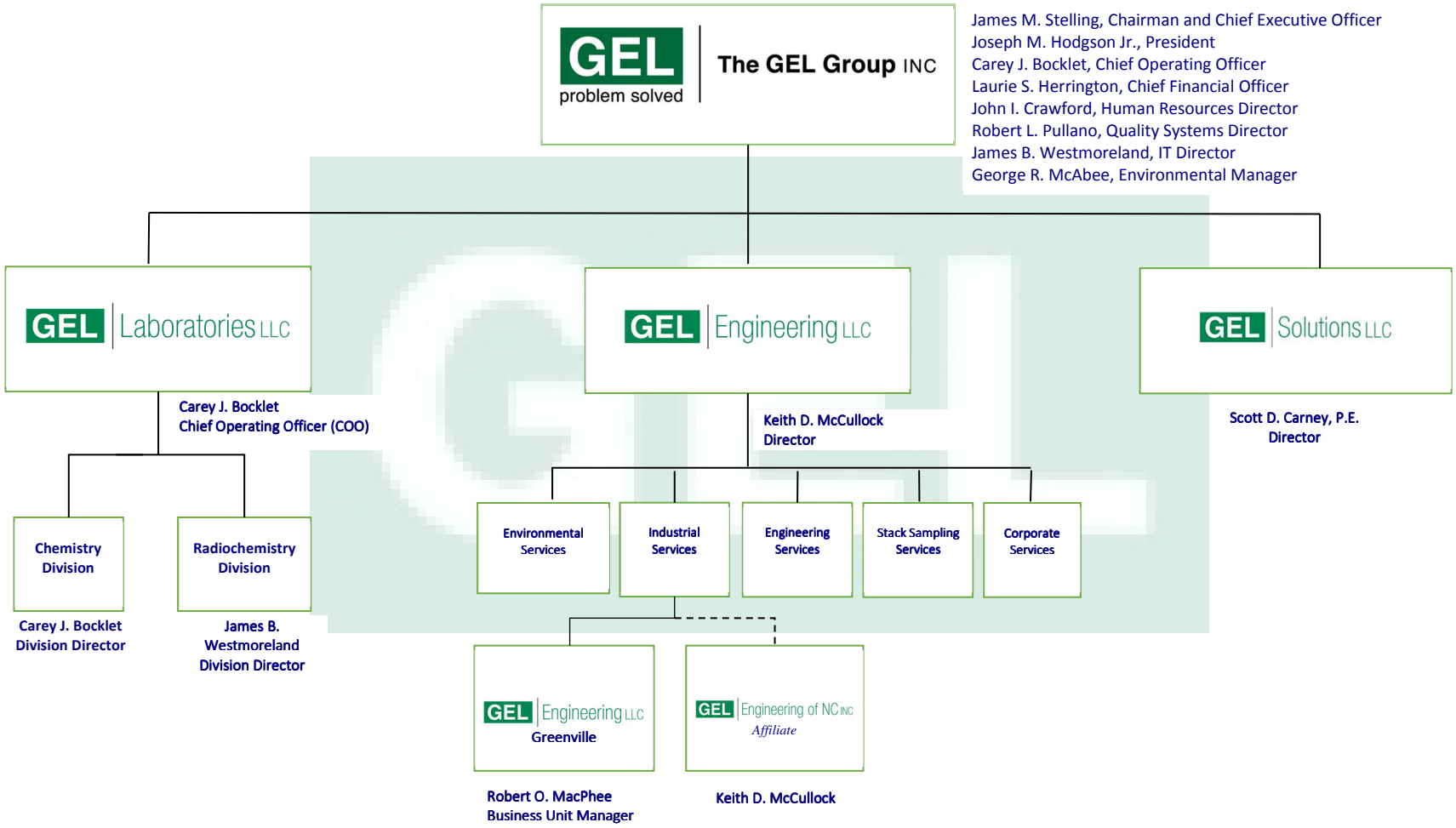
Validation: The process of substantiating specified performance criteria.

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

NOTE: Verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation, or specification peculiar to the management of the measuring equipment.

The result of verification leads to a decision either to restore in service, to perform adjustments, or to repair, or to downgrade, or to declare obsolete. In all cases it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

APPENDIX C: CORPORATE ORGANIZATION CHART



APPENDIX D: CERTIFICATIONS

GEL Laboratories, LLC maintains environmental laboratory certification in many states, including primary NELAP in Utah and secondary in Florida, Illinois, Kansas, Louisiana, New Hampshire, New Jersey, New York, Pennsylvania, Texas and Virginia. We expand our list of certifications as needed.

Original Scope of Accreditation/Range of Activities are maintained in the Quality Assurance work area. Electronic copies are available in .pdf form on the GEL intranet. *Please call to confirm the status of any certification of interest.*

- **Department of Defense (DoD) Department of Energy (DOE**) Consolidated Quality Systems Manual Version 5.3, May 2019 through American Association for Environmental Laboratory Accreditation (A2LA) (A2LA 2567.01)
- **U.S. Department of Agriculture –** Foreign soil importation permit # P330-18-00302, P330-18-00303
- **National Environmental Laboratory Accreditation Program (NELAP) –** Primary issued through the State of Utah, Department of Health; Secondary issued through the States of Florida, Illinois, Kansas, Louisiana, New Hampshire, New Jersey, New York, Pennsylvania, Texas and Virginia
- **Clinical Laboratory Improvement Amendments (CLIA) –** U.S. Department of Health and Human Services, Certificate of Compliance for Acceptance of Human Specimens (GEL ID: 42D0904046)
- **Alaska Department of Environmental Conservation Contaminated Sites** Laboratory Approval 17-018
- **Alaska Department of Environmental Conservation Laboratory Certification Program, Chemical Analysis in Drinking Water** SC00012
- **Arkansas** Department of Environmental Quality Laboratory Certification Program for Wastewater, Groundwater, Solid Waste Reciprocal Certification to SC DHEC (88-0651)
- **California** Environmental Laboratory Accreditation Program Certification, ELAP (GEL ID: 2940)
    - Sanitation Districts of Los Angeles County (GEL ID: 9255651)
- **Colorado** Department of Public Health and Environment, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water Chemistry and Radiochemistry (SC00012)
- **Connecticut** Department of Public Health – Potable Water, Waste Water and/or Trade Waste, Sewage and/or Effluent, Soil and Radiochemistry Reciprocal Certification (GEL ID: PH-0169)
- **Florida** Department of Health, Bureau of Laboratories, Secondary NELAP (GEL ID E87156)
- **Georgia** Department of Natural Resources, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water (GEL ID: 967)
- **Hawaii** Department of Health, Safe Drinking Water, reciprocal to Utah NELAP, SC00012
- **Idaho** Department of Health and Welfare, SC00012

- **Illinois** EPA Environmental Laboratory Accreditation for Drinking Water, Wastewater, and Hazardous and Solid Waste, Secondary NELAP (GEL ID: 200029)
- **Indiana** State Department of Health (C-SC-01)
- **Kansas** Department of Health and Environmental Laboratory, Non-potable Water and Solid and Hazardous Waste, Secondary NELAP (GEL ID: E-10332)
- **Kentucky** Department of Environmental Protection for Drinking Water and Waste Water (GEL ID: 90129)
- State of **Louisiana** Department of Health and Hospitals (SC00012), Safe Drinking Water, Secondary NELAP
- State of **Louisiana** Department of Environmental Quality, (03046, AI 33904), Non-drinking water, Secondary NELAP
- State of **Maine** Laboratory Accreditation Program (SC00012)
- **Maryland** Department of Health and Mental Hygiene, Laboratories Administration, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water –Radiochemistry (GEL ID: 270)
- **Massachusetts** Department of Environmental Protection, Division of Environmental Analysis – Potable Water, Radiochemistry (GEL ID: M-SC012), Per- and Polyfluoralkyl Substances (PFAS)
- **Michigan** Department of Environmental Quality – Potable Water, Radiochemistry (GEL ID: 9976)
- **Mississippi** State Department of Health NELAP reciprocity
- **Nebraska**, Department of Health and Human Services (GEL ID: NE-OS-26-13)
- **Nevada** Department of Human Resources, Health Division, Bureau of Licensure and Certification, Radiologicals and Non-Radiologicals (GEL ID: SC000122020-1), Nevada Mining
- State of **New Hampshire** Environmental Laboratory Accreditation Program, Secondary NELAP (2054)
- **New Jersey** Department of Environmental Protection, Safe Drinking Water, Solid and Hazardous Waste, and Water Pollution Certification, Secondary NELAP (GEL ID: SC002)
- State of **New Mexico** Environment Department, Drinking Water Bureau, reciprocal to NELAP SC00012
- **New York** Department of Health, Environmental Laboratory Approval Program Certification, Potable Water, Non-potable Waters and Solids/Hazardous Wastes, Secondary NELAP (GEL ID: 11501)
- **North Carolina** Division of Water Quality Lab Certification Program, Waste Waters/Ground Waters. (GEL ID: 233)
- **North Carolina** Department of Health and Human Services, North Carolina State Laboratory Public Health Environmental Sciences, Safe Drinking Water. (GEL ID: 45709)

- **North Dakota** State Department Protection- Bureau of Laboratories, Secondary NELAP (R-158) and TENROM
- **Oklahoma** Department of Environmental Quality, General Water Quality/Sludge Testing Laboratory Dual Certification (GEL ID: 9904)
- **Pennsylvania** Department of Environmental Protection – Bureau of Laboratories, Secondary NELAP (GEL ID: 68-00485)
- **Puerto Rico** Department of Health Recipricol certification to Manual for the Certification of Laboratories Analyzing Drinking Water. PRDOH (SC00012)
- **South Carolina** Department of Health and Environmental Control – Environmental Laboratory Certification Program, Clean Water, Safe Drinking Water, Radiological, and Solid/Hazardous Wastes (GEL ID: 10120001/10120002)
- **South Carolina** Department of Health and Environmental Control (DHEC) Radioactive Material License (License #362)
- **Tennessee** Department of Health – Division of Laboratory Services, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program, Safe Drinking Water-Radiochemistry and Non-radiochemistry (GEL ID: 02934)
- **Texas** Commission on Environmental Quality, Secondary NELAP (GEL ID: T104704235-20-16)
- **Utah** Department of Health, Division of Epidemiology and Laboratory Services, Safe Drinking Water, Clean Water and Resource and Conservation and Recovery Act Certifications Primary NELAP (Customer ID: SC000122020-32)
- **Vermont** Department of Environmental Conservation, Water Supply Division, Secondary NELAP (VT87156)
- Commonwealth of **Virginia** Department of General Services – Division of Consolidated Laboratory Services, Safe Drinking Water, Clean Water Act and Resource and Conservation Act Certifications, Secondary NELAP (GEL ID: 460202)
- **Washington** State Department of Ecology, Safe Drinking Water, Clean Water and Resource and Conservation and Recovery Act Certifications (GEL ID: C780)

APPENDIX E: ESSENTIAL QUALITY CONTROL REQUIREMENTS

At GEL, we enforce strict adherence to quality control measures. Quality control measures for each type of analysis are delineated in the associated standard operating procedure and include those specified in the identified analytical method. Client requests for additional quality control agreed to by us will be communicated to the laboratory by the Project Manager and performed accordingly.

All quality control measures are assessed and evaluated on an ongoing basis. We use these measures to establish statistically derived quality control acceptance criteria. The acceptance criteria are used to evaluate whether the analytical process is in control and to assist us in establishing the validity of the data. Our procedures for handling out- of-control situations are written in the analytical standard operating procedure.

Method-specific quality measures are described in the appropriate standard operating procedure. Essential but general quality control requirements are summarized in the sections below for chemical testing, including inorganic and organic analyses, and radiochemical testing.

E1 Chemical Testing

This section includes our quality control requirements for inorganic and organic analyses, and discusses:

- Negative controls
- Positive controls
- Analytical variability and reproducibility
- Method evaluation
- Method detection limits
- Data reduction
- Quality of standards and reagents
- Selectivity
- Constant and consistent test condition

E1.1 Negative controls

We implement a negative control at least once per analytical batch of samples having the same matrix, and where, if applicable, the same extraction or preparation method is employed. The negative control is a method blank that we use to determine the presence of contamination. If discovered, we must investigate the source of contamination and take measures to correct, minimize, or eliminate the source if:

1. The concentration of target analyte exceeds the established practical quantitation limit and exceeds a concentration greater than 1/10 of the measured concentration of any sample in the analytical batch;
2. The concentration of a target analyte in the method blank exceeds that present in the samples and is greater than 1/10 of the specified regulatory limit.

If a method blank is indicative of contamination, we must assess each sample in that batch against the above criteria to determine if the data are acceptable. Any sample associated with a contaminated method blank shall be reprocessed for analysis, as needed, or we will report the results with appropriate data qualifiers.

E1.2 Positive Control – Method Performance

E1.2.1 Laboratory Control Sample (LCS)

Purpose: The LCS is used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Results of the LCS are compared to established criteria and, if found to be outside of these criteria, indicates that the analytical system is “out of control.” Any

affected samples associated with an out-of-control LCS shall be reprocessed for re-analysis or the results reported with appropriate data qualifying codes, as necessary.

Frequency: The LCS is analyzed at a minimum of 1 per preparation batch. Exceptions would be for those analytes for which no spiking solutions are available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, temperature, dissolved oxygen or turbidity. In those instances for which no separate preparation method is used (example: volatiles in water) the batch shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Composition: The LCS is a controlled matrix, known to be free of analytes of interest, spiked with known and verified concentrations of analytes. **NOTE:** The matrix spike may be used in place of this control as long as the acceptance criteria are as stringent as for the LCS. Alternatively the LCS may consist of a medium containing known and verified concentrations of analytes or as Certified Reference Material (CRM). All analyte concentrations shall be within the calibration range of the methods. The following shall be used in choosing components for the spike mixtures:

The components to be spiked shall be as specified by the mandated test method or other regulatory requirement or as requested by the client. In the absence of specified spiking components the laboratory shall spike per the following:

For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene, and PCBs, the spike should be chosen that represents the chemistries and elution patterns of the components to be reported.

For those test methods that have extremely long lists of analytes, a representative number may be chosen. The analytes selected should be representative of all analytes reported. The following criteria shall be used for determining the minimum number of analytes to be spiked.

a) For methods that include 1-10 targets, spike all components;
b) For methods that include 11-20 targets, spike at least 10 or 80%, whichever is greater;
c) For methods with more than 20 targets, spike at least 16 components.

NOTE: Unless otherwise noted in project quality assurance plans or if components interfere with an accurate assessment, all Department of Defense projects will have LCS, MS, and MSD that contain all target analytes.

Evaluation Criteria and Corrective Action: The results of the individual batch LCS are calculated in percent recovery. The laboratory shall document the calculation for percent recovery. The individual LCS is compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory determines internal criteria or utilizes client specified assessment criteria.

An LCS that is determined to be within the criteria effectively establishes that the analytical system is in control and validates system performance for the samples in the associated batch. Samples analyzed along with a LCS determined to be “out of control” should be considered suspect and the samples reprocessed and re-analyzed or the data reported with appropriate data qualifying codes as necessary.

E1.2.2 Sample Specific Controls

The laboratory must document procedures for determining the effect of the sample matrix on method performance. These procedures relate to the analyses of matrix specific Quality Control (QC) samples and are designed as data quality indicators for a specific sample using the designated test method. These controls alone are not used to judge

laboratory performance. Examples of matrix specific QC include: Matrix Spike (MS); Matrix Spike Duplicate (MSD); Post Spike (PS) and Post Spike Duplicate (PSD) sample duplicates; and surrogate spikes.

E1.2.3 Matrix Spike ; Matrix Spike Duplicates, Post Spike ; Post Spike Duplicates :

Purpose:	Matrix specific QC samples indicate the effect of the sample matrix on the precision and accuracy of the results generated using the selected method. The information from these controls is sample/matrix specific and would not normally be used to determine the validity of the entire batch.
Frequency:	The frequency of the analysis of matrix specific samples shall be determined as part of a systematic planning process (e. g. Data Quality Objectives) or as specified by the required mandated test method.
Composition:	The components to be spiked shall be as specified by the mandated test method. Any permit specified analytes, as specified by regulation or client requested analytes shall also be included. If there are no specified components, the laboratory shall spike per the following: For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike should be chosen that represents the chemistries and elution patterns of the components to be reported. For those test methods that have extremely long lists of analytes, a representative number may be chosen using the following criteria for choosing the number of analytes to be spiked. However, the laboratory shall insure that all targeted components are included in the spike mixture over a 2-year period. a) For methods that include 1-10 targets, spike all components; b) For methods that include 11-20 targets, spike at least 10 or 80%, whichever is greater; c) For methods with more than 20 targets, spike at least 16 components.
Evaluation Criteria and Corrective Action:	The results from matrix spike/matrix spike duplicate and post spike/post spike duplicate are primarily designed to assess the precision and accuracy of analytical results in a given matrix and are expressed as percent recovery (%R) and relative percent difference (RPD). Results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory should determine internal criteria and document the method used to establish the limits. For matrix spike or post spike results outside established criteria, corrective action shall be documented or the data reported with appropriate data qualifying codes.

E1.2.4 Matrix Duplicates:

Purpose:	Matrix duplicates are defined as replicate aliquots of the same sample taken through the entire analytical procedure. The results from this analysis indicate the precision of the results for the specific sample using the selected method. The matrix duplicate provides a usable measure of precision only when target analytes are found in the sample chosen for duplication.
Frequency:	The frequency of the analysis of matrix duplicates may be determined as part of a systematic planning process (e. g. Data Quality Objectives) or as specified by the mandated test method.
Composition:	Matrix duplicates are performed on replicate aliquots of actual samples. The composition is usually not known.
Evaluation Criteria and	The results from matrix duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD) or another

Corrective Action	statistical treatment (e. g., absolute differences). The laboratory shall document the calculation for relative percent difference or other statistical treatments. Results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory shall determine internal criteria and document the method used to establish the limits. For matrix duplicates results outside established criteria corrective action shall be documented or the data reported with appropriate data qualifying codes.

E1.2.5 Surrogate Spikes:

Purpose	Surrogates are used most often in organic chromatography test methods and are chosen to reflect the chemistries of the targeted components of the method. Added prior to sample preparation/extraction, they provide a measure of recovery for every sample matrix.
Frequency	Except where the matrix precludes its use or when not available, or is not a method requirement, surrogate compounds are added to all samples, standards, and blanks for all appropriate test methods.
Composition:	Surrogate compounds are chosen to represent the various chemistries of the target analytes in the method. They are often specified by the mandated method and are deliberately chosen for their being unlikely to occur as an environmental contaminant. Often this is accomplished by using deuterated analogs of select compounds.
Evaluation Criteria and Corrective Action:	The results are compared to the acceptance criteria as published in the mandated test method or determined using statistical process controls (SPC). Where there are no established criteria, the laboratory determines internal criteria and documents the method used to establish the limits. Surrogates outside the acceptance criteria must be evaluated for the effect indicated for the individual sample results. The appropriate corrective action may be guided by the data quality objectives or other site specific requirements. Results reported from analyses with surrogate recoveries outside the acceptance criteria include appropriate data qualifiers.

E1.3 Method Evaluation

The following procedures, as described in the other sections of the QAP, are in place in order to ensure the accuracy of the reported result:

- Procedure for initial demonstration of analytical capability performed initially (prior to the analysis of any samples) and if there is a significant change in instrument type, personnel, matrix or test method. Refer to Section 8.
- Procedures for initial and continuing calibration protocols as specified in Section 7.
- Procedures for utilizing proficiency test samples to evaluate the ability of a procedure and/or analyst laboratory to produce accurate data as specified in Section 3.

E1.4 Method Detection Limits

Method detection limits (MDLs) are determined as described in GL-LB-E-001 for The Determination of Method Detection Limits. This procedure is based on that established in 40 CFR Part 136, Appendix B.

Where possible, MDL studies are conducted for both aqueous and solid matrices and biological tissues using a clean matrix appropriate to the test method (such as laboratory pure reagent water or Ottawa sand). MDL studies for the majority of routine parameters are conducted by:

- analyzing a minimum of seven replicates of the lowest calibration standard
- determining the standard deviation of the seven replicates

- multiplying the standard deviation by 3.143 (based on six degrees of freedom and representing a 99% confidence level) to obtain the calculated MDL.

If the MDL study is being conducted for a new method or target analyte, the following steps are taken:

- the MDL is estimated based on information provided in the method or analytical experience
- a standard with a concentration three to five times the estimated MDL is prepared and analyzed a minimum of seven times
- the MDL is calculated as above based on the standard deviation and degrees of freedom
- the MDL is evaluated for reasonableness by verification through analysis of a prepared standard solution two to three times the calculated MDL.

MDL studies are not performed for any target analyte for which spiking solutions are not available such as total volatile solids, pH, color, temperature, dissolved oxygen, or turbidity.

Practical quantitation limits (PQLs) are determined by either multiplying the MDL by approximately 2 to 10 or are equal to that of the lowest calibration standard. Concentrations of a target analyte determined to be greater that it's PQL are defined as quantitative results. All quantitative reported results are bracketed by calibration or calibration verification standards.

All MDL studies conducted by the laboratory are submitted to the Quality Group for an independent review. Upon acceptance of the MDL study, the MDLs reported to clients via our computer system are updated unless otherwise specified by contract. PQLs are also updated as directed by the new MDLs or changes to procedures.

All data pertaining to the study and the calculation of MDLs is stored on the production file system for data packages for four years and then archived to DVD.

GEL uses an industry standard approach to establishing radiochemistry and radiobioassay MDA (minimum detectable activity). This approach is based on MARLAP guidance for posteriori determination of MDA. The approach incorporates real time events that affect the observed sensitivity for every measurement performed in the laboratory. GEL recognizes for EPA radiological drinking water samples, that a MDL study is required similar to chemical constituents tested for drinking water.

GEL will follow the source document EPA 815-R-05-004 EPA Manual for the Certification of Laboratories Analyzing Drinking Water. In Chapter VI Critical Elements for Radiochemistry, section 1.5 of this document and alternate procedure is given for radiological constituents.

The analyst should prepare and measure a sample set of at least four reagent blanks and four laboratory fortified blanks that have the radioanalyte of interest added to quantitation levels appropriate for drinking water samples, the activity level added to the laboratory fortified blanks should be between the radioanalyte's MCL and its required detection limit. To be deemed an acceptable demonstration of proficiency, the mean recoveries and the standard deviation of the recoveries of the replicate measurements should be consistent with the requirements for accuracy and precision described in Section 7.7, and reagent blank measurements must have a mean result below the detection limit for each analyte measured with the method.

E1.5 Data Reduction

The procedures for data reduction, such as use of linear regression, are documented in the individual analytical standard operating procedures. GEL's policy governing the manual integration of chromatographic data is detailed in GL-LB-E-017, Procedure and Policy for Manual Integration. Manual integrations of chromatographic peaks can only be performed in accordance with GL-LB-E-017. This ensures that the integrations are done in a consistent and technically justifiable manner while meeting the requirements set forth under the Good Automated Laboratory Practices.

SOP GL-QS-E-014, Quality Assurance Measurement Calculations and Processes, discusses the use of laboratory data in statistical determinations and includes discussion of Estimation of Total Analytical Uncertainty, Statistical Process Control (SPC) Limits, and Calibration of Instrumentation. Understanding of the procedures used for data generation and reduction is an important part of an analyst demonstrating proficiency in an analytical procedure. All analysts and technicians responsible for generating curves and using curve-generated data are trained to this SOP per GEL annual and interim training requirements.

E1.6 Quality of Standards and Reagents

The quality of standards used in instrument calibration or quality control samples and reagents used in sample preparation and/or analysis must meet the criteria described in Section 7. In methods where the purity is not specified, analytical grade reagents are used. Reagents of lesser purity than those specified by the test method are never used. Upon receipt and prior to use, the labels on the container are checked to verify that the purity of the reagents meets the documented requirements of the particular test method.

The quality of water sources is monitored and documented as described in Section 4. The quality of water used in sample preparation or analysis meets the method-specified requirements. The type of water available in the laboratory is described in Section 4.

E1.7 Selectivity

Absolute and relative retention times aid in the identification of components in chromatographic analyses and in evaluation of the effectiveness of a column in separating constituents. The procedures governing retention time widows are documented in the applicable analytical SOP and meet all regulatory and method requirements.

In addition to retention time windows, the acceptance criterion for mass spectral training is also documented in the appropriate analytical SOP. In all cases, the acceptance criteria meet or exceed those specified in the analytical methods.

Unless stipulated in writing by the client, confirmations are performed to verify the compound identification of positive results detected on a sample from a location that has not been previously tested by our laboratory. Such confirmations are performed on a second column for organic tests such as pesticides, herbicides, or acid extractable or when recommended by the analytical test method except when the analysis involves the use of a mass spectrometer. All conformation is documented.

E1.8 Constant and Consistent Test Conditions

GEL's implementation of standard operating procedures that specify quality criteria including initial and continuing calibrations assures that our test instruments consistently operate within the specifications required of the application for which the equipment is used.

In addition to the specifications applied to instrumentation, glassware used for sample preparation or analysis is cleaned in a manner that reduces the potential for positive or negative interferences. Glassware is prepared in accordance with GL-LB-E-003 for Glassware Preparation.

This SOP details the procedures used to clean the following groups of glassware:

- That used for the determination of metals
- Reusable bottles and plastic ware
- Bottles sued for the determination of biochemical oxygen demand (BOD)
- Glassware used in the determination of organic compounds
- That used for the determination of methylene blue active substances (MBAS)
- Glassware used in the determination of total organic halides (TOX)
- Glassware used in the analyses of samples for total Kjeldahl nitrogen (TKN) and total phosphorous
- Generic glassware used in all other analyses

If the method specifies that the glassware be stored in a particular manner, this requirement is documented in the appropriate analytical SOP.

Section E2 Radiochemical Analysis

This section describes the general quality control applied to radiochemical analysis. The specific quality control criteria applied to each analysis are delineated in the corresponding SOP. Detector Capabilities, Relative Bias, Relative Precision, and methods of calculating results for periodic Quality Control Determinations are discussed in the appropriate SOPs.

Discussed in this section are:

- Negative controls
- Positive controls
- Test variability/reproducibility
- Tracers and carriers
- Method evaluation
- Radiation measurement system calibration
- Data reduction
- Quality of standards and reagents
- Test conditions

E2.1 Negative Controls

Method blanks serve as the primary negative controls providing a means of assessing the existence and magnitude of contamination introduced via the analytical scheme. A method blank is analyzed at a frequency of one per preparation or analytical batch and is one of the quality control measures used to assess batch acceptance.

The activity level determined for each target in the method blank is assessed against the specific acceptance criteria specified in the applicable SOP. These criteria are based on a designated sample aliquot size and include appropriate calculations to compare the blank to activity levels determined for different sizes of sample aliquots.

The activity level of any target analyte in the method blank should be less than or equal to the contract required detection limit. The method blank may exceed this limit if the activity is less than 5% that of the lowest sample activity in the batch.

If the method blank acceptance criteria are not met, the specified corrective action and contingencies delineated in the SOPs are followed. Any failures of method blanks to meet the acceptance criteria are documented in the laboratory report and through GEL's nonconformance reporting system specified in GL-QS-E-004 for the Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items.

The activity levels determined for method blanks are not subtracted from those obtained for the samples in the associated preparation or analytical batch. Correction factors such as instrument background and analyte presence in the tracer may, however, be applied to all analyzed samples including both client samples and internal quality control samples.

E2.2 Positive Controls

Positive controls routinely employed in radiochemical analyses include both laboratory control samples (LCS) and matrix spikes (MS).

The laboratory standards used to prepare LCS and MS are from a different source than those used in instrument calibration, except when the calibration has been verified with a different source. This requirement may be superseded by client specific contract requirements. The activity levels of target analytes in the LCS and MS exceed ten times the prior detection limit and are less than one hundred times this detection limit. If a radiochemical method,

however, has more than one reportable analyte isotope, the LCS and MS need to only include one of the analyte isotopes.

Gamma spectroscopy is the exception to this guideline requiring the LCS and MS to contain isotopes representing the low, medium, and high-energy range of the analyzed gamma spectra.

E2.2.1 Laboratory Control Sample (LCS)

Laboratory control samples are analyzed at a minimum of once per preparation or analytical batch containing twenty or less samples.

The recovery of target analytes in the LCS is compared to the acceptance criteria specified in the applicable analytical SOP. If the recovery of the LCS does not fall within the acceptance range, the corrective actions and contingency steps specified in the SOP are implemented. These steps include the completion of an internal nonconformance report in accordance with GL-QS-E-004 and noting the failure on the laboratory report.

E2.2.2 Matrix Spike (MS)

Matrix spikes are analyzed at a minimum of once per preparation or analytical batch containing twenty samples or less under the following conditions:

- The analytical method does not utilize an internal standard or carrier
- There is a physical or chemical separation process
- There is sufficient sample volume provided for the analysis.

The target analyte recoveries are one of the quality control measures used to assess batch acceptance. The recovery of target analytes in the MS is compared to the acceptance criteria specified in the applicable analytical SOP. If the recovery of the MS does not fall within the acceptance range, the data associated with that matrix spike are qualified accordingly.

E2.3 Test Variability/Reproducibility

The reproducibility of measurements is evaluated by the use of matrix duplicates. Matrix duplicates are analyzed once per preparation or analytical batch of twenty samples. The relative percent difference (RPD) obtained between the activity levels obtained for the sample and its duplicate is evaluated against the range in the SOP.

E2.4 Tracers and Carriers

Two additional quality control measures specific to radiochemical analysis are tracers and carriers. If the analytical method requires a tracer or carrier, each sample result will be associated with a tracer recovery that is calculated and reported. For radiochemistry procedures requiring gravimetric or radiometric recovery (tracer yields), the acceptable limits are 15% - 125%. These limits may vary for specific clients and/or projects. If the applicable limits are not met, the corrective actions delineated in the SOP are implemented.

E2.5 Method Evaluation

GEL evaluates the radiochemical preparation and analytical methods to ensure the accuracy of the reported result. This evaluation includes initial demonstrations of capability as described in Section 8 and the analysis of proficiency test samples as described in Section 3. The suppliers of proficiency test samples conform to the requirements of ANSI N42.22 and ISO/IEC 17025-2017.

E2.6 Radiation Measurement System Calibration

It is not generally necessary or practical to calibrate radiochemical instrumentation each day of use due to its stability and the time-consuming nature of some of the measurements. There are, therefore, significant differences in the calibration requirements for radiochemical instrumentation from that used for chemical analyses.

Calibration differences include but are not limited to the following:

- The requirement in Section 7 for the determination of the appropriate number of standards for initial calibration is not applicable to radiochemical methods. If the radiochemical method requires multiple standards for initial calibration, the number of standards is included in the applicable SOP.
- If linear regression or non-linear regression is used to fit standard response or calibration standard results to a calibration curve, the correlation coefficient is determined. This differs from Section 7.
- The requirement identified in Section 7 for the bracketing of quantitative results by calibration or calibration verification standards is not applicable to radiochemical analyses due to the non-correlated event nature of decay counting instrumentation.
- As indicated in Section 7, the LCS may fill the requirements for the performance of an initial calibration and continuing calibration verification standard. The calibration verification acceptance criteria are the same as specified for the LCS (75 -125%).
- Background calibration measurements are made on a regular basis and monitored using control charts. These values are subtracted from the total measured activity in the determination of the sample activity. The frequency of these measurements is indicated in the SOP GL-RAD-I-010.
- Instrument calibration shall be performed with reference standards as defined in Section E3.8.
- The frequency of calibration shall be addressed in the governing SOPs.

E2.7 Data Reduction

All sources of method uncertainties and their propagation must be traceable to reported results. This is performed under the guidance of the ISO "Guide to the Expression of Uncertainty in Measurement" and the NIST Technical Note 1297 on "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." Details of calculations and equations used in reporting Radiochemistry analytical results may be found in GL-RAD-D-003 for Data Review, Validation and Data Package Assembly.

E2.8 Quality of Standards and Reagents

The reference standards we use are obtained from the National Institute of Standards and Technology (NIST), EPA, or suppliers providing NIST standards. Reference standards should be accompanied by a certificate of calibration whose content is described in ANSI N42.22 – 1995, Section 8, Certificates. All reagents used shall be analytical reagent grade or better.

E2.9 Test Conditions

GEL adheres to written procedures that minimize the possibility of cross contamination between samples. This prevents incorrect analysis results from the cross contamination. Procedures are in place, for example, to separate known radioactive and nonradioactive samples from the time of sample receipt to analysis and sample disposal.

Instrument performance checks are performed on a regular basis and monitored with control charts. This ensures that the instrument is operating properly and that the calibration has not changed. The same check source used in the preparation of the control chart at the time of calibration is used in the performance checks of the instrument. The sources must provide adequate counting statistics for a relatively short count time and should be sealed or encapsulated to provide loss of activity and contamination of the instrument and laboratory personnel.

Instrument performance checks include checks on the counting efficiency and the relationship between channel number and alpha or gamma ray energy.

APPENDIX F: ETHICS AND DATA INTEGRITY AGREEMENT

The GEL Group Inc.

ETHICS and DATA INTEGRITY AGREEMENT

I. I, (Name), state that I understand the high standards of integrity required of me with regard to the duties I perform and the data I report in connection with my employment at The GEL Group, Inc.

II. I agree that in the performance of my duties at The GEL Group, Inc.:

A. I shall not intentionally report data values that are not the actual values obtained,

B. I shall not intentionally report data that does not meet method or procedural specifications unless that data is properly qualified through comments or other notations in the analytical report.

C. I shall not intentionally report dates and times of data analyses that are not the actual dates and time of data analyses; and

D. I shall not intentionally represent another individual's work as my own.

III. I agree to inform a Group Leader, Manager, Director, or member of the Executive Committee of The GEL Group, Inc. of any accidental or intentional reporting of non-authentic data by myself or other employees in a timely manner.

IV. I will not knowingly participate in any questionable activities or violations of the Procurement Integrity Act during purchasing or sales activities. I will report any questionable activities to a Group Leader, Manager, Director, or member of the Executive Committee of The GEL Group, Inc. This includes discussions on analytical, consulting, and geophysical services pricing and contracts, vendor pricing, or other essential business information to anyone outside of The GEL Group, Inc. family.

This Ethics and Data Integrity Agreement has been explained to me by the Director of Quality Systems, my Group Leader, or at a training session, at which time I have been provided the opportunity to ask questions on any part of this agreement that I did not understand. It has also been explained to me that any violation of this agreement conducted during work performed under a subcontract or direct contract to a government agency could subject me to potential prosecution.

I understand that violation of this policy subjects me to disciplinary action, up to and including termination of my employment with The GEL Group Inc.

Employee Signature: _____ Date: _____

Trainer Signature: _____ Date: _____

APPENDIX G: EQUIPMENT LIST

SEMI-VOLATILE ANALYSIS-INSTRUMENTATION

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Agilent 6890N Gas Chromatograph/ 5973 Mass Spectrometer w/ 7683 Autosampler Tower	5973	September-05	CN10521005/US52440275 MSD1
1	Agilent 7890A Gas Chromatograph/ 5975C Inert Mass Spectrometer w/ 7683 Autosampler Tower	5975	April-09	CN10848121/US83131300 MSD2
1	Agilent 7890A Gas Chromatograph/ 5975C Inert Mass Spectrometer w/ 7683 Autosampler Tower	5975	April-09	CN10821032/US83131355 MSD3
1	Agilent 7890A Gas Chromatograph/ 5975C Inert Mass Spectrometer w/ 7683 Autosampler Tower	5975	November-07	CN10727001/US90704000 MSD4
1	Hewlett Packard 6890 Gas Chromatograph/ 5973 Mass Spectrometer w/ 7683 Autosampler Tower	5973	May-97	US00023050/US82311233 MSD5
1	Hewlett Packard 6890 Gas Chromatograph/ 5973 Mass Spectrometer w/ 7683 Autosampler Tower	5973	May-97	US00025502/US82311417 MSD6
1	Agilent 7890 Gas Chromatograph with MMI/ 5977A Mass Spectrometer w/ 7693 Autoinjector	5977A	June-15	CN15233175/US1523M414 MSDA

SEMI-VOLATILE ANALYSIS-INSTRUMENTATION

1	Hewlett Packard 6890 Gas Chromatograph/ 5973 Mass Spectrometer w/ 7683 Autosampler Tower	5973	May-97	US00028102/US82311610 MSD8
1	Agilent 6890N Gas Chromatograph-FID w/ CTCH5500 Headspace Autosampler	6890	July-08	CN10805007 FID8
1	Agilent 6890N Gas Chromatograph-FID w/ 7683B Autosampler	6890	March-08	CN10805005 FID6
1	Agilent 6890N Gas Chromatograph-FID w/ 7683B Autosampler	6890	June-08	CN10811015 FID7
1	Agilent 6890N Gas Chromatograph-FID w/ 7683B Autosampler	6890	July-07	US10604037 FID5
1	Hewlett Packard 6890 Gas Chromatograph-FID w/ 6890 Autosampler	6890	March-98 (Installed 4/11/2011. Old MSD2 GC)	US0009213 FID9
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ 7683 Autosampler	6890	March-98	US00023402 ECD1
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ LEAP PAL RSI Autosampler	6890	March-98	US00028911 ECD2

SEMI-VOLATILE ANALYSIS-INSTRUMENTATION

1	Agilent 7890A Gas Chromatograph-Dual Micro ECD w/ 7693 Autosampler	7890A	March-10 (Purchased from CFA December-11)	CN10842125 ECD3
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ 7673 Autosampler	6890	November-97	US00009591 ECD5
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ 7683 Autosampler	6890	November-97	US00023343 ECD6
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ 7673 Autosampler	6890	November-97	US00010134 ECD7
1	Agilent 6890 Gas Chromatograph-Dual ECD w/ 7683 Autosampler	6890	July-98	US10133016 ECD8
1	Agilent 7890A Gas Chromatograph-Dual Micro ECD w/ 7693 Autosampler	7890A	July-10	CN10261088 ECD9
1	Agilent 1260 Infinity II HPLC w/ DAD	1260	March-19	DEAEK04846, DEAEQ24263

1	Agilent 1100 HPLC w/ DAD	1100	2000?	US80603453, DE91609651
1	Ohaus Adventurer Analytical Balance		July-05	8912414746

LIQUID CHROMATOGRAPHY/HPLC

#	Equipment	Model #	Purchase Date	ID/Serial #
7	LC/MS/MS	Quattro Ultima (2)	May-02	D99SM9012R (LC) VB150 (MS)
		ABSCiex 4000 (3)	Sep-05	DE91608981 (LC) V04290402 (MS)
		ABSciex QTRAP 5500 (5)	Dec-14	L20435252316(LC) L20435252317(LC) AU212181403 (MS)
		ABSciex 5500 (6)	Nov-16	L20435453570(LC) L20435453571(LC) BB214331608 (MS)
		ABSciex 5500 (7)	Apr-17	L20435453807(LC) L20435453808(LC) BB215361701 (MS)
		ABSciex 5500 (8)	Nov-17	L20435553978(LC) L20435553979(LC) BB231241708 (MS)
		ABSciex 5500 (9)	Apr-19	L20435654577(LC) L20435654578(LC) BB230071702 (MS)
1	Shimadzu Column Heater (5)	CTO-20AC	Dec-14	L20215251917
1	Shimadzu Degasser (5)	DGU-20A	Dec-14	L20705263668

LIQUID CHROMATOGRAPHY/HPLC				
1	ABSciex PAL Autosampler (5)	MXY013-02A	Dec-14	326966
1	Shimadzu Column Heater (6)	CTO-20AC	Nov-16	L20215452696
1	Shimadzu Degasser (6)	DGU-20A	Nov-16	L20705366534
1	CTC Analytics PAL Autosampler (6)	MXY04-01A	Nov-16	380940
1	Shimadzu Column Heater (7)	CTO-20AC	Apr-17	L20215452846
1	Shimadzu Degasser (7)	DGU-20A	Apr-17	L20705467839
1	ABSciex PAL Autosampler (7)	MXY013-02A	Apr-17	141417
1	Shimadzu Column Heater (8)	CTO-20AC	Nov-17	L20215452696
1	Shimadzu Degasser (8)	DGU-20A	Nov-17	L20705568380
1	ABSciex PAL Autosampler (8)	MXY013-02A	Nov-17	410574
1	Shimadzu Column Heater (9)	CTO-20AC	Apr-19	L20215653401
1	Shimadzu Degasser (9)	DGU-20A	Apr-19	L20705670383
1	ABSciex PAL Autosampler (9)	MXY013-02A	Apr-19	423934
1	Agilent ALS	1100	Sep-05	JP13212623
1	Agilent Degasser	1100	Sep-05	US82404465
1	Agilent Column Heater	1100	Sep-05	DE11120879
1	Agilent Column Heater	1100	Apr-07	DE23919817
1	Hewlett Packard Quantum Pump	1100	Oct-99	DE91607770
1	Hewlett Packard ALS	1100	Oct-99	DE14913984
1	Hewlett Packard DAD	1100	Oct-99	JP03925183
1	Hewlett Packard Degasser	1100	Oct-99	US72103603

LIQUID CHROMATOGRAPHY/HPLC				
1	Hewlett Packard Column Heater	1100	Oct-99	DE91606066
1	Hewlett Packard Quantum Pump	1100	Nov-99	US80603453
1	Hewlett Packard ALS	1100	Nov-99	DE54627302 DE14904242
1	Agilent HPLC with DAD and FLD	1100	Nov-99	JP63203519
1	Hewlett Packard Degasser	1100	Nov-99	DE91609651
1	Hewlett Packard Column Heater	1100	Nov-99	DE33224733
1	Aglient Quantum Pump	1100	Jun-05	DE23909584
1	Agilent ALS	1100	Jun-05	DE91608331 DE92001137
1	Agilent HPLC with DAD and FLD	1100	Jun-05	JP13211588
1	Agilent Degasser	1100	Jun-05	DE33235932
1	Agilent Column Heater	1100	Jun-05	DE23919852
1	Aglient Quantum Pump	1100	Jun-07	US64401050
1	Aglient ALS	1100	Jun-07	DE43603083
1	Agilent DAD	1100	Jun-07	JP73016466
1	Agilent Degasser	1100	Jun-07	US82404303
1	Agilent Column Heater	1100	Jun-07	00119266EK
1	OHAUS Analytical Balance	CQ10R11-2E1	N/A	61476

1	Organomation N-EVAP112	9125	Nov-16	

VOLATILE ORGANIC ANALYSIS

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4760/Eclipse/4100 Sample Processor	5973	Oct-99 Jul-19	A917447740 US91911845 (US7119196) VOA1 E921410286
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with 0I 4760 Eclipse/4100 sample Processer	5973	Nov-98 Jul-19	G107466806P US71191097 (US00023264) VOA9 E919410643
1	Aglient Gas Chromatograph/Mass Spectrometer Chemstation with OI 4760 Eclipse/4100 Sample Processor	5973	Apr-09 May-19	A910447548 US71191093/US00026073 VOA4 B521413051
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5975	Aug-06	K736460761 12534 US61332879(CN10848050)(VOA5)

VOLATILE ORGANIC ANALYSIS

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with 0I 4660 Eclipse/Arcon Autosampler	5973	Jan-98	K523466628P 12548 US71191112(US00010331)VOA8
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI Eclipse/Arcon Autosampler	5975C	Apr-09	(E911466523P) VOA2 MS0901W017 US83131318/CN10606080
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5973	Jul-04	M948460722 41581 US71191113(US00028288)VOA3
1	Agilent Gas Chromatograph/Mass Spectrometer Chemstation	5977A	July-15	US51523M408/CN15173066 VOAC
1	Agilent Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5975	Sep-05	A920447563 US52430466(CN10525054)VOA6 E919410645
1	Agilent Gas Chromatograph/Mass Spectrometer Chemstation with OI Eclipse/Arcon Autosampler	5975	Apr-09	E911466524P CN10848117 (VOAA) MS0901W018

				US83131219
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI Eclipse/Arcon Autosampler PID/FID Detectors	6890	June-11	US0026725 (B431466149P) (VOAB) FID=1471 PID=54500 Archon 13382
1	Agilent Flame Ionization Detector /Chemstation with OI 4560	6890N	Aug-08	CN10813002 (VOC4)
1	OHAUS Toploading Balance	AV812N	N/A	B323410747
1	Sartorius Toploading Balance	CP622	N/A	19452583

ORGANICS EXTRACTIONS

Equipment	Model #	Purchase Date	ID/Serial #
Tekmar Sonic Distribution	600		22461D
J2 Scientific GPC	Accup-MP5	Jul-05	05C-1159-4-0

ORGANICS EXTRACTIONS

Equipment	Model #	Purchase Date	ID/Serial #
Zymark Turbovap	Turbovap II	May-96	TV9612N6726 TV9631N6975 TV9628N6939 TV9809R7994 TV0146N10597 TV0146N10596 TV0146N10598 TV0146N10595 TV1346N20168 TV1246N17453
Soxtherms	SOX416/SE416	Jan-05 Nov-16	4041427 4040014 4040019 4040018 SX2033 SX2050 1/846516004 1/8465160005 1/8465160006 1/8465160007
Turbovap II Biotage	Turbovap II	Feb-18	180600348 174600239 180200293 180600353 180600350 180300303

N-Evaps Organomation	115 1205	Jun-93 Jun-95	2812 6184 2038 11634
2- OHAUS Adventurer Toploading Balance	AX2202	July-2019	B843654719 B843654723
Sartorius AG Toploading Balance	LP8200P	N/A	14908834

METALS ANALYSIS

#	Equipment	Model #	Purchase Date	ID/Serial #
3	Perkin Elmer Mercury Analyzer	FIMS 100 FIMS 100 FIMS 100	Feb-14 Oct-18 Nov-19	101S14020102 101S18092701 101S19081301
1	AA WINLAB (Software)	6.5.0.0266	Feb-14	NA
2	Syngistix for AA (software)	Ver 3.1	10/18/2018 11/20/2019	NA
1	PS Analytical Atomic Fluorescence Mercury Analyzer	10.035	Aug-17	606
1	Millennium (Software)	NA	Aug-17	NA

METALS ANALYSIS

4	Perkin Elmer Inductively Coupled Plasma Mass Spectrometer	ELAN 9000 NexION 300 NexION 350 NexION 350X	Apr-10 May-14 Aug-14 Mar-18	AJ13141002 81VN4031301 85VN4061701 85XN7111002
4	Perkin Elmer ICPMS (Software)	2.4 SP3	Apr-10 May-14 Aug-14 Mar-18	NA
4	Perkin Elmer Inductively Coupled Plasma Spectrometer	7300DV 8300DV AVIO500 AVIO500	Mar-10 Apr-14 Feb-18 Jan-20	077C0022701 078S1403012 081S1711281 081S1911213
1	Winlab 32 (software)	Ver 3.1.0	Apr-19	NA
3	Syngistix (software)	Ver 3.0	Mar-10 Mar-18 Jan-20	NA
1	Thermo Orion 3Star	3Star	Dec-17	9731
1	Thermo Orion pH meter	420	Prior to 2008	065576
1	OHAUS Balance	AV313	Jan-14	B351136893
1	Sartorius Balance	CP22025	Prior to 2008	14509268

3	OHAUS Balance	AX423/E AX423/E AX2202	1/19/2019 1/19/2019 10/28/2019	B848841591 B843640835 B925840821
4	TCLP Tumblers	NA	Prior to 2008	T 101 T 104 T 105 T 106
3	Environmental Express HotBlock	SC100	Prior to 2008	Various units
11	Environmental Express HotBlock	SC154	Prior to 2008	Various units
2	Torrey Pines Scientific Hotplate	HP51	Prior to 2008	08301024 08301025
1	U.S. Filter Modulab Water System	M00100	Prior to 2008	LW2264
1	Barnstead NANOpure Diamond	D11901	Aug-02	1190030186870
1	Thermo Centrifuge	CL30	Apr-08	307070484

GENERAL CHEMISTRY

#	Equipment	Model #	Purchase Date	ID/Serial #
1	OI Analytical, TOC 1030S	OI1030S	Oct-15	A536733677
2	OI Analytical, TOC 1030W	OI1030W	Apr-15 Jan-16	P504730315 P550730559P

GENERAL CHEMISTRY

#	Equipment	Model #	Purchase Date	ID/Serial #
2	ATOC (software)		Apr-15	NA
2	Horizon Speed Vap II	9000 9000	Oct-01 Apr-02	01-337 01-340
2	Lachat QuikChem 8000	8000 series	Jul-01 Jul-02	A83000-1910 A83000-2077
1	Lachat QuikChem 8500	8500 series	Jan-06	60900000344
3	Omnion (software)	3.0.218 3.0.218 3.0.219	Jul-01 Jul-02 Jan-06	NA
2	ThermoSpectronic	20D+	Nov-03 Aug-06	3DUD255001 3DUJ199004
2	Mitsubishi Total Organic Halogen Analyzer	AOX-200	Jul-10 Mar-16	E7B00117 E7BA0376
2	Dionex Ion Chromatograph	ICS-3000	Apr-09 Apr-09	09030720 09030721
1	Dionex Ion Chromatograph	ICS-5000	Jul-10	10060501
3	Dionex Ion Chromatograph	Aquion	Jun-16 Aug-19 Mar-20	160540166 190640129 200240003
1	Dionex Ion Chromatograph	ICS-1600	Jul-14	14060002

GENERAL CHEMISTRY

#	Equipment	Model #	Purchase Date	ID/Serial #
7	Chromeleon (software)	7.2.1	Jul-14	NA
1	Turbidimeter	430T	Nov-19	19430781
1	Titrino Karl Fischer Moisture Analyzer	870KF	Mar-20	1870001031535
2	TKN Block Digestor	TKN100	Jul-16 May-17	2016TKNBC115 2017TKNBC133
2	Fried Electronics Stirring Hotplates	MH1-3x2	Jul-17	0568 0569
1	YSI Dissolved Oxygen Meter	5000	Apr-15	15D100827
1	IEC Clinical Centrifuge	Clinical	Prior to 2008	428-17189
1	Rapid Tester Setaflash	RT-00001	May-14	142271
1	VWR Oven	1370FM	Prior to 2008	101399
2	Yamato	DX602C DX600	3/20/2020 Prior to 2008	J1812255 A7700008
1	Vulcan Furnace	3-550PD	Apr-15	DKZ1316115V
2	HACH COD Reactor	95600-00	Jan-94	911005731C 9807000017919
1	Orion Conductivity Meter	A212	Dec-17	X37231

GENERAL CHEMISTRY

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Parr 6200 Calorimeter	Parr 6200	Aug-14	M40303
6	Sartorius Balance	1872 BP2100S BA210S BA221S LC4800-P ED2200S	Prior to 2008	40245216 3410156 90710197 90606741 410010032 25150025
2	OHAUS Balance	PA 114 AX124	Jan-11 Apr-17	8331440032 B649420569
1	Brookfield Viscometer	LVDVE	Apr-05	E6515383
1	Beckman Centrifuge	TJ-6	Prior to 2008	4359
1	VWR Centrifuge	Clinical 200	Nov-11	68105001
5	Simple Cn Hotblocks	SC6002	Apr-09 Apr-09 Jan-09 Jan-09 Dec-18	5388DIS1012 5388DIS1016 5873DIS1030 5873DIS1036 2018DISW1225
2	BOD incubator	2020 818	Jan-99 Jan-10	10059509 26AW-9
1	Thermo Orion Star A111	A111	Sep-15	J10067
1	Thermo Orion Star A111	A111	Feb-14	J06078

1	Electronic Digital Caliper	62379-531	Dec-18	191986678
1	Setaflash Series 8 Active Cool	82100-2 U	Aug-19	1059732
2	MicroBlock R Distillation	EMD 1920-107	Nov-17 Dec-18	2262 2386

RADIOCHEMISTRY/BIOASSAY				
#	**Equipment**	**Model #**	**Purchase Date**	**ID/Serial #**
96	Canberra Alpha Spectrometers for Alpha Spectroscopy System (environmental)	7401	1992 to 1995	Various
156	Canberra Alpha Analyst Spectrometers with PIPS Detectors (environmental)	7200	1988 to 2009	Various
144	Canberra Alpha Analyst Spectrometer with PIPS Detectors (bioassay)	7200	1988-2009	Various
1	Perkin Elmer Automatic Gamma Counter	1480	Jun-05	4800440
1	Gamma Products G5400W Low background Alpha/Beta Counting System with 4 detectors	G5420-400T	Jan-17	121603

RADIOCHEMISTRY/BIOASSAY				
4	Compaq/DEC Alpha Work Stations for Alpha/Gamma Data Management System	500AU 500AU 500AU DS-10 DS-10	Nov-98 Nov-98 Jan-04 May-06 Mar-09	N188806229 4006DP9Z1060 AY93206555 AY30703843 (spare)
2	Protean Automatic Proportional Counter (Bioassay)	WPC 9550	Oct-2003 Jul-2004	EMC 0329438 924233
11	Protean Multi-Detector (40) Proportional Counter	MDS-16	Apr-02 Jul-2005 Oct-05 Mar-02	10751,10752,10753,10754 0525767,0525768 0531474,0531474 311437,311438, 0021910
4	Protean Multi-Detector (16) Proportional Counter	MDS-16	Feb-09	9115168, 169, 170,171
2	Tennelec LB-4100 Proportional Counter with 32 detectors	LB4100	Jun-93 Dec-98	18483 21938
1	Tennelec LB-4100 Proportional Counter with 16 detectors	LB4100	2010	70562
1	Gas Flow Proportional Counter with 4 detectors	G5420-400T	Jan-17	121603

RADIOCHEMISTRY/BIOASSAY				
8	Beckman Liquid Scintillation Counters	LS6000 LS6500 LS6500 LS6000 LS6500 LS6500 LS6000 LS6000	Jun-93 Jun-93 Apr-94 Mar-03 Oct-03 Dec-98 Dec-98 Jan-14	7065155 7067083 7067404 7060655 7070506 7069123 7060656 7069693
1	Perkin Elmer Inductively Coupled Plasma Mass Spectrometer	ELAN9000	Jun-10	AJ13351006
2	Perkin Elmer Liquid Scintillation Counter – Wallac Guardian (environmental)	1414	1997 2010	4140127 4140421
2	Protean Automatic Proportional Counter	WPC 4550		2910 1111
1	Perkin Elmer Liquid Scintillation Counter – Wallac Guardian (bioassay)	1414	1998	4140299
2	Perkin Elmer Quantulus	1220	1998 2009	2200082 DG06095168
2	Ortec – Alpha Spectrometers	alpha ensemble-8	2010	10235232 10230971
7	Ortec – Alpha Spectrometers	octete-pc	2010	177, 182, 217, 266, 264, 144, 176

RADIOCHEMISTRY/BIOASSAY				
#	Equipment	Model #	Purchase Date	ID/Serial #
1	Perkin Elmer Liquid Scintillation Counter – Rackbeta	1219	2010	206147
1	Perkin Elmer ICPMS	ELAN 9000	2010	AJ13271005
1	Broad-Energy Germanium Detector(Carbon Comp. Window)	BE3825	2006	3068173
1	High Purity Germanium Coaxial Detector	GEM90210-P	1990	30-TP30546-A
1	High Purity Germanium Coaxial Detector	GEM-35190	2004	CV-P122204CA
1	High Purity Germanium Coaxial Detector	GEM35	2007	CV-PO42407CA
1	High Purity Germanium Coaxial Detector	GEM35P4-83	2008	CV-TP011608CA
1	High Purity Germanium Well Detector	GCW3523	1994	3941466
1	Low Energy Germanium Detector (Beryllium Window)	GL1015	1988	488926
1	Low Energy Germanium Detector (Beryllium Window)	GL1010S	1990	10902649
1	Low Energy Germanium Detector (Beryllium Window)	GL2820R	1995	1954119
1	Low Energy Germanium Detector (Beryllium Window)	GL2820R	1998	3984452

RADIOCHEMISTRY/BIOASSAY				
#	**Equipment**	**Model #**	**Purchase Date**	**ID/Serial #**
1	Low Energy Germanium Detector (Beryllium Window)	GL2020R	2007	9078304
1	Low Energy Germanium Detector (Carbon Comp. Window)	GL2020-S	1992	12922782
1	N-Type High Purity Germanium Coaxial Detector	GMX 45225-P-S	1990	37-TN11260A
1	N-Type High Purity Germanium Coaxial Detector	GMX30200-P	1990	30-TN10348
1	N-Type High Purity Germanium Coaxial Detector	NIG3019	1991	PGT2461
1	P-Type High Purity Germanium Coaxial Detector (Bioassay)	IGC3919	1993	2605
1	Reverse-Electrode Coaxial Germanium Detector (Beryllium Window)	GR3019	1986	9861606
1	Reverse-Electrode Coaxial Germanium Detector (Beryllium Window)	GR2020	1991	1912509
1	Reverse-Electrode Coaxial Germanium Detector (Carbon Comp. Window)	GR3520	1993	8932581
1	Reverse Electrode Coaxial Germanium Detector	GR3021	1992	3922553

RADIOCHEMISTRY/BIOASSAY				
#	**Equipment**	**Model #**	**Purchase Date**	**ID/Serial #**
1	Reverse Electrode Coaxial Germanium Detector (Beryllium Window)	GR4019	1996	1966073
2	Standard Electrode Coaxial Germanium Detector	GC3519	1991	9912854, 11912876
2	Standard Electrode Coaxial Germanium Detector	GC3520	1992 2000	12922955 2007152
4	Standard Electrode Coaxial Germanium Detector	GC2018	1992	9923035 9923043 10923049 10923050
1	Standard Electrode Coaxial Germanium Detector	GC3018	1993	5933088
1	Standard Electrode Coaxial Germanium Detector	GC3519	1994	1943234
1	Standard Electrode Coaxial Germanium Detector	GC8021	1994	8943324
1	Standard Electrode Coaxial Germanium Detector (Bioassay)	GC3519	1994	1943199

RADIOCHEMISTRY/BIOASSAY				
1	Standard Electrode Coaxial Germanium Detector	GC3519	1992 2005	3922907 7059000
8	Standard Electrode Coaxial Germanium Detector	GC4019	1995 2001 2006 2007	6953489 6953483 6953542 10017452 10017444 9069163 9069175 10079344
3	Standard Electrode Coaxial Germanium Detector	GC4020	2005 2006	10059017 10059015 4069118
4	Standard Electrode Coaxial Germanium Detector	GC4520	2009	4099544 4099570 10099624 11099639
1	N-Type High Purity Germanium Coaxial Detector	GMX35195-P-S	1991	34-TN-20891A

RADIOCHEMISTRY/BIOASSAY				
8	Ludlum Alpha Scintillation Detector	Ludlum-182	2007 Mar-17 Jul-17 Jan-17	PR086493 PR140731 PR101846 PR078964 PR364855 PR139590 PR286612 PR286613
1	Perkin Elmer Automatic Gamma Counter	Model 2480	Oct-17	DG12095812
1	Sartorius Balance	A200S		38080204
1	Sartorius Balance	CP2201		18150253
2	Sartorius Balance	CP323S		18550299 15750050
1	Sartorius Balance	CP 2202S		17955156
1	Sartorius Balance	HD 2000 D		39020004
2	Sartorius Balance	I 12000 S		40109033 39039003
1	Sartorius Balance	L2200S		38110007
1	Sartorius Balance	BP3100S		51204863

RADIOCHEMISTRY/BIOASSAY				
1	Sartorius Balance	U5000D		36080009
1	Sartorius Balance	R 300S		38110047
1	Sartoris Balance	LC6200S		30503875
1	Sartoris Balance	LC3201D		60108592
1	Sartoris Balance	TE313S		16107662
1	Sartoris Balance	ENTRIS5201		34104035
3	Sartoris Entirs Balance	ENTRIS5201-1S		35602249 35602240 33005595
1	Sartoris Entris Balance	ENTRIS224-15		33604148
1	Sartoris Entris Balance	ENTRIS52202-1S		33010896
1	Mettler Analytical Balance	AE160		C31514
1	Mettler Analytical Balance	AE163		F33394

RADIOCHEMISTRY/BIOASSAY				
2	Mettler Analytical Balance	AE200		F30560 1113021018
1	Mettler Analytical Balance	AE240		L28658
1	Mettler Analytical Balance	AE50		1113092273
1	Mettler Analytical Balance	PM16-N		N39169
1	Mettler Analytical Balance	PM 4600		J93763
1	OHAUS Toploader Balance	RD6RM		2525244
2	Mettler Analytical Balance	Model AT261	Jan-05	M64061
HIGH RAD ALIQUOT ROOM				
#	**Equipment**	**Model #**	**Purchase Date**	**ID/Serial #**
1	Adventurer Pro	AV2102	Oct-14	B440101411

LABORATORY INFORMATION MANAGEMENT SYSTEMS

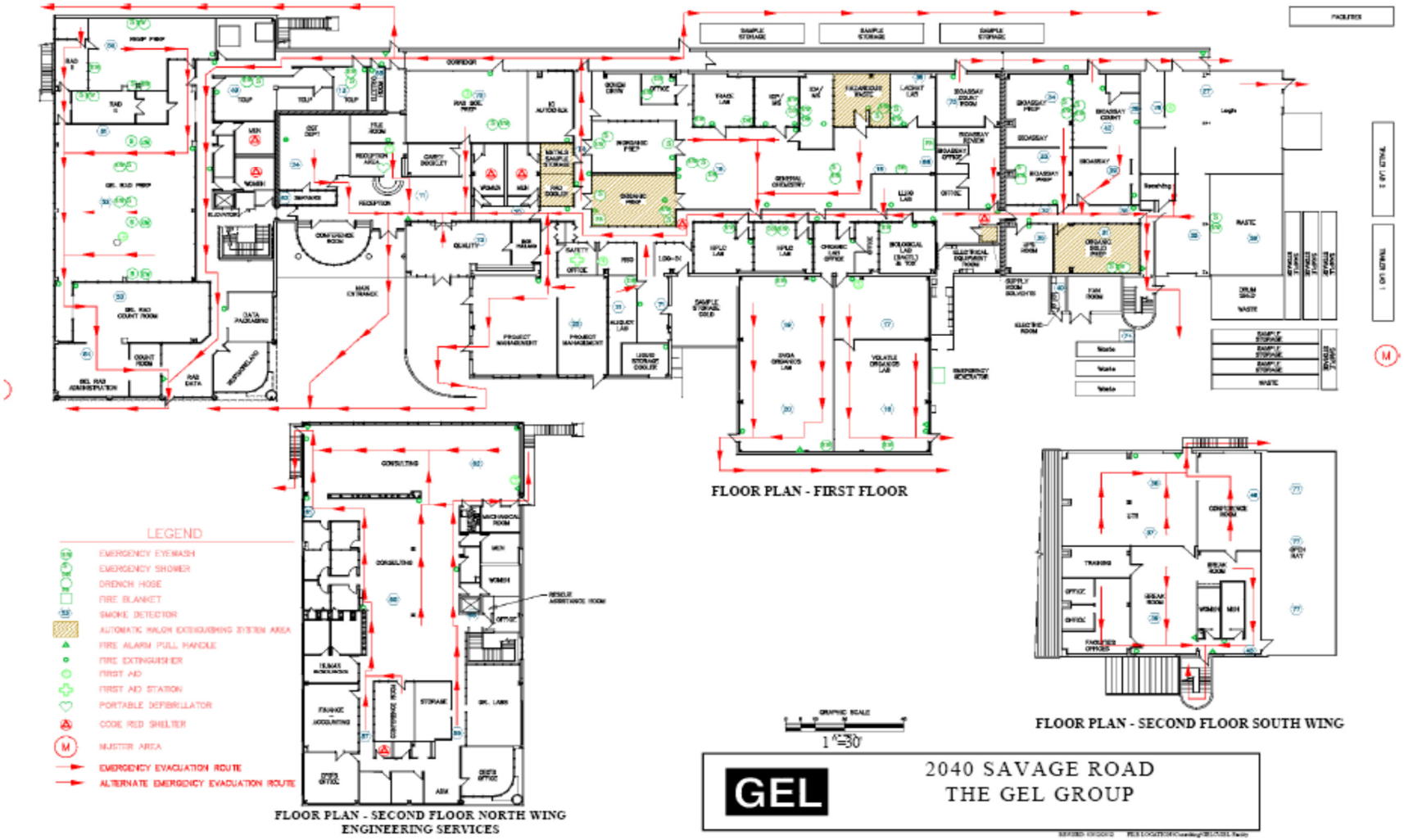
#	Equipment	Model #	Purchase Date	ID/Serial #
1	DELL Poweredge 2950 2 X 3.0Ghz 2GB ram	2950	2007	DG2CNB1
1	HP9000 Dclass, HP-UX 10.20, 2 cpu, 256 MB RAM, (hpclp1) 50GB Disk (mirrored and RAID%), Raid tower, 100 Mbps Eth card, Target Software	N/A	Nov-97	A3480A
1	HP9000 Dclass, HP-UX 10.20, 2 cpu, 256 MB RAM, (104ilroy) 50GB Disk (mirrored and RAID5), Raid tower, 100 Mbps Eth card, Target Software	N/A	Nov-97	A3480A
1	HP9000 Dclass, HP-UX 10.20, 2 cpu, 256 MB RAM, (prdsvr07) 50GB Disk (mirrored and RAID5), Raid tower, Target Software	N/A	Nov-97	A3480A
1	Sun V890 (prodsvr01) 8X1.5Ghz) 128GB ram (mirrored and raid5)	V890	2007	0529AM019F
1	Sun V890(standbysvr01) 4X1.35Ghz 32GB (mirrored and rad5)	V890	2008	0526AM02F

1	HP-Prolient DL380 Gen9 (vmhost01) 2-10QuadCoreX2.40GHz 352GB	DL380	2009	MXQ6290GNC
1	HP-Prolient DL380 Gen9 (vmhost02) 2-10QuadCoreX2.40GHz 352GB	DL380	2009	MXQ6290GNH
1	HP-Prolient DL380 Gen9 (vmhost03) 2-QuadCoreX2.83GHz 352GB	DL362	2009	MXQ6290GP5
1	HP2012i (san01) DC Modular Smart Array	2012i	2009	3CL904C108
1	HPE Nimble Hybrid Storage Array	HF40	2019	5UM9390073
1	EMC Storage Array Network (SAN)	VNX5200	Jan-2015	APM00145036951

UNIVERSAL POWER SUPPLY

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Mitsubishi	9900B	~10/10/17	16-7M85443-01

APPENDIX H: FACILITIES WITH EVACUATION ROUTES



APPENDIX I: STANDARD OPERATING PROCEDURES AND ANALYTICAL METHODS

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-ADM-E-001	Preparation, Authorization, Advance Change, Revision, Release, and Retirement of Standard Operating Procedures	N/A
GL-AP-E-001	Invoicing Analytical Lab Numbers	N/A
GL-CO-E-001	Revising GEL Laboratories Catalog of Analytical Services	N/A
GL-CO-E-002	Delegated Authority to Commit the Company	N/A
GL-CO-E-003	Request for Proposal (RFP) and Contract Review	N/A
GL-CS-E-002	Internal Review of Contractually Required Quality Criteria for Client Package Delivery	N/A
GL-CS-E-005	Electronic Data Deliverables	N/A
GL-CS-E-006	Subcontracting Analytical Services	N/A
GL-CS-E-008	Prelogin, Login, and Login Review	N/A
GL-CS-M-001	Project Management AlphaLIMS Manual	N/A
GL-DC-E-001	Document Control	N/A
GL-FC-E-001	Facility Security	N/A
GL-FC-E-002	Testing Emergency Eyewash and Shower Equipment	N/A
GL-FC-E-003	Local Exhaust Ventilation Systems	N/A
GL-FC-E-004	Inspection of Fire Extinguishers	N/A
GL-GC-E-001	Total Dissolved Solids	EPA 160.1, 2540C
GL-GC-E-004	General Chemistry Standards, Definitions, and Preparation	N/A
GL-GC-E-007	Total Organic Halogen (TOX) and Adsorbable Organic Halides on Liquid Samples Using the Mitsubishi AOX-200 Analyzer	1650C, 9020B
GL-GC-E-008	pH	EPA 150.1, 9040B/9040C, 9041A, 9045C/9045D 4500-H^+ -00
GL-GC-E-009	Conductivity and Salinity	EPA 120.1, 9050A, SM 2510B-97, SM 2520B-10
GL-GC-E-010	Paint Filter Test	EPA 9095A/9095B
GL-GC-E-011	Total Solids	2540B, 2540G-2011
GL-GC-E-012	Total Suspended Solids	SM 2540D
GL-GC-E-028	Carbonaceous Biochemical Oxygen Demand (CBOD)	EPA 405.1, 5210B-01
GL-GC-E-029	Corrosivity Toward Steel	1110(M), 1110A(M)
GL-GC-E-032	Carbon Dioxide (Total and Free) by Calculation	4500-CO_2 D
GL-GC-E-033	Alkalinity: Total, Bicarbonate, Carbonate, Hydroxide, and Phenolphthalein	EPA 310.1(M), 2320B-97
GL-GC-E-035	Volatile Suspended Solids	EPA 160.4, 2540E
GL-GC-E-036	Color by Visual Comparison	2120B

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-GC-E-037	Turbidity	180.1, 2130-B
GL-GC-E-040	Pretreatment of Cyanide Amenable to Chlorination	EPA 335.1, 9010B/9010C, 9012A/9012B 4500-CN^- G-99
GL-GC-E-044	Colorimetric Determination of Hexavalent Chromium	7196A, 3500-Cr D, 3060A
GL-GC-E-045	Biochemical Oxygen Demand (BOD)	EPA 405.1, 5210B
GL-GC-E-047	Methylene Blue Active Substance	EPA 425.1, 5540C
GL-GC-E-048	Heating Value Determination by Bomb Calorimeter	ASTM D 240-14, 4809-13, E 711-87(M)
GL-GC-E-052	Sulfide (Methylene Blue Method)	EPA 376.2(M), HACH 8131, 4500 S^{2-} D
GL-GC-E-056	Sulfite	4500-SO_3^{2-} B-2000, EPA 377.1
GL-GC-E-057	Volatile Solids and % Ash Procedure for Water Samples	EPA 160.4, 2540E
GL-GC-E-058	Volatile Solids and % Ash Procedure for Solid and Semisolid Samples	2540G
GL-GC-E-059	Dissolved Oxygen Analysis by Membrane Electrode Method	4500-O^- G, EPA 360.1
GL-GC-E-061	Chemical Oxygen Demand (COD) Digestion Reactor Method	EPA 410.4, 5220-D, HACH 8000
GL-GC-E-062	Total Carbon and Total Organic Carbon Analysis Using the OI Analytical 1030S TOC Solids Module	9060 (M) 9060A (M), 5310-B
GL-GC-E-064	Density	ASTM D5057
GL-GC-E-065	Specific Gravity	ASTM D5057
GL-GC-E-066	Flashpoint by Setaflash	1020, ASTM D 3278-78
GL-GC-E-067	Cyanide Sample Distillation	9012, 9010 335.3, 335.4, 335.2-M, 4500-CN^- C
GL-GC-E-068	Viscosity	ASTM D2161 (Mod), ASTM D2983 (Mod), Brookfield Viscometer
GL-GC-E-069	Reactive Cyanide and Sulfide	SW-846 Chap 7.3.3, Chap 7.3.4
GL-GC-E-071	Total Phosphorous and Total Kjeldahl Nitrogen Sample Preparation	EPA 365.4, 351.2, 4500N_{org}-D-2011
GL-GC-E-072	Ammonia-Nitrogen Sample Preparation	EPA 350.1, 4500-NH_3^- B
GL-GC-E-073	Free Cyanide Analysis by Microdiffusion	ASTM D 4282
GL-GC-E-074	Extractable Organic Halides (EOX)	SW-846 9023
GL-GC-E-076	Total Residue Chlorine	4500-Cl G
GL-GC-E-077	Cyanide Weak Acid Dissociable Sample Preparation and Analysis	EPA 335.4, 4500-CN^-I
GL-GC-E-079	Bomb Preparation Method for Solid Waste	5050
GL-GC-E-082	Acid-Soluble Sulfides	9030B, 9034
GL-GC-E-086	Ion Chromatography (IC)	EPA 300.0, 9056

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-GC-E-087	Percent Water by Karl Fischer Titration	ASTM E203-08
GL-GC-E-090	Acidity	2310B
GL-GC-E-091	Wavelength Calibration Verification of Thermospectronic Spectrophotometers	N/A
GL-GC-E-092	General Chemistry Data Review and Packaging	N/A
GL-GC-E-093	Total, Total Inorganic and Total Organic Carbon (TOC) using the OI Analytical Model 1010 TOC Analyzer	EPA 415.1, 9060, 9060A 5310B-2011
GL-GC-E-094	N-Hexane Extractable Material (HEM; Oil and Grease) and Silica GEL Treated N-Hexane Extractable Material (SGT-HEM Non-Polar Material) in Aqueous Matrices	1664, 1664B
GL-GC-E-095	Cyanide Analysis by Lachat QuikChem 8000 FIA	CLP 335.2-M, 335.3. 335.4, 9010, 9012, 4500-CN^- E
GL-GC-E-096	Perchlorate by Ion Chromatography (IC)	EPA 314.0
GL-GC-E-100	Total Hardness by Titration	SM 2340C-97
GL-GC-E-102	Total Recoverable Phenol by the Lachat QuikChem FIA+ 8000 Series	EPA 420.4, 9066
GL-GC-E-103	Total Phosphorus by the Lachat Quickchem FIA+ 8000 Series Instrument	EPA 365.4, 4500 P H
GL-GC-E-104	Total Kjeldahl Nitrogen (TKN) Using the Lachat QuikChem FIA+ 8000 Series Instrument	EPA 351.2, 4500 N_{org} D
GL-GC-E-106	Ammonia Determination by the Lachat Quickchem FIA + 8000 Series	EPA 350.1 Rev 2, 4500-NH_3 H
GL-GC-E-107	Inorganic Calculations	N/A
GL-GC-E-123	Column Settling	EM 1110-02-5027
GL-GC-E-127	Modified Elutriate Test	N/A
GL-GC-E-128	Nitrate/Nitrite (NO_3+NO_2) Analysis Using The Lachat QuickChem FIA + 8000 Series Instrument	EPA 353.2, 4500-NO_3^-
GL-GC-E-130	Percent Ash Determined at 775 C Procedure for Solid and Semisolid Samples	ASTM D 482-03 (M)
GL-GC-E-132	Hexavalent Chromium Analysis Using the Lachat Quikchem FIA +8000 Series Instrument	SM 3500-Cr B, SW-846 7196A
GL-HR-E-002	Employee Training	N/A
GL-IT-E-001	Information Technology Program for Good Laboratory and Good Manufacturing Practices	N/A
GL-IT-E-002	Computer Systems Team Roles and Responsibilities	N/A
GL-IT-E-003	Requirements, Design, Operation, Validation and Removal of Hardware and Software Systems Used by the GEL Group, Inc.	N/A
GL-IT-E-004	Change Control Requirements for Hardware and Software	N/A
GL-IT-E-005	Requirements, Design, Operation, Validation and Removal of Applications Used by The GEL Group, Inc.	N/A

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-IT-E-006	Change Control Requirements for Applications	N/A
GL-IT-E-007	User Roles and Responsibilities for Personnel Using Computer Services	N/A
GL-IT-E-009	Archive and Retrieval of Systems Information	N/A
GL-IT-E-010	Backup of Computer Controlled Instrumentation	N/A
GL-IT-E-011	System Security and Virus Protection	N/A
GL-IT-E-012	Application Tools used by Computer Services Personnel	N/A
GL-IT-E-013	GEL Electronic Processes and LIMS Audit System	N/A
GL-IT-E-014	Disaster Recovery	N/A
GL-IT-E-015	Operation of LIMS Database Primary and Failover Servers	N/A
GL-LB-E-001	The Determination of Method Detection Limits and Method Quantitation Limits	N/A
GL-LB-E-002	Balances	N/A
GL-LB-E-003	Glassware Preparation	N/A
GL-LB-E-004	Temperature Monitoring and Documentation Requirements for Refrigerators, Ovens, Incubators, and Other Similar Devices	N/A
GL-LB-E-005	Data Review and Validation	N/A
GL-LB-E-006	Toxicity Characteristic Leaching Procedure Preparation	SW-846 1311
GL-LB-E-007	Laboratory Standards Documentation	N/A
GL-LB-E-008	Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms and Other Recordkeeping Devices	N/A
GL-LB-E-009	Run Logs	N/A
GL-LB-E-010	Maintenance and Use of Air Displacement Pipets	N/A
GL-LB-E-012	Verifying the Maintenance of Sample Integrity	N/A
GL-LB-E-013	CLP-Like/DOE Data Package Assembly and Revision	N/A
GL-LB-E-016	The Collection and Monitoring of the DI Water Systems	N/A
GL-LB-E-017	Procedure and Policy for Manual Integration	N/A
GL-LB-E-018	Instrument Clock Verification	N/A
GL-LB-E-020	Tuning of High Intensity Ultrasonic Processor	N/A
GL-LB-E-023	Waste Extraction Test (WET)	N/A
GL-LB-E-024	Synthetic Precipitation Leaching Preparation	EPA 1312
GL-LB-E-026	Container Suitability Testing	N/A
GL-LB-E-027	Bioassay Kit Delivery and Retrieval	N/A
GL-LB-E-029	Laboratory Sub-Sampling	N/A
GL-LB-E-030	Silica Gel and Air Filter Removal and Replacement	N/A
GL-LB-E-031	Sample Compositing	N/A
GL-LB-E-032	The Distribution of High Risk and Limited Volume Samples	N/A

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-LB-E-033	Proper Peak Identification for Organics	N/A
GL-LB-E-034	Laboratory Filtration Samples	N/A
GL-LB-G-001	Laboratory Waste Management Plan	N/A
GL-LB-N-001	Safety, Health and Chemical Hygiene Plan	N/A
GL-LB-S-001	Disaster Preparedness and Recovery Plan	N/A
GL-LB-E-X-001	Facility Closure Plan	N/A
GL-MA-E-006	Acid Digestion of Total Recoverable or Dissolved Metals in Surface and Groundwater Samples for Analysis by ICP or ICP-MS	3005A
GL-MA-E-008	Acid Digestion of Total Metals in Aqueous Samples and Extracts for Analysis by ICP and ICP-MS	3010A
GL-MA-E-009	Acid Digestion of Sediments, Sludges, and Soils	3050B, 6010, 6020
GL-MA-E-010	Mercury Analysis Using the Perkin Elmer Automated Mercury Analyzer	245.1, 245.2, 7470A, 7471A, 7471B
GL-MA-E-013	Determination of Metals by ICP	EPA 200.7, 6010B, 6010C, 6010D
GL-MA-E-014	Determination of Metals by ICP-MS	6020, 6020A, 6020B, EPA 200.8,
GL-MA-E-016	Sample Preparation for Total Recoverable Elements by EPA Method 200.2	EPA 200.2
GL-MA-E-017	Metals Data Validation	N/A
GL-MA-E-018	Mercury Analysis using the PS Analytical Millennium Automated Mercury Analyzer	EPA 1631 Rev E
GL-MA-E-020	Acid Digestion of Personal Cassette Filters for Analysis by ICP	NIOSH 7303
GL-OA-E-001	Establishing Retention Time Windows for GC and HPLC Analysis	SW-846 8000
GL-OA-E-003	Non-Volatile Total Petroleum Hydrocarbons by Flame Ionization Detector	8000, 8015, 3541, 3580
GL-OA-E-004	Volatile Total Petroleum Hydrocarbons by Flame Ionization Detector	5030, 5035, 8000, 8015
GL-OA-E-009	Analysis of Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry	8270, EPA 625.1
GL-OA-E-010	Extraction of Semivolatile and Nonvolatile Organic Compounds from Soil, Sludge, and Other Miscellaneous Solid Samples	3500, 3550, 8270, 8081, 8082, 8015, 8310
GL-OA-E-011	Analysis of Chlorophenoxy Acid Herbicides by ECD	8000, 8151A
GL-OA-E-013	Extraction of Semivolatile and Nonvolatile Organic Compounds from Groundwater, Wastewater, and Other Aqueous Samples	3510, 8270, 8081, 8082, 8015 8310, 608.3, 625.1, AK102, AK103
GL-OA-E-015	The Extraction of Herbicides from Groundwater, Wastewater, and Other Aqueous Samples	8151

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-OA-E-020	Percent Moisture	ASTM D2216-05
GL-OA-E-022	Volatile Organic Compounds by Gas Chromatograph/Mass Spectrometer Applicable to EPA Method 524.2	EPA 524.2
GL-OA-E-026	Volatile Organic Compounds (VOC) by Gas Chromatograph/Mass Spectrometer	EPA 624.1
GL-OA-E-027	The Extraction of Herbicides from Soil and Sludge Samples	8151
GL-OA-E-030	Polynuclear Aromatic Hydrocarbons	8310
GL-OA-E-033	Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC)	8000, 8330A, 3535
GL-OA-E-036	Florisil Cleanup of Organochlorine Pesticide Solvent Extracts	3510, 3620, 3550, 8081,
GL-OA-E-037	Sulfuric Acid/Permanganate Cleanup of PCB Solvent Extract	3550C, 3665A, 8082,
GL-OA-E-038	Volatile Organic Compounds (VOC) by Gas Chromatograph/Mass Spectrometer	8260, 5030, 5035, 8000, 3585, SM 6200
GL-OA-E-039	Closed-System Purge-and-Trap Collection and Extraction Volatile Organics in Soil and Waste Samples	EPA 5035, 3585
GL-OA-E-040	Polychlorinated Biphenyls	8000, 8082, 608.3
GL-OA-E-041	Organochlorine Pesticides and Chlorinated Hydrocarbons	8000, 8081, 608.3
GL-OA-E-044	Organics Validation	N/A
GL-OA-E-045	Sulfur Clean-up	3660B
GL-OA-E-046	Common Industrial Solvents, Glycols, and Various Organic Compounds by Flame Ionization Detector	8000, 8015
GL-OA-E-047	Gel Permeation Cleanup of Solvent Extracts	3640A, 3510C, 3550C, 8270, 8081, 8082
GL-OA-E-049	Silica Gel Cleanup Using Solid Phase Silica Gel Extraction Cartridges	3550C, 3510C, 3630C, 3541
GL-OA-E-050	The Extraction of Semi-Volatile and Nonvolatile Organic Compounds from Oil	3580, 8015, 8081, 8082, 8081, 8270
GL-OA-E-054	The Determination of Gasoline Range Organics Using Flame Ionization Detection Per Alaska Method AK101	AK101
GL-OA-E-055	The Determination of Diesel Range and Residual Range Organics	AK102. AK 103, 3510C, 3550B
GL-OA-E-056	Definitive Low Level Analysis of Nitroaromatic Explosives Utilizing Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS) by SW-846 Method 8321 Modified (8321M)	8321A(M), 8000, 8330(M), , 8330B(M)
GL-OA-E-058	Volatile Storage Blanks	N/A
GL-OA-E-059	Analysis of 1,2-Dibromoethane (EDB) and 1,2-Dibromo-3-Chloropropane (DBCP) in Water by GC/ECD Using Methods 504.1 or 8011	EPA 504.1, 8011
GL-OA-E-061	Haloacetic Acids in Water	EPA 552.2

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-OA-E-063	Massachusetts Method for the Determination of Extractable Petroleum Hydrocarbons	Massachusetts EPH
GL-OA-E-064	Dissolved Gases in Water by Flame Ionization Detector (FID)	RSK-175
GL-OA-E-065	Reagent/Solvent/Standards Screening for Organic Prep	N/A
GL-OA-E-066	Automated Soxhlet Extraction	EPA 3541,
GL-OA-E-067	Definitive Low Level Perchlorate Analysis Utilizing Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS) by EPA Method 6850 Modified (6850M)	6850(M), 8000
GL-OA-E-068	The Processing, Extraction, and Analysis of Nitroaromatics, Nitroamines, and Nitrate Esters by SW-846 8330B	8330B, 3535
GL-OA-E-070	Solid-Phase Extraction	EPA 3535
GL-OA-E-071	The Pre-Extraction Processing of Soil Samples Collected Using Multi-Incremental Sampling (MIS) Techniques	EPA 8330B
GL-OA-E-073	Analysis of 1,4-Dioxane in Drinking Water by Solid Phase Extraction (SPE) and Gas Chromatography/Mass Spectrometry	EPA 522
GL-OA-E-074	Massachusetts Volatile Petroleum Hydrocarbons by Photoionization and Flame Ionization Detectors	N/A
GL-OA-E-075	Washington Method for the Determination of Extractable Hydrocarbons	WA EPH
GL-OA-E-076	The Extraction and Analysis of Per and Polyfluroalkyl Substances Using LCMSMS	DOD QSM Table B-15 V., 5.3; ASTM D79698-17A; 537 Version, 1.1
GL-OA-E-078	The Extraction and Analysis of Cannabinoids by QuEChERS and High Performance Liquid Chromatography	GEL Developed Method
GL-OA-E-079	The Extraction of Herbicides using Solid Phase Extraction	GEL Developed Method
GL-OA-E-080	The Analysis of Naphthalene Sulfonate Using High Performance Liquid Chromatography	GEL Developed Method
GL-QS-B-001	Quality Assurance Plan	N/A
GL-QS-E-001	Conduct of Quality Audits	N/A
GL-QS-E-002	Conducting Corrective/Preventive Action and Identifying Opportunities for Improvement	N/A
GL-QS-E-003	Training and Qualifying Quality Assurance Audit Personnel	N/A
GL-QS-E-004	AlphaLIMS Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items	N/A
GL-QS-E-005	Review of Monitoring Device Logs	N/A
GL-QS-E-007	Thermometer Verification	N/A

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-QS-E-008	Quality Records Management and Disposition	N/A
GL-QS-E-011	Method Validation and Initial and Continuing Demonstrations of Capability	N/A
GL-QS-E-012	Client NCR Database Operation	N/A
GL-QS-E-013	Handling of Proficiency Evaluation Samples	N/A
GL-QS-E-014	Quality Assurance Measurement Calculations and Processes	N/A
GL-QS-E-015	Use of Logos and Describing Accredited Status	N/A
GL-QS-E-016	Identification and Implementation of New and Revised Methods	N/A
GL-QS-E-017	Maintaining Technical Training Records	N/A
GL-QS-E-018	Communication of Substantial Nonconforming Safety Related Services	N/A
GL-QS-E-019	Trending of Performance Evaluation Data	N/A
GL-RAD-A-001	The Determination of Gross Alpha And Gross Non-Volatile Beta in Water	900.0, 9310
GL-RAD-A-001B	The Determination of Gross Alpha And Gross Non-Volatile Beta in Soil, Filters, Solid Matrices and Direct Count Air Filters	900.0(M), 9310
GL-RAD-A-001C	The Determination of Gross Alpha in Water by Co-precipitation	520/5-84-006 Method 00-02
Gl-RAD-A-001D	The Determination of Gross Alpha Gross Non-Volatile Beta in Drinking Water	600/4-80-032 Method 900.0
GL-RAD-A-002	The Determination of Tritium	600/4-80-032, 906.0(M)
GL-RAD-A-003	The Determination of Carbon-14 in Water, Soil, Vegetation and Other Solid Matrices	N/A
GL-RAD-A-004	The Determination of Strontium 89/90 in Water, Soil, Milk, Filters, Vegetation and Tissues	905.0(M), DOE RP501 Rev1(M), HASL 300(M)
GL-RAD-A-005	The Determination of Technitium-99 Using ICP-MS	HASL 300(M) TC-02-RC, DOE RP550(M), ASTM C 1387-03(M), ASTM 1476-00(M)
GL-RAD-A-006	The Determination of Radiometric Iodine	901.1(M), HASL 300(M) I-01
GL-RAD-A-007	The Determination of Radon-222 in Water	SM 7500 Rn-B
GL-RAD-A-008	The Determination of Radium-226	903.1(M), HASL 300(M) Ra-04-RC
GL-RAD-A-009	The Determination of Radium-228 in Water and Solids	904.0(M)
GL-RAD-A-010	Total Alpha Radium Isotopes in Soil and Water	900.1(M)
GL-RAD-A-011	The Isotopic Determination of Americium, Curium, Plutonium, and Uranium	DOE RP800 1997(M), HASL-300 U-02-RC(M), HASL-300 Am-05-RC(M) HASL-300 Pu-11-RC(M)
GL-RAD-A-013	The Determination of Gamma Isotopes	901.1 (M), HASL-300 (M) Sec. 4.5.2.3, HASL-300 Ga-01-R
GL-RAD-A-015	Digestion for Soil	N/A

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-RAD-A-016	The Determination of Radiometric Polonium	EPA 600/4-80-032
GL-RAD-A-017	The Determination of Iodine-131 in Drinking Water	902.0, 7500 I^- B
GL-RAD-A-018	The Determination of Lead-210 in Liquid and Solid Matrices	N/A
GL-RAD-A-019	Determination of Phosphorus-32 in Soil and Water	N/A
GL-RAD-A-020	The Determination of Promethium-147 in Soil and Water	N/A
GL-RAD-A-021	Soil Sample Preparation for the Determination of Radionuclides	N/A
GL-RAD-A-021B	Soil Sample Ashing for the Determination of Radionuclides	N/A
GL-RAD-A-022	The Determination of Ni-59 and Ni-63	N/A
GL-RAD-A-026	The Preparation of Special Matrices for the Determination of Radionuclides	N/A
GL-RAD-A-028	Radium-226 in Drinking Water by EPA Method 903.1	EPA 903.1
GL-RAD-A-029	The Determination of Strontium-89/90 in Drinking Water by EPA Method 905.0	EPA 905.0
GL-RAD-A-030	Determination of Radium-228 in Drinking Water	904.0, 9320
GL-RAD-A-031	The Determination of Selenium	N/A
GL-RAD-A-032	The Isotopic Determination of Neptunium/Thorium	N/A
GL-RAD-A-033	Determination of Chlorine-36 in Solid and Liquid Samples	N/A
GL-RAD-A-035	The Isotopic Determination of Plutonium-241	HASL-300 Pu-11-RC(M)
GL-RAD-A-036	The Isotopic Determination of Americium, Curium, and Plutonium in Large Soil Samples	DOE RP800(M) HASL-300 Am-05-RC(M) HASL-300 Pu-11-RC(M) HASL-300 Pu-12-RC(M)
GL-RAD-A-037	Radium-226 and Radium-228 in Drinking Water by Sulfate Precipitation and Gamma-Ray Spectrometry	N/A
GL-RAD-A-038	The Isotopic Determination of Thorium	DOE RP800(M), HASL-300(M) Pu-02-RC, Pu-03-RC
GL-RAD-A-040	The Determination of Fe-55 in Liquid and Solid Matrices by Liquid Scintillation Counter	N/A
GL-RAD-A-041	The Determination of Total Activity in Solids and Liquids	N/A
GL-RAD-A-044	Total Alpha Radium Isotopes In Drinking Water	903.0, 9315, HASL 300(M)
GL-RAD-A-046	The Determination of Radium-224 and Radium-226 by Alpha Spectroscopy	N/A
GL-RAD-A-047	48 Hour Rapid Gross Alpha Test	ECLS-R-G-A, EPA 600/4-80-032, 900.0(M)
GL-RAD-A-048	The Determination of Calcium-45 in Soils and Waters	N/A
GL-RAD-A-049	The Determination of Sulfur-35	NAS-NS-3054
GL-RAD-A-050	The Determination of Tritium in Drinking Water Samples	600/4-80-032, 906.0
GL-RAD-A-051	The Rapid Determination of Strontium 89/90 by Cerenkov Counting	N/A

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-RAD-A-052	The Determination of Organically Bound Tritium	600\4-80-032, 906.0
GL-RAD-A-053	Isotopic Determination of Plutonium in Large Water Resin Samples	HASL 300 Pu-11-RC
GL-RAD-A-054	The Determination of Strontium-90 in Brine	N/A
GL-RAD-A-055	The Preparation of Environmental Samples for Isotopic Uranium Analysis Via ICP-MS	N/A
GL-RAD-A-056	The Determination of Gross Alpha and Beta by Liquid Scintillation Counter	N/A
GL-RAD-A-058	The Rapid Determination of Strontium 89/90 by Gas Flow Proportional Counting	N/A
GL-RAD-A-059	The Determination of Technetium-99 Using Analytical Grade 1X8 Resin	N/A
GL-RAD-A-060	The Preparation of Vegetation and Filter Samples Via Organic Destruction and Strong Acid Leach for Radiochemistry Metals Analysis	N/A
GL-RAD-A-063	The Determination of Radium-228 Using DGA Cartridges	N/A
GL-RAD-A-064	The Determination of Fe-55 in Liquid and Solid Matrices Using DGA Resin	N/A
GL-RAD-A-065	The Determination of Carbon-14 in Atmospheric Screening Cartridges	N/A
GL-RAD-A-066	The Determination of Radiometric Polonium Using DGA Cartridges	N/A
GL-RAD-A-067	The Determination of Radiometric of Tritium and Carbon 14 in Combustible Materials Using Pyrolysis	N/A
GL-RAD-A-068	The Determination of Americium, Curium, Plutonium, Uranium, and Thorium in Liquid and Solid Matrices Using Eichrom Resin	N/A
GL-RAD-A-069	Determination of Neptunium Using AG Anion Resin	N/A
GL-RAD-A-070	The Preparation of Environmental Samples for Isotopic Uranium Using DGA Resin Via ICP-MS	N/A
GL-RAD-B-001	The Sequential Determination of Isotopic Americium, Curium, Californium, Plutonium, Strontium and Uranium in Urine	N/A
GL-RAD-B-002	The Determination of Polonium-210 or Radium-226 in Bioassay Samples	N/A
GL-RAD-B-005	Management of Blank Populations	N/A
GL-RAD-B-008	The Determination of Gross Alpha Activity in Nasal Swipes	N/A
GL-RAD-B-009	Bioassay Countroom Alpha Spectroscopy Instrument Standardization and Performance	N/A
GL-RAD-B-010	The Determination of Thorium in Fecal Samples	N/A
GL-RAD-B-011	The Determination of Tritium in Urine	EPA 906
GL-RAD-B-012	The Ashing of Fecal, Bone, and Tissue Samples	N/A

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-RAD-B-013	Sequential Determination of Americium, Plutonium, Strontium, Plutonium-241, and Uranium in Fecal, Bone, and Tissue Samples	N/A
GL-RAD-B-014	The Preparation of Synthetic Urine and Fecal Material	N/A
GL-RAD-B-016	The Determination of Technetium-99 in Urine	N/A
GL-RAD-B-020	The Determination of Ni-59 and Ni-63 in Urine	N/A
GL-RAD-B-022	The Determination of Gross Alpha and Gross Non-volatile Beta in Urine	EPA 900.0, 9310, EERF 00-01, USGS R-1120-76
GL-RAD-B-023	The Determination of Carbon-14 in Urine	EERF C-01(M)
GL-RAD-B-024	Managing Statistical Data in the Bioassay Laboratory	N/A
GL-RAD-B-025	The Combination and Preservation of Urine Samples	N/A
GL-RAD-B-026	Bioassay Data Review, Validation and Data Package Assembly	N/A
GL-RAD-B-027	Specific Gravity in Urine	ASTM D5057
GL-RAD-B-029	The Determination of Radiometric Iodine in Urine	N/A
GL-RAD-B-030	The Preparation and Determination of Gamma Isotopes in Urine and Fecal Samples	600/4-80-032
GL-RAD-B-031	Bioassay Quality Control Package Assembly	N/A
GL-RAD-B-033	Bioassay Count Room Alpha Spectrometry Instrument Calibration	N/A
GL-RAD-B-034	The Determination of Metals by ICP-MS	N/A
GL-RAD-B-035	The Preparation of Urine Samples for Total Uranium Analysis by ICP-MS	N/A
GL-RAD-B-036	Initial Installation and Returning to Service of Repaired Instrumentation	N/A
GL-RAD-B-038	The Determination of Neptunium in Fecal Samples	N/A
GL-RAD-B-039	The Determination of Iron-55 in Urine	N/A
GL-RAD-B-040	The Determination of Radium-224 and Radium-226 by Alpha Spectroscopy in Bioassay Sample	N/A
GL-RAD-B-041	The Sequential Determination fo Isotopic Thorium and Neptunium in Urine	N/A
GL-RAD-B-042	The Isotopic Determination of Thorium and Neptunium and Fecal Samples	N/A
GL-RAD-D-002	Analytical Methods Validation for Radiochemistry	N/A
GL-RAD-D-003	Data Review, Validation, and Data Package Assembly	N/A
GL-RAD-D-005	REMP Quality Control Package Assembly	N/A
GL-RAD-D-006	Equations Used in Data Reduction for Environmental Radiochemistry	N/A
GL-RAD-I-001	Gamma Spectroscopy System Operation	N/A

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-RAD-I-004	Beckman LS-6000/6500	N/A
GL-RAD-I-006	LB4100 Gross Alpha/Beta Counter Operating Instructions	N/A
GL-RAD-I-007	Ludlum Lucas Cell Counter	N/A
GL-RAD-I-008	VAX/VMS Quality Control Software Program	N/A
GL-RAD-I-009	Alpha Spectroscopy System	N/A
GL-RAD-I-010	Counting Room Instrumentation Maintenance	N/A
GL-RAD-I-012	Managing Statistical Data in the Radiochemistry Laboratory	N/A
GL-RAD-I-013	Column Preparation	N/A
GL-RAD-I-014	WALLAC Guardian Model 1414	N/A
GL-RAD-I-015	WPC 9550 Gross Alpha/Beta Counter: Operating Instructions	N/A
GL-RAD-I-016	Multi-Detector Counter: Operating Instructions	N/A
GL-RAD-I-017	Wallac 1220 Quantalus Liquid Scintillation Counter	N/A
GL-RAD-I-018	Operation of Wallac 1480 Gamma Wizard	N/A
GL-RAD-I-019	Management of Blank Populations	N/A
GL-RAD-I-021	G5400W Series Alpha/Beta Counting System Operating Instructions	N/A
GL-RAD-M-001	Preparation and Verification of Radioactive Standards	N/A
GL-RAD-M-003	Restoring Data from Magnetic Tape for Bioassay and Alpha Spectroscopy	N/A
GL-RAD-S-000	Radiation Safety Plan for GEL Laboratories, LLC	N/A
GL-RAD-S-001	Radiological Surveys	N/A
GL-RAD-S-002	Radiation Related Emergencies	N/A
GL-RAD-S-003	Administration of the Radioactive Material License Inventory	N/A
GL-RAD-S-004	Radioactive Material Handling	N/A
GL-RAD-S-006	Radiation Worker Training	N/A
GL-RAD-S-007	Receiving Radioactive Packages	N/A
GL-RAD-S-009	Personnel Dosimetry	N/A
GL-RAD-S-010	The Handling of Biological Materials	N/A
GL-RAD-S-013	Air Sampling for Radioactivity	Guide 825
GL-RAD-S-014	Release of Laboratory Coats	N/A
GL-RAD-S-015	The Acceptance and Classification of Radioactive Material	N/A
GL-RAD-S-016	Radiation Work Permits	N/A
GL-RAD-S-018	Laboratory Analysis of High Activity (RAD 3) Samples	N/A
GL-RC-E-001	Receipt and Inspection of Material and Services	N/A
GL-RC-E-002	Material Requisition	N/A

Standard Operating Procedures and Analytical Methods		
SOP #	**SOP Title**	**Methods**
GL-SR-E-001	Sample Receipt, Login, and Storage	N/A
GL-SR-E-002	Transportation and Shipping of Samples and Pre-Preserved Sample Containers	N/A
GL-SR-E-003	The Inspection, Cleaning and Screening of Sample Coolers	N/A
GL-SR-E-004	Control of Foreign Soils	N/A
GL-SR-E-005	Wipe Test	N/A
GL-SVR-D-001	Design Specifications for the Network Infrastructure	N/A
GL-SVR-D-002	Design Specifications for the Mail Server	N/A
GL-SVR-D-005	Design Specifications for Backupsvr01	N/A
GL-SVR-E-001	Network Infrastructure	N/A
GL-SVR-E-002	The Mail Server	N/A
GL-SVR-E-005	Backupsvr01	N/A
GL-SVR-R-001	System Requirements for Network Infrastructure	N/A
GL-SVR-R-002	System Requirements for The Mail Server	N/A
GL-SVR-R-005	System Requirements for Backupsvr01	N/A

APPENDIX J: SAMPLE STORAGE AND PRESERVATION REQUIREMENTS
STORAGE AND PRESERVATION

Parameter	Container [1]	Preservation	Holding Time[2]	Min. Volume[5]
INORGANICS				
Acidity	P,G	0 ≤ 6° C	14 days	25 mL / NA
Adsorbable Organic Halides (AOX)	G, amber	0 ≤ 6° C, HNO_3 to pH < 2, zero headspace	>3 days and < 6 months from collection	50 mL / 1 g
Alkalinity	P,G	0 ≤ 6° C	14 days	50 mL / NA
Biochemical Oxygen Demand (BOD) and Carbonaceous Oxygen Demand (CBOD)	**P,G**	**0 ≤ 6° C**	**48 hours**	**500 mL / NA**
Bromide	P,G	None required	28 days	10 mL / 4 g
Carbon Dioxide	**P,G**	**0 ≤ 6° C**	**Immediate**	**50 mL / NA**
Chemical Oxygen Demand (COD)	P,G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	2 mL / NA
Chlorine by Bomb Calorimeter	P,G	0 ≤ 6° C	None	NA / 0.5 g
Chloride	P,G	None required	28 days	10 mL / 4 g
Color	**P,G**	**0 ≤ 6° C**	**48 hours**	**50 mL / NA**
Conductivity	P,G	0 ≤ 6° C	28 days	25 mL / NA
Corrosivity by pH	**P,G**	**None**	**Immediate**	**25 mL / 5 g**
Corrosivity to Steel	P,G	None	None	290 mL / NA
Cyanide amenable to chlorination	P,G	0 ≤ 6° C, NaOH to pH > 12, 0.6 g ascorbic acid [3]	14 days [4]	50 mL / NA
Cyanide, Reactive Releasable	G, amber	Zero headspace	7 days liquids, 28 days solids	10 mL / 10 g
Cyanide, total, available, free or Weak Acid Dissociable	P,G	0 ≤ 6° C, NaOH to pH > 12, 0.6 g ascorbic acid [3]	14 days [4]	50 mL / 1 g
Density	P,G	0 ≤ 6° C	7 days	NA / 10 g
Dissolved Oxygen	**G (bottle and top)**	**None, Zero headspace**	**Immediate**	**300 mL / NA**
Extractable Organic Halides (EOX)	G, amber	Zero headspace, 0 ≤ 6° C	**28 days**	**25 mL**
Flashpoint	Metal, G	None	None	25 mL / 2 g Setaflash
Fluoride	P,G	None Required	28 days	25 mL / 4 g
Fluorine by Bomb	P,G	0 ≤ 6° C	None	NA/ 0.5 g
Hardness (EDTA titration)	P,G	0 ≤ 6° C, HNO_3 to pH < 2	6 months	50 mL / NA
Hardness (calculation)	P,G	HNO_3 to pH < 2	6 months	50 mL / NA
Heating Value	P,G	0 ≤ 6° C	None	1 mL / 0.5 g
Nitrogen-Ammonia	P,G	0 ≤ 6° C, H_2SO_4 to pH< 2	28 days	20 mL / 5 g
Nitrate – Liquids	**P,G**	**0 ≤ 6° C**	**48 hours**	**10 mL**

Nitrate – Solids	P,G	0 ≤ 6° C	28 days for extraction, 48 hrs from extraction to analysis	4 g
Nitrite - Liquids	**P,G**	**0 ≤ 6° C**	**48 hours**	**10 mL**
Nitrite - Solids	P,G	0 ≤ 6° C	28 days for extraction, 48 hrs from extraction to analysis	4 g
Nitrate/Nitrite	P,G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	4 mL / 4 g
Nitrogen - Total Kjeldahl and Organic	P,G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	20 mL / 5 g
Oil and Grease	G	0 ≤ 6° C, HCl or H_2SO4 to pH < 2	28 days	1000 mL
Orthophosphate -Liquids	**P,G**	**Field filter immediately, 0 ≤ 6° C**	**48 hours**	**10 mL**
Orthophosphate – Solids	P,G	0 ≤ 6° C	28 days for extraction, 48 hrs from extraction to analysis	4 g
Paint Filter Liquids Test	Any	None	None	100 g
Percent (%) Moisture	P,G	0 ≤ 6° C	None	2 mL / 5 g
Perchlorate by Ion Chromatography	P,G	0 ≤ 6° C	28 days	10 mL / 4g
Total Phenols	G,	0 ≤6° C, H_2SO_4 to pH < 2	28 days	50 mL / 1 g
pH	**P,G**	**None if within 15 mins of collection,** 0 ≤ 6° C when shipped to lab	**Immediate**	**25 mL / 5 g**
Total Phosphorus	P,G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	20 mL / 1 g
Residual Chlorine	**P,G**	**None Required**	**Immediate**	**25 mL / NA**
Residue, Total	P,G	0 ≤ 6° C	7 days	100 mL / NA
Residue, Filterable (TDS)	P,G	0 ≤ 6° C	7 days	70 mL / NA
Residue, NonFilterable (TSS)	P,G	0 ≤ 6° C	7 days	1000 mL
Residue, Volatile and Fixed (% Ash)	P,G	0 ≤ 6° C	7 days	25 mL / 1 g
Salinity	P,G	0 ≤ 6° C	28 days	25 mL / NA
Specific Gravity	P,G	0 ≤ 6° C	7 days	50 mL / NA
Sulfate	P,G	0 ≤ 6° C	28 days	10 mL / 4 g
Sulfide	P,G	0 ≤ 6° C, add ZnAc and NaOH to pH > 9	7 days	200 mL / 20 g
Sulfide, Reactive Releasable	G, amber	Zero headspace, 0 ≤ 6° C	7 days liquids, 28 days solids	10 mL / 10 g
Sulfide, Acid-Soluble	P,G	Zero headspace, 0 ≤ 6° C Liquids: ZnAc and NaOH to pH > 9. Solids: Fill surface with 2N ZnAc	7 days liquids, 365 days solids	200 mL / 20 g
Sulfite	**P,G**	**EDTA[9]**	**Immediate**	**50 mL / NA**

Sulfur by Bomb	P,G	0 ≤ 6° C	None	NA / 0.5 g
Surfactants	**P,G**	**0 ≤ 6° C**	**48 hours**	**100 mL / NA**
Total Organic Carbon (TOC), also applies Dissolved Organic Carbon (DOC), Total Carbon (TC) and Total Inorganic Carbon (TIC)	G, amber	0 ≤ 6° C, HCl or H_2SO_4 to pH < 2	28 days	50 mL / 5 g
Total Organic Halides (TOX)	G	0 ≤ 6° C, H_2SO_4 to pH < 2, Zero headspace	28 days	50 mL / 1 g
Total Petroleum Hydrocarbons	G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	1000 mL / NA
TCLP (Toxicity Characteristic leaching Procedure) and Synthetic Precipitation Leaching Procedure (SPLP)	P,G depending on test	0 ≤6° C, depends on test	14 days, VOA 14 days, SVOA 28 days Mercury 180 days non-Hg metals	105 g or 130 g for full TCLP list
Turbidity	**P,G**	**0 ≤ 6° C**	**48 hours**	**50 mL / NA**
Viscosity	P,G	0 ≤ 6° C	None	7 mL
Metals – Liquids (except chromium VI, Boron, Silica and mercury)	P, (G as long as no B or Si is required)	HNO_3 to pH < 2	6 months	20 mL
Boron-Liquids	P, Teflon or Quartz	HNO_3 to pH <2	6 months	50 mL
Silica- Liquids	P or Quartz	0 ≤ 6° C	28 days	50 mL
Metals – Solids[8] (except chromium VI and mercury)	P, (G as long as no B or Si is required)	None	6 months	2 g
Chromium VI – Liquids	**P,G**	**0 ≤ 6° C**	**24 hours**	**25 mL**
Chromium VI - Liquids	P,G	0 ≤ 6° C, $(NH_4)_2SO_4$, pH = 9.3 to 9.7	28 days	25 mL
Chromium VI - Solids[8]	P,G	0 ≤ 6° C	30 days to digestion, 7 days from digestion to analysis	1 g
Mercury - Liquids	P,G	HNO_3 to pH < 2	28 days	50 mL
Mercury - Solids[8]	P,G	0 ≤ 6° C	28 days	2 g
Mercury – Low Level Liquids	P,G	HCl or BrCl	90 days when preserved w/in 48 hrs or oxidized w/in 28 days	50 mL

ORGANICS				
Method AK101-Solids[7]	Amber G	4 ± 2 °C, zero headspace, methanol	14 days	4 oz[7]
Method AK101-Liquids	Amber G	4 ± 2 °C, HCl < 2	14 days	3x40 mL
Method AK102-Liquids	Amber G	4 ± 2 °C, HCl or H_2SO_4 to pH < 2	14 days	1000 mL

Method AK102/103-Solids	Amber G	4 ± 2 °C	14 days for extraction 40 days after extraction for analysis	4 oz
MADEP EPH - Liquids	Amber G	4 ± 2 °C, HCl < 2	14 days	4 oz
MADEP EPH – Solids	Amber G	4 ± 2 °C	14 days	1000 mL
MADEP VPH – Liquids (ambient purge) Trip Blank Required	G, teflon-lined septum	4 ± 2 °C, HCl < 2	14 days	3x40 mL
MADEP – VPH Liquids (Heated Purge) Trip Blank Required	G, teflon-lined septum	4 ± 2 °C, Add 0.40 – 0.44g trisodium phosphate dodecahydrate to pH>11	14 days	3x40 mL
MADEP VPH – Solids Trip Blank Required	G, Teflon-lined septum	1mL MeOH/g sample at sampling or within 48 hrs, 4 ± 2 °C	28 days	60mL vials add 25g sample, 40 mL vials add 15 g sample
BTEX – Liquids	G, Teflon-lined septum	0 ≤ 6° C, zero headspace, HCl to pH < 2, 0.008% $Na_2S_2O_3$ [3]	14 days [6]	3x40 mL
BTEX - Solids[8]	**G, Teflon-lined septum**	**0 ≤ 6° C**	**48 hours for preservation and 14 days for analysis**	**3x5 g EnCores or 2 low and 1 high level vials**
Volatiles - Drinking Water, Wastewater/groundwater (except 2-CLEVE, acrolein, and acrylonitrile)	G, Teflon-lined cap	0 ≤ 6° C, zero headspace, HCl to pH < 2	14 days	3x40 mL
Volatiles (including 2 CLEVE) - Wastewater	G, Teflon-lined cap	0 ≤ 6° C, zero headspace, unpreserved	7 days [6]	3x40 mL
Volatiles - (acrolein and acrylonitrile)	G, Teflon-lined cap	0 ≤ 6° C, zero headspace, unpreserved	3 days [6] by EPA 624.1 7 days [6] by EPA 8260	3x40 mL
Volatiles - Solids[8]	**EnCore Sampler**	**0 ≤ 6° C**	**48 hours for preservation 14 days for analysis**	**3x5 g EnCores**
Volatiles - Concentrated Waste	G, teflon-lined septum	None	14 days	1x40 mL
Base/Neutral and Acid Extractables and 1,4-Dioxane – Liquids	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% $Na_2S_2O_3$ [3]	7 days for extraction 40 days after extraction for analysis	1000 mL / 50 g
Base/Neutral and Acid Extractables and 1,4-Dioxane-Solids[8]	G, Teflon-lined cap	0 ≤ 6° C	14 days for extraction 40 days after extraction for analysis	1000 mL / 50 g
Base/Neutral and Acid Extractables - Concentrated Waste	G, Teflon-lined cap	None	7 days for extraction 40 days after extraction for analysis	1000 mL / 50 g
TPH-GRO	G, Teflon-lined cap	0 ≤ 6° C, HCl to pH < 2, zero headspace	14 days	3x40 mL

TPH-DRO	G, Teflon-lined cap	0 ≤ 6° C, HCl to pH < 2	7 days for extraction (Liquids) 14 days for extraction (Solids) 40 days after extraction to analysis	1000 mL / 50 g
Chlorinated Herbicides - Liquids	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% $Na_2S_2O_3$ [3]	7 days for extraction 40 days after extraction for analysis	1000 mL
Chlorinated Herbicides - Solids[8]	G, Teflon-lined cap	0 ≤ 6° C	14 days for extraction 40 days after extraction	50 g
Organochlorine Pesticides by SW-846 EPA 8081 Liquids	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% $Na_2S_2O_3$	7 days for extraction 40 days after extraction for analysis	1000 mL
Organochlorine Pesticides by SW-846 EPA 8081 Solids	G, Teflon-lined septum	0 ≤ 6° C	14 days for extraction 40 days after extraction for analysis	50g
Organochlorine Pesticides and PCBS by EPA 608.3 only	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% , $Na_2S_2O_3$ [3], NaOH and H_2SO_4preserve to pH 5.0 -9.0 (for prep >72 hrs and < 7 days)	**Unpreserved Prep within 72 hrs** Preserved prep within 7 days 40 days after extraction for analysis	**1000 mL / NA**
PCBs- Liquids	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% $Na_2S_2O_3$ [3]	365 days for extraction 40 days after extraction for analysis	1000 mL
PCBs- Solids	Wide-mouth glass	0 ≤ 6° C	365 days for extraction 40 days after extraction for analysis	50g
PCBs in Oil	G, Teflon-lined cap	None	365 days for extraction 40 days after extraction for analysis	1x40 mL
Solvents, Glycols, Alcohols and Acetates -- Liquid	G, Teflon-lined septum	0 ≤ 6° C, zero headspace or 0 ≤ 6° C, zero headspace HCl to pH < 2	7 days unpreserved 14 days preserved	1 x 40mL
Solvents, Glycols, Alcohols and Acetates -- Solids	G, Teflon-lined septum	0 ≤ 6° C	14 days	10g
Industrial Solvents	G, Teflon-lined septum	0 ≤ 6° C	14 days	1x40 mL

1,4-Dioxane in Drinking Water by EPA 522	G, Teflon-lined septum	<10ºC during transport, Sodium sulfite (50mg/L), sodium bisulfate (1g/L)	28 days for extraction at 0 ≤ 6° C (not frozen) and 28 days after extraction for analysis at -5º C, protected from light	100 mL to 500 mL
Dioxin Screen	G, Teflon-lined cap	0 ≤ 6° C	7 days for extraction 40 days after extraction for analysis	1000 mL / 50 g
EDB and DBCP	G, Teflon-lined septum	0 ≤ 6° C, 0.4% $Na_2S_2O_3$	14 days	3x40 mL / NA
Polynuclear Aromatic Hydrocarbons	Amber G, Teflon-lined septum (Liquids), Teflon-lined cap (Solids)	0 ≤ 6° C	7 days for extraction (Liquids) 14 days to extraction (Solids) 40 days to analysis after extraction	1000 mL / 30 g
Nitroaromatics and Nitroamines	Amber G, Teflon-lined septum	0 ≤ 6° C	7 days for extraction 40 days after extraction for analysis	1000 mL / 2 g
Nitroaromatics and Nitroamines by MIS Prep (solid samples)	Protect from light	0 ≤ 6° C until air drying 22 ± 4° C (or cooler) after drying	14 days for extraction, 40 days after extraction for analysis	Entire Sample
RDX Breakdown	Amber G, Teflon-lined septum for liquids and Teflon-lined cap for solids	0 ≤ 6° C	7 days to extraction for liquids 14 days to extraction for solids 40 days to analysis after extraction	1000 mL / 2 g
Low Level Perchlorate	P	0 ≤ 6° C , headspace required	28 days	10 mL / 2 g
Haloacetic Acids	G, amber, Teflon-lined septum	0 ≤ 6° C , zero headspace, ammonium chloride	14 days to extraction, 7 days after extraction for analysis	3x40 mL
Dissolved Gases	G, Teflon-lined septum	0 ≤ 6° C, HCl to pH < 2, zero headspace	7 days if unpreserved, 14 days if preserved	2x40 mL

Perfluorinated Alkyl Acids PFAS	HDPE Bottle - unlined polyethylene screw cap	0 ≤ 10° C for liquids, 0 ≤ 6° C for solids, 1.25g Trizma® (Drinking Water only)	14 days from collection to extraction, 28 days from extraction to analysis (liquids) 28 days from collection to extract and analyze (solids)	250 mL/10 g
RADIOCHEMISTRY				
Americium – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Americium – Solids[8]	P,G	None	6 months	20 g
Calcium-45 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	500 mL
Calcium-45 - Solids[8]	P,G	None	6 months	20 g
Carbon-14 Liquids & Solids[8]	P,G	None	6 months	500 mL / 20 g
Cesium 134 – Drinking Water	P,G	HCl to pH < 2	6 months	2000 mL
Chlorine-36 Liquids & Solids[8]	P,G	None	6 months	500 mL / 20 g
Curium - Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Curium - Solids[8]	P,G	None	6 months	20 g
Gamma Isotopes - Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	2000 mL
Gamma Isotopes - Solids[8]	P,G	None	6 months	200 g
Gross Alpha & Beta – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	500 mL
Gross Alpha & Beta, Rapid - Liquids	**P,G**	**HNO_3 or HCl to pH < 2**	**48 – 72 hrs**	**500 mL**
Gross Alpha & Beta - Solids[8]	P,G	None	6 months	20 g
Iodine-129 - Liquids & Solids[8]	P,G	None	6 months	1000 mL / 50 g
Iodine -131 - Liquids	**P,G**	**None**	**8 days**	**1000 mL**
Iron 55 -Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	500 mL
Iron 55 - Solids[8]	P,G	None	6 months	20 g
Lead-210 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Lead-210 - Solids[8]	P,G	None	6 months	200 g
Neptunium - Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Neptunium - Solids[8]	P,G	None	6 months	20 g
Nickel-59 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Nickel-59 – Solids[8]	P,G	None	6 months	20 g
Nickel-63 - Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Nickel-63 - Solids[8]	P,G	None	6 months	20 g
Phosphorus-32 –Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Phosphorus-32 - Solids[8]	P,G	None	6 months	20 g
Plutonium – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Plutonium - Solids[8]	P,G	None	6 months	20 g
Polonium - Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Polonium - Solids[8]	P,G	None	6 months	20 g
Promethium-147/Samarium-151 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Promethium-147/Samarium-151 - Solids[8]	P,G	None	6 months	20 g
Radium-223 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	2000 mL

Radium-224 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	2000 mL
Radium-226 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Radium-228 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Radon-222 – Liquids	**G**	**None, Zero headspace**	**4 days**	**2x40 mL**
Selenium-79 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	500 mL
Selenium-79 - Solids[8]	P,G	None	6 months	20 g
Strontium-89/90 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Strontium-89/90 - Solids[8]	P,G	None	6 months	20 g
Sulfur-35 - Liquids	P,G	None	6 months	500 mL
Sulfur-35 - Solids[8]	P,G	None	6 months	20 g
Technetium-99 – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Technetium-99 – Solids[8]	P,G	None	6 months	20 g
Thorium – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Thorium - Solids[8]	P,G	None	6 months	20 g
Total Activity Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	100 mL
Total Activity - Solids[8]	P,G	None	6 months	20 g
Total Alpha Radium – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	500 mL
Total Alpha Radium - Solids[8]	P,G	None	6 months	20 g
Total Uranium - Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	100 mL
Total Uranium - Solids[8]	P,G	None	6 months	20 g
Tritium – Drinking Water	G	None	6 months	250 mL
Tritium – Liquids & Solids[8]	P,G	None	6 months	250 mL / 20 g
Uranium – Liquids	P,G	HNO_3 or HCl to pH < 2	6 months	1000 mL
Uranium - Solids[8]	P,G	None	6 months	20 g

[1] P = Polyethylene; G = Glass

[2] Samples should be analyzed as soon as possible after collection. The holding times listed are maximum times that samples may be held before analysis and be considered valid.

[3] Used only in the presence of residual chlorine.

[4] Maximum holding time is 24 hours when sulfide is present. All samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If present, remove by adding cadmium nitrate powder until a negative spot test is obtained. Filter sample and add NaOH to pH 12.

[5] Minimum amount of sample needed to prepare and analyze for the parameter. Some parameters may be combined into one analysis, others may need additional amount if quality control is being requested for site-specific samples. Please check with GELs Project Manager for proper sample amounts based on project specific requirements.

[6] Volatiles Groundwater/Wastewater: If samples are to be analyzed for vinyl chloride, styrene, or 2-chloroethylvinyl ether (2-CLEVE) for soil or water, separate samples must be collected without acid preservation and analyzed within 7 days. For aqueous samples to be analyzed for acrolein and acrylonitrile, by EPA Method 624.1, the samples are not to be acidified and must be analyzed within 3 days of collection.

[7] Solids Method AK101 2-4 oz amber wide-mouth jars tared and labeled, 1-4 oz amber wide-mouth jar labeled (evaporative loss), 2-25 mL 2.5 ppm surrogated P/T methanol tubes.

[8] Solids matrix typically applies to soils, sludges and sediments. Some tests have been developed for filters, miscellaneous solid waste, plant and animal tissue, also referred to as solids. Contact GEL to verify a particular matrix for the test of interest.

[9] 1mL of 2.5% EDTA solution per 100mL sample

APPENDIX K: STATE SPECIFIC REPORTING CRITERIA

Massachusetts: Drinking Water (Only)

Regulations at 310 CMR 42.13 (5) require that a laboratory have current knowledge of all Federal and Massachusetts standards for all categories in which it has been certified. Within 24 hours of obtaining valid data, a certified laboratory must notify its clients for any results exceeding an EPA-or Department-established maximum contaminant level, maximum residual disinfectant level or reportable concentration.

The laboratory must identify, in writing, those samples needing special reports (e.g. MCL exceedance) when the laboratory subcontracts with another laboratory.

Reports for drinking water samples must contain information relating to the maximum contaminant levels for each analyte. 310 CMR 42.13(3) specifies that with exception of reports submitted to the Department in a format approved by the Department, all reports of finished drinking water analyses must indicate the maximum contaminant level for each analyte measured. This can be accomplished in AlphaLIMS through the permit level in client set up. (Project Managers must enter these values). The maximum contaminant levels should be verified prior or sample log-in. **Please check with Quality Assurance Officer to verify that the information is correct.**

The report must identify, analyses for which the laboratory holds Department certification and which it does not. Regulations at 310 CMR 42.13(3) (b-c) require that such a distinction be made and that the laboratory clearly distinguish in the report between those analyses that it conducted in accordance with Department certification standards and those it did not.

Pennsylvania: Drinking Water (Only)

Any individual (laboratory, sample collection/pic-up facility, consultant, PWS, etc.) providing a sample to an accredited laboratory for SDWA compliance testing purposes must ensure that all relevant, and necessary information is provided along with the sample. Since the laboratory that performs the testing is responsible for reporting and making any notifications (such as MCL violations) to the PWS and the Department, the PWS and sample specific information is both relevant and necessary. If a laboratory chooses, or is required, to subcontract testing to another accredited laboratory, § 109.810(b)(1)(ii) requires that the following information MUST be provided to the subcontract laboratory:

- PWSID# and Name of the System
- Sample Location ID#
- Dates and Times of Sample Collection
- Name and Contact Number of the PWS

The testing laboratory may, if it chooses to, relinquish its authority to report the sample results. However, this relinquishment can only be made to another accredited laboratory and must be made in writing as described in § 109.810(c). The other accredited laboratory, to which the reporting and notification responsibilities are delegated, is then responsible for meeting all of the 25 Pa. Code Chapter 109.810 requirements.

Failure of the testing laboratory to provide verbal and written notification to the Public Water Supply ("PWS") or the Department, or both of an MCL violation with the required timeframes:
The Department requires in § 109.810(b)(1) that the testing laboratory **notify the PWS by telephone within 1 hour of the determination** that an MCL violation has occurred for any SDWA compliance testing result that is at or above the listed MCL for that contaminant. Chapter 252, §§ 252.708(a)(2) and (3) outline the allowable time that may elapse between initial acquisition of the sample result and the final "determination" of the sample result. The time of the determination of the final sample result triggers the start of the clock for the allowable timeframes to provide notification to the PWS and the Department. It is of upmost importance that you understand that leaving a message or voicemail is not considered "notification" of an MCL exceedance. Should the testing laboratory be unable to notify the PWS within 1 hour of the determination, the laboratory must **notify the appropriate DEP regional office by telephone within 2 hours of the determination** of the MCL exceedance. Finally, the testing laboratory is responsible for providing written notification to the Department of any MCL exceedance within 24 hours of the determination.

Failure of the testing laboratory to maintain full and complete records documenting the notification made to the PWS or the Department, or both, when an MCL violation occurs:
The accreditation regulations require that an accredited laboratory maintain accurate and complete records that allow historical reconstruction of the activities undertaken in the laboratory. The testing laboratory must maintain documentation outlining the steps taken to meet the requirements of § 109.810(a)(1) and § 252.708(a)(2) and (3), also known as the acquisition of the initial sample results and the final determination of the sample results to determine compliance with the 1-hour or 2-hour notification requirements. Specifically, the testing laboratory must maintain the following:

- Date and Time of the initial acquisition of the sample result
- Date and Time of the determination of the sample result
- Date and Time of the telephone call(s) to the PWS
- Individual at the PWS to whom the notification was made
- Date and Time of the telephone call(s) to the Department, if required
- Individual at the Department to whom the notification was made, if required
- Any other pertinent information that would be necessary to ensure a complete record

If the testing laboratory delegates the reporting and notification responsibility to another accredited laboratory, as allowed by § 109.810(c), both laboratories must maintain the records to document their activities and must ensure that the notifications occur with the required timelines. It is important to note that the **reporting laboratory has 1 hour from the determination of the result made by the testing laboratory** to notify the PWS of the MCL violation. The 1-hour notification cannot be extended due an intermediate notification from a testing laboratory to a reporting laboratory.

Failure of the laboratory to accurately and fully report the subcontracting testing laboratory's results to the PWS:
It is the laboratory's responsibility to report the final test results of any PA-DEP compliance sample accurately, correctly, unambiguously, and with any specific client instructions or regulations. The laboratory is required to ensure that it reports only those test results that are associated with appropriately collected, handled, stored, prepared, and analyzed samples or report the results with appropriate data qualifiers. In some cases, a laboratory that subcontracts the testing to another accredited laboratory may choose to transcribe the accredited

laboratory's results onto its own letterhead/report format. In these cases, the reporting laboratory is responsible for full, accurate, and complete transcription of all sample results; data qualifiers; sample collection, handling, preparation comments; any case narrative or other applicable comment directly to the PWS.

The Department recommends that laboratories provide the testing laboratory's final test report directly to the PWS instead of the transcribing the results. The Department also reminds all laboratories that only results that are associated with acceptable sample collection, storage, handling, preparation, analysis, test conditions, and quality control may be reported to DWELR. A laboratory may request permission to report qualified DW results by using the "Request to Report Qualified DW Results" form and submission instructions. Please note that microbiology test results are handled differently than chemistry results. Once the microbiology samples are accepted and the analysis begins, positive microbiology test results can only be invalidated by the Department regardless of the performance of the QC, instrument test conditions, etc.

Failure to maintain an SOP for reporting PA-DEP SDWA compliance samples that meet the requirements of 25 PA. Code Chapter 109:
The Department requires all laboratories accredited to perform SDWA compliance testing to maintain an SOP that meets the requirements of § 109.810(b)(3)(ii), also known as the "SWDA Reporting SOP." The SWDA Reporting SOP must be established initially upon accreditation and updated annually thereafter. The SOP must include procedures to meet all of the reporting, documentation, notification requirements of § 109.810. At a minimum, the SOP must include:

- The procedure for ensuring that the laboratory obtains and maintains the information regarding the Public Water Supplier, including PWSID#, name of the PWS, contact name and telephone number for the PWS;
- The procedure for ensuring that the laboratory obtains the sample specific information, including sample location, contaminants(s) of interest, date and time of sample collection;
- The procedure for notifications of MCL exceedances, both telephonic and in writing;
- The procedure for documenting the laboratory's activities related to MCL violations and notifications of such violations;
- The procedure for reporting results to DWELR;
- The telephone numbers for each DEP regional office's main number and after hours emergency response telephone number.

The following is an expert from 25 Pa. Code Chapter 109 as it relates to the requirements for accredited laboratories:

25 Pa. Code Chapter 109, § 109.810. Reporting and notification requirements.

(a) Beginning November 13, 2009, a laboratory accredited under Chapter 252 (relating to environmental laboratory accreditation) shall electronically report to the Department on behalf of the public water supplier and in accordance with the reporting requirements under § 109.701(a) (relating to reporting and recordkeeping), the results of test measurements or analyses performed by the laboratory under this chapter using a secure computer application provided by the Department. In the event of a Department computer application failure, the Department will notify the laboratory of an alternate reporting method. In the event that a laboratory is unable to submit data electronically, due to circumstances beyond its control, the laboratory shall notify the Department prior to the applicable reporting deadline. If the Department

determines that the circumstances were beyond the control of the laboratory, the Department will specify a temporary, alternate reporting method the laboratory shall use to meet the reporting deadline.

(1) Unless a different reporting period is specified in this chapter, these results shall be reported within either the first 10 days following the month in which the result is determined or the first 10 days following the end of the required monitoring period as stipulated by the Department, whichever is shorter.

(2) Beginning November 23, 2009, an accredited laboratory and the public water supplier shall be given until the 10th of the following month to review and update submitted data using a secure computer application provided by the Department. Omissions and data errors remaining after the review period shall be considered reporting violations of the public water supplier.

(b) A laboratory accredited under Chapter 252 shall whenever the results of test measurements or analyses performed by the laboratory under this chapter indicate an MCL, MRDL or treatment technique performance requirements under § 109.202 (relating to State MCLs , MRDLs and treatment technique requirements) is exceeded, or an action level under § 109.1102 (a) (relating to lead and copper) is exceeded, or sample result requires the collection of check or confirmation samples under § 109.301 (relating to general monitoring requirements), or a sample collected under Subchapter M (relating to additional requirements for groundwater sources) is *E. Coli*-positive:

(1) Notify the public water supplier by telephone within 1 hour of the laboratory's determination. If the supplier cannot be reached within that time, notify the Department by telephone within 2 hours of the determination. If is necessary for the laboratory to contact the Department after the Department's routine business hours, the laboratory shall contact the appropriate Department's regional office's after-hours emergency response telephone number and provide information regarding the occurrence, the name of contact person and the telephone number where that individual may be reached in the event further information is needed. If the Department's appropriate emergency number cannot be reached, the laboratory shall notify the appropriate Department regional office by telephone within 1 hour of the beginning of the next business day. Each accredited laboratory shall be responsible for the following:

Obtaining and then maintaining the Department's current after-hours emergency response telephone numbers for each applicable regional office.

(i) Establishing or updating a standard operating procedure by November 8, 2002, and at least annually thereafter to provide the information needed to report the occurrences to the Department. The information regarding the public water system must include, but is not limited to, the PWSID number of the system, the system's name, the contaminant involved in the occurrence, the level of the contaminant found, where the sample was collected, the dates and times that the sample was collected and analyzed, the name and identification number of the certified laboratory, the name and telephone number of a contact person at the laboratory and what steps the laboratory took to contact the public water system before calling the Department.

(2) Notify the appropriate Department district office in writing within 24 hours of the determination. For the purpose of determining compliance with this requirement, the postmark, if the notice is mailed, or the date the notice is received by the Department, whichever is earlier, will be used. Upon approval by the Department, the notice may be made electronically to the Department as long as the information is received within the 24-hour deadline.

(c) A laboratory accredited under Chapter 252 shall meet the requirements under subsections (a) and (b), regarding the results of test measurements or analyses performed by the laboratory under this chapter, unless the laboratory assigns in writing the responsibility for reporting and notification to another accredited laboratory.

(d) A laboratory accredited under Chapter 252 shall be responsible for the accurate reporting of data required under the section to the Department.