100-HR-3 Groundwater Operable Unit Well
Installation Sampling and Analysis Plan

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Terms

aG                amber glass
ALARA             as low as reasonable achievable
ASTM              American Society for Testing and Materials
CAS               Chemical Abstracts Service
CCC               criterion continuous concentration
CHPRC             CH2M HILL Plateau Remediation Company
Cr(VI)            hexavalent chromium
DOE               U.S. Department of Energy
DOE-RL            DOE Richland Operations Office
dpm               disintegrations per minute
DQA               data quality assessment
DWS               drinking water standard
ECO               Environmental Compliance Officer
Ecology           Washington State Department of Ecology
EPA               U.S. Environmental Protection Agency
FSB               fuel storage basin
FSP               field sampling plan
FWS               Field Work Supervisor
G                 glass
GEA               gamma energy analysis
GPC               gas proportional counter
HASQARD           Hanford Analytical Services Quality Assurance Requirements Documents (DOE/RL-96-68)
HEIS              Hanford Environmental Information System
IC                ion chromatography
ICP               inductively coupled plasma
LSC               liquid scintillation counter
MCL               maximum contaminant level
MDL               method detection limit
MS                mass spectroscopy
N/A               not applicable
NCO               Nuclear Chemical Operator
NV                no value
<table>
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<tr>
<th>Acronym</th>
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<td>OU</td>
<td>operable unit</td>
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<tr>
<td>P</td>
<td>plastic</td>
</tr>
<tr>
<td>PCB</td>
<td>polychlorinated biphenyl</td>
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<tr>
<td>PSQ</td>
<td>principal study question</td>
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<tr>
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<td>Ringold Formation upper mud</td>
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<td>volatile organic analyte</td>
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<tr>
<td>VOC</td>
<td>volatile organic carbon</td>
</tr>
<tr>
<td>WAC</td>
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1 Introduction

This sampling and analysis plan (SAP) has been prepared for the installation of wells in the 100-HR-3 Groundwater Operable Unit (OU). Groundwater contamination conditions, the existing monitoring network, and existing remediation systems at the 100-HR-3 OU were evaluated to identify where additional monitoring or remediation wells may be needed to support the OU objectives. The 100-HR-3 objectives for monitoring and remediation are river protection, contaminant mass removal, and contaminant delineation. These objectives are discussed in Recommendations and Technical Justification for New and Replacement Wells and Re-alignment of Existing Wells Associated with Interim Remedial Actions at 100-D/H Area (SGW-54542).

The existing interim remedy consists of two operating pump-and-treat systems that capture contaminated groundwater, treat it to remove hexavalent chromium (Cr(VI)), and inject the treated water back into the aquifer. Currently, the interim remedy is successfully capturing the Cr(VI) plume; however, some additional wells have been identified that will enhance the operation. Groundwater remediation efforts have been proceeding under the existing interim action remedial design/remedial action work plan for KR-4 and HR-3 as described in Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units’ Interim Action (DOE/RL-96-84). In addition, characterization efforts have been developed within the remedial investigation/feasibility study (RI/FS) work plan (Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 1: 100-DR-1, 100-D-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units [DOE/RL-2008-46-ADD1]) and results and remediation alternatives compiled in the RI/FS (Remedial Investigation/Feasibility Study for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units [DOE/RL-2010-95]).

1.1 Background

The primary contaminants in groundwater at 100-HR-3 are Cr(VI), strontium-90, and nitrate. Uranium is present in a small, localized area near the 183-H Solar Evaporation Basins. Tritium is also present in groundwater at levels slightly below maximum contaminant levels (MCLs) at 100-D, as a result of reactor operations in that area (DOE/RL-2010-95; Hanford Site Groundwater Monitoring for 2011 [DOE/RL-2011-118]).

1.1.1 Hexavalent Chromium

Cr(VI) originated from planned discharges of chromium-treated cooling water to the retention basins during reactor operations and to the 116-DR-1&2 Trench during the 1967 infiltration test. Other sources of contamination were from planned releases and unplanned releases (UPRs) of concentrated sodium dichromate solution prior to entering the reactor. Cr(VI) is currently in the unconfined aquifer at the 100-D and 100-H reactor areas and across the Horn. Cr(VI) is also present in the first water bearing unit of the Ringold Formation upper mud (RUM), a confined or semi-confined aquifer.

1.1.2 Strontium-90

Strontium-90 was produced as a fission product in reactor fuel during plutonium production operations. Contamination of water by fission products occurred commonly in the reactor fuel storage basins (FSBs); water was released from the FSBs by UPRs (i.e., leaks and spills), as well as during planned releases (e.g., basin water overflow during reactor defueling operations). In addition, reactor cooling water became contaminated with fuel and fission product residues during reactor fuel failure incidents. Strontium-90 is present near the reactors at both 100-D and 100-H, associated with the FSBs.
1.1.3 Nitrate

The primary source of nitrate in 100-HR-3 is nitric acid used during reactor operations as a decontamination solution. Nitric acid and other decontamination solutions were disposed in cribs, trenches, and French drains near the building where they were used. These solutions were also occasionally combined with reactor cooling water and discharged to the river (100-D Area Technical Baseline Report [WHC-SD-EN-TI-181]). Another reactor operation related source is from oxidation of ammonia discharged in the condensate solution. Secondary contributors include septic systems, sewer lines, and former agricultural practices. Nitrate is present in the 100-D and 100-H reactor areas.

1.1.4 Tritium

The primary sources of tritium are reactor operations at 105-D and 105-DR. Historically, tritium was detected in the unconfined aquifer at concentrations greater than the drinking water standard (DWS) of 20,000 pCi/L in several wells at 100-D. Tritium is not present in the Horn or 100-H above the DWS. 100-N has also contributed to the tritium now found in the unconfined aquifer underlying the southern portion of 100-D. Tritium has not been detected above the DWS of 20,000 pCi/L in wells/piezometers completed in the first water bearing unit of the RUM.

1.1.5 Uranium

Uranium has historically been detected in groundwater near the 183-H Solar Evaporation Basins. The 183-H Solar Evaporation Basin site is a Resource Conservation and Recovery Act of 1976 treatment, storage, and disposal unit consisting of four basins. The basins were originally part of the 183-H water treatment facility. Four of the remaining basins were then used from 1973 to 1985 to evaporate various liquid waste streams, including neutralized, spent acid etch solutions containing technetium-99 and uranium. The basins were demolished in 1995, and soil was removed from beneath the site.

1.2 Well Needs

The 100-HR-3 geographic area is evaluated periodically to identify new well requirements, as well as the re-alignment of existing wells, supporting extraction, injection, and/or ongoing groundwater monitoring (SGW-54542). This evaluation is based on the following three-level priority:

1. River Protection: To maintain protection of the Columbia River from discharges of groundwater exceeding the Cr(VI) remedial action objective of 20 µg/L.

2. Mass Removal: To remove mass effectively from the areas of highest Cr(VI) concentration in groundwater.

3. Plume Delineation: To delineate the extent of Cr(VI) groundwater plumes and other identified co-contaminants. The specific co-contaminants in groundwater that were evaluated in this assessment are strontium-90, nitrate, and tritium. Both uranium and technetium-99 are monitored in association with the 183-H solar evaporation basins; however, the contaminants are localized to that area.

Based on the priorities of river protection, mass removal, and plume delineation, the following principal study questions (PSQs) were established:

- PSQ1a. Is the river being protected within the unconfined aquifer?
- PSQ1b. Is the river being protected within the confined aquifer?
- PSQ2. Can mass removal be increased?
- PSQ3a. Is the Cr(VI) plume sufficiently delineated in the unconfined aquifer?
- PSQ3b. Is the Cr(VI) plume sufficiently delineated in the confined aquifer?
1.2.1 Data Need for PSQ1a and PSQ1b
Capture maps developed for Calendar Year 2012 Annual Summary Report for the 100-HR-2 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation (DOE/RL-2013-13) indicate that the plume within the unconfined aquifer is not protected or may be at risk in several locations. For the confined aquifer, protection improvement areas were identified based on the knowledge of the plume, relative proximity to the river, and contaminant concentrations. Well placement along these identified areas in 100-D and 100-H will meet that need.

Soil samples will be collected during drilling to determine the geology of the material for use in well design, screen sizing, and pumping rates. Groundwater samples will be collected to determine Cr(VI) concentrations in the proposed location of each well and to confirm conditions and applicability of the location for extraction or injection purposes.

1.2.2 Data Need for PSQ2
Areas of Cr(VI) high concentrations have been identified in 100-HR-3. Increased extraction from selected areas would result in an increase in mass removal from the plume. Well placement along these identified areas in 100-HR-3 will meet that need.

Soil samples will be collected during drilling to determine the geology of the material for use in well design, screen sizing, and pumping rates. Groundwater samples will be collected to determine Cr(VI) concentrations in the proposed location of each well and to confirm conditions and applicability of the location for extraction or injection purposes.

1.2.3 Data Need for PSQ3a and PSQ3b
Plume delineation is considered adequate in areas where sentry wells have no contamination identified and capture of the plume has been shown. The area south of Well 199-D3-5 has been identified as a gap in the plume delineation. In addition, the plume located within the first water bearing unit of the RUM is not well defined. Additional wells in those areas will meet that need.

1.3 Purpose and Scope
The purpose and scope of this SAP are to provide well locations and construction and sampling requirements. Specific quality control (QC) measures and a field sampling plan (FSP) are also included.

1.4 Document Organization
This SAP is presented as one document, with addenda, to add flexibility to future document updates and to add/revise addenda as work progresses. Both the document and addenda make up a secondary document under the Hanford Federal Facility Agreement and Consent Order (Ecology et al., 1989), hereinafter called the Tri-Party Agreement (TPA), requiring U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and/or Washington State Department of Ecology (Ecology) approval. Subsequent addenda require the same approvals.

This SAP contains the appropriate information for the 100-HR-3 OU. A key element of this plan is the Quality Assurance Project Plan (QAPjP) in Chapter 2 and the FSP in Chapter 3. In order to be comprehensive, the QAPjP and the FSP have identified many constituents and methods that may be needed. Specific information for each well will be identified in an addendum and will be a subset of that identified in the QAPjP and FSP.
2 Quality Assurance Project Plan

This QAPjP complies with the following requirements:

- DOE O 414.1D, Quality Assurance
- EPA/240/B-01/003, EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)
- DOE/RL-96-68, Hanford Analytical Services Quality Assurance Requirements Documents (HASQARD)

This section describes the applicable quality requirements and controls. Sections 6.5 and 7.8 of the TPA (Ecology et al., 1989) require that DOE conduct quality assurance (QA)/QC and sampling and analysis activities in accordance with EPA/240/B-01/003; therefore, this QAPjP is organized based on the QA elements specified in EPA/240/B-01/003. This QAPjP demonstrates conformance to the Part B requirements of ANSI/ASQC E4-1994, Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs. The QAPjP is divided into the following four sections that describe the quality requirements and controls applicable to this investigation: Project Management; Data Generation and Acquisition; Assessment and Oversight; and Data Review, Verification, Validation, and Usability Requirements.

2.1 Project Management

This section addresses project management to ensure that the project has a defined goal, participants understand the goal and approach to be used, and planned outputs are appropriately documented.

2.1.1 Project Organization

The CH2M HILL Plateau Remediation Company (CHPRC) Soil and Groundwater Remediation Project (S&GRP) is responsible for planning, coordinating, sampling, preparing, packaging, and shipping samples to the laboratory. The project organization is described in the following list and is shown graphically in Figure 2-1:

- **DOE-RL Project Manager.** The DOE Richland Operations Office (DOE-RL) Project Manager is responsible for Hanford Site cleanup. DOE-RL is responsible for providing daily oversight of the contractor’s work scope performance, working with the contractor and the regulatory agencies to identify and work through issues, and providing technical input to the DOE Federal project director.

- **Regulatory Lead.** The Regulatory Lead is responsible for regulatory oversight of cleanup projects and activities. The Regulatory Lead has approval authority as the lead regulatory agency for the work being performed under this SAP. The lead regulatory agency will work with DOE-RL to resolve concerns over the work as described in this SAP in accordance with the TPA (Ecology et al., 1989).

- **Operable Unit Project Manager.** The OU Project Manager provides oversight for activities and coordinates with DOE-RL, the regulatory agencies, and contractor management. In addition, support is provided to the Technical Lead to ensure that work is performed safely and cost effectively. The OU Project Manager (or designee) is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks.
**Quality Assurance Engineer and Environmental Compliance Officer.** The QA engineer and the Environmental Compliance Officer (ECO) work under the Environmental Program and Strategic Planning group. The QA Engineer is matrixed to the OU Project Manager and is responsible for QA on the project. Responsibilities include documenting well acceptance, overseeing implementation of project QA requirements, closing corrective actions, reviewing project documents (including SAPs and the QAPjP), and participating in QA assessments. The ECO provides oversight in dealing with environmental management assessments and compliance assessments, defining potential environmental impacts, and identifying corrective actions (if needed) for Hanford Site activities.

**Operable Unit Technical Lead.** The OU Technical Lead ensures that the Drilling Lead and others responsible for implementing this SAP and QAPjP are provided with current copies of this document and revisions thereto. For each sampling event, the OU Technical Lead establishes the analytes, directs the drilling lead (i.e., sample coordinator), and works closely with the QA and the Health and Safety organizations to integrate these and other lead disciplines in planning and implementing the work scope.

**Drilling Lead.** The Drilling Lead has overall responsibility for planning, coordinating, and executing field activities. Specific responsibilities include converting the sampling design requirements into field task instructions to provide specific direction for field activities, as well as directing training, mock-ups, and practice sessions with field personnel to ensure that the sampling design is understood and can be performed as specified. The Drilling Lead also communicates with the OU Project Manager to identify field constraints or emergent conditions affecting sampling design/execution, to direct the procurement and installation of materials and equipment to support field work, and to prepare data packages based on instructions from the OU Project Manager (or designee) and information contained in this SAP.

**Waste Management Lead.** The Waste Management Lead communicates policies and protocols, and also ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and...
cost effective manner. In addition, the Waste Management Lead is responsible for identifying waste
management sampling CHARACTERIZATION requirements to ensure regulatory compliance, interpreting the
characterization data to generate waste designations and profiles, and preparing and maintaining other
documents confirming compliance with waste acceptance criteria.

- **Radiological Engineering.** Radiological Engineering is responsible for the radiological engineering
and health physics support for the project. Specific responsibilities include conducting as low as
reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls
optimization for work planning. In addition, radiological hazards are identified and appropriate
controls are implemented to maintain worker exposures to hazards at ALARA levels. Radiological
Engineering interfaces with the project Health and Safety representative and other appropriate
personnel, as needed, to plan and direct Radiological Control Technician (RCT) support for activities.

- **Health and Safety.** The Health and Safety organization’s responsibilities include coordinating
industrial safety and health support within the project as carried out through health and safety plans,
job hazard analyses, and other pertinent safety documents required by Federal regulations or internal
contractor work requirements. In addition, the organization assists project personnel in complying
with applicable health and safety standards and requirements. Personal protective equipment
requirements are coordinated with Radiological Engineering.

- **Sample Management and Reporting.** The Sample Management and Reporting (SMR) organization
is responsible for managing the analyses and resulting analytical data for samples collected for this
SAP. SMR selects laboratories to perform the required analyses and ensures that the laboratories
conform to HASQARD (DOE/RL-96-68), as approved by DOE, EPA, and Ecology, and to the
requirements of this SAP. After the selected laboratories complete the analyses, SMR receives the
analytical data from the selected laboratories, performs data entry into the Hanford Environmental
Information System (HEIS) database, and alerts the OU Project Manager of the availability of data
for interpretation. After analytical data interpretation is completed, SMR provides the analytical data
to the waste management lead (i.e., waste coordinator). SMR also interfaces with the Drilling Lead
(i.e., sample coordinator) regarding sampling information and schedules, including sampling
activities, sample and associated data tracking, distribution of analytical data, and sample turnaround
requirements.

- **Fielding Sampling Organization and Sampling Lead.** The Field Sampling Organization provides
the Field Work Supervisor (FWS). The FWS is the Sampling Lead and is responsible for planning
and coordinating field sampling resources. The FWS directs the Nuclear Chemical Operators (NCOs)
(these are the “Samplers”). The FWS ensures that NCOs are appropriately trained and available.
Additional related responsibilities include ensuring that the sampling design is understood and can be
performed, as specified, by directing training, mock-ups, and practice sessions with field personnel.
The NCOs collect groundwater, soil, vapor, and multimedia samples, including replicates/duplicates,
and prepare sample blanks in accordance with the SAP, corresponding protocols, and work packages.
The NCOs complete field logbook entries, chain-of-custody forms, and shipping paperwork, and
ensure delivery of samples to the analytical laboratory.

- **Contract Laboratories.** The contract laboratories analyze samples in accordance with established
protocols and provide necessary sample reports and explanation of results in support of data
validation. The laboratories must meet site-specified QA requirements and must have an approved
QA plan in place.
2.1.2 Quality Objectives and Criteria for Measurement Data

The QA objective of this SAP is to develop implementation guidance providing data of known and appropriate quality. Data quality for this SAP may be assessed by five criteria: representativeness, accuracy, comparability, completeness, and precision. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical methods.

The analytical methods, detection limits, and precision and accuracy requirements for each analysis to be performed are summarized in Section 2.2.2. Procedures from the contractor (or its approved subcontractor) will be used for sampling.

2.1.2.1 Representativeness

Representativeness is a measure of how closely analytical results reflect the actual concentration and distribution of the constituents at a sampling point. Sampling plan design, sampling techniques, and sample handling protocols (e.g., storage, preservation, and transportation) are discussed in subsequent sections of this SAP and in the addenda.

2.1.2.2 Accuracy

Accuracy is a measure of the closeness of the measured value to the true value. Accuracy refers to the degree to which a measurement agrees with an accepted reference or true value. Accuracy is evaluated by the use of certified standards, control standards, and/or spiked samples to calculate percent recovery.

2.1.2.3 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be maintained by using standard requirements for analytical and field QC parameters, standard procedures, uniform methods, and consistent units.

2.1.2.4 Completeness

Completeness is a measure of the amount of usable and/or valid data obtained from the samples actually analyzed compared to the total amount of data planned.

2.1.2.5 Precision

Precision is a measure of the data agreement among repeated measurements of the same sample. Precision can be expressed as the relative percent difference (RPD) for duplicate measurements or relative standard deviation for triplicates.

2.1.3 Special Training/Certification

The Environmental, Safety, Health, and Quality training program provides workers with the knowledge and skills necessary to execute assigned duties safely. A graded approach is used to ensure that workers receive a level of training commensurate with responsibilities and compliant with applicable DOE orders and government regulations. The FWS, in coordination with line management, will ensure that special training requirements for field personnel are met.

Training requirements or qualifications have been instituted by the CHPRC management team to meet training requirements imposed by the contract, regulations, DOE orders, DOE contractor requirement documents, American National Standards Institute/American Society of Mechanical Engineers, and the Washington Administrative Code. Field personnel typically have completed the following training before starting work:
- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training and supervised 24-hour hazardous waste site experience
- 8-Hour Hazardous Waste Worker Refresher Training (as required)
- Hanford General Employee Radiation Training
- Hanford General Employee Training
- Radiological Worker Training

Project-specific safety and/or technical training, geared specifically to the project and the day’s activity, will be provided as necessary. Project-specific training includes the following:

- Training requirements or qualifications needed by sampling personnel will be in accordance with QA requirements. Samplers are required to have training and/or experience in the type of sampling being performed in the field:
  - Soil/aquifer sediment sampling
  - Water sampling
- Qualification requirements for RCTs are established by the Radiation Protection Program. RCTs assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.

In addition, pre-job briefings will be performed to evaluate an activity and its hazards, by considering many factors, and may include the following:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required
- Safety procedures applicable to the job
- Training requirements for individuals assigned to perform the work
- Level of management control
- Proximity of emergency contacts

Training records are maintained for each individual in an electronic training record database. The contractor training organization maintains the training records system. Line management will be used to confirm that an individual employee’s training is appropriate and up-to-date before performing any field work.

### 2.1.4 Documentation and Records

Field sampling and laboratory analytical documentation will be in accordance with HASQARD (DOE/RL-96-68) and contractor procedures. Work products resulting from sampling and analysis may be included as documents and records, including the following:
• Forms required by WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells,” and the master drilling contract
• Borehole summary reports
• Field sampling logbooks
• Laboratory data packages
• Laboratory electronic data deliverables
• Verification and validation reports
The OU Project Manager is responsible for ensuring that project personnel are working to the current version of this SAP and that the project file is properly maintained.

2.2 Data Generation and Acquisition
The following subsections present the requirements for sampling collection, preservation holding times, analytical methods, and field and laboratory QC. The sampling design is presented in Chapter 3 of this SAP.

2.2.1 Sample Collection, Preservation, Containers, and Holding Times
Sample container, preservation, and holding time requirements are specified in Table 2-1 for soil/aquifer sediment samples and in Table 2-2 for groundwater samples. These requirements are in accordance with the analytical method specified. The final container type and volumes will be identified on the sampling authorization form and the chain-of-custody form. This SAP defines a “sample” as a filled sample bottle for starting the clock for holding time requirements.

<table>
<thead>
<tr>
<th>Method</th>
<th>Analysis/Analytes</th>
<th>Preservation Requirement</th>
<th>Holding Time</th>
<th>Bottle Type</th>
<th>Minimum Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha Energy Analysis</td>
<td>Americium-241/Curium-244</td>
<td>None</td>
<td>6 months</td>
<td>G/P</td>
<td>8 g</td>
</tr>
<tr>
<td>Isotopic – Plutonium</td>
<td>None</td>
<td>6 months</td>
<td>G/P</td>
<td>8 g</td>
<td></td>
</tr>
<tr>
<td>Isotopic – Uranium</td>
<td>None</td>
<td>6 months</td>
<td>G/P</td>
<td>8 g</td>
<td></td>
</tr>
<tr>
<td>Gas Flow Proportional Counting</td>
<td>Strontium-90</td>
<td>None</td>
<td>6 months</td>
<td>G/P</td>
<td>10 g</td>
</tr>
<tr>
<td>Gross Alpha/Gross Beta</td>
<td>None</td>
<td>6 months</td>
<td>G/P</td>
<td>2 g</td>
<td></td>
</tr>
<tr>
<td>Liquid Scintillation Counter</td>
<td>Carbon-14</td>
<td>None</td>
<td>6 months</td>
<td>G/P</td>
<td>8 g</td>
</tr>
<tr>
<td></td>
<td>Technetium-99</td>
<td>None</td>
<td>6 months</td>
<td>G/P</td>
<td>18 g</td>
</tr>
<tr>
<td></td>
<td>Tritium</td>
<td>None</td>
<td>6 months</td>
<td>G</td>
<td>400 g</td>
</tr>
<tr>
<td>Method</td>
<td>Analysis/Analytes</td>
<td>Preservation Requirement</td>
<td>Holding Time</td>
<td>Bottle Type</td>
<td>Minimum Sample Size²</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------------------</td>
<td>--------------------------</td>
<td>------------------</td>
<td>-------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Gamma Energy Analysis</td>
<td>Gamma Emitters</td>
<td>None</td>
<td>6 months</td>
<td>G/P</td>
<td>500 mL</td>
</tr>
<tr>
<td>EPA 6010</td>
<td>Metals</td>
<td>Cool ~4°C</td>
<td>6 months</td>
<td>G/P</td>
<td>20 g</td>
</tr>
<tr>
<td>EPA 7196</td>
<td>Hexavalent Chromium</td>
<td>Cool ~4°C</td>
<td>30 days</td>
<td>G/P</td>
<td>60 g</td>
</tr>
<tr>
<td>EPA 7471</td>
<td>Mercury by Cold Vapor Atomic Absorption</td>
<td>None</td>
<td>28 days</td>
<td>G/P</td>
<td>15 g</td>
</tr>
<tr>
<td>UKPA</td>
<td>Uranium (Total)</td>
<td>None</td>
<td>6 months</td>
<td>G/P</td>
<td>10 g</td>
</tr>
<tr>
<td>EPA 8082</td>
<td>Polychlorinated Biphenyls</td>
<td>Cool ~4°C</td>
<td>14/40 days</td>
<td>aG</td>
<td>120 g</td>
</tr>
<tr>
<td>EPA 8260ᵇ/EPA 8015</td>
<td>Volatile Organic Analytes</td>
<td>Cool ~4°C</td>
<td>14 days</td>
<td>G</td>
<td>5 x 40 g</td>
</tr>
<tr>
<td>EPA 8270</td>
<td>Semivolatile Organic Compound</td>
<td>Cool ~4°C</td>
<td>14/40 days</td>
<td>aG</td>
<td>250 g</td>
</tr>
<tr>
<td>EPA 300.0</td>
<td>Anions</td>
<td>Cool ~4°C</td>
<td>48 hours/28 days</td>
<td>G/P</td>
<td>120 g</td>
</tr>
<tr>
<td>EPA 9012</td>
<td>Cyanide</td>
<td>None</td>
<td>14 days</td>
<td>G/P</td>
<td>120 g</td>
</tr>
<tr>
<td>ASTM D2216</td>
<td>Moisture Content</td>
<td>None</td>
<td>None</td>
<td>Moisture-proof container</td>
<td>200 g</td>
</tr>
<tr>
<td>ASTM D2937</td>
<td>Density</td>
<td>None</td>
<td>None</td>
<td>G/P</td>
<td>1,000 g</td>
</tr>
<tr>
<td>ASTM D2434</td>
<td>Permeability</td>
<td>None</td>
<td>None</td>
<td>P</td>
<td>1,000 g</td>
</tr>
<tr>
<td>ASTM D5084</td>
<td>Hydraulic Conductivity</td>
<td>None</td>
<td>None</td>
<td>P</td>
<td>1,000 g</td>
</tr>
<tr>
<td>Batch Leaching Test</td>
<td>--</td>
<td>Cool ~4°C</td>
<td>28 days from field to extraction</td>
<td>G</td>
<td>100 g/120 mL</td>
</tr>
<tr>
<td>Distribution Coefficient</td>
<td>--</td>
<td>Cool ~4°C</td>
<td>--</td>
<td>Moisture-proof container</td>
<td>250 g</td>
</tr>
</tbody>
</table>
Table 2-1. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

<table>
<thead>
<tr>
<th>Method</th>
<th>Analysis/Analytes</th>
<th>Preservation Requirement</th>
<th>Holding Time</th>
<th>Bottle Type</th>
<th>Minimum Sample Size^a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>48 hours</td>
<td>6 months</td>
<td>2,000 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28 days</td>
<td>6 months</td>
<td>250 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24 hours</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28 days</td>
<td>6 months</td>
<td>250 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 months</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28 days</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 months</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28 days</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 months</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28 days</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 months</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28 days</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 months</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28 days</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 months</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28 days</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 months</td>
<td>6 months</td>
<td>500 mL</td>
</tr>
</tbody>
</table>

Notes:
For EPA Method 300.0, see EPA-600/4-79-020, Methods for Chemical Analysis of Water and Wastes.
For the four-digit EPA methods, see SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.

a. Based on minimum quality control requirements.
b. Field preservation, EPA Method 5035A, also may be used.
48 hours/28 days = 48 hours for nitrate, nitrite, and phosphate; others, 28 days
14 days/40 days = 14 days from sample collection to extraction; 40 days from extraction to analysis
aG = amber glass
ASTM = American Society for Testing and Materials
EPA = U.S. Environmental Protection Agency
G = glass
P = plastic
UKPA = total uranium by kinetic phosphorescence analysis

Table 2-2. Sample Preservation, Container, and Holding Time for Groundwater Samples

<table>
<thead>
<tr>
<th>Method</th>
<th>Analytes</th>
<th>Preservation Requirement</th>
<th>Holding Time</th>
<th>Bottle Type</th>
<th>Minimum Sample Size^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Flow Proportional Counting</td>
<td>Strontium-90</td>
<td>Nitric Acid to pH &lt;2</td>
<td>6 months</td>
<td>G/P</td>
<td>2,000 mL</td>
</tr>
<tr>
<td>Liquid Scintillation Counter</td>
<td>Tritium</td>
<td>None</td>
<td>6 months</td>
<td>G</td>
<td>250 mL</td>
</tr>
<tr>
<td></td>
<td>Technetium-99</td>
<td>Hydrochloric Acid to pH &lt;2</td>
<td>6 months</td>
<td>G/P</td>
<td>1,000 mL</td>
</tr>
<tr>
<td>EPA 6020 or 200.8</td>
<td>Metals</td>
<td>Nitric Acid to pH &lt;2</td>
<td>6 months</td>
<td>G/P</td>
<td>250 mL</td>
</tr>
<tr>
<td>EPA 6010</td>
<td>Metals</td>
<td>Nitric Acid to pH &lt;2</td>
<td>6 months</td>
<td>G/P</td>
<td>250 mL</td>
</tr>
<tr>
<td>EPA 7196</td>
<td>Hexavalent Chromium</td>
<td>Cool ~4° C</td>
<td>24 hours</td>
<td>aG</td>
<td>500 mL</td>
</tr>
<tr>
<td>EPA 7470 or 200.8</td>
<td>Mercury</td>
<td>Nitric Acid to pH &lt;2</td>
<td>28 days</td>
<td>G</td>
<td>250 mL</td>
</tr>
<tr>
<td>KPA or 200.8</td>
<td>Uranium (Total)</td>
<td>Nitric Acid to pH &lt;2</td>
<td>6 months</td>
<td>G/P</td>
<td>500 mL</td>
</tr>
</tbody>
</table>
Table 2-2. Sample Preservation, Container, and Holding Time for Groundwater Samples

<table>
<thead>
<tr>
<th>Method</th>
<th>Analytes</th>
<th>Preservation Requirement</th>
<th>Holding Time</th>
<th>Bottle Type</th>
<th>Minimum Sample Size*</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA 8260</td>
<td>Volatile Organic Analytes</td>
<td>Cool ~4°C, Hydrochloric Acid or Sulfuric Acid to pH &lt;2</td>
<td>14 days</td>
<td>aGs</td>
<td>4 × 40 mL</td>
</tr>
<tr>
<td>EPA 8270</td>
<td>Semivolatile Organic Analytes</td>
<td>None</td>
<td>7 days/40 days</td>
<td>aG</td>
<td>4 × 1,000 mL</td>
</tr>
<tr>
<td>EPA 8310</td>
<td>Polynuclear Aromatic Hydrocarbons</td>
<td>None</td>
<td>14 days/40 days</td>
<td>aG</td>
<td>4 × 1,000 mL</td>
</tr>
<tr>
<td>EPA 8081</td>
<td>PCBs</td>
<td>None</td>
<td>1 year</td>
<td>aG</td>
<td>1,000 mL</td>
</tr>
<tr>
<td>EPA 8082</td>
<td>PCBs</td>
<td>None</td>
<td>1 year</td>
<td>aG</td>
<td>1,000 mL</td>
</tr>
<tr>
<td>EPA 1668A</td>
<td>PCB Congeners</td>
<td>None</td>
<td>1 year</td>
<td>aG</td>
<td>1,000 mL</td>
</tr>
<tr>
<td>EPA 9012</td>
<td>Cyanide</td>
<td>Sodium Hydroxide to pH ≥12</td>
<td>14 days</td>
<td>G/P</td>
<td>250 mL</td>
</tr>
<tr>
<td>EPA 300.0</td>
<td>Anions</td>
<td>Cool ~4°C</td>
<td>48 hours/28 days</td>
<td>P</td>
<td>60 mL</td>
</tr>
</tbody>
</table>

Notes:
For EPA Method 200.8, see EPA-600/R-94-111, Methods for the Determination of Metals in Environmental Samples, Supplement I.
For EPA Method 300.0, see EPA-600/4-79-020, Methods for Chemical Analysis of Water and Wastes.
For the four-digit EPA methods, see SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.

* Based on minimum quality control requirements.
14 days/40 days = 14 days from sample collection to extraction; 40 days from extraction to analysis
7 days/40 days = 7 days from sample collection to extraction; 40 days from extraction to analysis
48 hours/28 days = 48 hours for nitrate, nitrite, and phosphate; others, 28 days
aG = amber glass
aGs = amber glass septum; no headspace
EPA = U.S. Environmental Protection Agency
G = glass
P = plastic
PCB = polychlorinated biphenyl

2.2.2 Analytical Methods Requirements
Analytical methods are specified and controlled in accordance with HASQARD (DOE/RL-96-68), the laboratory’s QA plan, and the requirements of this QAPjP. The primary Mission Support Alliance contractor or vadose zone contractor, as applicable, participates in overseeing the contracts with offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.
The CHPRC SMR organization oversees analytical laboratory performance on S&GRP projects.
Analytical performance requirements are presented in Table 2-3 for soil/aquifer sediment samples during drilling and in Table 2-4 for groundwater samples. If the laboratory uses a nonstandard or unapproved method, then the laboratory must provide method validation data to confirm that the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. Deviations from the analytical methods noted in Tables 2-3 and 2-4 must be approved by the SMR organization in consultation with the OU Project Manager and as discussed in Chapter 4.

Laboratories providing analytical services in support of this SAP will have a corrective action program in place that addresses analytical system failures and documents the effectiveness of any corrective actions. Issues that may affect analytical results are to be resolved by the SMR organization in coordination with the OU Project Manager.
## Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples

<table>
<thead>
<tr>
<th>CAS No.</th>
<th>Analyte</th>
<th>Estimated Quantitation Limit</th>
<th>Analytical Methoda</th>
<th>Precision Requirement (%)</th>
<th>Accuracy Requirement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>Gross gamma</td>
<td>10 pCi/g</td>
<td>Portable sodium iodide detector</td>
<td>≤50</td>
<td>___c</td>
</tr>
<tr>
<td>12587-46-1</td>
<td>Gross alpha</td>
<td>100 dpm/100 cm²</td>
<td>Portable contamination detector</td>
<td>≤50</td>
<td>___c</td>
</tr>
<tr>
<td>12587-47-2</td>
<td>Gross beta</td>
<td>5,000 dpm/100 cm²</td>
<td>Portable contamination detector</td>
<td>≤50</td>
<td>___c</td>
</tr>
<tr>
<td>Performance Requirements for Field Measurementsb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14596-10-2</td>
<td>Americium-241</td>
<td>1 pCi/g</td>
<td>Americium-241/Curium-244</td>
<td>≤30d</td>
<td>70-130d</td>
</tr>
<tr>
<td>14762-75-5</td>
<td>Carbon-14</td>
<td>5 pCi/g</td>
<td>LSC – Carbon-14</td>
<td>≤30d</td>
<td>70-130d</td>
</tr>
<tr>
<td>13967-70-9</td>
<td>Cesium-134</td>
<td>0.5 pCi/g</td>
<td>Gamma energy analysis</td>
<td>≤30d</td>
<td>70-130d</td>
</tr>
<tr>
<td>10045-97-3</td>
<td>Cesium-137</td>
<td>0.1 pCi/g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10198-40-0</td>
<td>Cobalt-60</td>
<td>0.05 pCi/g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14683-23-9</td>
<td>Europium-152</td>
<td>0.1 pCi/g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15585-10-1</td>
<td>Europium-154</td>
<td>0.1 pCi/g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14391-16-3</td>
<td>Europium-155</td>
<td>0.1 pCi/g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13994-20-2</td>
<td>Neptunium-237</td>
<td>1 pCi/g</td>
<td>Atomic energy absorption</td>
<td>≤30d</td>
<td>70-130d</td>
</tr>
<tr>
<td>13981-37-8</td>
<td>Nickel-63</td>
<td>30 pCi/g</td>
<td>LSC – Nickel-63</td>
<td>≤30d</td>
<td>70-130d</td>
</tr>
<tr>
<td>13981-16-3</td>
<td>Plutonium-238</td>
<td>1 pCi/g</td>
<td>Isotopic – Plutonium</td>
<td>≤30d</td>
<td>70-130d</td>
</tr>
<tr>
<td>—</td>
<td>Plutonium-239/240</td>
<td>1 pCi/g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10098-97-2</td>
<td>Strontium-90c</td>
<td>1 pCi/g</td>
<td>Strontium-90</td>
<td>≤30d</td>
<td>70-130d</td>
</tr>
<tr>
<td>14133-76-7</td>
<td>Technetium-99</td>
<td>1.5 pCi/g</td>
<td>LSC – Technetium-99</td>
<td>≤30d</td>
<td>70-130d</td>
</tr>
</tbody>
</table>

---

In Table 2-3, the analytical performance requirements for soil/aquifer sediment samples are detailed. Each row represents a different analyte with specific requirements for quantitation limits, analytical methods, and precision and accuracy requirements. The table is organized into two main sections: Performance Requirements for Field Measurements and Performance Requirements for Laboratory Measurements (Radiological). Each entry includes the CAS number, the analyte name, its estimated quantitation limit, the analytical method, and the precision and accuracy requirements. The table covers a range of elements, including gamma, alpha, beta, and various isotopes, each with detailed specifications for measurement and analysis. The requirements are specified in terms of percentages for precision and accuracy, with values ranging from ≤30% to 70-130%.
<table>
<thead>
<tr>
<th>CAS No.</th>
<th>Analyte</th>
<th>Estimated Quantitation Limit</th>
<th>Analytical Method(^a)</th>
<th>Precision Requirement (%)</th>
<th>Accuracy Requirement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10028-17-8</td>
<td>Tritium</td>
<td>30 pCi/g</td>
<td>LSC – Tritium</td>
<td>≤30(^d)</td>
<td>70-130(^d)</td>
</tr>
<tr>
<td>—</td>
<td>Uranium-233/234</td>
<td>1 pCi/g</td>
<td>Isotopic – Uranium</td>
<td>≤30(^d)</td>
<td>70-130(^d)</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>Uranium-235</td>
<td>1 pCi/g(^f)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>—</td>
<td>Uranium-238</td>
<td>1 pCi/g</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Performance Requirements for Laboratory Measurements (Nonradiological)**

<table>
<thead>
<tr>
<th>—</th>
<th>pH</th>
<th>1 pH unit</th>
<th>EPA 9045 or 160.1</th>
<th>≤30</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-12-5</td>
<td>Cyanide</td>
<td>1 mg/kg</td>
<td>EPA 9012</td>
<td>≤30(^g)</td>
<td>70-130(^g)</td>
</tr>
<tr>
<td>18540-29-9</td>
<td>Hexavalent chromium</td>
<td>0.5 mg/kg</td>
<td>EPA 7196 (Hexavalent chromium)</td>
<td>≤30(^g)</td>
<td>70-130(^g)</td>
</tr>
<tr>
<td>7439-97-6</td>
<td>Mercury</td>
<td>0.2 mg/kg</td>
<td>EPA 7471 (mercury by cold vapor)</td>
<td>≤30(^g)</td>
<td>70-130(^g)</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>Uranium (total)</td>
<td>1.5 mg/kg</td>
<td>UKPA or via isotopic</td>
<td>≤30(^g)</td>
<td>70-130(^g)</td>
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<tr>
<td>12674-11-2</td>
<td>Aroclor-1016 (PCB)</td>
<td>0.008 mg/kg</td>
<td>EPA 8082 (PCBs by GC)</td>
<td>Statistically Derived(^h)</td>
<td>Statistically Derived(^h)</td>
</tr>
<tr>
<td>11104-28-2</td>
<td>Aroclor-1221 (PCB)</td>
<td>0.016 mg/kg</td>
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<tr>
<td>11141-16-5</td>
<td>Aroclor-1232 (PCB)</td>
<td>0.008 mg/kg</td>
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<td>53469-21-9</td>
<td>Aroclor-1242 (PCB)</td>
<td>0.008 mg/kg</td>
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<tr>
<td>12672-29-6</td>
<td>Aroclor-1248 (PCB)</td>
<td>0.008 mg/kg</td>
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<tr>
<td>11097-69-1</td>
<td>Aroclor-1254 (PCB)</td>
<td>0.008 mg/kg</td>
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<tr>
<td>11096-82-5</td>
<td>Aroclor-1260 (PCB)</td>
<td>0.008 mg/kg</td>
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<tr>
<td>CAS No.</td>
<td>Analyte</td>
<td>Estimated Quantitation Limit</td>
<td>Analytical Method</td>
<td>Precision Requirement (%)</td>
<td>Accuracy Requirement (%)</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------</td>
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<tr>
<td>319-85-7</td>
<td>beta-BHC</td>
<td>0.00165 mg/kg</td>
<td>EPA 8081 (pesticides by GC)</td>
<td>≤30&lt;sup&gt;i&lt;/sup&gt;</td>
<td>70-130&lt;sup&gt;i&lt;/sup&gt;</td>
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<tr>
<td>60-57-1</td>
<td>Dieldrin</td>
<td>0.0033 mg/kg</td>
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<tr>
<td>16984-48-8</td>
<td>Fluoride</td>
<td>25 mg/kg</td>
<td>EPA 300.0 (anions by IC)</td>
<td>≤30&lt;sup&gt;g&lt;/sup&gt;</td>
<td>70-130&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
<tr>
<td>14797-55-8</td>
<td>Nitrate (as N)</td>
<td>5 mg/kg</td>
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<tr>
<td>14797-65-0</td>
<td>Nitrite (as N)</td>
<td>5 mg/kg</td>
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<tr>
<td>14808-79-8</td>
<td>Sulfate</td>
<td>27.5 mg/kg</td>
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<tr>
<td>7440-36-0</td>
<td>Antimony</td>
<td>1.2 mg/kg</td>
<td>EPA 6010 or 200.8 (ICP or ICP/MS metals)</td>
<td>≤30&lt;sup&gt;g&lt;/sup&gt;</td>
<td>70-130&lt;sup&gt;g&lt;/sup&gt;</td>
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<tr>
<td>7429-90-5</td>
<td>Aluminum</td>
<td>1.2 mg/kg</td>
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<tr>
<td>7440-38-2</td>
<td>Arsenic</td>
<td>10 mg/kg</td>
<td></td>
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</tr>
<tr>
<td>7440-39-3</td>
<td>Barium</td>
<td>2 mg/kg</td>
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<tr>
<td>7440-41-7</td>
<td>Beryllium</td>
<td>0.5 mg/kg</td>
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<tr>
<td>7440-43-9</td>
<td>Cadmium</td>
<td>0.5 mg/kg</td>
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<tr>
<td>7440-47-3</td>
<td>Chromium (total)</td>
<td>1 mg/kg</td>
<td></td>
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<tr>
<td>7440-48-4</td>
<td>Cobalt</td>
<td>2 mg/kg</td>
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<tr>
<td>7440-50-8</td>
<td>Copper</td>
<td>0.8 mg/kg</td>
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<tr>
<td>7439-92-1</td>
<td>Lead</td>
<td>5 mg/kg</td>
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<tr>
<td>7439-96-5</td>
<td>Manganese</td>
<td>5 mg/kg</td>
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<td>7440-02-0</td>
<td>Nickel</td>
<td>4 mg/kg</td>
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<tr>
<td>7782-49-2</td>
<td>Selenium</td>
<td>10 mg/kg</td>
<td></td>
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</tr>
<tr>
<td>CAS No.</td>
<td>Analyte</td>
<td>Estimated Quantitation Limit</td>
<td>Analytical Methoda</td>
<td>Precision Requirement (%)</td>
<td>Accuracy Requirement (%)</td>
</tr>
<tr>
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<td>-------------------</td>
<td>------------------------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
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</tr>
<tr>
<td>7440-22-4</td>
<td>Silver</td>
<td>1 mg/kg</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7440-28-0</td>
<td>Thallium</td>
<td>5 mg/kg</td>
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<tr>
<td>7440-62-2</td>
<td>Vanadium</td>
<td>2.5 mg/kg</td>
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<tr>
<td>7440-66-6</td>
<td>Zinc</td>
<td>1 mg/kg</td>
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<td></td>
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<tr>
<td>67-64-1</td>
<td>Acetone</td>
<td>0.02 mg/kg</td>
<td>EPA 8260 (volatile organic compounds)</td>
<td>Statistically Derivedg</td>
<td>Statistically Derivedg</td>
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<tr>
<td>71-43-2</td>
<td>Benzene</td>
<td>0.005 mg/kg</td>
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<tr>
<td>78-93-3</td>
<td>2-Butanone</td>
<td>0.01 mg/kg</td>
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<tr>
<td>56-23-5</td>
<td>Carbon tetrachloride</td>
<td>0.005 mg/kg</td>
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<tr>
<td>67-66-3</td>
<td>Chloroform</td>
<td>0.005 mg/kg</td>
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<tr>
<td>75-35-4</td>
<td>1,1-Dichloroethene</td>
<td>0.01 mg/kg</td>
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<tr>
<td>156-60-5</td>
<td>trans-1,2-Dichloroethylene</td>
<td>0.005 mg/kg</td>
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<tr>
<td>100-41-4</td>
<td>Ethylbenzene</td>
<td>0.005 mg/kg</td>
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<tr>
<td>591-78-6</td>
<td>2-Hexanone</td>
<td>0.02 mg/kg</td>
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<tr>
<td>75-09-2</td>
<td>Methylene chloride</td>
<td>0.005 mg/kg</td>
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<tr>
<td>108-10-1</td>
<td>4-Methyl-2-pentanone</td>
<td>0.01 mg/kg</td>
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<tr>
<td>127-18-4</td>
<td>Tetrachloroethene</td>
<td>0.005 mg/kg</td>
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<td>108-88-3</td>
<td>Toluene</td>
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<tr>
<td>79-01-6</td>
<td>Trichloroethene</td>
<td>0.005 mg/kg</td>
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<tr>
<td>75-01-4</td>
<td>Vinyl Chloride</td>
<td>0.01 mg/kg</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CAS No.</td>
<td>Analyte</td>
<td>Estimated Quantitation Limit</td>
<td>Analytical Methoda</td>
<td>Precision Requirement (%)</td>
<td>Accuracy Requirement (%)</td>
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<tr>
<td>--------------</td>
<td>----------------------------------</td>
<td>------------------------------</td>
<td>-------------------------------------</td>
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<tr>
<td>1330-20-7</td>
<td>Xylenes (total)</td>
<td>0.01 mg/kg</td>
<td>Batch leach followed by EPA 6010</td>
<td>≤30b</td>
<td>70-130b</td>
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<tr>
<td>7440-38-2</td>
<td>Arsenic</td>
<td>10 µg/L</td>
<td>(ICP metals)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7440-39-3</td>
<td>Barium</td>
<td>20 µg/L</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
</tr>
<tr>
<td>7440-43-9</td>
<td>Cadmium</td>
<td>5 µg/L</td>
<td>compounds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7440-47-3</td>
<td>Chromium</td>
<td>10 µg/L</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
</tr>
<tr>
<td>7440-47-3</td>
<td>Chromium</td>
<td>10 µg/L</td>
<td>compounds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18540-29-9</td>
<td>Hexavalent chromium</td>
<td>10 µg/L</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
</tr>
<tr>
<td>7439-92-1</td>
<td>Lead</td>
<td>15 µg/L</td>
<td>compounds)</td>
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<tr>
<td>7440-22-4</td>
<td>Silver</td>
<td>10 µg/L</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
</tr>
<tr>
<td>7782-49-2</td>
<td>Selenium</td>
<td>50 µg/L</td>
<td>compounds)</td>
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<tr>
<td>65-85-0</td>
<td>Benzoic acid</td>
<td>16.5 mg/kg</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
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<tr>
<td>117-81-7</td>
<td>Bis(2-ethylhexyl) phthalate</td>
<td>0.33 mg/kg</td>
<td>compounds)</td>
<td></td>
<td></td>
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<tr>
<td>85-68-7</td>
<td>Butylbenzyl phthalate</td>
<td>0.33 mg/kg</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
</tr>
<tr>
<td>86-74-8</td>
<td>Carbazole</td>
<td>0.33 mg/kg</td>
<td>compounds)</td>
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<tr>
<td>59-50-7</td>
<td>4-Chloro-3-methylphenol</td>
<td>0.33 mg/kg</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
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<td>95-57-8</td>
<td>2-Chlorophenol</td>
<td>0.33 mg/kg</td>
<td>compounds)</td>
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<tr>
<td>541-73-1</td>
<td>1,3-Dichlorobenzene</td>
<td>0.33 mg/kg</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
</tr>
<tr>
<td>106-46-7</td>
<td>1,4-Dichlorobenzene</td>
<td>0.33 mg/kg</td>
<td>compounds)</td>
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<tr>
<td>84-66-2</td>
<td>Diethyl phthalate</td>
<td>0.33 mg/kg</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
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<tr>
<td>84-74-2</td>
<td>di-n-Butyl phthalate</td>
<td>0.33 mg/kg</td>
<td>compounds)</td>
<td></td>
<td></td>
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<tr>
<td>88-75-5</td>
<td>2-Nitrophenol</td>
<td>0.633 mg/kg</td>
<td>EPA 8270 (semivolatile organic</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
</tr>
</tbody>
</table>

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples
Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples

<table>
<thead>
<tr>
<th>CAS No.</th>
<th>Analyte</th>
<th>Estimated Quantitation Limit</th>
<th>Analytical Methoda</th>
<th>Precision Requirement (%)</th>
<th>Accuracy Requirement (%)</th>
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</thead>
<tbody>
<tr>
<td>87-86-5</td>
<td>Pentachlorophenol</td>
<td>0.33 mg/kg</td>
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<tr>
<td>108-95-2</td>
<td>Phenol</td>
<td>0.33 mg/kg</td>
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<tr>
<td>83-32-9</td>
<td>Acenaphthene</td>
<td>0.33 mg/kg</td>
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<td>120-12-7</td>
<td>Anthracene</td>
<td>0.33 mg/kg</td>
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<tr>
<td>56-55-3</td>
<td>Benzo(a)anthracene</td>
<td>0.015 mg/kg</td>
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<td></td>
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</tr>
<tr>
<td>50-32-8</td>
<td>Benzo(a)pyrene</td>
<td>0.015 mg/kg</td>
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<tr>
<td>205-99-2</td>
<td>Benzo(b)fluoranthene</td>
<td>0.015 mg/kg</td>
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<tr>
<td>191-24-2</td>
<td>Benzo(ghi)perylene</td>
<td>0.33 mg/kg</td>
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<tr>
<td>207-08-9</td>
<td>Benzo(k)fluoranthene</td>
<td>0.015 mg/kg</td>
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<tr>
<td>218-01-9</td>
<td>Chrysene</td>
<td>0.04 mg/kg</td>
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<tr>
<td>53-70-3</td>
<td>Dibenz[a,h]anthracene</td>
<td>0.03 mg/kg</td>
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<tr>
<td>206-44-0</td>
<td>Fluoranthene</td>
<td>0.33 mg/kg</td>
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<tr>
<td>86-73-7</td>
<td>Fluorene</td>
<td>0.33 mg/kg</td>
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<tr>
<td>193-39-5</td>
<td>Indeno(1,2,3-cd)pyrene</td>
<td>0.33 mg/kg</td>
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<tr>
<td>85-01-8</td>
<td>Phenanthrene</td>
<td>0.33 mg/kg</td>
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</tr>
<tr>
<td>129-00-0</td>
<td>Pyrene</td>
<td>0.33 mg/kg</td>
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<tr>
<td>86-74-8</td>
<td>Carbazole</td>
<td>0.33 mg/kg</td>
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</tr>
<tr>
<td>72-54-8</td>
<td>4,4’-DDD</td>
<td>0.0033 mg/kg</td>
<td>EPA 8270 (semivolatile organic compounds)</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
</tr>
<tr>
<td>72-55-9</td>
<td>4,4’-DDE</td>
<td>0.0033 mg/kg</td>
<td>EPA 8081 (pesticides)</td>
<td>Statistically Derivedb</td>
<td>Statistically Derivedb</td>
</tr>
</tbody>
</table>
Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples

<table>
<thead>
<tr>
<th>CAS No.</th>
<th>Analyte</th>
<th>Estimated Quantitation Limit</th>
<th>Analytical Methoda</th>
<th>Precision Requirement (%)</th>
<th>Accuracy Requirement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5103-74-2</td>
<td>gamma-Chlordane</td>
<td>0.0165 mg/kg</td>
<td>1:1 water extract followed by SW-846 Method 6010, 6020, 7196, 7470, or EPA 200.8</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>—</td>
<td>Distribution coefficient for metals</td>
<td>N/A</td>
<td>Field procedure or ASTM D422-63</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>—</td>
<td>Grain size (sieve) analysis</td>
<td>N/A</td>
<td>Calculation</td>
<td>N/A</td>
<td>N/A</td>
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<td>—</td>
<td>Porosity</td>
<td>N/A</td>
<td>ASTM D2216</td>
<td>N/A</td>
<td>N/A</td>
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<td>—</td>
<td>Sediment moisture content</td>
<td>N/A</td>
<td>ASTMD2434 for soil with high hydraulic conductivity (sand or sandy gravel)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Performance Requirements for Physical Properties

| —       | Saturated hydraulic conductivity     | N/A                          | ASTM D2434 for soil with high hydraulic conductivity (silt or a mud) | N/A                       | N/A                      |
| —       | Permeability (calculated)            | N/A                          | ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel) | N/A                       | N/A                      |
| —       | Bulk density                         | N/A                          | ASTM D2937                                    | N/A                       | N/A                      |
| —       | Calcium Carbonate                    | N/A                          | ASTM D4373                                    | N/A                       | N/A                      |
Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples

<table>
<thead>
<tr>
<th>CAS No.</th>
<th>Analyte</th>
<th>Estimated Quantitation Limit</th>
<th>Analytical Method&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Precision Requirement (%)</th>
<th>Accuracy Requirement (%)</th>
</tr>
</thead>
</table>


b. Soil will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.

c. Field measurements have no specific quality control requirement for accuracy except to perform checks to verify manufacturer’s expected performance.

d. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

e. Strontium-90 will be assessed as total radioactive strontium.

f. Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

g. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

h. Determined by the laboratory based on historical data or statistically-derived control limits. Limits are reported with the data. Where specific acceptance criteria are listed, those acceptance criteria may be used in place of statistically derived acceptance criteria.

i. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.

j. To meet or approach calculated cleanup goals, laboratories must use axial-based (“trace”) ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.

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ASTM = American Society for Testing and Materials
CAS = Chemical Abstracts Service
dpm = disintegrations per minute
EPA = U.S. Environmental Protection Agency
IC = ion chromatography
ICP = inductively coupled plasma
LSC = liquid scintillation counter
MS = mass spectroscopy
N/A = not applicable
NV = no value
pH = acidity or alkalinity of an aqueous solution
UKPA = total uranium by kinetic phosphorescence analysis
WAC = Washington Administrative Code
### Table 2-4. Analytical Performance Requirements for Water Samples

<table>
<thead>
<tr>
<th>CAS #</th>
<th>Analyte</th>
<th>Analytical Method</th>
<th>Estimated Quantitation Limit</th>
<th>Precision Requirement (%)</th>
<th>Accuracy Requirement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Performance Requirements for Field Measurements</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>—</td>
<td>Oxidation reduction potential</td>
<td>REDOX PROBE</td>
<td>N/A</td>
<td>____ c</td>
<td>____ c</td>
</tr>
<tr>
<td>—</td>
<td>pH measurement</td>
<td>PROBE</td>
<td>0.5 pH unit</td>
<td>____ c</td>
<td>____ c</td>
</tr>
<tr>
<td>—</td>
<td>Specific conductance</td>
<td>PROBE</td>
<td>1 µS/cm</td>
<td>____ c</td>
<td>____ c</td>
</tr>
<tr>
<td>—</td>
<td>Temperature</td>
<td>PROBE</td>
<td>___</td>
<td>___ c</td>
<td>___ c</td>
</tr>
<tr>
<td>—</td>
<td>Dissolved oxygen</td>
<td>PROBE</td>
<td>___</td>
<td>___ c</td>
<td>___ c</td>
</tr>
<tr>
<td>—</td>
<td>Turbidity</td>
<td>PROBE</td>
<td>0.1 Nephelometric Turbidity Unit</td>
<td>____ c</td>
<td>____ c</td>
</tr>
<tr>
<td>—</td>
<td>Alkalinity (as CaCO3)</td>
<td>Alkalinity 310.1</td>
<td>5,000 µg/L</td>
<td>±20%</td>
<td>80-120%</td>
</tr>
<tr>
<td></td>
<td>Performance Requirements for Laboratory Measurements (Radiological)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12587-46-1</td>
<td>Gross alpha</td>
<td>GPC</td>
<td>3 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>12587-47-2</td>
<td>Gross beta</td>
<td>GPC</td>
<td>4 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>10045-97-3</td>
<td>Cesium-137</td>
<td>GEA</td>
<td>15 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>10198-40-0</td>
<td>Cobalt-60</td>
<td>GEA</td>
<td>25 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>14683-23-9</td>
<td>Europium-152</td>
<td>GEA</td>
<td>50 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>15585-10-1</td>
<td>Europium-154</td>
<td>GEA</td>
<td>50 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>13966-00-2</td>
<td>Potassium-40</td>
<td>GEA</td>
<td>4,000 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>10098-97-2</td>
<td>Strontium-90e</td>
<td>Strontium-90</td>
<td>2 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>14133-76-7</td>
<td>Technetium-99</td>
<td>LSC –Technetium-99</td>
<td>15 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>10028-17-8</td>
<td>Tritium</td>
<td>LSC –Tritium</td>
<td>400 pCi/L</td>
<td>≤30 d</td>
<td>70-130 d</td>
</tr>
<tr>
<td>CAS #</td>
<td>Analyte</td>
<td>Analytical Methoda</td>
<td>Estimated Quantitation Limitb</td>
<td>Precision Requirement (%)</td>
<td>Accuracy Requirement (%)</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------</td>
<td>--------------------------------------------------------</td>
<td>------------------------------</td>
<td>---------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>7440-36-0</td>
<td>Antimony</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>5 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7440-38-2</td>
<td>Arsenic</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>2 µg/L hi</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7440-41-7</td>
<td>Beryllium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>2 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7440-39-3</td>
<td>Barium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>5 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7440-43-9</td>
<td>Cadmium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>2 µg/L hi</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7440-70-2</td>
<td>Calcium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>1,000 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7440-47-3</td>
<td>Chromium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>10 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7440-48-4</td>
<td>Cobalt</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>2.6 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7440-50-8</td>
<td>Copper</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>8 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>57-12-5</td>
<td>Cyanide¹</td>
<td>EPA 9012</td>
<td>20 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>18540-29-9</td>
<td>Hexavalent chromium¹</td>
<td>EPA 7196 (Hexavalent chromium)</td>
<td>10 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7439-89-6</td>
<td>Iron</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>50 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>7439-92-1</td>
<td>Lead</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>2 µg/L</td>
<td>≤20f</td>
<td>80-120f</td>
</tr>
<tr>
<td>CAS #</td>
<td>Analyte</td>
<td>Analytical Method</td>
<td>Estimated Quantitation Limit</td>
<td>Precision Requirement (%)</td>
<td>Accuracy Requirement (%)</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>------------------------------------------</td>
<td>-----------------------------</td>
<td>---------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>7439-96-5</td>
<td>Manganese</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>5 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7439-95-4</td>
<td>Magnesium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>750 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7439-97-6</td>
<td>Mercury</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>0.5 µg/L&lt;sup&gt;g&lt;/sup&gt;</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7440-02-0</td>
<td>Nickel</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>40 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7440-09-7</td>
<td>Potassium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>4,000 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7782-49-2</td>
<td>Selenium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>4 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7440-22-4</td>
<td>Silver</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>2 µg/L&lt;sup&gt;h&lt;/sup&gt;</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7440-23-5</td>
<td>Sodium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>500 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7440-24-6</td>
<td>Strontium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>10 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7440-28-0</td>
<td>Thallium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>2 µg/L&lt;sup&gt;h&lt;/sup&gt;</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>Uranium</td>
<td>Total uranium (chemical)</td>
<td>15 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7440-62-2</td>
<td>Vanadium</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>25 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>7440-66-6</td>
<td>Zinc</td>
<td>Trace – ICP (6010) or ICP/MS (6020 or 200.8)</td>
<td>10 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Table 2-4. Analytical Performance Requirements for Water Samples

<table>
<thead>
<tr>
<th>CAS #</th>
<th>Analyte</th>
<th>Analytical Methoda</th>
<th>Estimated Quantitation Limitb</th>
<th>Precision Requirement (%)</th>
<th>Accuracy Requirement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>75-35-4</td>
<td>1,1-Dichloroethene</td>
<td>EPA 8260 (VOCs)</td>
<td>2 µg/L&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>71-43-2</td>
<td>Benzene</td>
<td>EPA 8260 (VOCs)</td>
<td>0.8 µg/L</td>
<td>Statistically Derived&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>56-23-5</td>
<td>Carbon tetrachloride</td>
<td>EPA 8260 (VOCs)</td>
<td>1 µg/L</td>
<td>Statistically Derived&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>67-66-3</td>
<td>Chloroform</td>
<td>EPA 8260 (VOCs)</td>
<td>5 µg/L</td>
<td>Statistically Derived&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>79-01-6</td>
<td>Trichloroethene</td>
<td>EPA 8260 (VOCs)</td>
<td>1 µg/L</td>
<td>Statistically Derived&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>75-01-4</td>
<td>Vinyl Chloride</td>
<td>EPA 8260 (VOCs)</td>
<td>1 µg/L</td>
<td>Statistically Derived&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>16887-00-6</td>
<td>Chloride</td>
<td>EPA 300.0 (anions by IC)</td>
<td>400 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>16984-48-8</td>
<td>Fluoride</td>
<td>EPA 300.0 (anions by IC)</td>
<td>500 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>14797-55-8</td>
<td>Nitrate (as N)</td>
<td>EPA 300.0 (Anions by IC)</td>
<td>100 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>14797-65-0</td>
<td>Nitrite (as N)</td>
<td>EPA 300.0 (Anions by IC)</td>
<td>100 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>14808-79-8</td>
<td>Sulfate</td>
<td>EPA 300.0 (Anions by IC)</td>
<td>550 µg/L</td>
<td>≤20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>N/A</td>
<td>Pesticides&lt;sup&gt;i&lt;/sup&gt;</td>
<td>EPA 8081</td>
<td>0.5 to 5 µg/L</td>
<td>Statistically Derived&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>N/A</td>
<td>PCBs&lt;sup&gt;i&lt;/sup&gt;</td>
<td>EPA 1668A</td>
<td>0.02 µg/L</td>
<td>Statistically Derived&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>N/A</td>
<td>PCBs&lt;sup&gt;i&lt;/sup&gt;</td>
<td>EPA 8082</td>
<td>5 µg/L</td>
<td>≤20&lt;sup&gt;g&lt;/sup&gt;</td>
<td>80-120&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>N/A</td>
<td>Polynuclear aromatic hydrocarbons&lt;sup&gt;i&lt;/sup&gt;</td>
<td>EPA 8310</td>
<td>0.5 to 5 µg/L</td>
<td>Statistically Derived&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Table 2-4. Analytical Performance Requirements for Water Samples

<table>
<thead>
<tr>
<th>CAS #</th>
<th>Analyte</th>
<th>Analytical Method</th>
<th>Estimated Quantitation Limit</th>
<th>Precision Requirement (%)</th>
<th>Accuracy Requirement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Semivolatile organic compounds</td>
<td>EPA 8270</td>
<td>10 to 50 µg/L</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
<td>Statistically Derived&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Sources:
40 CFR 141.66, “National Primary Drinking Water Regulations,” “Maximum Contaminant Levels for Radionuclides.”
EPA-600/4-79-020, Methods for Chemical Analysis of Water and Wastes.
EPA-600/R-94-111, Methods for the Determination of Metals in Environmental Samples, Supplement I.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020. For EPA Method 200.8, see EPA-600/R-94-111. For the four-digit EPA methods, see SW-846 Methods SW-846 8260 and 8270.

b. Estimated quantitation limits are obtained from the Waste Sampling and Characterization Facility statement of work for analytical services provided to CHPRC S&GRP.

c. Field measurements have no specific quality control requirement except to perform checks to verify manufacturer’s expected performance.

d. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

e. Strontium-90 will be assessed as total radioactive strontium.

f. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples is also performed. The precision criteria shown is for batch laboratory replicate matrix spike or replicate sample relative percent differences.

g. To meet or approach calculated action levels, laboratories must use axial-based (“trace”) ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.
Table 2-4. Analytical Performance Requirements for Water Samples

<table>
<thead>
<tr>
<th>CAS #</th>
<th>Analyte</th>
<th>Analytical Method</th>
<th>Estimated Quantitation Limit</th>
<th>Precision Requirement (%)</th>
<th>Accuracy Requirement (%)</th>
</tr>
</thead>
</table>

h. Action levels are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

i. If a validated detection is obtained, sample collection and analysis for this method at the well will be performed for all subsequent sample events. If there is no validated detection for an analyte or method from the initial scheduled event(s) at the well, that analyte and/or method will be dropped from the analytical suite for the well for subsequent sampling events.

j. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.

k. Determined by the laboratory based on historical data or statistically-derived control limits. Limits are reported with the data. Where specific acceptance criteria are listed, those acceptance criteria may be used in place of statistically derived acceptance criteria.

l. Hexavalent chromium analysis could be performed using a HACH© Test kit for screening purposes.

CAS = Chemical Abstracts Service
CCC = criterion continuous concentration
GEA = gamma energy analysis
GPC = gas proportional counter
IC = ion chromatography
ICP = inductively coupled plasma
LSC = liquid scintillation counter
MCL = maximum contaminant level
MS = mass spectroscopy
N/A = not applicable
NV = no value
PCB = polychlorinated biphenyl
VOC = volatile organic compound
WAC = Washington Administrative Code
2.2.3 Quality Control Requirements

To ensure that reliable data are obtained, QC procedures must be followed in the field and laboratory. Field personnel will collect QC samples to evaluate the potential for cross contamination and to provide information pertinent to field variability. Field QC sampling will require the collection of field duplicates, trip or field transfer blanks, equipment rinsate blanks, and field splits. Laboratory QC samples estimate the precision and bias of the analytical data. No QC samples are required for the archived geologic samples.

Particular care will be exercised to avoid the following common ways in which cross contamination or background contamination may compromise samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

Table 2-5 summarizes field and laboratory QC samples. Additional QC samples may be collected if conditions arise.

<table>
<thead>
<tr>
<th>Quality Control Sample Type</th>
<th>Purpose</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field Quality Control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full trip blank</td>
<td>Assess contamination from containers or transportation</td>
<td>One per 20 samples, per media sampled.</td>
</tr>
<tr>
<td>Field transfer blank</td>
<td>Assess contamination from sampling site</td>
<td>One per day when volatile organic compounds are sampled or for groundwater monitoring activities. A minimum of one field transfer blank will be collected at each borehole, per media sampled where the sample will undergo volatile organic analysis.</td>
</tr>
<tr>
<td>Equipment rinsate blank</td>
<td>Verify adequacy of sampling equipment decontamination</td>
<td>As needed.(^a) If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. Otherwise, 1 per 20 samples, per media sampled.</td>
</tr>
<tr>
<td>Field duplicates</td>
<td>Estimate precision, including sampling and analytical variability</td>
<td>One per batch,(^b) 20 samples maximum, for groundwater monitoring activities. A minimum of one field duplicate will be collected at each borehole, per media sampled.</td>
</tr>
</tbody>
</table>
Table 2-5. Field and Laboratory Quality Control Checks

<table>
<thead>
<tr>
<th>Quality Control Sample Type</th>
<th>Purpose</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field split</td>
<td>Estimate precision, including sampling, analytical, and inter-laboratory variability</td>
<td>At a minimum, one per analytical method, per media, for analyses performed where detection limit and precision and accuracy criteria have been defined in the Analytical Performance Requirements Tables.</td>
</tr>
<tr>
<td>Laboratory Quality Control&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method blank</td>
<td>Assess response of an entire laboratory analytical system</td>
<td>One per batch&lt;sup&gt;b&lt;/sup&gt;, 20 samples maximum, or as identified by the method guidance, &lt;i&gt;per media sampled&lt;/i&gt;.</td>
</tr>
<tr>
<td>Matrix spike</td>
<td>Identify analytical (preparation and analysis) bias; possible matrix effect on the analytical method used</td>
<td>When required by the method guidance, one per batch&lt;sup&gt;b&lt;/sup&gt;, 20 samples maximum, or as identified by the method guidance, &lt;i&gt;per media sampled&lt;/i&gt;.</td>
</tr>
</tbody>
</table>
| Matrix duplicate or matrix spike duplicate | Estimate analytical bias and precision | When required by the method guidance, one per batch<sup>b</sup>, 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i>.
| Laboratory control samples | Assess method accuracy | One per batch<sup>b</sup>, 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i>. |
| Surrogates                 | Estimate recovery or yield | When required by the method guidance, as identified by the method guidance. |

<sup>a</sup> Whenever a new type of non-dedicated equipment is used, an equipment rinsate blank will be collected every time sampling occurs until it can be shown that less frequent collection of equipment rinsate blanks is adequate to monitor the decontamination procedure for the non-dedicated equipment.

<sup>b</sup> Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

1. **Field Quality Control Samples**

   The field QC sample types are discussed within this section.

   3. **Full trip blanks** are samples prepared by the sampling team before traveling to the sampling site.

   4. The preserved bottle set is identical to the set collected in the field, but it is filled with reagent water or silica sand, as appropriate to the primary sample media. The bottles are sealed and transported, unopened, to the field in the same storage container used for samples collected the same day. Full trip blanks are typically analyzed for the same constituents as the samples from the associated sampling event. However, the analytical list for full trip blanks for soil may be limited to volatile organic compounds (VOCs), semivolatile organic compounds, and total petroleum hydrocarbons. Full trip blanks are not required for aquifer sediments being analyzed for metals, mercury, and Cr(VI).
**Field transfer blanks** are preserved VOC sample vials filled at the sample collection site with reagent water or silica sand. The samples are prepared during the sampling to evaluate potential contamination caused by field conditions. After collection, field transfer blank bottles are sealed and placed in the same storage container with the samples from the associated sampling event. Field transfer blank samples are analyzed for VOCs only.

The field transfer blank will consist of reagent water, or silica sand, added to clean sample vials at the location where the VOC sample was collected. The field transfer blank will be batched with samples for which VOC analysis is requested.

**Equipment rinsate blanks** are collected for reused sampling devices to assess the adequacy of the decontamination process. Equipment rinsate blanks will consist of silica sand or reagent water poured over the decontaminated sampling equipment and placed in containers, as identified on the project sampling authorization form. If disposable (e.g., single-use) equipment is used, equipment rinsate blanks will not be required.

For the field blank samples (e.g., full trip blank, field transfer blank, equipment rinsate blank), results greater than two times the method detection limit (MDL) are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the MDL. For radiological data, blank results are flagged as suspected contamination if they are greater than two times the total minimum detectable activity.

**Field duplicate samples** are used to evaluate sample consistency and the precision of field sampling methods. Field duplicates are independent samples collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently.

The duplicate should be collected generally from an area expected to have some contamination, so valid comparisons between the samples can be made (e.g., at least some of the constituents will be greater than the detection limit). When sampling is performed from a split spoon, VOC samples and VOC duplicate samples are collected directly from the sampler. The remaining soil/aquifer sediment is then composited in a stainless steel mixing bowl. The soil/aquifer sediment sample and duplicate sample are collected from this composited material.

Evaluation of the results can provide an indication of intra-laboratory variability. Evaluation criteria for field duplicate sample results are described in Section 2.2.3.3.

A **field split** is a representative sample from a sampling event sent to a third party laboratory (i.e., reference laboratory). Evaluation of the results can provide an indication of inter-laboratory variability. Field split sample result evaluation criteria are described in Section 2.2.3.3.

### 2.2.3.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, matrix spike) are defined for three-digit EPA methods (EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*; EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement I*) and four-digit EPA methods (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*), and are communicated to the laboratory in the applicable laboratory's statement of work. QC checks outside of control limits will be reflected in the data validation process and during the data quality assessment (DQA) described in Section 2.4.
2.2.3.3 Quality Control Requirements

If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. If no VOC samples are collected, then a field transfer blank is not required. Only those field duplicate result pairs with at least one result greater than five times the appropriate detection limit or minimum detectable activity are evaluated. Field duplicate sample results must agree within 20 percent, as measured by the RPD, to be acceptable. Unacceptable field duplicate results are flagged with a “Q” qualifier in the HEIS database. Large RPDs can be an indication of laboratory performance problems and should be investigated.

Only field split result pairs with at least one result greater than five times the appropriate detection limit or minimum detectable activity are evaluated. Field split sample results must agree within 20 percent, as measured by the RPD, to be acceptable. Unacceptable field split results are qualified and flagged in the HEIS database, as appropriate. Large RPDs can be an indication of inter-laboratory variability and potential laboratory performance problems, and should be investigated.

Tables 2-3 and 2-4 present the acceptance criteria for laboratory duplicate sample, matrix spike sample, matrix spike duplicate sample, and laboratory control sample results for chemical analyses.

Holding time is the elapsed time period between sample collection and analysis, or sample collection to extraction and sample extraction to analysis, as applicable to the method. Exceeding recommended holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, as specified for three- and four-digit EPA methods (EPA-600/4-79-020; EPA-600/R-94-111; SW-846). Data associated with exceeded holding times are flagged and qualified in HEIS, as appropriate.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The laboratories participate in national studies such as the EPA-sanctioned water pollution and water supply performance evaluation studies. The Soil and Groundwater Remediation Project periodically audits the analytical laboratories to identify and solve quality problems or to prevent such problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report (e.g., Hanford Site Groundwater Monitoring for Fiscal Year 2008 [DOE/RL-2008-66]). QC failure will be determined and evaluated during data validation and the DQA process. Data will be qualified as appropriate.

2.2.4 Equipment

Equipment used for collection, measurement, and testing shall meet applicable standards (e.g., American Society for Testing and Materials) or have been evaluated as acceptable and valid in accordance with the applicable methods, requirements, and specifications. Each user of collection, measurement, and testing equipment is responsible to ensure that the equipment is functioning as expected, properly handled, and calibrated before expiration in accordance with procedures governing control of the equipment. Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer’s specifications and other approved procedures. The equipment and procedures shall be selected on a site-specific basis, depending on the media and the nature of the contaminant to be sampled.

Laboratories and onsite collection, measurement, and testing equipment shall be tested, inspected, and maintained. Measurement equipment must be inspected before use. Maintenance requirements (e.g., parts lists and documentation of routine maintenance) will be included in the individual laboratory’s and onsite organization’s QA plan and/or operating procedures. Measurement and testing equipment used in the field
or in the laboratory directly affecting the quality of analytical data will be subject to preventive
maintenance measures to ensure that measurement system downtime is minimized.

Laboratories and onsite measurement organizations must calibrate equipment. Calibration of laboratory
instruments will be performed in accordance with the latest version of EPA analytical methods being used
by the laboratory, with instrument manufacturer specifications, with approved procedures, or with
auditable HASQARD (DOE/RL-96-68). RCTs will perform measurements with calibrated instruments.

2.2.5 Inspection of Consumable Supplies

Consumables, supplies, and reagents will be reviewed in accordance with the current requirements of
SW-846, or other EPA method being used, or by an approved site analytical procedure. Potential
contamination is monitored by field QC samples and laboratory blanks. The lot number from the
manufacturer certified, pre-cleaned sample containers will be recorded in the sampler’s logbook.

2.2.6 Data Management

Data resulting from the implementation of the SAP will be stored in the HEIS database. Reports and
supporting analytical data packages will be subject to final technical review by qualified reviewers before
submittal to the regulatory agencies or before inclusion in reports or technical memoranda. Electronic
data access, when appropriate, shall be through computerized databases (e.g., HEIS). Where electronic
data are not available, hardcopies will be provided in accordance with Section 9.6 of the TPA
(Ecology et al., 1989).

2.2.7 Field Documentation Management

Field documentation shall be maintained in the form of chain-of-custody/sample analysis request forms
and logbook entries. Other documentation is described in Section 2.1.4.

2.3 Assessment and Oversight

Routine evaluation of data quality described for this project will be documented and filed with the data in
the project file. The OU Project Manager (or designee) and/or the Drilling Lead will monitor field
activities for this SAP. The OU Project Manager retains overall responsibility for sampling but may
delegate specific responsibilities to the Drilling Lead or other appropriate contractor staff. The QA
Engineer ensures implementation of associated QA activities on the project.

The SMR organization will select a laboratory to perform the soil and groundwater analyses for this SAP.
The SMR organization will assess and verify that analytical data are complete and contractually correct
and will then enter the verified data into the HEIS database.

2.3.1 Assessments and Response Action

Random surveillance and assessments may be conducted to verify compliance with the requirements
outlined in this SAP, project work packages, the QAPjP, procedures, and regulatory requirements.
Deficiencies identified by these assessments will be reported. The project’s QA organization coordinates
corrective actions/deficiencies in accordance with the contractor’s QA program. When appropriate,
corrective actions will be taken by the OU Project Manager (or designee).

2.3.2 Reports to Management

Management will be made aware of deficiencies identified by self assessments, corrective actions from
ECOs, and findings from QA assessments and surveillances.
2.4 Data Review, Verification, Validation, and Usability Requirements

Samples taken for standard turnaround time during drilling will be received from the laboratory, loaded into a database (e.g., HEIS), and verified (Section 2.4.1). A total of 5 percent of the data will be validated (Section 2.4.3). A DQA may be performed, if requested, on the final data sets for a set of wells (Section 2.4.4). At the direction of the OU Project Manager (or designee), analytical data packages will be subject to final technical review by qualified personnel before submittal to the regulatory agencies or inclusion in reports. Electronic data access, when appropriate, will be via a database (e.g., HEIS).

Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the TPA (Ecology et al., 1989).

2.4.1 Data Verification and Usability Methods

The SMR organization is responsible for review of field paperwork, analytical data packages, and electronic files from the laboratory information management system. Sampling documents include the groundwater sampling record, chain-of-custody forms, field logbook pages, and other paperwork associated with sampling and shipping. SMR reviews these documents for completeness, approvals, and legibility. SMR verifies that analytical and QC data from the laboratories are complete, reported correctly, and within applicable limits. SMR rechecks laboratory documents to verify the condition of the samples upon receipt at the laboratory and determines if problems arose during analysis that may have affected the data. When issues arise with samples before the analytical data is processed, SMR oversees the resolution of those issues.

2.4.2 Resolution of Analytical System Errors

Errors reported by the laboratories are reported to the SMR project coordinator, who initiates a sample disposition record in accordance with contractor procedures. This process is used to document analytical errors and establish resolution with the OU Project Manager. In addition, the contractor QA Engineer receives quarterly reports providing summaries and statistics of the analytical errors.

2.4.3 Data Validation

The format and requirements for data validation activities are based upon the most current version of National Functional Guidelines for Superfund Organic Methods Data Review (USEPA-540-R-08-01 [OSWER 9240.1-48]) and National Functional Guidelines for Inorganic Superfund Data Review (USEPA-540-R-10-011 [OSWER 9240.1-51]). The SMR organization arranges for the performance of data validation activities, typically by a party independent of the data collector, the data generator, and the data user. Third party data validation reports are reviewed by SMR personnel, for completeness and contractual compliance, and also by Project QA personnel. A total of 5 percent of the results will undergo Level C validation, as defined by the validation guidelines.

2.4.4 Data Quality Assessment

The DQA process compares completed field activities to those in corresponding documents and provides an evaluation of the resulting data. The purpose of the DQA is to determine whether quantitative data are of the correct type and adequate quality and quantity to meet the project data quality objectives. The assessment will be consistent with the DQA process in Data Quality Assessment: A Reviewer’s Guide (EPA/240/B-06/002), and Data Quality Assessment: Statistical Methods for Practitioners (EPA/240/B-06/003).
3 Field Sampling Plan

This FSP identifies activities for installation of new groundwater wells, soil sampling during borehole installation, and groundwater sampling following completion of well development. This FSP provides for soil and groundwater sampling to meet the sampling objectives identified in Section 3.1 and data needs identified in Chapter 1.

3.1 Sampling Objectives

The soil and groundwater sampling objectives are to confirm the lithology, assist in well design, collect lithologic samples to meet potential future needs, and determine the vadose and groundwater contaminant levels.

3.2 Sampling Design

To meet project sampling objectives, the sampling design identifies the sample collection requirements for each of the well types. Sampling locations and frequencies, along with site-specific sampling information (e.g., number of samples), and the method of sampling (e.g., grab samples and split spoons) will be provided in addenda documents. The key features of soil and groundwater sampling design are summarized in Table 3-1.

3.2.1 Soil Sampling

Geologic soil samples will be collected during borehole installation to total borehole depth but will not be analyzed under this SAP. These samples will be archived for future analysis if data needs are identified. Samples will also be collected at the Hanford/Ringold contact, RUM contact, and other identified lithologic changes, and archived. Should contamination or other unexpected conditions be identified during drilling, the OU Project Manager and DOE-RL Project Manager will be notified as soon as possible, and additional samples for laboratory analysis may be required.

Aquifer sediments will be collected during borehole installation. Geologic samples of aquifer sediment will be collected within the aquifer/planned screened interval to design the filter pack and corresponding well screen. Sieve analysis will be conducted in accordance with ASTM D422-63(2007), Standard Test Method for Particle-Size Analysis of Soils.

Soil samples may be collected for chemical analysis from expected vadose zone contaminated intervals (Table 2-3). RUM samples will be analyzed for permeability and grain size to confirm the competency of the RUM material and potential for contaminants to migrate through the first RUM layer.

3.2.2 Groundwater Sampling

Groundwater samples will be collected at intervals throughout the thickness of the aquifer during drilling, as specified in addenda, to confirm ambient chromium concentrations, develop a baseline chromium concentration within the aquifer in the vicinity of the new well, and determine if a vertical distribution of contaminants is present. Samples will be analyzed for Cr(VI) in the field using a Hach® Test Kit. This analysis will also be used to determine screen placement, and whether use of the well in the selected location is appropriate for extraction or injection purposes.

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Immediately following well development, samples will be collected for laboratory analysis (Table 2-4) to confirm the field test results and confirm that other potential contaminants are not present. Water chemistry parameters and field parameters (Table 2-4) will also be collected to evaluate the aquifer connection to the river. Continued sampling for these wells are discussed in the appropriate plan, a monitoring plan or SAP, or an Operation and Maintenance Plan.

3.2.3 Borehole Drilling

Boreholes for new groundwater wells will be drilled as detailed in the addenda. The drilling method will be determined by the drilling lead and drilling contractor. Method must be compatible with data needs. Depending on the purpose of the well certain drilling aspects (e.g. drill depths, casing size) need to be considered. All reasonable efforts will be made to minimize or eliminate the addition of water to the borehole. If water addition is necessary, the volume added should be kept to the smallest volume required.

Extraction wells will be drilled to a depth adequate to ensure pump operations during low water periods. Wells completed in the first water bearing unit of the RUM will be drilled to the bottom of the water producing zone. The driller will be required to downsize temporary casing when drilling through the RUM and completing in the lower water bearing unit to prevent interconnecting aquifers as required in WAC-173-160-181. Documentation of drilling is summarized in a borehole completion report and includes: detail description of geologic material, addition of water to borehole, natural moisture content of material, photographic log, etc.

3.2.4 Geophysical Logging

Geophysical logging will be performed through each single string of casing (i.e., before telescoping) to produce a geophysical log of the entire length of the borehole. A Spectral Gamma Logging System will be passed from ground surface to the total depth of the borehole for all five monitoring wells to determine the vertical distribution and concentration of gamma emitting radionuclides. A Neutron-Moisture Logging System will also be passed from ground surface to the top of the water table for all five monitoring wells to determine soil moisture.

3.2.5 Well Installation and Development

Well drilling and completion will be performed in accordance with the requirements of WAC 173-160. If the completion differs from the WAC 173-160 requirements, then variances will be obtained from Ecology.

The wells will be constructed generally (as shown in Figures 3-1 and 3-2) using 15.2 cm (6 in.) diameter (or larger) casing. The wells will be built with Schedule 10, Type 304 or 316, stainless steel, V-slot, continuous wire-wrap screen, on top of a 0.9 to 1.5 m (3 to 5 ft) long, stainless steel sump with end cap. The screen will fully penetrate the aquifer, and the top of the screen will be set above the high water level mark except for the well(s) completed in the RUM. A schedule 10 stainless steel casing will extend from the top of the well screen to the ground surface. Colorado silica sand or approved equivalent will be used for the sand pack; sodium bentonite pellets and/or natural sodium bentonite chunks, crumbles, or powdered bentonite will be used for bentonite sealing material; Type I/II Portland cement will be used for cement grout.

If drilling through a confining or semi-confining unit, drilling will be such that any water bearing zones are sealed to prevent flow between units. Telescoping casing is usually used to prevent flow between units.
Surface construction will consist of a protective casing, protective guard posts, and cement pad.

The protective casing shall be a minimum of 5.1 cm (2 in.) larger in diameter than the permanent casing. Protective casing shall rise approximately 0.9 m (3 ft) above the ground surface. Permanent casing shall rise to approximately 0.3 m (1 ft) below the top of the protective casing. Protective casing shall have a lockable well cap extending approximately 38 cm (15 in.) above the top of the protective casing.

The functionality of the well is dependent on the well design and development of the well during completion activities. Surging and pumping the well will assist in obtaining maximum flow rates. Well surging will continue until there is less than 3 cm (0.1 ft) of screen infill per 15 minutes of surge time. Surging will continue until the well ceases to exceed this rate of settling and turbidity has decreased to ≤5 nephelometric turbidity units, and temperature, pH, and specific conductance measurements have stabilized (i.e., at least three consecutive measurements within 10 percent of each other).

A pump test is utilized to select the most effective pump size as well as the characteristics of the local aquifer. A pump test will be performed contingent upon purgewater handling capabilities. The test will be conducted after well completion and surging. Pumping will continue at a maximum constant sustainable rate for a minimum of 4 hours. Drawdown at the well and at the nearest well screened at the same depth in the aquifer will be measured during pumping. This stress on the aquifer will assist in the determination of aquifer properties.
<table>
<thead>
<tr>
<th>Well Type</th>
<th>Geological Archive Media</th>
<th>Soil Physical Properties</th>
<th>Groundwater</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Vertical Permeability</td>
<td>From Screened Interval</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical Hydraulic</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conductivity</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring Unconfined Aquifer</td>
<td>Grab sample every 5 ft (1.5 m) and at lithologic change for archival purposes</td>
<td>One composited from the</td>
<td>Top of unconfined aquifer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>top of the unconfined</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>aquifer and one composited from the base of the unconfined aquifer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>One at the top of the unconfined aquifer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and one at the base of the unconfined aquifer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>One per selected depth interval through depth of waste site or expected zone of contamination; one per selected depth interval from bottom of waste site to top of water table; or no sampling if not within a vadose zone contaminated area</td>
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</tr>
<tr>
<td>Extraction/Injection</td>
<td>Grab sample every 5 ft (1.5 m) and at lithologic change for archival purposes</td>
<td>One composited from the</td>
<td>Top of unconfined aquifer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>top of the unconfined</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>aquifer and one composited from the base of the unconfined aquifer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>One at the top of the unconfined aquifer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and one at the base of the unconfined aquifer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>One per selected depth interval through depth of waste site or expected zone of contamination; one per selected depth interval from bottom of waste site to top of water table; or no sampling if not within a vadose zone contaminated area</td>
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</tr>
<tr>
<td>Monitoring Semi-confined to Confined Aquifer</td>
<td>Grab sample every 5 ft (1.5 m) and at lithologic change for archival purposes</td>
<td>One composited from the</td>
<td>Top of unconfined aquifer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>top of the unconfined</td>
<td></td>
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<td></td>
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<td>aquifer, one composited</td>
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<td></td>
<td>from the base of the unconfined aquifer, and one composited from water bearing unit(s) within the semi-confined/confined aquifer</td>
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<td></td>
<td></td>
<td>One from the RUM</td>
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<tr>
<td></td>
<td></td>
<td>One at the top of the unconfined aquifer, one at the base of the unconfined aquifer, and one from water bearing unit(s) within the semi-confined/confined aquifer</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>One per selected depth interval through depth of waste site or expected zone of contamination; one per selected depth interval from bottom of waste site to top of water table; or no sampling if not within a vadose zone contaminated area</td>
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</tbody>
</table>

a. Specific soil sampling intervals and packaging techniques will be identified in later addenda.

b. Specific depth for individual waste site or expected zone of contamination to be identified in addenda based on soil profile. Backfill will not be sampled at previously remediated waste sites.
Figure 3-1. General Well Construction Diagram for Monitoring of Unconfined Aquifer and for Extraction/Injection Wells
Figure 3-2. General Well Construction Diagram for Monitoring of Semi confined to Confined Aquifer
3.3 Sampling Methods

Water samples will be collected according to the current revision of an operating procedure. For certain types of samples, preservatives are required. While the preservative may be added to collection bottles before their use in the field, it is allowable to add the preservative at the sampling vehicle immediately after collection.

To ensure sample and data usability, sampling associated with this monitoring plan will be performed in accordance with established sampling practices, procedures, and requirements pertaining to sample collection, collection equipment, and sample handling. The OU Project Manager and contractor management are responsible for ensuring that all field procedures are followed completely and that field sampling personnel are adequately trained to perform sampling activities under this monitoring plan.

Field sampling shall comply with HASQARD (DOE/RL-96-68).

3.3.1 Decontamination of Sampling Equipment

Sampling equipment shall be decontaminated in accordance with the sampling equipment decontamination procedures. To prevent potential contamination of the samples, care should be taken to use clean equipment for each sampling activity. Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events; field decontamination (e.g., field washing and reuse), which is not appropriate for sampling equipment

3.3.2 Radiological Field Data

Alpha and beta/gamma data collection in the field will be used, as needed, to support sampling and analysis efforts. The following information will be distributed to personnel performing work in support of this SAP:

- RCTs will receive instructions on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the Geiger-Müller, alpha/beta, beta/gamma, and sodium iodide portable instruments will include a physical description of the instruments, radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and application/operation of the instrument. These instruments are commonly used on the Hanford Site to obtain measurements of removable surface contamination measurements and direct measurements of the total surface contamination. Operation and maintenance instructions are contained in approved contractor procedures.

3.4 Documentation of Field Activities

Field activities are documented in field logbooks or data forms in accordance with HASQARD, Volume 2 (DOE/RL-96-68). Data forms may be used to collect field information; however, the information
recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

3.4.1 Field Sample Logbook

Information pertinent to sampling and analysis will be recorded in field checklists and logbooks in accordance with existing sample collection protocols. The sampling team will be responsible for recording relevant sampling information (e.g., wind direction and sample color). Entries made in the logbook will be dated and signed by the individual making the entry. Program requirements for managing the generation, identification, transfer, protection, storage, retention, retrieval, and disposition of records will be followed.

A summary of information to be recorded in logbooks is as follows:

- Purpose of activity
- Day, date, time, and weather conditions
- Names, titles, and organizations of personnel present
- Deviations from the FSP
- Site activities, including field tests
- Details of samples collected (e.g., preparation, splits, duplicates, matrix spikes, and blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations and surveys and equipment identification numbers, as applicable
- Equipment decontaminated, number of decontaminations, and variations to decontamination methods
- Equipment failures or breakdowns and descriptions of any corrective actions

3.4.2 Corrective Actions and Deviations for Sampling Activities

The OU Project Manager, Sampling Lead, Drilling Lead, or designee must document deviations from protocols, problems pertaining to sample collection, chain-of-custody, target analytes, contaminants of potential concern, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected because of field conditions, changes in sample locations because of physical obstructions, or additions of sample depth(s).

As appropriate, such deviations or problems will be documented in the field logbook or on nonconformance report forms in accordance with internal corrective action protocols. The OU Project Manager, Sampling Lead, Drilling Lead, or designee will be responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities. More significant changes in sample locations not impacting the data needs will require notification and approval of the OU Project Manager. Changes to sample locations resulting in impacts to meeting the data needs will require concurrence from the DOE-RL Project Manager and Regulatory Lead. Changes to the SAP will be documented, as noted, in Chapter 5.
3.5 Calibration of Field Equipment

The Sampling Lead is responsible for ensuring that field equipment is calibrated appropriately. Onsite environmental instruments are calibrated in accordance with the manufacturer’s operating instructions, contractor procedures, internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. Either hard copy or electronic calibration activity records are acceptable.

Calibrations must be performed as follows:

- Before initial use of a field analytical measurement system
- At the frequency recommended by the manufacturer or procedure, or as required by regulations
- Upon failure to meet specified QC criteria

Field instrumentation, calibration, and QA checks will be performed in accordance with the following:

- Calibration of radiological field instruments on the Hanford Site is performed by the Mission Support Alliance contractor, as specified in their program documentation.
- Daily calibration checks will be performed, as applicable, and documented for each instrument used to characterize areas under investigation. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.
- Calibration is conducted with certified equipment and/or standards with a known valid relationship to nationally recognized performance standards. If no such standards exist, the basis for calibration shall be documented (i.e., traceable to recognized standards).

3.6 Sample Handling

A sampling and data tracking database is used to track the samples from the point of collection through the laboratory analysis process. Samplers should note any anomaly with a sample (e.g., sample appears unusual or sample is sludge). If anomalies are found, the sampler should inform the SMR organization.

Laboratory analytical results are entered and maintained in the HEIS database. HEIS sample numbers are issued to the sampling organization for the project. Each chemical, radiological, and physical properties sample is identified and labeled with a unique HEIS sample number.

3.6.1 Packaging

Level I EPA pre-cleaned sample containers will be used for soil and water samples collected for chemical analysis. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. The Radiological Engineering organization will measure both the contamination levels and dose rates associated with the filled sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample is shipped in accordance with the U.S. Department of Transportation (DOT) shipping regulations and can be received by the analytical laboratory in accordance with the laboratory’s acceptance criteria. If the dose rate on the outside of a sample container or the curie content exceeds levels acceptable by an offsite laboratory, the Sampling Lead (in consultation with the SMR group), can send smaller volumes to the laboratory. Container types and volumes are identified in Tables 2-1 and 2-2.
3.6.2 Container Labeling

The sample location, depth, and corresponding HEIS numbers are documented in the sampler’s field logbook. Except for volatile organic analyte (VOA) samples, a custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to indicate potential tampering. The custody seal will be inscribed with the sampler’s initials and date. Custody tape is not applied directly to VOA sample containers based on the potential for affecting analyte results and/or fouling of laboratory equipment. Custody seals and any other required labels/documentation can be fixed to the exterior of a plastic bag holding vials in such a manner to detect potential tampering.

Each sample container will be labeled with the following information on firmly affixed, water resistant labels:

- HEIS number
- Sample collection date and time
- Analysis required
- Preservation method (if applicable)
- Sample authorization form number
- Chain-of-custody identification number

In addition, sample records must include the following information:

- Analysis required
- Source of sample
- Matrix (water or soil)
- Field data (pH and radiological readings)

3.6.3 Sample Custody

Sample custody will be maintained in accordance with existing Hanford Site protocols to ensure maintenance of sample integrity throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory.

Sample custody during laboratory analysis is addressed in the applicable laboratory standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by the SMR organization.

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility changes for the custody of the sample, the new and previous custodians will sign the record and note the date and time. The NCO will make a copy of the signed record before sample shipment and will transmit the copy to the SMR organization within 48 hours of shipping.

The following information is required on a completed chain-of-custody form:

- Project name
- Signature of sampler
3.6.4 Sample Transportation

All packaging and transportation instructions shall be in compliance with applicable transportation regulations, DOE requirements, and contractor requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by DOT as described in 49 CFR, Parts 171 through 177. Carrier specific requirements defined in the International Air Transportation Association Dangerous Goods Regulations should also be considered when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents shall be considered hazardous material in transportation and transported according to DOT 49 CFR requirements. If the sample material is known or can be identified, then it shall be packaged, marked, labeled and shipped according to the specific instructions for that material.

Materials are classified by DOT as radioactive when the isotope specific activity concentration and the exempt consignment limits described in 49 CFR, Part 173 are exceeded. Samples shall be screened or relevant historical data shall be used to determine if these values are exceeded. When screening or historical data indicate that samples are radioactive, they shall be properly classified, described, packaged, marked, labeled, and transported according to DOT requirements.
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4 Change Management

Changes to this SAP and addenda will be reviewed and approved by DOE and the lead regulatory agency prior to implementation. Table 4-1 defines the types of changes that may be made to the documents.

A revision to this document may be necessary after a certain number (e.g., 5) of TPA (Ecology et al., 1989) change notices, at a major change in sampling, or at the request of the regulatory agency.

Table 4-1. Change Control

<table>
<thead>
<tr>
<th>Type of Change</th>
<th>Action</th>
<th>Documentation</th>
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</thead>
<tbody>
<tr>
<td>Adding constituents or increasing sampling</td>
<td>DOE-RL Project Manager approval; notify regulator.</td>
<td>Project’s schedule tracking system</td>
</tr>
<tr>
<td>Eliminating constituents, wells, decreasing sampling, or a change in analytical method/quantitation limit</td>
<td>Revise sampling and analysis plan (or TPA Change Notice, if appropriate); obtain DOE and regulatory approval; distribute plan.</td>
<td>Letter report documenting changes or revised plan (or approved TPA Change Notice)</td>
</tr>
<tr>
<td>Well construction material or depth</td>
<td>DOE-RL Project Manager approval; notify regulator.</td>
<td>Project’s schedule tracking system</td>
</tr>
<tr>
<td>Well type</td>
<td>Revise sampling and analysis plan (or TPA Change Notice, if appropriate); obtain DOE and regulatory approval; distribute plan.</td>
<td>Letter report documenting changes or revised plan (or approved TPA Change Notice)</td>
</tr>
</tbody>
</table>

DOE = U.S. Department of Energy
DOE-RL = U.S. Department of Energy, Richland Operations Office
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5 Waste Management

All waste (including unexpected waste) generated by sampling activities will be managed in accordance with *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units* (DOE/RL-97-01). Pursuant to 40 CFR 300.440, “National Oil and Hazardous Substances Pollution Contingency Plan,” “Procedures for Planning and Implementing Off-Site Response Actions,” approval from the DOE Remedial Project Manager is required before returning unused samples or waste from offsite laboratories.

Purge water will be collected and contained at the well head until it is either transported to the Modular Storage Unit or, if waste acceptance criteria can be met, the Effluent Treatment Facility. Purge water, groundwater samples, and decontamination fluids generated during well drilling, sample screening, and analysis will be managed as purge water in accordance with the guidance provided in *Investigation-Derived Waste Purge Water Management Action Memorandum* (DOE/RL-2009-39) and *Investigation Derived Waste Purge Water Management Work Plan* (DOE/RL-2009-80).
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6 Health and Safety

Field operations will be performed in accordance with health and safety requirements and appropriate Prime Contractor project requirements. The project’s site-specific health and safety plan will be followed. Work control documents will be prepared to provide further control of site operations. Safety documentation will include an activity hazard analysis and, as applicable, radiological work permits. The sampling procedures and associated activities will implement ALARA practices to minimize radiation exposure to the sampling team, consistent with the requirements defined in 10 CFR 835, “Occupational Radiation Protection.”
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7 References


171, “General Information, Regulations, and Definitions.”


173, “Shippers—General Requirements for Shipments and Packagings.”

174, “Carriage by Rail.”

175, “Carriage by Aircraft.”

176, “Carriage by Vessel.”

177, “Carriage by Public Highway.”


340-720, “Groundwater Cleanup Standards.”