U.S. Department of Energy
Hanford Site

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22-SGD-000748

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Addressees:

TRANSMITTAL OF THE SAMPLING AND ANALYSIS PLAN FOR DRILLING INTERIM REMEDIAL ACTION WELLS IN THE 200-BP-5 AND 200-PO-1 GROUNDWATER OPERABLE UNITS, DOE/RL-2020-10, DRAFT A

This letter transmits the Sampling and Analysis Plan for Drilling Interim Remedial Action Wells in the 200-BP-5 and 200-PO-1 Groundwater Operable Units, DOE/RL-2020-10, Draft A, to the Washington State Department of Ecology and the U. S. Environmental Protection Agency for review and comment. Comments are requested within 45 days of receipt, per Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Action Plan, Section 9.0.

If you have any questions please contact me, or you may contact Naomi Jaschke, Project Lead, Soil and Groundwater Division, on (509) 316-8622.

Sincerely,

MICHAEL CLINE Digitally signed by MICHAEL CLINE
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Michael W. Cline, Director
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SGD:NMJ

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Attachment
22-SGD-000748

Sampling and Analysis Plan for Drilling Interim Remedial Action Wells in the 200-BP-5 and 200-PO-1 Groundwater Operable Units
DOE/RL-2020-10, DRAFT A

(95 pages including cover sheet)

Signature Page

Title: *Sampling And Analysis Plan for Drilling Interim Remedial Action Wells in the 200-BP-5 and 200-PO-1 Groundwater Operable Units*

_____	_____	_____
Print Name	Signature	Date
U.S. Department of Energy, Richland Operations Office		

_____	_____	_____
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U.S. Environmental Protection Agency		

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Contents

1 Introduction 1-1

1.1 Project Scope and Objectives 1-4
1.2 Background 1-5
1.2.1 A-AX Farm Waste Site Description and History 1-7
1.2.2 C Farm Waste Site Description and History 1-9
1.2.3 Geology 1-11
1.2.4 Hydrogeology 1-19
1.2.5 Groundwater Contamination and Model Capture 1-20
1.3 Systematic Planning Summary 1-21
1.4 Well Design and Construction Requirements 1-23
1.5 Opportunistic Sampling Requirements 1-27
1.6 Target Analytes/Parameters of Interest 1-28
1.7 Geologic and Geophysical Logging 1-29
1.8 Hydraulic Testing Requirements 1-30
1.9 Radiological and Industrial Hygiene Field Screening 1-30
1.10 Well Development 1-31

2 Quality Assurance Project Plan 2-1

2.1 Project Management 2-1
2.1.1 Project/Task Organization 2-1
2.1.2 Quality Objectives and Criteria 2-5
2.1.3 Methods-Based Analysis 2-8
2.1.4 Special Training/Certification 2-8
2.1.5 Documents and Records 2-9
2.2 Data Generation and Acquisition 2-11
2.2.1 Analytical Methods Requirements 2-11
2.2.2 Field Analytical Methods 2-13
2.2.3 Quality Control 2-13
2.2.4 Measurement Equipment 2-20
2.2.5 Instrument and Equipment Testing, Inspection, and Maintenance 2-20
2.2.6 Instrument/Equipment Calibration and Frequency 2-20
2.2.7 Inspection/Acceptance of Supplies and Consumables 2-20
2.2.8 Nondirect Measurements 2-20
2.2.9 Data Management 2-20
2.3 Assessment and Oversight 2-21
2.3.1 Assessments and Response Action 2-21
2.3.2 Reports to Management 2-21

2.4 Data Review and Usability 2-21
2.4.1 Data Review and Verification 2-21
2.4.2 Data Validation 2-22
2.4.3 Reconciliation with User Requirements 2-22
3 Field Sampling 3-1
3.1 Sampling Objectives/Design 3-2
3.2 Sample Location, Frequency, and Constituents to be Monitored 3-2
3.2.1 Sampling Locations 3-8
3.2.2 Frequency 3-8
3.2.3 Constituent/Parameters 3-8
3.3 Sampling Methods 3-9
3.3.1 Decontamination of Sampling Equipment 3-9
3.3.2 Radiological Field Data 3-10
3.4 Aquifer Testing 3-10
3.5 Documentation of Field Activities 3-12
3.5.1 Corrective Actions and Deviation for Sampling Activities 3-13
3.6 Calibration of Field Equipment 3-13
3.7 Sample Handling 3-14
3.7.1 Containers 3-14
3.7.2 Container Labeling 3-14
3.7.3 Sample Custody 3-14
3.7.4 Sample Transportation 3-15
4 Reporting 4-1
5 Management of Waste 5-1
6 Health and Safety 6-1
7 References 7-1

Figures

Figure 1-1. Location Map of the Hanford Site, Central Plateau, and the 200 East Area 1-2
Figure 1-2. C Farm Technetium-99 Concentrations and Plume Extent, 2015–2020 and Proposed Extraction Wells 1-3
Figure 1-3. Groundwater Capture Zone Analyses Model Using Pump Rate of 75 gal/min at Well 299-E25-240 (South Well) and 175 gal/min at Well 299-E27-157 (North Well) 1-4
Figure 1-4. Site Map of Items of Interest at and near the A-AX and C Farms 1-6
Figure 1-5. 2007 Fence Diagram Interpretation of the Geology near the A-AX and C Farms 1-7

Figure 1-6. Three-Dimensional View of Low-Resistivity Targets Beneath C Tank Farm, Plan View (Top), and View Looking from East to West (Bottom) 1-10
Figure 1-7. Cross Section of the Interpreted Geology Along the South Boundary of A Farm 1-13
Figure 1-8. Cross Section of the Interpreted Geology Along the South Boundary of C Farm..... 1-14
Figure 1-9. Stratigraphy of the Hanford Site 1-15
Figure 1-10. Cross Section of the Geology South of A Farm 1-17
Figure 1-11. Standard Extraction Well Design 1-26
Figure 2-1. Project Organization 2-2

Tables

Table 1-1. Release Estimates for Liquid Volume, Technetium-99 Curie Content, and Average Technetium-99 Concentration for Liquid Waste Releases near and Within the A-AX Farms 1-8
Table 1-2. Release Estimates for Liquid Volume, Technetium-99 Curie Content, and Average Technetium-99 Concentration for Liquid Waste Releases near and Within C Farm 1-10
Table 1-3. Estimated Upper Geologic Contacts and Depths to Water 1-19
Table 1-4. 200-BP-5 Operable Unit Expected Well Parameters 1-24
Table 1-5. Target Constituent, Soil Property, and Field Analyses 1-28
Table 2-1. Data Quality Indicators 2-5
Table 2-2. Change Control for Sampling Projects 2-9
Table 2-3. Performance Requirements for Soil and Water Analysis 2-11
Table 2-4. Quality Control Samples 2-13
Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria 2-14
Table 2-6. Holding Time and Preservation Guidelines for Laboratory Analytes 2-17
Table 2-7. Volume/Bottle Requirements for Soil and Water Samples 2-18
Table 3-1. Aquifer Test Information 3-1
Table 3-2. Planned Sampling During Drilling of 200-BP-5 Removal Action Groundwater Wells 3-3

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Terms

bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CCU	Cold Creek unit
CCUg	Cold Creek unit gravel
CSM	conceptual site model
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOT	U.S. Department of Transportation
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FSO	Field Sample Operations
FWS	Field Work Supervisor
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document*
HEIS	Hanford Environmental Information System
Hf1	Hanford formation unit 1
Hf2	Hanford formation unit 2
Hf3	Hanford formation unit 3
HSU	hydrostratigraphic unit
IATA	International Air Transportation Association
MB	method blank
MS	matrix spike
MSD	matrix spike duplicate
OU	operable unit
P&T	pump and treat

QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
QSM	Quality Systems Manual
RCT	radiological control technician
RD/RAWP	remedial design/remedial action work plan
Rlm	Ringold Formation member of Wooded Island – lower mud unit
ROD	record of decision
Rwia	Ringold Formation member of Wooded Island – unit A
Rwie	Ringold Formation member of Wooded Island – unit E
SAP	sample and analysis plan
SMR	Sample Management and Reporting
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WIDS	Waste Information Data System

1 Introduction

This sampling and analysis plan (SAP) was prepared for well design criteria required for optimal installation of two interim action groundwater extraction wells within the 200 East Area (Figure 1-1) as part of an interim action remedy under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). The U.S. Department of Energy (DOE) conducted remedial investigations and evaluations in the 200-BP-5 and 200-PO-1 Groundwater Operable Units (OUs) and has generated a feasibility study and proposed plan to support the interim record of decision (ROD) for the expedited remediation of groundwater contaminant plumes at the single-shell A-AX and C Tank Farms (A-AX and C Farms) area and B Complex as they pose a risk to human health and the environment if exposure were to occur. This SAP supports the design and construction of two extraction wells for interim action remediation of technetium-99 in the groundwater at the A-AX and C Farms (Figure 1-2). The interim action remediation goals in the A-AX and C Farm area include the following:

- Capture and removal of technetium-99 concentrations in excess of the drinking water standards (DWSs)
- Reduce technetium-99 concentrations in groundwater from the A-AX and C Farm area

Other groundwater contaminants exceeding federal DWSs include iodine-129, nitrate, and sulfate. Another constituent of interest is tritium.

The locations of the two proposed extraction wells, 299-E25-240 (A-AX Farm) and 299-E27-157 (C Farm), were based on capture zone analyses for the technetium-99 plume (ECF-200BP5-19-0036, *Simulations of Focused Feasibility Study Remedy at Waste Management Area C*; Figure 1-3). The capture depicted in Figure 1-3 is based on the following proposed pumping rates during the first 4 years of a 12-year plan to achieve plume cleanup and source containment at the A-AX and C Farm area. The planned pumping rates for wells 299-E25-240 and 299-E27-157 during the first 4 years are 284 and 662 L/min (75 and 175 gal/min), respectively. The planned pumping rates after 4 years are 662 and 284 L/min (175 and 75 gal/min), respectively. According to ECF-200BP5-19-0036, this planned pumping scenario should achieve current plume cleanup within 12 years. The final design details, including flow rates, will be identified in the interim remedial design/remedial action work plan (RD/RAWP) that will be developed following the issuance of the interim action ROD. Continuing waste source release contributions to groundwater may require additional pumping for source containment.

This SAP describes both sample collection and analysis as well as hydraulic testing planned during the drilling and construction of groundwater extraction wells 299-E25-240 and 299-E27-157. A systematic data quality objective (DQO) process was used to create problem statements from uncertainties discovered in the scoping process. The systematic process provided the basis for developing decisions and actions to resolve uncertainty. The primary problem addressed in this SAP is how to optimally design the extraction wells for effective removal of technetium-99 in groundwater from the A-AX and C Farm areas. Both sample collection and analysis as well as hydraulic testing activities described in this plan are based on implementation of the DQO process (EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*; discussed in Section 1-3).

Integration meetings with DOE, regulators, and other Hanford Site contractors were held to identify areas of uncertainty associated with the optimal design of the A-AX and C Farm extraction wells. Although additional areas of uncertainty for optimal design of the extraction wells were not identified, several opportunistic sampling and hydraulic testing intervals were identified as defined in Sections 1.5 and 1.8.

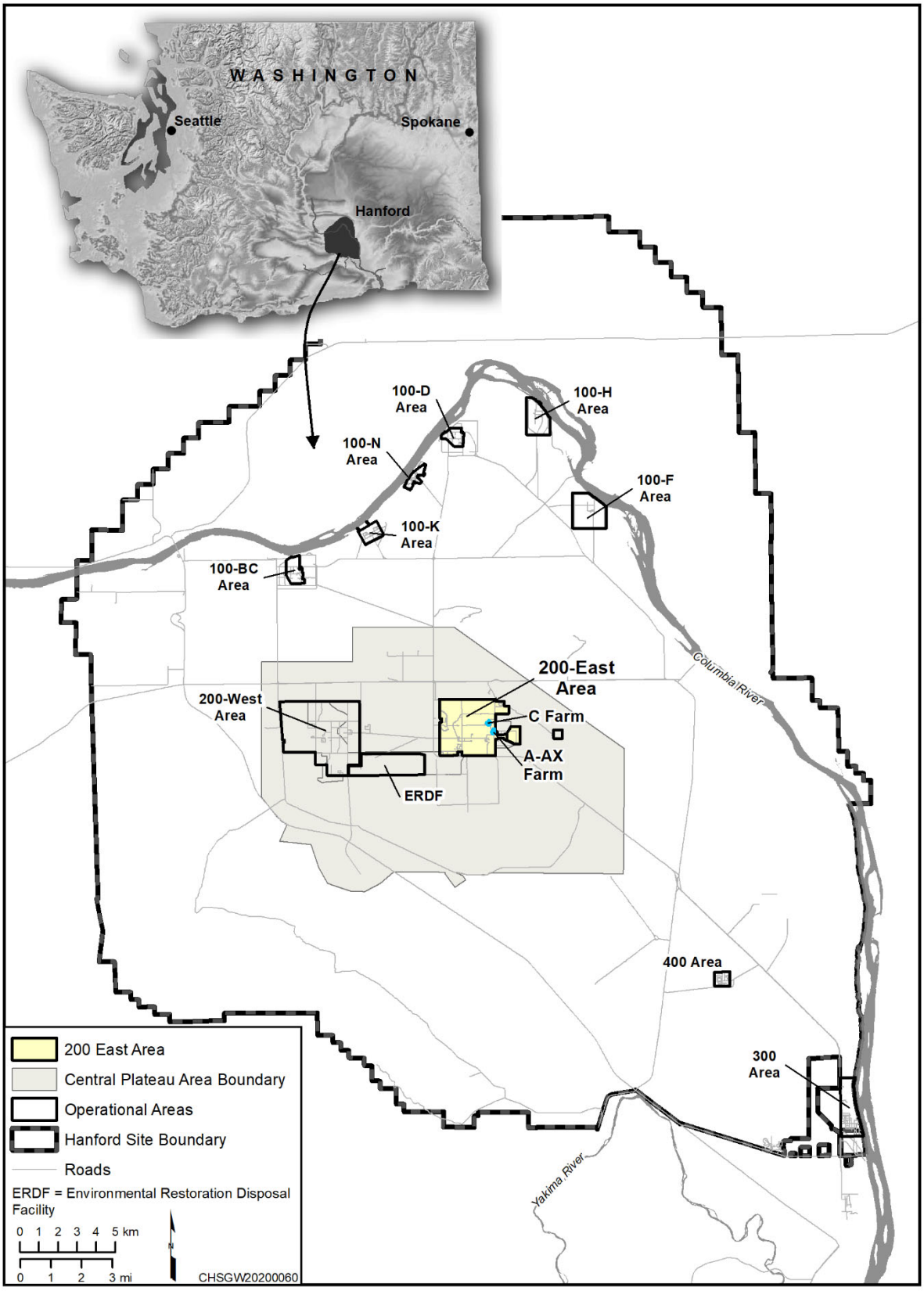


Figure 1-1. Location Map of the Hanford Site, Central Plateau, and the 200 East Area

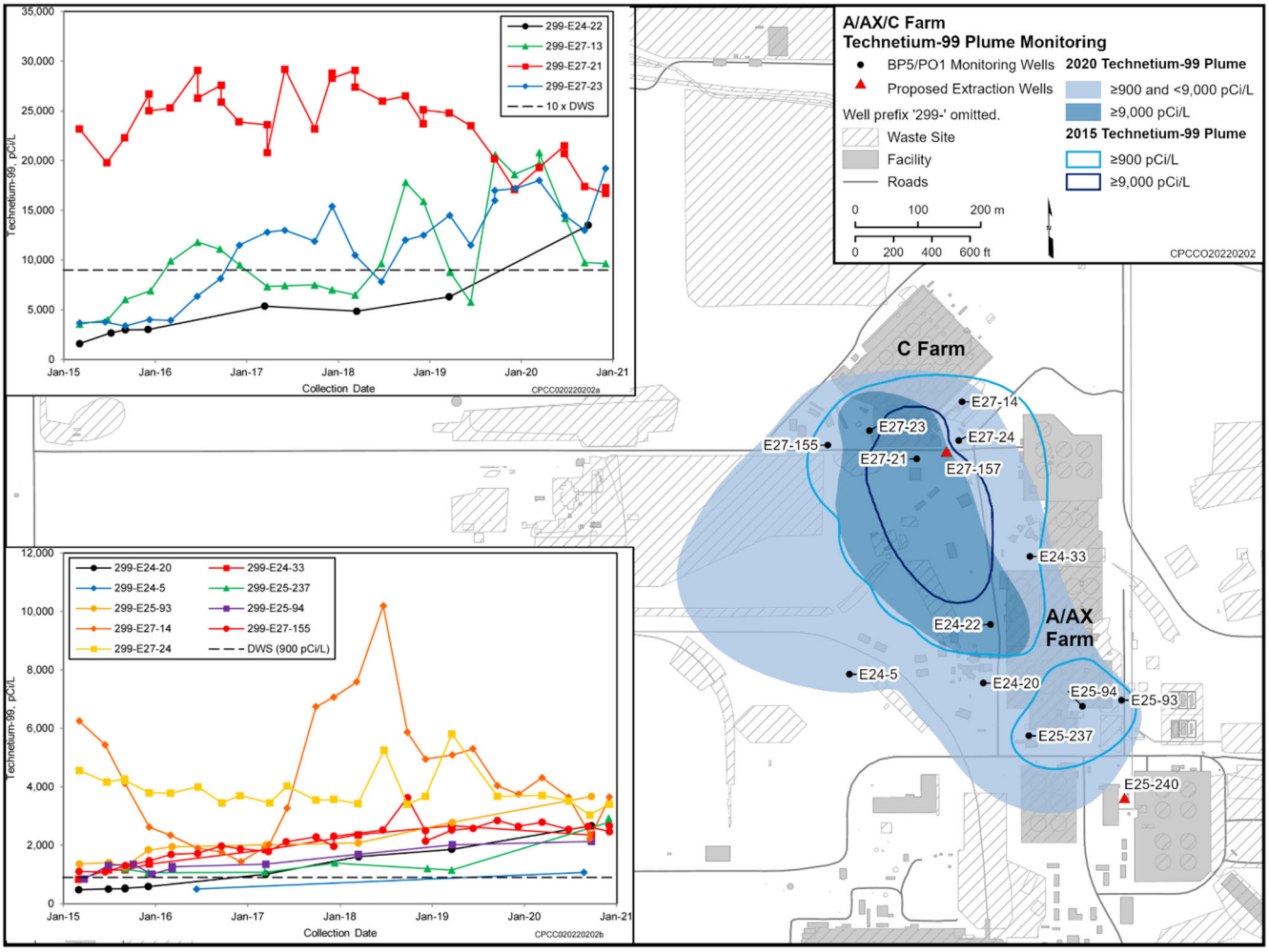
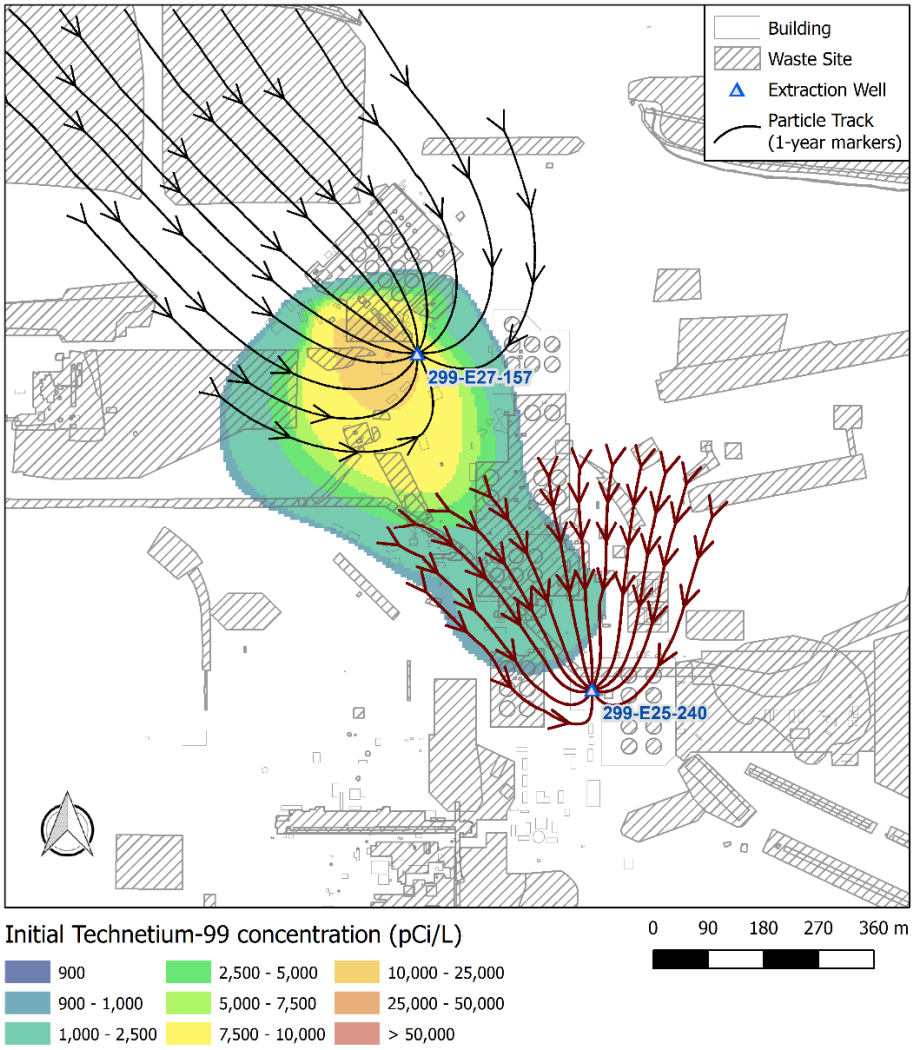


Figure 1-2. C Farm Technetium-99 Concentrations and Plume Extent, 2015–2020 and Proposed Extraction Wells



Reference: ECF-200BP5-19-0036, *Simulations of Focused Feasibility Study Remedy at Waste Management Area C*.

Note: Arrows on the groundwater flow lines illustrate the movement of groundwater over a 1-year period.

This figure represents the first 4 years of a 12-year plan to achieve plume cleanup and source containment in the minimum amount of time. After year 4, the plan is to change pumping rates to 175 gal/min and 75 gal/min, respectively.

Figure 1-3. Groundwater Capture Zone Analyses Model Using Pump Rate of 75 gal/min at Well 299-E25-240 (South Well) and 175 gal/min at Well 299-E27-157 (North Well)

1.1 Project Scope and Objectives

This SAP describes the data collection requirements for optimal extraction design of wells 299-E25-240 and 299-E27-157 for removal of technetium-99 from the groundwater at the A-AX and C Farm areas. The scope includes sampling and analysis of groundwater and aquifer sediments to ensure optimal placement of the well screen and optimal sizing of the well screen slot and sand pack mesh size. Depth-discrete hydraulic testing was included to provide additional input for various models (e.g., geoframework and groundwater model updates). In addition, basalt competency evaluation will be performed by drilling 4 m (13 ft) into the basalt.

Groundwater samples are planned at well 299-E25-240 to define the vertical profile of technetium-99 concentrations in the aquifer for determining the length and placement of the well screen. Collection of opportunistic soil and groundwater samples is also planned as discussed in Section 1.5. Aquifer sediments from both wells will be evaluated by sieve analysis to determine the optimal well screen slot and sand pack mesh size. In addition, geologic and geophysical logging will be completed to refine the conceptual site model. Expedited geophysical logging and hydraulic testing results will be completed and reviewed for the unconfined aquifer to ensure no subordinate silt or silty sand layers are present requiring changes to the well screen slot and sand pack mesh size. After well construction and development is complete, a post-development groundwater sample will be collected from both wells for process engineering at the 200 West pump and treat (P&T). Once the wells are operational, routine monitoring of groundwater will be scheduled in accordance with DOE/RL-2009-124, *200 West Pump and Treat Operations and Maintenance Plan* (modified by TPA-CN-0844, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-124, 200 West Pump and Treat Operations and Maintenance Plan, Rev. 5*, and referred to as DOE/RL-2009-124 throughout this plan) and the remedial action performance monitoring plan. In addition, multi-well aquifer testing will be performed on each of the completed extraction wells to be performed under a separate hydraulic testing plan as summarized in the RD/RAWP.

1.2 Background

This section provides Hanford Site details near proposed extraction wells 299-E25-240 and 299-E27-157. The sections provide background information for the following:

- Section 1.2.1, “A-AX Farm Waste Site Description and History”
- Section 1.2.2, “C Farm Waste Site Description and History”
- Section 1.2.3, “Geology”
- Section 1.2.4, “Hydrogeology”
- Section 1.2.5, “Groundwater Contamination and Model Capture”

The background information is used to develop process knowledge and evaluate areas of uncertainty for systematic planning of optimal well design of extraction wells 299-E25-240 and 299-E27-157 through the DQO process.

Geographically, the A-AX Farm lies approximately 230 m (755 ft) south of C Farm (Figure 1-4). The ground surface topography dips from an elevation of 212 m (695.5 ft) southwest of A Farm to 193 m (633 ft) north of C Farm (NAVD88, *North American Vertical Datum of 1988*). Underlying the A-AX and C Farms are suprabasalt sediments that range in thickness from 82 m (269 ft) north of C Farm to 116 m (380 ft) southeast of A Farm. The suprabasalt sediments include the Ringold Formation, Cold Creek unit (CCU), and Hanford formation. The unconfined aquifer thickens from 11.2 m (37 ft) north of C Farm to 25.7 m (84 ft) south of A Farm. PNNL-15955, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*, provides a detailed description of the geology within the area of interest from historic knowledge through 2007 (Figure 1-5). More recent geology interpretations associated with the geologic framework model are discussed in Section 1.2.3. The Elephant Mountain Member (basalt) of the Saddle Mountains Basalt Formation defines the base of the underlying unconfined aquifer.

The two extraction wells are located downgradient of the respective farms, where technetium-99 at the A-AX and C Farm area continues to impact groundwater quality (Figure 1-2). The history of technetium-99 releases, including transfer lines, in the vicinity of proposed wells 299-E25-240 and 299-E27-157 is discussed in Sections 1.2.1 and 1.2.2.

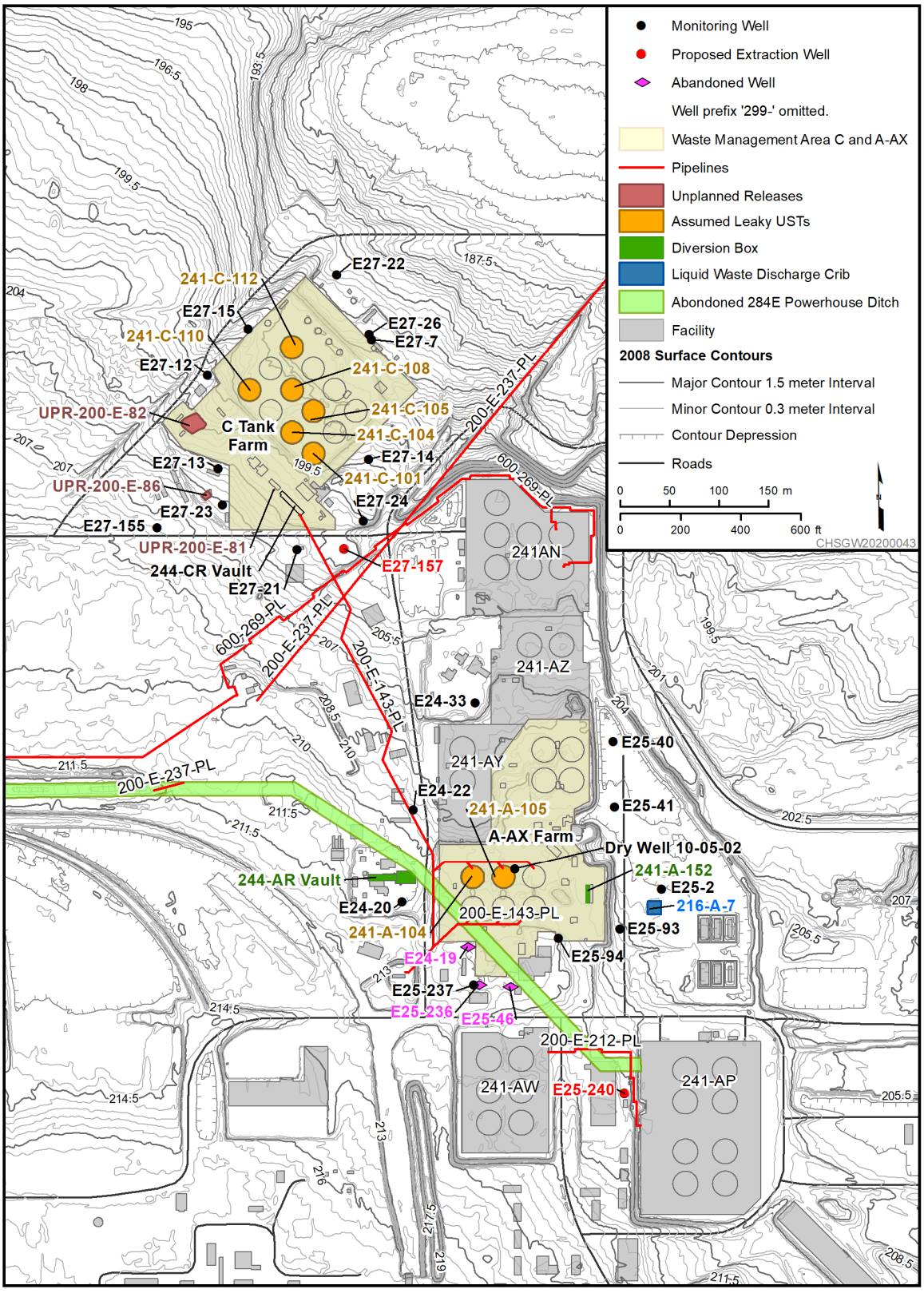
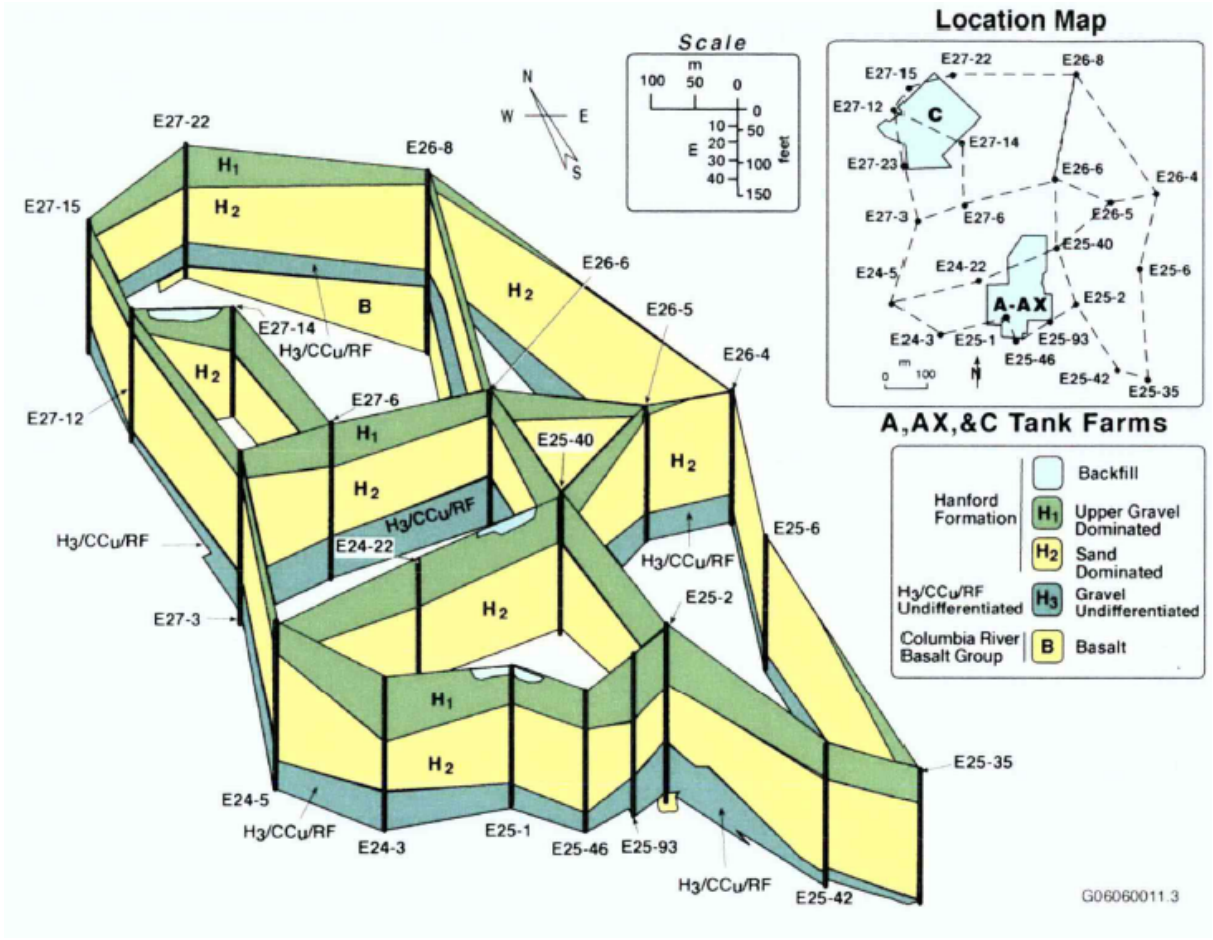


Figure 1-4. Site Map of Items of Interest at and near the A-AX and C Farms



Reference: PNNL-15955, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site.*

Figure 1-5. 2007 Fence Diagram Interpretation of the Geology near the A-AX and C Farms

1.2.1 A-AX Farm Waste Site Description and History

The A-AX Farms contain 10 underground single-shell tanks with a 3.785 million L (1,000,000 gal) capacity each. The tanks are constructed of reinforced concrete with a single, inner carbon steel liner as discussed in RPP-10435, *Single-Shell Tank System Integrity Assessment Report*. Both farms contain ancillary equipment consisting of diversion boxes and underground pipelines. The 244-AR Waste Transfer Vault is located 25 m (82 ft) west of the A Farm boundary (Figure 1-4).

The 216-A-7 Crib and tank 241-A-105 (Figure 1-4) appear to have sufficient technetium-99 inventory to impact groundwater, but geophysical data have not resolved the spatial resistivity at depth (e.g., increased moisture, increased ionic strength of pore water, or a combination of these items). The 216-A-7 Crib, located 45 m (150 ft) east of the 241-A Tank Farm, received 326,000 L (86,130 gal) of catch tank overflow waste, sump waste, and pump pit drainage from the 241-A-152 Diversion Box between 1956 and 1966 (Figure 1-4). The crib dimensions are 3 m (10 ft) wide by 3 m (10 ft) long by 4.9 m deep (16 ft). RPP-26744, *Hanford Soil Inventory, Rev. 1*, calculated the mean technetium-99 inventory released from the 216-A-7 Crib at 0.064 Ci, which provides an average technetium-99 concentration of 1.96×10^5 pCi/L (Table 1-1). The proposed location for well 299-E25-240 is of sufficient distance from the 216-A-7 Crib that residual contamination in the vadose zone is not likely to be encountered during drilling.

Table 1-1. Release Estimates for Liquid Volume, Technetium-99 Curie Content, and Average Technetium-99 Concentration for Liquid Waste Releases near and Within the A-AX Farms

Tank	Leak Volume (L)	Technetium-99 Inventory Lost (Ci)	Average Concentration (pCi/L)
241-A-104	7,570	0.4	5.3E7
241-A-105	7,570 to 151,400	6.5 to 22	8.6E9 to 1.45E8
216-A-7 Crib	326,000	0.064	1.96E5
Total	**341,140 to 484,970**	**7 to 22.5**	**2.0E7 to 4.6E7**

Reference: RPP-ENV-37956, *Hanford 241-A and 241-AX Tank Farms Leak Inventory Assessment Report.*

Tank 241-A-105 released liquid waste multiple times (RPP-ENV-37956, *Hanford 241-A and 241-AX Tank Farms Leak Inventory Assessment Report*). Radioactivity at 50,000 counts per minute or more were detected in the vadose zone in November 1963, March 1965, November 1968, and August 1970 beneath tank 241-A-105. Drywell 10-05-02, adjacent to the northeast wall of tank 241-A-105, continued to emit significant gamma radiation at 30.5 m (100 ft) below ground surface (bgs) for 20 years following the initial release in 1963. RPP-ENV-37956 estimated the liquid waste volume and associated curie inventory of technetium-99 released from tank 241-A-105 as shown in Table 1-1. Table 1-1 also includes leak loss estimates for tank 241-A-104, which is the only other A-AX tank with a significant technetium-99 release. Although the release volume from tank 241-A-105 is sufficient to reach groundwater, it is not large enough to migrate laterally through the vadose zone to well 299-E25-240, which is approximately 240 m (800 ft) south-southeast of tank 241-A-105.

Drawing H-2-55900, *Plot Plan PUREX Waste Disposal*, provides the trace of an abandoned 284-E Powerhouse ditch and is represented in Figure 1-4. The unlined ditch received cooling water, boiler blowdown, floor drain discharge, and softener regeneration effluents from the 284-E Powerhouse from 1940 to the mid-1950s. The former ditch extended southeast through the southwest corner of A Farm, then eastward approximately 20 m (65 ft) north of the proposed location for well 299-E25-240. Softener regeneration effluent from the 284-E Powerhouse contained significant concentrations of chloride that may have migrated into the sediments beneath the unlined ditch and contributed to advanced casing corrosion at three decommissioned A Farm wells (299-E24-19, 299-E25-46, and 299-E25-236), near the southwest corner of A Farm (Figure 1-4). Alternatively, the fine-grained sand facies adjacent to where the advanced casing corrosion occurred is interpreted to have absorbed and evaporated sufficient amounts of meteoric water, possibly containing high concentrations of chloride (PNNL-13757-1, *Characterization of Vadose Zone Sediment: Uncontaminated RCRA Borehole Core Samples and Composite Samples*). The latest casing corrosion was observed at approximately 79 to 85 m (260 to 280 ft) bgs at well 299-E25-236, where fine-grained sand and silt zone of the CCU exists. Pore water characterization within the fine-grained sand and silt did not reveal unusually high chloride concentrations from samples collected during drilling at well 299-E25-237. The soils in the upper 15 m (50 ft) of the vadose zone, at proposed well 299-E25-240, were removed after the ditch was abandoned as part of the installation of the double-shell 241-AP Tank Farm. Precautionary well design measures are recommended to protect against potential advanced casing corrosion at well 299-E25-240, as discussed in Section 1.3.

Although well 299-E25-240 is a considerable distance from groundwater contaminant source sites, an active underground transfer line is within 9 m (30 ft) of the well location. A summary of the transfer line from the Waste Information Data System (WIDS) is as follows:

- Transfer line 200-E-212-PL is approximately 9 m (30 ft) east of proposed well 299-E25-240 and contains two sets of encased pipes. The first set contains two 5 cm (2 in.) diameter carbon steel pipes encased in a 10 cm (4 in.) diameter carbon steel pipe. The second set are two 7.6 cm (3 in.) diameter carbon steel pipes encased within a 15 cm (6 in.) diameter carbon steel pipe. These pipelines are active and transfer waste between the 241-AW and 241-AP Tank Farms.

RPP-27591, *Volume 2: IQRPE DST System Integrity Assessment – Pipeline Integrity*, assessed the double-shell transfer lines, including 200-E-212-PL, and determined that "the material selection (e.g., piping, fittings, valves, flanges, gaskets, thread sealant, coating) of the original design were appropriate for their use, and existing corrosion protection measures (e.g., an active cathodic protection system, exterior protective coatings, control of waste chemical composition, waste temperature control, and waste transfer line flushing requirements) are suitable corrosion measures." RPP-27591 concluded that "the estimated remaining useful life of nearly all pipelines analyzed will maintain wall thickness to satisfy the 2028 mission and erosion-accelerated corrosion failures within the life of the mission are not expected." In summary, vadose zone contamination is not expected at well 299-E25-240 other than possibly high chloride concentrations from the abandoned 284-E Powerhouse ditch.

1.2.2 C Farm Waste Site Description and History

The C Farm contains 12 underground single-shell tanks with an operating capacity of 1,892,500 L (530,000 gal). In addition, four smaller underground single-shell tanks are present with a 208,000 L (55,000 gal) capacity. C Farm also includes the 244-CR Vault and eight diversion boxes. The 244-CR Vault is located in the southern portion of the farm and houses four underground tanks, two with a 170,343 L (45,000 gal) capacity and two with a 55,494 L (14,700 gal) capacity. In addition, C Farm contains ancillary equipment consisting of associated piping and various pits (Figure 1-4).

RPP-ENV-33418, *Hanford C-Farm Leak Inventory Assessments Report*, provides the liquid waste loss estimates within and adjacent to C Farm (Table 1-2). Visualizations using an inversion model of the estimated distribution of resistivity values within C Farm indicate the spatial distribution of past waste releases to the vadose zone has impacted groundwater (RPP-RPT-49288, *C Farm Surface Geophysical Exploration-Reprocessing*). Figure 1-6 (taken from RPP-RPT-49288) shows small concentrated and larger, more dilute low resistivity values at depth along the south and within the central part of C Farm. Groundwater monitoring indicates technetium-99 releases at C Farm have affected groundwater, and associated modeling suggests the impacts may continue for 35 years or more (CHPRC-02349-VA, *Approach For Estimating Groundwater Mass/Activity Flux within 200-BP-5 OU; Briefing to the Washington State Department of Ecology*). The proposed location for well 299-E27-157 is of sufficient distance from C Farm that residual contamination in the vadose zone is not likely to be encountered during drilling (Figure 1-6).

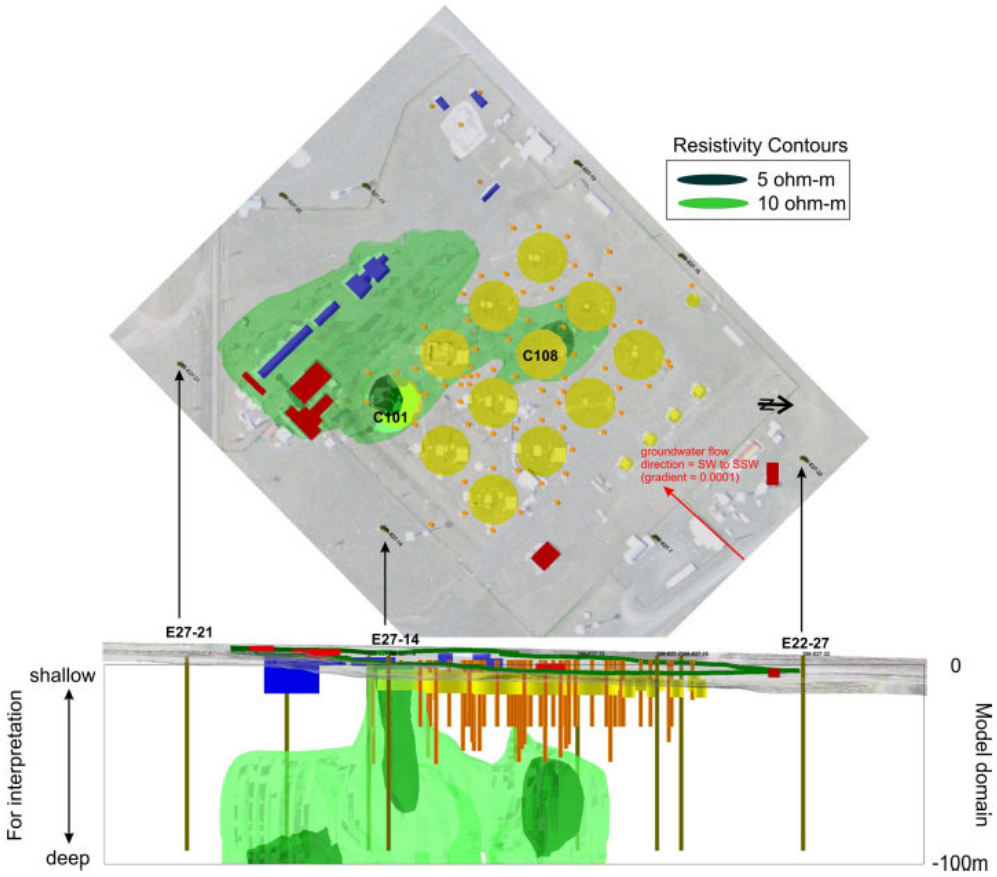


Figure 1-6. Three-Dimensional View of Low-Resistivity Targets Beneath C Tank Farm, Plan View (Top), and View Looking from East to West (Bottom)

Table 1-2. Release Estimates for Liquid Volume, Technetium-99 Curie Content, and Average Technetium-99 Concentration for Liquid Waste Releases near and Within C Farm

Tank	Lost Volume (L)	Technetium-99 Inventory Lost (Ci)	Average Concentration (pCi/L)
241-C-101	140,045	0.25	1.78E7
241-C-104	105,980	0.03	2.8E5
241-C-105	7,570 to 77,593	1.0 to 9.8	1.3E8 to 1.3E8
241-C-108	68,130	0.02	2.9E5
241-C-110	<7,570	3.4	4.5E8
241-C-112	26,495	0.0075	2.8E5
UPR-200-E-81	136,260	0.1	7.3E5
UPR-200-E-82	9,841	1.3	1.3E8
UPR-200-E-86	64,345	2.7	4.2E7
Total	**<566,236 to <636,259**	**8.8 to 17.6**	**1.55E7 to 2.77E7**

Reference: RPP-ENV-33418, *Hanford C-Farm Leak Inventory Assessments Report*.

Although well 299-E27-157 is 100 m (328 ft) or more from contributing groundwater source sites of technetium-99, within C Farm it is within 30 m (100 ft) of three transfer lines: 200-E-143-PL, 600-269-PL, and 200-E-237-PL. A summary of the transfer lines from WIDS is as follows:

- Transfer line 200-E-143-PL is approximately 22 m (70 ft) to the west-southwest of well 299-E27-157 and contains one 10 cm (4 in.) diameter stainless steel pipe (line 8656) encased in a concrete transfer line (drawing H-2-44778, *Plan & Profile - Branch Encasement Line #8656 from Main Encasement to 244CR Vault*). This line is buried approximately 1.5 m (5 ft) bgs and extends north-northwest and south-southeast. Line 8656 transferred Plutonium Uranium Extraction Plant and B Plant waste between the A-AX Farms and the 244-CR Vault from 1965 to 1976 (WIDS). Waste streams transferred by line 8656 included transuranics, uranium compounds, fission products, heavy metals, other inorganics, volatile organics, and semivolatile organics (WIDS). Overlying this transfer line is a 20 cm (8 in.) raw water line. The raw water line extends eastward toward well 299-E27-157, and its location is shown in drawing H-2-830461, *Site Map Raw Water System 200 East Enlarged Plan (Sheet 10)*.
- Transfer line 600-269-PL, constructed in 1995, is approximately 18 m (60 ft) southeast of well 299-E27-157 and contains two 7.6 cm (3 in.) diameter stainless steel pipelines, of which only one line (SNL-3150) was used and transferred 241-SY Tank Farm liquid waste to the 244-A Lift Station in the 200 East Area. Transfer line 600-269-PL was buried approximately 2.5 m (8 ft) bgs. SNL-3150 is encased within another pipe for containment, was last used in March 2007, and was taken out of service in 2008.
- Transfer line 200-E-237-PL is approximately 30 m (100 ft) southeast of well 299-E27-157 and consists of a 76 cm (30 in.) diameter corrugated metal pipe that transferred 284-E Powerhouse water to B Pond. The pipeline received cooling water, boiler blowdown, floor drain discharge, softener regeneration effluents from the 284-E Powerhouse along with filter backwash, and sedimentation basin cleanout from the 282-E Powerhouse and 283-E Powerhouse via this pipeline. The line was replaced by 600-291-P and has been inactive since.

In summary, contamination in the vadose zone at well 299-E27-157 is unlikely based on the distance from significant release sites and lack of vadose zone contamination at nearby wells 299-E27-21 and 299-E27-24. Transfer line 600-269-PL, made of similar metal and design as transfer line 200-E-212-PL (near proposed well 299-E25-240), was found to be intact with no detectable readings or dose rates in 2017 when excavation for the new export water lines were placed above 600-269-PL. Transfer line 200-E-143-PL is located closer to well 299-E27-21, and geophysical logging at well 299-E27-21 showed no contamination in the vadose zone. Transfer line 200-E-237-PL conveyed remnant liquid waste from the 284-E Powerhouse, which has not been linked to soil contamination; however, precautionary well design measures are recommended to protect against potential elevated chloride pore water and future advanced casing corrosion.

Small water leaks are common with buried water lines; thus, enhanced moisture levels within the vadose zone is possible considering the distance from the 20 cm (8 in.) east-west raw water line south of the proposed well location.

1.2.3 Geology

This section provides the interpreted geology anticipated while drilling wells 299-E25-240 and 299-E27-157. The lithologic units beneath C Farm are the Hanford formation and the CCU, based on the following:

- Descriptions in PNNL-15503, *Characterization of Vadose Zone Sediments Below the C Tank Farm: Borehole C4297 and RCRA Borehole 299-E27-22*

- Hydraulic investigation results in Appendix D of PNNL-14656, *Borehole Data Package for Four CY 2003 RCRA Wells 299-E27-4, 299-E27-21, 299-E27-22, and 299-E27-23 at Single-Shell Tank, Waste Management Area C, Hanford Site, Washington*
- ECF-HANFORD-18-0035, *Central Plateau Vadose Zone Geoframework*

The stratigraphic positioning of the lithologic units at well 299-E25-240 has higher uncertainty than at well 299-E27-157 because of the sparse number of wells extending to the basalt (Figures 1-7 and 1-8). Geologic suprabasalt sediment descriptions were summarized from the documents previously mentioned as well as the following documents:

- Lindsey, 1996, *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-central Washington and North-central Oregon*
- PNNL-19702, *Hydrogeologic Model for the Gable Gap Area, Hanford Site*
- RPP-14430, *Subsurface Conditions Description of the C and A-AX Waste Management Area*

The surface of the basalt forms the base of the unconfined aquifer under the A-AX and C Farms. Descriptions of the basalt underlying the unconfined aquifer generally is characterized as dense, low permeability, and presenting a nonconductive lower boundary to the overlying aquifer as reflected in Section 3.2.4 of CP-57037, Rev. 2, *Model Package Report: Plateau to River Groundwater Model; Version 8.3*. The basis of that description at the A-AX and C Farms is the local geophysical investigation noted in SGW-42313, *Geophysical Investigations: 200-PO-1 Groundwater Operable Unit*, which indicated a lack of discontinuities (e.g., fractures or faults) in the basalt. The basalt dips to the south beneath the A-AX and C Farms. The basalt thickness is estimated at approximately 30 m (100 ft) beneath the A-AX and C Farms (WHC-SD-EN-EV-024, *Site Characterization Report for the Liquid Effluent Retention Facility*). The generalized structure of the basalt was originally described in RHO-BWI-LD-5, *Geology of Gable Mountain-Gable Butte Area*.

Throughout the past 10.5 million years, fluvial sediments have been deposited and scoured repeatedly at the A-AX and C Farm locations, and the remaining saturated suprabasalt sediments include the following:

- Ringold basalt gravels (e.g., unit A or hydrostratigraphic unit [HSU] 9C and referred to as the Ringold Formation member of Wooded Island – unit A [Rwia] in this SAP); however, interpreted as being removed at well 299-E27-157.
- Ringold lower mud (HSU 8 and referred to as Ringold Formation member of Wooded Island – lower mud unit [Rlm] in this SAP); however, interpreted as being removed at well 299-E27-157.
- Ringold upper gravels (e.g., unit E or HSU 5 and referred to as Ringold Formation of Wooded Island – unit E [Rwie] in this SAP); however, interpreted as being removed at well 299-E27-157.
- CCU (HSU 3 containing both gravels, referred to as Cold Creek unit gravel [CCUg] in this SAP, and fine-grained sands with silt, referred to as CCU in this SAP).
- Hanford sediments (HSU 1 containing three facies: Hanford formation unit 1 [Hf1] upper gravels, Hanford formation unit 2 [Hf2] sand-dominated facies, and Hanford formation unit 3 [Hf3] lower gravel unit. Hf1, Hf2, and Hf3 will be used in this SAP, respectively).

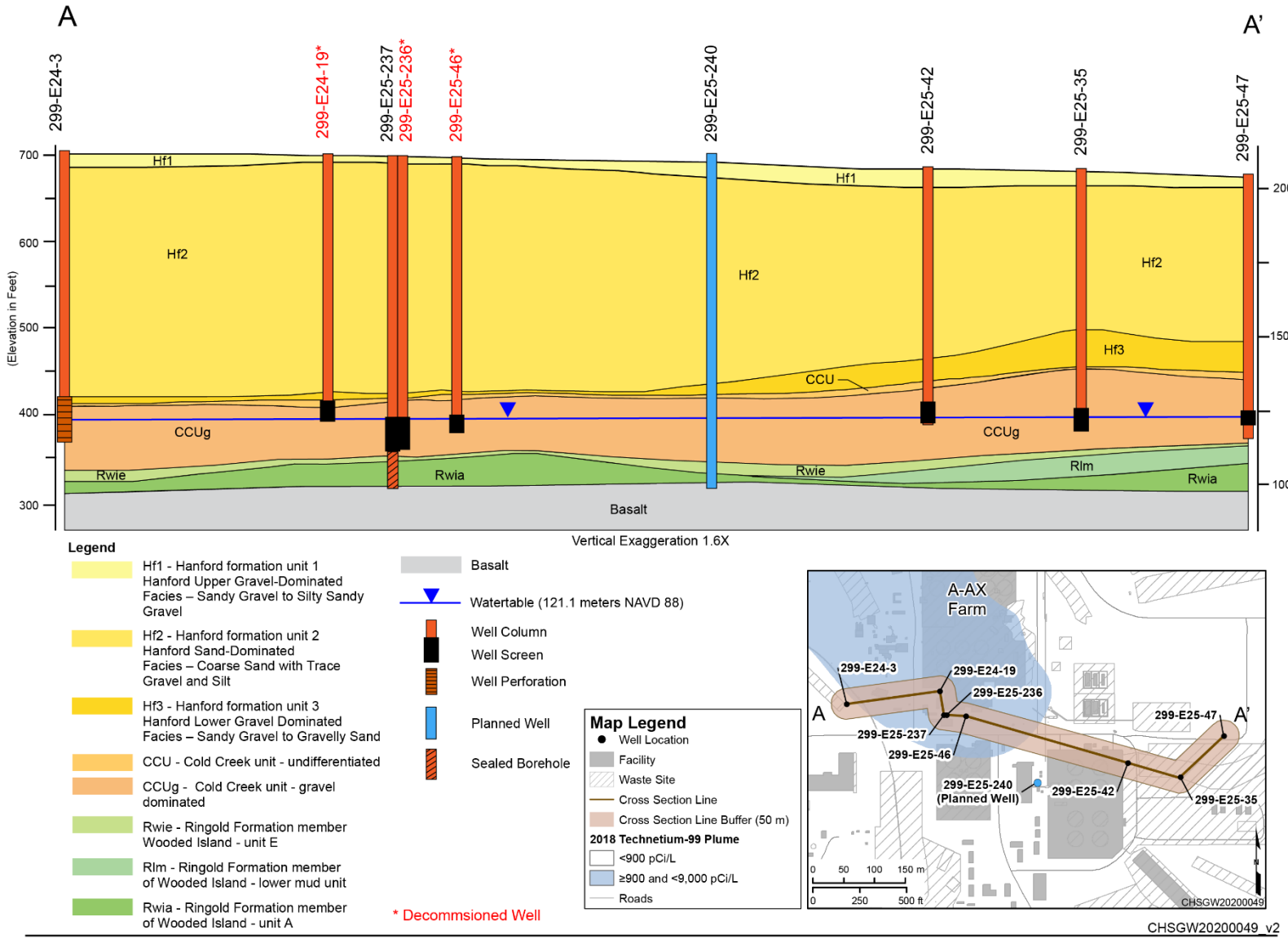


Figure 1-7. Cross Section of the Interpreted Geology Along the South Boundary of A Farm

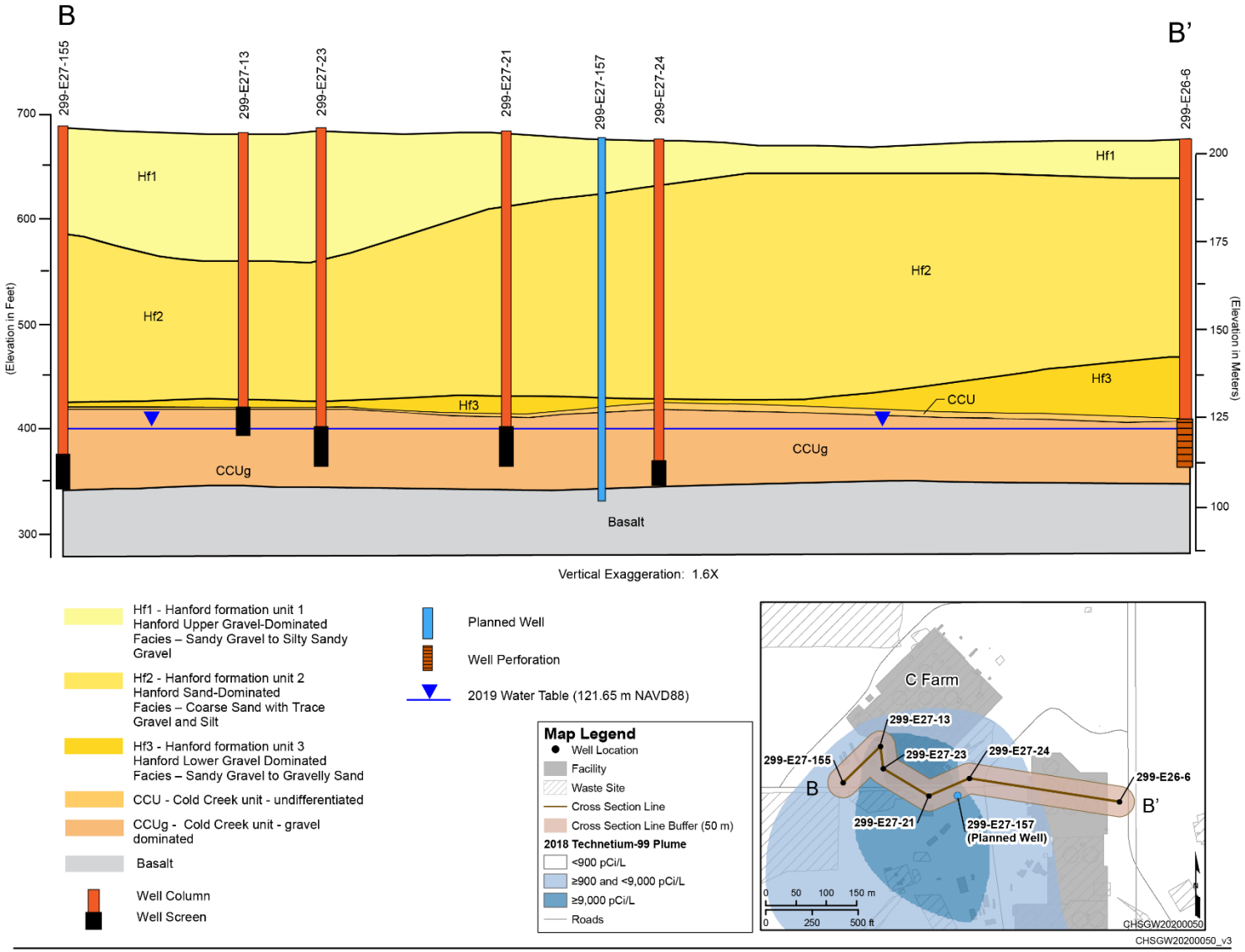
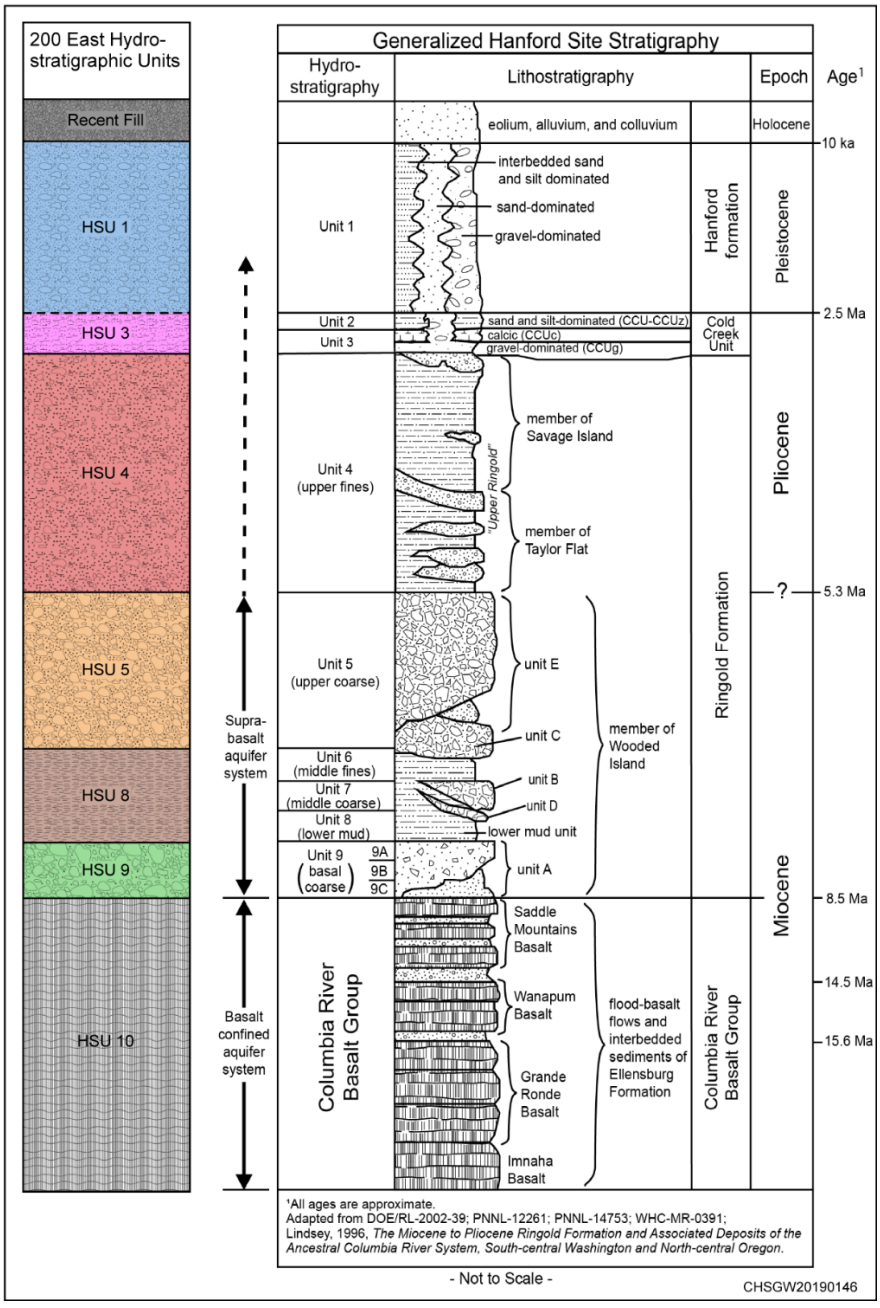


Figure 1-8. Cross Section of the Interpreted Geology Along the South Boundary of C Farm

Figure 1-9 provides the stratigraphic position as well as the hydrostratigraphic and lithostratigraphic names used to define the different suprabasalt sediments at the Hanford Site. Note that HSU 4 is missing in the discussion of stratigraphic units at the A-AX and C Farms, as it was interpreted to be scoured from this area. Current interpretations of the saturated stratigraphic position of the suprabasalt sediments are shown in Figures 1-7 and 1-8. The interpretations were derived from the study and correlation of borehole drill cuttings, geologic outcrops, and geophysical data (ECF-HANFORD-13-0029, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington; Fiscal Year 2016 Update*, and CP-60925, *Model Package Report: Central Plateau Vadose Zone Geoframework; Version 1.0*).



Note: Some suprabasalt sediments identified in this figure are interpreted to have been scoured and are interpreted to not be present as reflected in the interpretative cross sections and Section 1.2.3 discussions at extraction wells 299-E25-240 and 299-E27-157.

Figure 1-9. Stratigraphy of the Hanford Site

The following paragraphs summarize the interpreted suprabasalt sediments beneath the A-AX and C Farms.

The Rwia, the oldest sediments overlying the basalt, is interpreted as thinning to the east, west, and north of the A-AX Farms. The unit's thickness at well 299-E25-240 is interpreted at 4.6 m (15 ft), with the top of the unit estimated at 19.8 m (65 ft) below the water table (Figure 1-7). The Open File Report 96-8 (Lindsey, 1996) describes the texture and mineralogy of Rwia. The general facies for HSU 9C is bimodal, consisting of pebbles and cobbles up to 67% by weight, <5% granules, with the remainder as medium- to fine-grained sand. Gravel clasts are dominated by weathered and unweathered basalt, quartzite, and intermediate to silicic volcanics. The facies consists of clast- and matrix-supported pebble-to-cobble gravel with a fine- to coarse-grained sand matrix. The degree of cementation is variable, ranging from none to well developed. Cement horizons observed in outcrops are generally less than 1 m (3 ft) thick but can extend laterally for hundreds of meters. Based on extrapolation of nearby wells, it is probable that Rwia will be encountered during drilling at well 299-E25-240 but not at well 299-E27-157 (Figures 1-7 and 1-8).

The geologic framework model depicts the northern extent of the Rlm near well 299-E25-240. The Rlm thickens to the south, as shown at well 299-E25-17 (Figure 1-10). The Rlm is interpreted to pinch out at well 299-E25-240; however, the uncertainty in this interpretation is high. Thus, a thin layer of Rlm may be encountered at well 299-E25-240 but is interpreted to not be present at well 299-E27-157 (C Farm). Lindsey, 1996, interprets the lower mud as a lacustrine deposit, consistent with facies association IVb as described in Open File Report 96-8. Facies association IVb is described as gray, tan, or brown stratified silt to clay, which coarsens upward to sand. When this facies association is recovered from the subsurface, the matrix is consolidated and the dominant color is gray to blue-gray.

The geologic framework model depicts the Rwie as pinching out to the north of the A-AX Farms. The unit is interpreted to be approximately 6 m (20 ft) thick at proposed well 299-E25-240. Lindsey, 1996, describes Rwie as gray- to black-weathered basaltic pebble-cobble gravels. The matrix varies from sand-size basalt grains to clay. RPP-14430 adds to the description of the Rwie as "multilithic, clast-supported to matrix-supported, variably cemented and/or limonitic-stained, sandy gravel sequences. Sands are generally well-sorted and predominantly quartzo-feldspathic (i.e., light colored)." The geologic framework model interprets the top of the Rwie at the location of well 299-E25-240 at approximately 13.7 m (45 ft) below the water table; however, this unit is not expected to be present at C Farm.

The geologic framework model indicates the CCUg overlie either the basalt or Rwie sediments and extend above the water table at both A-AX and C Farms. The CCUg at well 299-E27-157 is anticipated at approximately 75.3 m (247 ft) bgs. PNNL-19702 describes the CCU gravels as mainstream alluvial deposits from the ancestral Columbia River. At C Farm, PNNL-15503 states that "the composition of the lower gravel sequence beneath C Tank Farm appears to be multi-lithic, unlike Hanford formation gravels." The unconsolidated nature and lack of weathering are two possible differences between the CCUg and Rwie. Appendix D in PNNL-14656 described slug test results completed at various depths during drilling at C Farm well 299-E27-22. Three successful slug tests were completed in the lower 5.5 m (18 ft) of the aquifer at well 299-E27-22. PNNL-14656 explains that the hydraulic conductivity ranged between 1.9E3 and 6.9E3 m/d in two of the three slug tests.

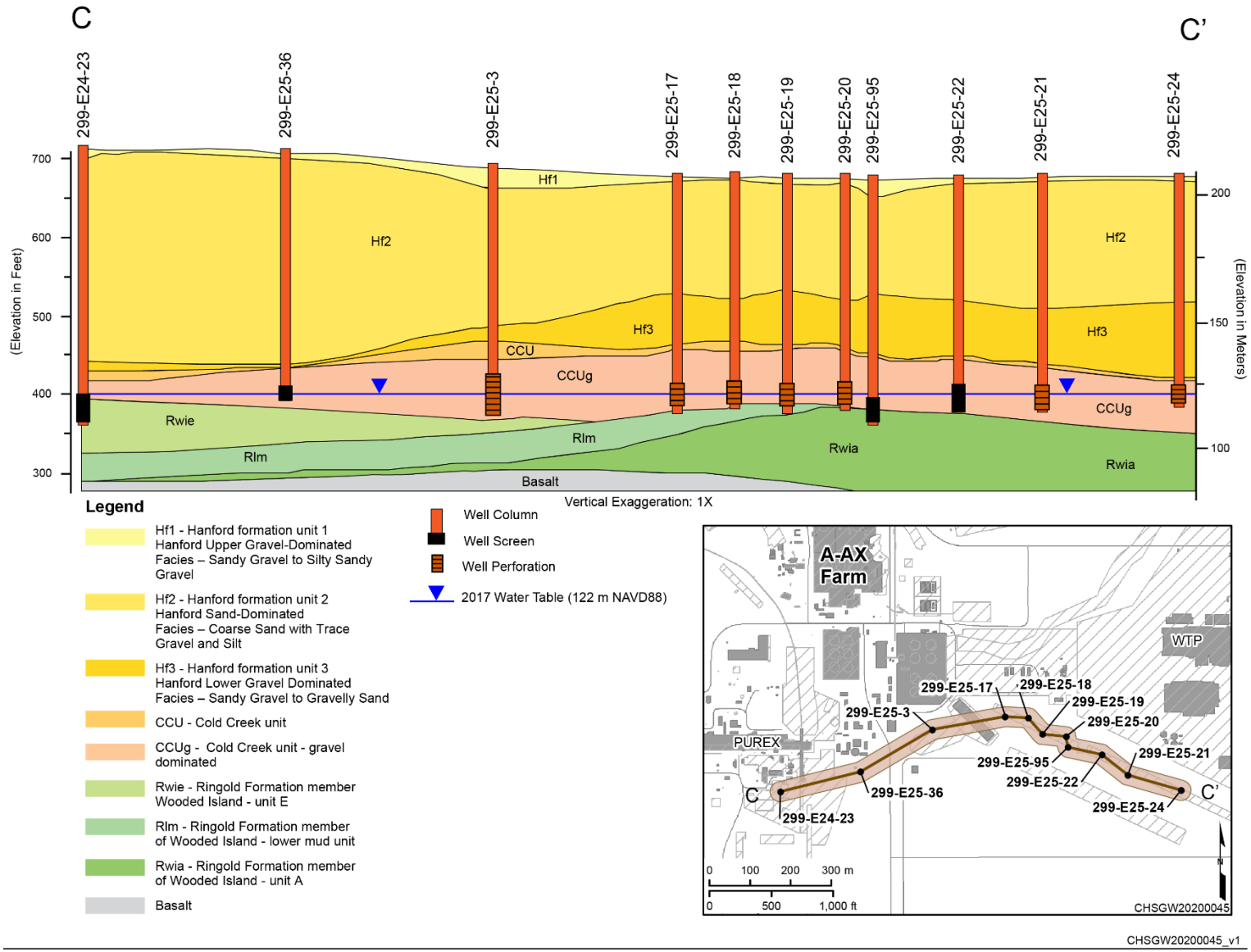


Figure 1-10. Cross Section of the Geology South of A Farm

These hydraulic conductivity ranges are more indicative of unconsolidated CCUg than Rwie. Descriptions of the CCUg are generally subrounded to rounded, gravel-size granule of quartzite, chert, and basalt, with 40% quartzite and granite, 20% metamorphics, and 40% basalt (DOE/RL-2015-75, *Aquifer Treatability Test Report for the 200-BP-5 Groundwater Operable Unit*). A secondary method used to distinguish the CCUg and Rwie in PNNL-19702 is the 20% to 50% by volume basalt in the sand fraction of the CCUg versus the 0% to 10% basalt fraction in the Rwie. RPP-14430 adds, "Unlike the Ringold Formation, mainstream facies of the CCU are generally unconsolidated, have a "whitish" or "bleached" appearance and lack limonitic staining, characteristic of the Ringold Formation." At the A-AX Farm, the CCUg delineation is easier because it underlies a thick CCU at approximately 85 m (280 ft) bgs.

The current interpretations of the stratigraphic position of the CCU are shown in Figures 1-7 and 1-8. The interpreted thickness of this unit at the A-AX Farms ranges from 0.64 to 4.57 m (2.1 to 15 ft) and is located approximately 84 m (275 ft) bgs. The top and bottom surfaces of the CCU are undulating beneath A-AX Farm and interpreted to extend toward well 299-E25-240. According to the geologic framework model, the CCU is 84 m (275 ft) bgs. The CCU at C Farm is described as a silty sand layer in wells to the east and west of well 299-E27-157, and the estimated top of the unit is 73 m (240 ft) bgs. The silty-sand CCU is described in local geologic logs as a yellowish-brown color versus the salt-and-pepper color associated with the Hf2 above. Geophysical logs show sharp peaks for potassium, uranium, and gross gamma where the unit is thicker. RPP-14430 provides three indicators of the top of silt-dominated intervals: an increase in background gamma activity from geophysical logging, increase in mud content (up to 75% by weight), and calcium carbonate content a few weight percent more than the overlying fine-grained Hanford formation. Borehole logs at the A-AX Farms describe the CCU as ranging from a slightly muddy sand to clay. The clay borehole log descriptions at A Farm are associated with wells within A Farm, while the silt descriptions are along the south boundary of A Farm. The silty sand-muddy sand to sandy mud borehole log descriptions of the CCU are north of A Farm.

The Hf3 is defined as a gravelly sand to sandy gravel below C Farm and appears to thin at proposed well 299-E27-157, and is approximately 1.8 m (6 ft) based on the geologic framework model and geologic log at well 299-E27-24 (Figure 1-8). The upper contact at C Farm is where fine-grained sand to silty-sand transitions to silty-sandy gravel. The silty-sandy gravel color has the characteristic salt and pepper color (gray). A yellowish-brown color represents the CCU below. At the A-AX Farms, the facies is 0.5 to 1.8 m (1.6 to 6 ft) thick, except at wells 299-E25-40 and 299-E25-41, where the facies is 14.7 to 16.7 m (48.3 to 54.7 ft) thick. At well 299-E25-240, the facies is approximately 4.6 m (15 ft) based on the geologic framework model.

The Hf2 is the dominant facies in the vadose zone beneath both A-AX and C Farms. This facies thickness is anticipated at 75 m (246 ft) for well 299-E25-240. At well 299-E27-157, the Hf2 thickness is interpreted as 56 m (184 ft) thick. The Hf2 at C Farm contains 3% or more gravel throughout the upper 52 m (170 ft), and the sand ranges from medium to coarse. Silt is generally absent in the Hf2 description at wells to the east and west of well 299-E27-157. The bottom 4.6 m (15 ft) of the Hf2 at C Farm ranges from a sand to a silty sand. The silty sand layers contain 5% to 20% silt. The sand in this lower portion of the facies is described as fine-grained that is interpreted to have absorbed and evaporated sufficient amounts of meteoric water, possibly containing high concentrations of chloride (PNNL-13757-1). RPP-ENV-58782, *Performance Assessment of Waste Management Area C, Hanford Site, Washington*, describes the lower portion of this facies beneath C Farm as containing either silt with strong geophysical potassium and occasional strong natural uranium peaks, or sand with no significant geophysical signature. The Hf2 at A-AX Farm has similar characteristics but contains more silt and less gravel.

The Hf1 is described as a gravelly sand to sandy gravel beneath both the A-AX and C Farms. Based on nearby well logs of potassium-40, gamma, and borehole descriptions along with previous investigator interpretations, the boundary of the Hf1 facies at proposed well 299-E27-157 is anticipated at approximately 15.2 m (50 ft) bgs. RPP-RPT-56356, *Development of Alternative Digital Geologic Models of Waste Management Area C*, describes the texture of the Hf1 as follows: pebble-cobble gravels, sandy gravels, and gravelly sands with very low percentage silt or very fine to fine sands. The thickness of the upper Hf1 at well 299-E25-240 is expected to be thinner, and the anticipated thickness is 4 m (14 ft).

Table 1-3 shows the estimated stratigraphic contacts and depth to water in the planned groundwater extraction wells.

Table 1-3. Estimated Upper Geologic Contacts and Depths to Water

Well Name	Facility	DTW (ft bgs)	Hanford Formation (ft bgs)			Cold Creek Unit Silt (ft bgs)	Cold Creek Unit Gravel (ft bgs)	Ringold Formation (ft bgs)	Basalt (ft bgs)
			Hanford Formation Unit 1	Hanford Formation Unit 2	Hanford Formation Unit 3				
299-E27-157	C Farm	268.5	0	50	234	240	247	NP	317
299-E24-240	A Farm	288.4	0	14	260	275	280	334[a]/354[b]	368

a. Ringold Formation member of Wooded Island – unit E.

b. Ringold Formation member of Wooded Island – unit A.

bgs = below ground surface DTW = depth to water NP = not present

1.2.4 Hydrogeology

This section provides the interpreted hydrogeology of anticipated lithologic units while drilling wells 299-E25-240 and 299-E27-157. The positioning of the lithologic units beneath the A-AX and C Farms is discussed in Section 1.2.3. The Ringold Formation sediments have a much lower hydraulic conductivity than the CCU and Hanford formation sediments and thicken to the east and south of well 299-E25-240 until the sediments are the only formation present in the saturated zone. Where the Ringold Formation sediments are the sole formation within the saturated zone, the hydraulic gradient decline is more distinct, representative of a lower permeability sediments. Zhao and Toksoz, 1994, "Solute Transport in Heterogeneous Porous Media," modeled solute flow where high permeability sediments were adjacent to lower permeability sediments (i.e., channel flow), much like the 200 East Area hydrogeology. Zhao and Toksoz, 1994, observed solute transport occurred primarily within the high-permeability channel, and diffusion was responsible for minor migration into the adjacent low-permeability (approximately two orders of magnitude lower) regions. By analogy, technetium-99 is thought to be more concentrated in the CCUg sediments than in the Ringold Formation sediments because the Ringold Formation sediments have a lower hydraulic conductivity by three to four orders of magnitude than do the CCUg.

Empirical data gathered from wells drilled into the Rwia below B Pond indicate cement intervals below the water table produce little to no water. Two samples of Rwia sediments collected beneath B Pond had a saturated hydraulic conductivity range from 1.9E-06 to 1.9E-04 cm/s (1.6E-03 to 0.16 m/d) (WHC-SD-EN-TI-019, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*). Current calibration values in CP-57037, Rev. 1, *Model Package Report: Plateau to River Groundwater Model;*

Version 8.2, defined the hydraulic conductivity of this unit at 1 m/d. The Rwia is interpreted to be 4.6 m (15 ft) thick at well 299-E25-240 but is interpreted not to be present at well 299-E27-157 (Table 1-3).

Two samples of the Rlm collected beneath B Pond had laboratory-measured saturated hydraulic conductivity ranging from 1.0E-08 to 3.08E-08 cm/s (8.64E-06 to 2.66E-05 m/d) (WHC-SD-EN-TI-019). Current calibration values in CP-57037, Rev. 1, determined the mean hydraulic conductivity of this unit is 0.008 m/d. The Rlm is interpreted to be missing at both wells 299-E25-240 and 299-E27-157.

The geologic framework model interprets approximately 6 m (20 ft) of Rwie at well 299-E25-240. Current calibration values in CP-57037, Rev. 1, determined the mean hydraulic conductivity of this unit is 35.5 m/d. The upper boundary of this unit is interpreted at approximately 13.7 m (45 ft) below the water table at well 299-E25-240 but is interpreted to be missing at well 299-E27-157.

The CCUg is interpreted to overlie either the basalt or Rwie and extend above the water table beneath the A-AX and C Farms. Pumping test results associated with the CCUg at the B Complex, located between 1.6 and 2.1 km (1 and 1.3 mi) northwest of wells 299-E25-240 and 299-E27-157, produced a hydraulic conductivity of 18,800 m/d (DOE/RL-2015-75). Slug tests at C Farm calculated a hydraulic conductivity of 1.9E3 to 6.9E3 m/d at well 299-E27-22 (Appendix D of PNNL-14656), and similar hydraulic conductivity values were calculated throughout the aquifer at well 299-E27-24. Current calibration values in CP-57037, Rev. 1, defined the mean hydraulic conductivity of CCUg at 15,216 m/d.

The CCU unsaturated hydraulic conductivity was determined from samples collected at the B Complex. The calculated values range from 2.1E-6 to 7.1E-5 cm/sec (1.8E-3 to 6.1E-2 m/d) (PNNL-19277, *Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*).

The Hf3 unsaturated hydraulic conductivity was determined from samples collected at the immobilized low-activity waste site and the B Complex. The calculated values range from 6.7E-5 to 1.06E-1 cm/sec (5.8E-2 to 9.2E1 m/d) (PNNL-23711, *Physical, Hydraulic, and Transport Properties of Sediments and Engineered Materials Associated with Hanford Immobilized Low-Activity Waste*). The B Complex calculations were also bounded by the values calculated at the immobilized low-activity waste site. RPP-ENV-58782 used the values calculated at the immobilized low-activity waste site.

The Hf2 unsaturated hydraulic conductivity was determined from samples collected at the immobilized low-activity waste site and the B Complex. The calculated values range from 2.1E-5 to 4.93E-2 cm/sec (1.8E-2 to 4.3E1 m/d) (PNNL-23711 and PNNL-19277). The immobilized low-activity waste site and the B Complex unsaturated hydraulic conductivity values bound previous results from the Grout Facility, US Ecology, Field Lysimeter Test Facility, and 241-AP Tank Farm, as discussed in WHC-EP-0883, *Variability and Scaling of Hydraulic Properties for 200 Area Soils, Hanford Site*. RPP-ENV-58782 used the values calculated at the immobilized low-activity waste site.

1.2.5 Groundwater Contamination and Model Capture

Technetium-99 groundwater contamination at A-AX and C Farms exceeds the DWS (900 pCi/L) at 11 groundwater monitoring wells (Figure 1-2). Figure 1-2 outlines the technetium-99 plume as defined in DOE/RL-2020-60, *Hanford Site Groundwater Monitoring Report for 2020*. As discussed in Section 1.2 of this report, several sources at the A-AX and C Farms make up the likely contributing sources. Fate and transport modeling discussed in Section 6.7 of ECF-200BP5-19-0036 derived the proposed extraction locations and pumping rates to minimize the amount of time to achieve plume cleanup and source containment without exceeding the capacity of the ion-exchange treatment train at the 200 West P&T.

Technetium-99 is interpreted to extend throughout the saturated vertical extent of the CCUg at C Farm proposed extraction well 299-E27-157. C Farm technetium-99 concentrations near the top of the basalt are based on concentrations at wells 299-E27-24 and 299-E27-155, which are screened at the bottom of the aquifer (Figure 1-8). Wells 299-E27-13 and 299-E27-14, located as shown in Figure 1-4, depict technetium-99 concentrations in the upper part of the aquifer. Well 299-E27-21 is screened across the upper 10 m (30 ft) of the aquifer and downgradient of the majority of the technetium-99 flux into the aquifer from C Farm. Proposed extraction well 299-E27-157 is located within 60 m (200 ft) of well 299-E27-21. Figure 1-3 shows the projected extent of capture during the first 4 years from extraction well 299-E27-157, when pumping at a rate of 662 L/min (175 gal/min). After the first 4 years, the planned optimum pumping rate is decreased at C Farm to 284 L/min (75 gal/min) to maintain plume containment of continuing sources. Concurrently, the planned pumping at the A-AX Farm is increased to remove the residual trechnetium-99 plume between the A-AX and C Farms within a minimal amount of time (e.g., 12 years). This plan optimizes removal of the existing technetium-99 plume without exceeding the capacity of the ion exchange treatment train at the 200 West P&T for the A-AX and C Farms and B Complex groundwater extraction systems. The final design details including flow rates will be identified in the interim RD/RAWP that will be developed following the issuance of the interim action ROD.

The vertical extent of technetium-99 in the aquifer downgradient of A Farm is uncertain. Prior to southeast migration of technetium-99 from C Farm, technetium-99 at the A-AX Farms only exceeded the technetium-99 DWS at well 299-E25-93 (Figure 1-4). Proposed extraction well 299-E25-240 is located approximately 160 m (525 ft) south of well 299-E25-93 and projected to capture the source site from and near the A-AX Farms. Capture calculations for well 299-E25-240 indicate that extraction well 299-E25-240 will also serve to capture the portion of the C Farm plume that has migrated downgradient beyond the capture of well 299-E27-157. Figure 1-3 shows the projected extent of capture during the first 4 years from extraction well 299-E25-240, when pumping at a rate of 284 L/min (75 gal/min). After the first 4 years, the pumping rate is increased to 662 L/min (175 gal/min), which is the planned pumping scenario to remove the remaining technetium-99 between A-AX and C Farms within a minimal amount of time (e.g., 12 years). The final design details including flow rates will be identified in the interim RD/RAWP that will be developed following the issuance of the interim action ROD.

1.3 Systematic Planning Summary

Systematic planning was used to define data collection criteria to resolve uncertainties for optimal design of extraction wells for effective removal of technetium-99 in groundwater from the A-AX and C Farm areas. Problem statements were created below to address uncertainties. A systematic process is used to carry each problem statement through the data quality objective process. The three primary problem statements are listed below. The problem statements extend through the principal study questions, decision statements, decision rules, and finally, the resolution of the problem statement. Each of the following steps is segregated by the order in which it was defined in the problem statement:

1. Potential elevated chloride pore water may reduce the longevity of the extraction well due to corrosion.

2. Vertical variability of technetium-99 concentrations in the aquifer could affect optimum placement of the well screen.

3. Vertical variability of alluvial sediment sorting could affect optimal well screen and sand pack mesh size and longevity of the extraction well.

The following principal study questions were defined to address each problem statement:

1. Are the extraction well locations potentially within a vadose zone area of elevated chloride pore water?
2. Do existing nearby monitoring well data provide representative data of the vertical extent of technetium-99 concentrations to optimize the well screen length at the proposed wells?
3. Is the texture of the saturated sediments sufficiently known for optimal sizing of the well screen slot and sand pack mesh size?

Decision statements were defined to determine whether uncertain conditions require alternative actions as follows:

1. Determine if potential elevated chloride pore water from nearby releases or potential releases could adversely impact the extraction well based on information discussed in Section 1.2, and if so, determine an appropriate action to protect the extraction well casing.
2. Determine if existing groundwater monitoring well data are sufficient to determine the vertical extent of technetium-99 in the unconfined aquifer or if additional data are required for optimal screen placement.
3. Determine if the texture of the saturated sediments is sufficiently known for optimal sizing of the well screen slot and sand pack mesh size or if additional data are needed.

Decision rules created to provide the criteria associated with the above decision statements are as follows:

1. If nearby releases or potential releases of elevated chloride discharge water were released within 30 m (100 ft) of the planned extraction well location or if fine-grained sand potentially containing elevated chloride pore water is found, assume elevated chloride pore water is present at the planned well.
2. If existing groundwater monitoring well data from January 2018 to November 2019 meet the following criteria, then the data can be used to define the vertical extent of technetium-99 contamination at the planned extraction well; otherwise, collect depth-discrete groundwater samples during drilling to determine optimal screen placement:
    a. Existing monitoring wells are within the technetium-99 groundwater plume boundary (Figure 1-2)
    b. Existing technetium-99 data within the date criteria are available from wells screened across the top, middle, and bottom of the aquifer within the technetium-99 plume boundary
    c. Existing monitoring wells used for vertical profiling of the aquifer are within 150 m (500 ft) of the planned extraction well
3. Is there evidence of varying saturated sediment size? If so, collect depth-discrete samples to determine the optimal sizing of the well screen slot and sand pack mesh size; otherwise, use existing saturated sediment size data.

By applying the decision rules, the observations in Section 1.2 drove the following resolution for each problem statement:

1. The extraction well locations are within the boundary of potential elevated chloride pore water, and an alternative annular seal must be used to optimize the longevity of the stainless steel extraction wells.

2. Existing monitoring well data near well 299-E27-157 meet the decision rule and no additional data are required; however, existing monitoring well do not meet the decision rule criteria at well 299-E25-240 and additional data are required before the length of the well screen can be optimally designed.

3. Because alluvial sediment grain size can vary considerably, grain size data are required for optimal sizing of the well screen, which promotes longevity of the extraction well.

Finally, the following decisions define the actions to resolve uncertainties for well design:

1. The extraction well locations may be potentially exposed to elevated chloride pore water. Therefore, use only type 316L stainless steel casing, and use a cement grout for the annular seal above the sand pack to optimize the longevity of the extraction wells.

2. Elevated technetium-99 concentrations are known to exist at the top, middle, and bottom of the aquifer near well 299-E27-157. Therefore, extend the extraction well screen across the entire aquifer. However, technetium-99 data are lacking near well 299-E25-240; thus, collect groundwater samples at 3, 9, 14, 17, 20, and 23 m (10, 30, 45, 55, 65, and 75 ft) below the water table for optimum placement of the well screen (see Tables 1-3 and 3-1 for interpreted geology changes with depth and associated sampling requirements, respectively).

3. The average texture of the alluvial sediments is not sufficient to design the optimal well screen slot and sand pack mesh size; thus, representative sediment collection within the aquifer is required at 3 m (10 ft) intervals and at lithologic changes for optimal well screen slot and sand pack mesh size. In addition, expedited geophysical logging and hydraulic testing results will be completed and reviewed for the aquifer to ensure no subordinate silt or silty-sand layers are present requiring changes to the well screen slot and sand pack mesh size. If significant technetium-99 concentration changes with depth are observed, then a blank section of casing between a higher and lower screen interval will be added for future extraction optimization.

Following well construction and development, the new wells will be connected to the 200 West P&T facility. Monitoring at the wellhead will be conducted at the frequency described in Section D3.5.2 of DOE/RL-2009-124, modified by TPA-CN-0844. In addition, multi-well aquifer testing will be performed on each of the completed extraction wells to be performed under a separate hydraulic testing plan as summarized in the RD/RAWP.

1.4 Well Design and Construction Requirements

The systematic planning process establishes sample requirements during well drilling to support the well design for two stainless steel extraction wells, 299-E25-240 and 299-E27-157. Well drilling and construction will be performed in accordance with WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells.” Well locations are shown in Figures 1-2 and 1-3.

Wells will be constructed as 20.4 cm (8 in.) diameter extraction wells with 316 L grade stainless steel casing and screens to provide corrosion resistance. Table 1-4 presents expected parameter descriptions and values for each well.

Table 1-4. 200-BP-5 Operable Unit Expected Well Parameters

Well Name (Well ID)[a]	Well Type	Parameter Description[b]	Parameter Value[b]
299-E25-240 (D0119)	Extraction well for source contaminant of technetium-99 from the A-AX Farm and nearby sites	Surface elevation (m NAVD88)	209.5
		Water-table elevation (m NAVD88)	121.6
		Elevation to the top of the Rwie (m NAVD88)	106.5
		Elevation to the top of the Rwia (m NAVD88)	100.4
		Elevation basalt (m NAVD88)	96.1
		Depth to water (ft bgs)	288.4
		Depth to the top of the Rwie (ft bgs)	333.5
		Depth to the top of the Rwia (ft bgs)	353.5
		Depth to basalt (ft bgs)	368.5
		Planned screen length (ft)[c]	TBD
		Planned depth to the top of the 8 in. stainless steel screen (ft bgs)[c]	TBD
		Planned depth to the bottom of the 8 in. stainless steel screen (ft bgs)[c]	TBD
		Planned total drill depth (ft bgs)	TBD
299-E27-157 (D0118)	Extraction well for source contaminant of technetium-99 from C Farm and nearby sites	Surface elevation (m NAVD88)	203.4
		Water-table elevation (m NAVD88)	121.6
		Elevation to the top of the Rwia (m NAVD88)	NP
		Elevation basalt (m NAVD88)	106.8
		Depth to the water (ft bgs)	268.5
		Depth to the basalt (ft bgs)	317
		Planned screen length (ft)[c]	53
		Planned depth to the top of 8 in. stainless steel screen (ft bgs)	264
		Planned depth to the bottom of the 8 in. stainless steel screen (ft bgs)[c]	317
		Planned total drill depth (ft bgs)	327[d]

Reference: NAVD88, *North American Vertical Datum of 1988*.

a. See Figure 1-2 for location of monitoring wells.

b. Depths are based on the Central Plateau three-dimensional solid model. Elevations are based on convergence of a Hanford Site annual report cross-sectional tool minus the difference between depth to water from the Central Plateau three-dimensional solid model and measured water-table elevation from nearby wells. Final depths will be determined based on observations during drilling.

c. The final screened interval for extraction wells will be optimized to capture the target plume(s) based on groundwater sample results during drilling, aquifer thickness, maximum contaminant concentrations, particle size across the saturated thickness of the aquifer, and expedited geophysical logging and hydraulic testing results completed and reviewed for the unconfined aquifer. A section of blank casing maybe added to optimize extraction during future source control.

d. Assumes 3.9 m (13 ft) of drilling into the basalt for well sump.

bgs = below ground surface
ID = identification
NP = not present
Rwia = Ringold Formation member of Wooded Island – unit A
Rwie = Ringold Formation member of Wooded Island – unit E
TBD = to be determined

Well 299-E25-240

The screened interval at well 299-E25-240 will be based on the vertical profile of technetium-99 groundwater sample results during drilling, aquifer thickness, maximum contaminant concentrations, particle size across the saturated thickness of the aquifer, and expedited geophysical logging and hydraulic testing results completed and reviewed for the unconfined aquifer. The OU Technical Lead will evaluate the data to support well design in conjunction with the drilling organization.

Well 299-E25-240 requires a vertical profile of technetium-99 concentrations within the aquifer for optimal well screen placement. If technetium-99 is found throughout the saturated zone above the basalt at well 299-E25-240, then drilling will also extend into the top 3.9 m (13 ft) of basalt to set the sump. If drilling though the upper 3.9 m (13 ft) of basalt is required, a basalt competency evaluation will be performed as explained in Section 1.7.

The filtered pack will extend from the bottom of the borehole to 1.5 m (5 ft) above the top of the screen if detectable concentrations of technetium-99 are found throughout the aquifer. If technetium-99 is not found in part of or all of the Ringold Formation, then bentonite will be used to fill the borehole to 0.6 m (2 ft) below the bottom of the sump.

Design of well filter pack mesh and screen slot sizes follows the approach described in Chapter 13, "Water Well Design," in Driscoll, 1986, *Groundwater and Wells*. Sediment sieve samples will be collected during drilling for grain size analysis at the intervals defined in Chapter 3. The grain-size distribution of the composited sample is determined by standard sieve methodology. The filter pack mesh size is based on the uniformity coefficient (D60/D10) and the range of three different cumulative weight percentages determined during the sieve analysis:

- Grain size where 10% of the cumulative weight of the sample passes (D10)
- Grain size where 30% of the cumulative weight of the sample passes (D30)
- Grain size where 60% of the cumulative weight of the sample passes (D60)

A screen slot-size is then selected that will allow approximately 10% of the selected filter pack to pass through the screen. When water chemistry is encrusting a larger screen, slot-size is recommended to allow for a longer service life.

The annular space above the filter pack will be completed with a 3 ft section of bentonite pellets overlain by cement grout to ground surface to minimize the potential for well corrosion.

Well 299-E27-157

The screened interval at well 299-E27-157 will extend throughout the aquifer. The estimated screen length is 16.2 m (53 ft), based on measurements defined in Table 1-4. The final design and placement of the well screen will be based on an evaluation of depth to groundwater, aquifer thickness, and particle size data collected across the saturated thickness of the aquifer, and expedited geophysical logging and hydraulic testing results completed and reviewed for the unconfined aquifer. The OU Technical Lead will evaluate the data to support well design in conjunction with the drilling organization.

Drilling into the top 3.9 m (13 ft) of basalt is required at well 299-E27-157 to set the sump. During drilling through the basalt, a basalt competency evaluation will be performed as explained in Section 1.7. The filtered pack will extend from the bottom of the borehole to 1.5 m (5 ft) above the top of the screen. The filter pack mesh and slot size will be based on sieve analysis as described for well 299-E25-240. The annular space above the filter pack will be completed with a 3 ft section of bentonite pellets overlain by cement grout to ground surface to minimize the potential for well corrosion. The generic well design for extraction well 299-E27-157 is shown in Figure 1-11.

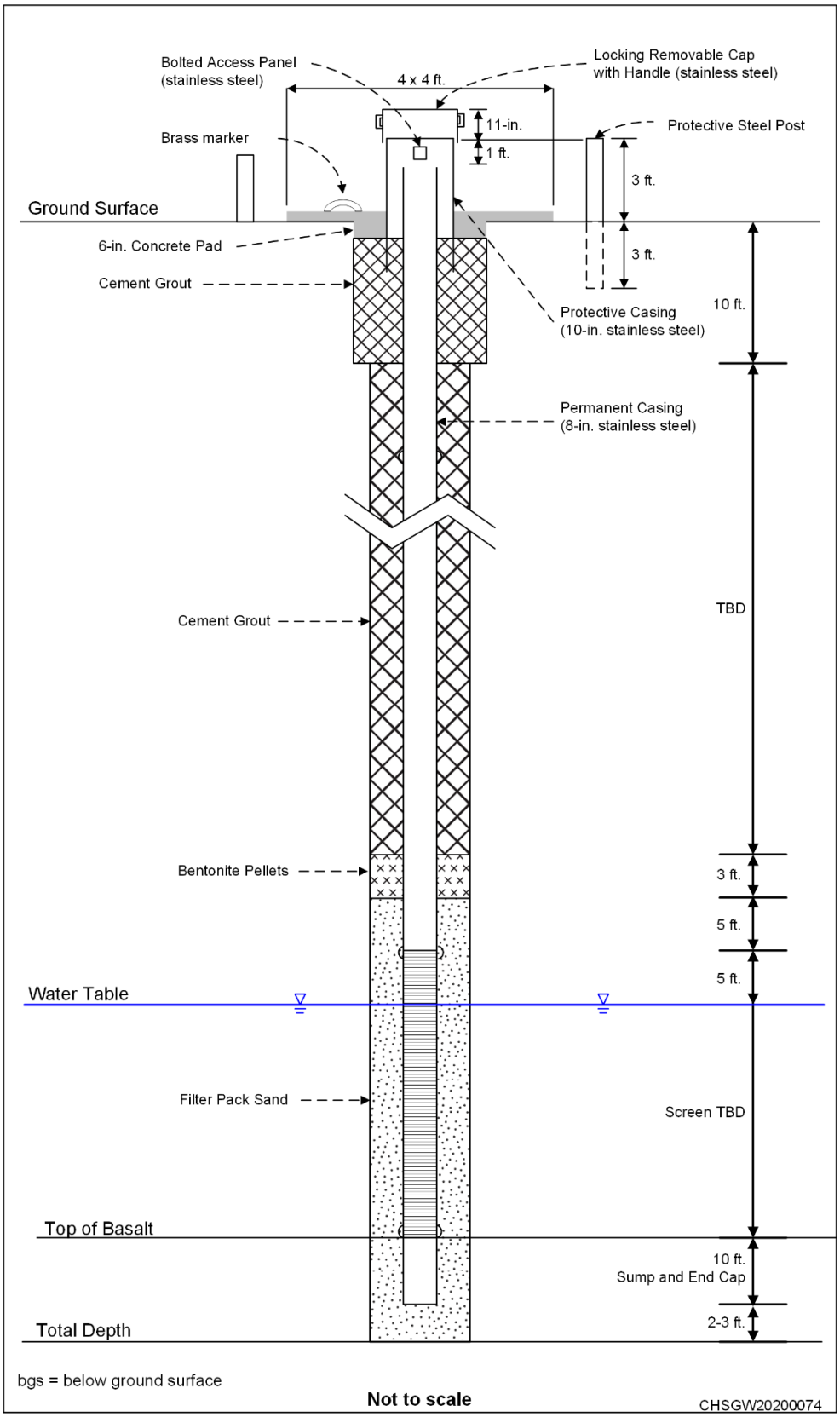


Figure 1-11. Standard Extraction Well Design

1.5 Opportunistic Sampling Requirements

During integration DQO meetings, opportunistic sampling intervals were identified for the vadose zone and saturated zone at wells 299-E25-240 and 299-E27-157 to support contaminant inventory needs of the conceptual site model (CSM). A second opportunistic sampling requirement was identified by the process engineering group for the 200 West P&T, requiring post-development groundwater samples for planning resin performance at the 200 West P&T. A third opportunistic sampling requirement is to evaluate anions and technetium-99 at certain vadose zone soil horizons. The following provides the planned opportunistic sample intervals for each well:

Well 299-E25-240

1. Collect soil samples at 12.2 m (40 ft) bgs for hydraulic property analysis.
2. Collect soil samples at 23.5 m (77 ft) bgs for hydraulic property analysis.
3. Collect soil samples at 38.1 m (125 ft) bgs for hydraulic property analysis.
4. Collect soil samples at 57 m (187 ft) bgs for hydraulic property analysis.
5. Collect soil samples at 64 m (210 ft) bgs for hydraulic property analysis.
6. Collect three soil samples between 83.5 and 85.7 m (274 and 281 ft) bgs (interval of anticipated CCU) for hydraulic property and chemical analysis. Further details are provided in Section 3.2.
7. Collect groundwater samples near lithologic changes for chemical analysis defined in the table in Section 3.2 for present day vertical profiling (e.g., 91.0, 97.1, 100.7, 103.8, 106.8, and 109.9 m [298.5, 318.5, 330.5, 340.5, 350.5, and 360.5 ft]).
8. Collect one post-development groundwater sample for process engineering at the 200 West P&T. Constituents include calcium, magnesium, nitrate, sulfate, technetium-99, and uranium.
9. If drilling into basalt is required by the above results and fractured basalt extends >1.5 m (5 ft), collect a groundwater sample from the fractured basalt zone for chemical analysis defined in the table in Section 3.2.

Well 299-E27-157

1. Collect soil samples at 15.2 m (50 ft) bgs (interface between Hf1 and Hf2) for hydraulic property and chemical analysis.
2. Collect soil samples at 23.5 m (77 ft) bgs (zone of gravelly sand with increasing natural potassium-40) for hydraulic property and chemical analysis.
3. Collect soil samples at 38.1 m (125 ft) bgs (zone of very coarse to medium-grained sand) for hydraulic property analysis.
4. Collect soil samples at 57 m (187 ft) bgs (zone of silty sandy gravel) for hydraulic property analysis.
5. Collect soil samples at 64 m (210 ft) bgs (zone of fine to very fine-grained sand) for hydraulic property and chemical analysis.
6. Collect soil samples at 73.2 to 74.7 m (240 to 245 ft) bgs (interval of anticipated CCU) for hydraulic property and chemical analysis.

7. Collect groundwater samples at 3 m (10 ft) intervals for chemical analysis defined in the table in Section 3.2 for present day vertical profiling (e.g., 85.3, 88.4, 91.4, 94.5, and 96.6 m [280, 290, 300, 310, and 317 ft]).

8. Collect one post-development groundwater sample for process engineering at the 200 West P&T. Constituents include calcium, magnesium, nitrate, sulfate, technetium-99, and uranium.

9. During basalt drilling, if >1.5 m (5 ft) of fractured basalt is encountered, collect a groundwater sample from the fractured basalt zone for chemical analysis as defined in the table in Section 3.2.

1.6 Target Analytes/Parameters of Interest

Target analytes and geotechnical soil properties of interest were developed during the DQO process (Sections 1.2.1, 1.2.2, 1.3, and 1.5). Target analytes and parameters of interest are listed in Table 1-5. Because gross beta results are attributed to the presence of technetium-99, gross beta will not be collected.

Table 1-5. Target Constituent, Soil Property, and Field Analyses

Constituent/Soil Property/Field Measurement	Analytical Methods[a]	Media	
Anions			
Chloride, nitrate, sulfate	EPA Method 300 or 9056	Soil	Water
Metals			
Calcium	EPA Method 6010	N/A	Water
Magnesium	EPA Method 6010	N/A	Water
Technetium	EPA Method 6020	N/A	Water
Uranium	EPA Method 6020	N/A	Water
Radionuclides			
Iodine-129	Low-energy gamma spectroscopy or gas proportional counting	N/A	Water
Technetium-99	Liquid scintillation counter	Soil	Water
Tritium	Liquid scintillation counter	N/A	Water
Sediment Properties			
Grain size distribution	Contractor procedure	Soil	N/A
Hydraulic Soil Property Analysis			
Bulk density	ASTM D7263-09(2018)e2[b]	Soil	N/A
Matric potential using filter paper	ASTM D5298-16[b]	Soil	N/A
Total porosity	Calculation using bulk density and particle density according to ASTM D7263-09(2018)e2[b]	Soil	N/A

Table 1-5. Target Constituent, Soil Property, and Field Analyses

Constituent/Soil Property/Field Measurement	Analytical Methods[a]	Media	
Saturated hydraulic conductivity	Methods described in PNNL-27846[b]	Soil	N/A
Unsaturated hydraulic conductivity	Methods described in PNNL-27846[b]	Soil	N/A
Field Screening			
Dissolved oxygen	Field measurement instrument/meter	N/A	Water
pH	Field measurement instrument/meter	N/A	Water
Specific conductivity	Field measurement instrument/meter	N/A	Water
Temperature	Field measurement instrument/meter	N/A	Water
Turbidity	Field measurement instrument/meter	N/A	Water

Note: Complete reference citations are provided in Chapter 7.

a. For EPA Method 300, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*.

b. Hydraulic and physical property samples within the vadose zone will be collected as part of the need identified in CP-63883, *Vadose Zone Flow and Transport Parameters Data Package for the Hanford Site Composite Analysis and Cumulative Impact Evaluation*. Because chemical or radiological analyses will not be performed on samples collected for future possible hydraulic property analysis, the only requirement for storing such samples is that the samples remain sealed and stored in a climate-controlled facility.

ASTM = American Society for Testing and Materials N/A = not applicable
EPA = U.S. Environmental Protection Agency

1.7 Geologic and Geophysical Logging

Geologic logging is a system of recording and documenting lithology and stratigraphic relationships of geologic materials encountered during borehole drilling operations. Soil cuttings and samples shall be examined throughout the borehole by the field geologist. The geologist will record observations of the soil cuttings and samples in a geologic log in accordance with Central Plateau Cleanup Company procedures, and the log shall also be reviewed and approved by a geologist that has not completed the log. The field geologist will collect archive drill cuttings every 1.5 m (5 ft) and at changes in lithology from surface-to-total depth for storage. The archive drill cutting samples will be collected in pint-sized glass jars and represent, by percentage and size, the collected depth of the soil column as closely as possible. A chip tray will contain a close approximation of the percentages of the finer materials collected at the depth within the soil column. If representative samples cannot be collected in the chip tray and pint-sized glass jars, notes of the difference between the observed soil cutting and samples versus the archived samples collected will be noted in the field geologist's log describing the condition of the samples. Archive samples will not be collected if contamination is encountered.

All boreholes will be logged with the high-resolution spectral gamma logging system and neutron moisture logging system to determine the vertical distribution and concentration of gamma-emitting radionuclides, soil moisture variations, and borehole lithology changes. Neutron data will be converted from counts to volumetric moisture to provide quantitative moisture data in the vadose zone. The boreholes will be geophysically logged before downsizing each temporary casing string and/or once total drill depth is reached. Expedited geophysical logging results will be completed and reviewed for the unconfined aquifer to ensure no subordinate silt or silty-sand layers are present, requiring changes to the well screen slot and sand pack mesh size.

Drilling at well 299-E27-157 provides an opportunity to investigate the basalt structure and may provide an opportunity at well 299-E25-240 if technetium-99 is found throughout the saturated zone above the basalt. Descriptions of the basalt underlying the unconfined aquifer generally is characterized as dense, low permeability, and presenting a nonconductive lower boundary to the overlying unconfined aquifer. This definition is reflected in the plateau to river transport model, which assumes the basalt forms an impermeable base to the unconfined aquifer (Section 3.2.4 of CP-57037, Rev. 2). Although past geophysical investigations near the planned well locations indicate competent basalt, the following observations will be completed and reported as part of the field summary report:

- Visual examination of basalt for documenting presence and size of vesicles.
- Documentation of advancement speed through the basalt (e.g., minutes per foot for each foot drilled).
- Visual examination of basalt hole using video camera.
- If the basalt displays fractured conditions and the fractured conditions extend >1.5 m (5 ft), hydraulic testing and groundwater sampling will be included as discussed in Section 1.8 and Section 3.2, respectively. The field geologist will determine the presence and extent of fracture conditions.

1.8 Hydraulic Testing Requirements

Single well aquifer pumping tests (aquifer testing) are planned during the drilling of wells 299-E25-240 and 299-E27-157. Eight aquifer tests are planned: five in the CCUg, two within the Rwie, and one within the Rwia (Tables 3-1 and 3-2). Up to two additional aquifer tests will be completed if while drilling into the basalt, a basalt fracture zone is observed as discussed in Section 1.7 and the fractured zone is >1.5 m (5 ft) thick.

Aquifer testing is accomplished by applying a known stress to the aquifer of known or assumed dimensions and observing the water-level response over time. Hydraulic characteristics of the aquifer can then be determined by measuring the water-level drawdown and water discharge rates. Testing will be conducted to determine the transmissivity and hydraulic conductivity within the aquifer. These data will provide additional input to various models (e.g., geoframework and groundwater model updates) being developed for the 200 Areas. Section 3.4 provides details on aquifer testing

1.9 Radiological and Industrial Hygiene Field Screening

Field screening (radiological and industrial hygiene) will be performed by the radiological control technician (RCT), industrial hygiene technician, and other qualified personnel in accordance with approved methods and procedures. The RCTs will record elevated field measurements, noting the depth of the sample and the instrument reading on a radiological survey report. The industrial hygiene technicians will record field measurements, enter the measurements into a database, and develop exposure assessment reports. Field measurements will be communicated to the field geologist. The frequency of

coverage will be determined by the supporting organizations during the associated planning activities for drilling these wells.

1.10 Well Development

The objectives of well development are to settle the filter pack, prevent uncontrolled infiltration of fines, and ensure communication of the well with the surrounding formation. Initial well development will be conducted during well construction and final development after the wells are completed. Initial development will be performed during well construction in conjunction with placement of the filter pack, with the use of a dual surge block to both settle the filter pack, and to develop communication across the borehole wall.

Final development is performed after well filter pack placement. Final well development with a submersible pump will occur after the fines are removed. The development pump intake shall be placed at equally spaced intervals of 6.1 m (20 ft) in length along the saturated thickness to develop the screened interval adequately.

During final well development, water samples will be screened in the field for analysis of turbidity, dissolved oxygen, temperature, pH, and conductivity using field instruments. Development will continue until the well produces water <5 nephelometric turbidity units (NTUs) and the temperature, pH, and conductivity have stabilized (at least three consecutive measurements within 10% of each other).

Groundwater samples at wells 299-E25-240 and 299-E27-157 will be collected during the drilling process, and a single groundwater sample will be collected after well development. The groundwater sample after development will be submitted for laboratory analyses and used as part of the baseline statistical approach by process engineers at the 200 West P&T. The pump intake will be placed at the depth where the highest technetium-99 depth-discrete result was collected as directed by the Project OU Lead.

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2 Quality Assurance Project Plan

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. It includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection requirements and controls based on the quality assurance (QA) elements found in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5), CPCC-00172, *Central Plateau Cleanup Company Environmental Quality Assurance Program Plan*,[1] and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD). DoD/DOE QSM, *Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories*, is also discussed. Section 7.8 of Ecology et al., 1989b, the *Hanford Federal Facility Agreement and Consent Order Action Plan* (hereinafter called the Tri-Party Agreement Action Plan), requires the QA/quality control (QC) and sampling and analysis activities to specify the QA requirements for past-practice processes. This QAPjP also describes applicable requirements and controls based on guidance in Washington State Department of Ecology (Ecology) Publication No. 04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies,* and EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans* (EPA QA/G-5).

This QAPjP references are included in Chapter 7. The QAPjP includes the following sections, which describe the quality requirements and controls applicable to Hanford Site OU sampling activities:

- Section 2.1, “Project Management”
- Section 2.2, “Data Generation and Acquisition”
- Section 2.3, “Assessment and Oversight”
- Section 2.4, “Data Review and Usability”

2.1 Project Management

This section includes project organization and goals, planned approaches, and planned output documentation.

2.1.1 Project/Task Organization

The project organization is described in the following sections and illustrated in Figure 2-1.

2.1.1.1 Regulatory Lead

The lead regulatory agency for the 200-BP-5 and 200-PO-1 OUs is Ecology. Ecology is responsible for regulatory oversight of cleanup projects and activities. The U.S. Environmental Protection Agency (EPA) retains approval authority for all SAPs. Ecology works with EPA and the DOE, Richland Operations Office (DOE-RL) to resolve concerns over the work described in this SAP in accordance with Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order* (hereinafter called the Tri-Party Agreement).

2.1.1.2 DOE-RL Manager

Hanford Site cleanup in the 200-BP-5 and 200-PO-1 OUs is the responsibility of DOE-RL. The DOE-RL Manager is responsible for authorizing the contractor to perform activities at the

[1] The quality assurance/quality control planning and implementing elements described in Chapters 1, 2, and 3 of this SAP are consistent with the associated environmental management plan elements described in CPCC-00172. CPCC-00172 is not a Tri-Party Agreement primary or secondary document and thus is not subject to Lead Regulatory Agency review or approval.

Hanford Site under CERCLA, *Resource Conservation and Recovery Act of 1976* (RCRA), *Atomic Energy Act of 1954*, and the Tri-Party Agreement (Ecology et al., 1989a).

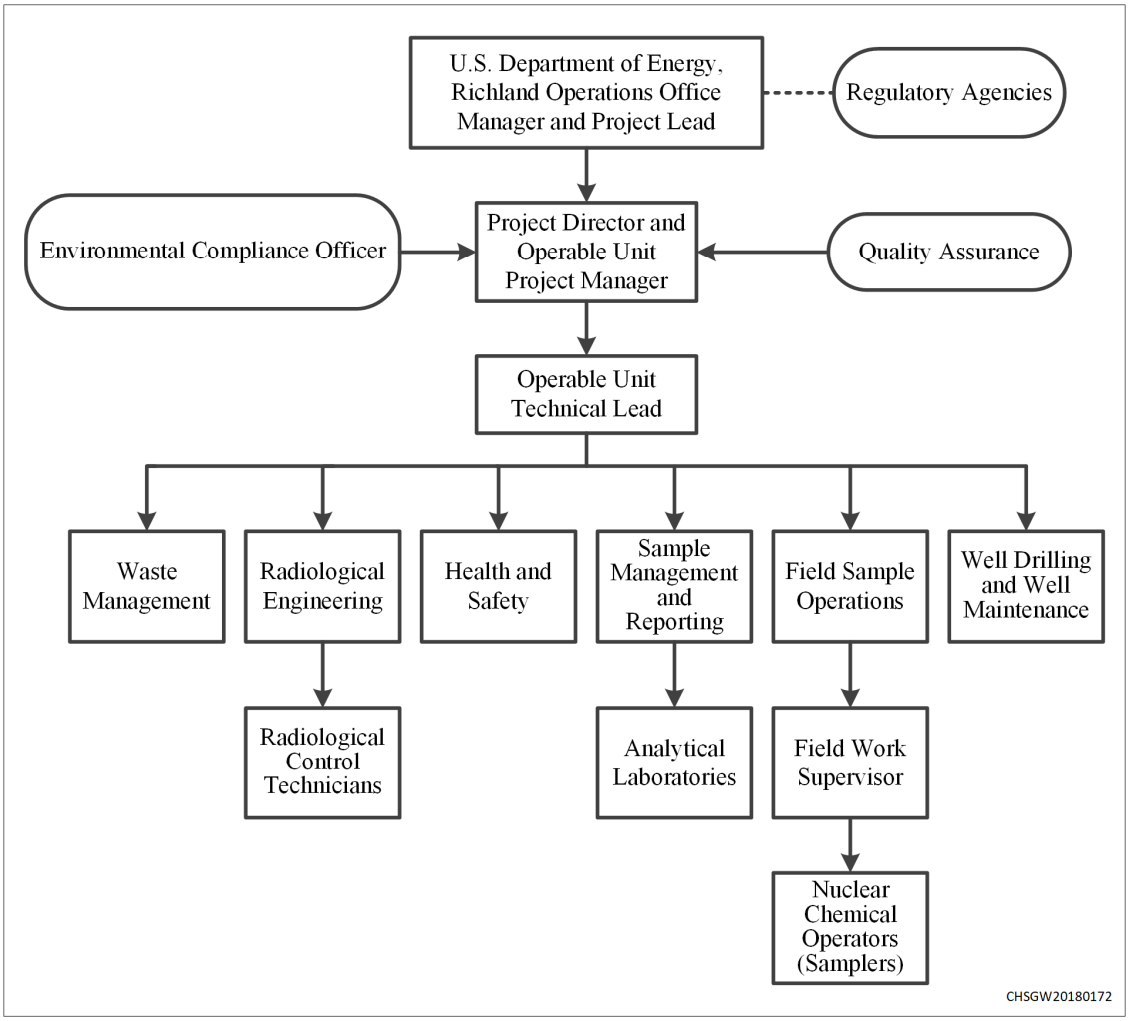

Figure 2-1. Project Organization

2.1.1.3 DOE-RL Project Lead

The DOE-RL Project Lead is responsible for providing day-to-day oversight of the contractor's performance of the work scope, working with the contractor to identify and work through issues, and providing technical input to DOE-RL management, and is the primary interface with regulatory agencies.

2.1.1.4 Primary Contractor Project Director

The Regulatory Strategy and Integration Director (i.e., Project Director in Figure 2-1) provides oversight and coordinates with DOE-RL and primary contractor management in support of sampling and reporting activities. The Regulatory Strategy and Integration Director also provides support to the OU Project Manager to ensure that work is performed safely and cost effectively.

2.1.1.5 Operable Unit Project Manager

The OU Project Manager (or designee) is responsible and accountable for the project-related activities including coordinating with DOE-RL, regulators, and contactor management in support of sampling activities to ensure work is performed safely, compliantly, and cost effectively. In addition, the

OU Project Manager (or designee) is also responsible for managing sampling documents and requirements, field activities, subcontracted tasks, and for ensuring the project file is properly maintained.

2.1.1.6 Operable Unit Technical Lead

The OU Technical Lead is responsible for developing specific sampling design, analytical requirements, and QC requirements, either independently or as defined through a systematic planning process. The OU Technical Lead ensures that sampling and analysis activities, as delegated by the OU Project Manager, are carried out in accordance with the SAP, and works closely with the Environmental Compliance Officer, QA, Health and Safety, the Field Work Supervisor (FWS), well drilling and planning, and the Sample Management and Reporting (SMR) group to integrate these and other technical disciplines in planning and implementing the work scope.

2.1.1.7 Sample Management and Reporting

The SMR group oversees offsite analytical laboratories, coordinates laboratory analytical work to ensure that laboratories conform to the requirements of this plan, and verifies that laboratories are qualified for performing Hanford Site analytical work. The SMR group generates field sampling documents, labels, and instructions for field sampling personnel and develops the sample authorization form, which provides information and instruction to the analytical laboratories. The SMR group ensures that field sampling documents are revised to reflect approved changes. The SMR group receives analytical data from the laboratories, ensures the data are appropriately reviewed, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation and recordkeeping. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with Field Sample Operations (FSO), laboratories, or other entities. The SMR group is responsible for informing the OU Project Manager of any issues reported by the analytical laboratories.

2.1.1.8 Field Sample Operations

FSO is responsible for planning and coordinating field sampling resources. The FWS directs the nuclear chemical operators (samplers) who collect samples in accordance with this sampling plan and corresponding standard methods and work packages. The FWS ensures that deviations from field sampling documents or issues encountered in the field are documented appropriately (e.g., in the field logbook). The FWS ensures that samplers are appropriately trained and available. Samplers collect samples in accordance with sampling requirements. Samplers also complete field logbooks, data forms, and chain-of-custody forms, including any shipping paperwork, and enable delivery of the samples to the analytical laboratory.

Prejob briefings are conducted by FSO, in accordance with work management and work release requirements, to evaluate activities and associated hazards by considering the following factors:

- 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

2.1.1.9 Quality Assurance

The QA point of contact provides independent oversight and is responsible for addressing QA issues on the project, overseeing implementation of the project QA requirements. Responsibilities include reviewing project documents including the QAPjP and participating in QA assessments on sample collection and analysis activities, as appropriate.

2.1.1.10 Environmental Compliance Officer

The Environmental Compliance Officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with the goal of minimizing adverse environmental impacts.

2.1.1.11 Health and Safety

The Health and Safety organization is responsible for 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 regulation or internal primary contractor work requirements.

2.1.1.12 Radiological Engineering

Radiological Engineering is responsible for the following:

- Radiological engineering and project health physics support
- Conducting as low as reasonably achievable reviews, exposure and release modeling, and radiological controls optimization
- Identifying radiological hazards and ensuring appropriate controls are implemented to maintain worker exposures to hazards at as low as reasonably achievable levels
- Interfacing with the project Health and Safety representative and other appropriate personnel, as needed, to plan and direct project RCT support

2.1.1.13 Waste Management

Waste Management is responsible for identifying waste management sampling/characterization requirements to ensure regulatory compliance and for interpreting data to determine waste designations and profiles. Waste Management communicates policies and practices and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

2.1.1.14 Analytical Laboratories

The analytical laboratories accept, manage, prepare, and analyze samples in accordance with established methods and the requirements of their subcontract, and provide necessary data packages containing analytical and QC results. Laboratories provide explanations of results to support data review and in response to resolution of analytical issues. Laboratory quality requirements are consistent with HASQARD (DOE/RL-96-68). The laboratories are evaluated under the DOE Consolidated Audit-Accreditation Program (DOE/CAP-AP) or its successor programs to DoD/DOE QSM requirements. HASQARD requirements, beyond those within the DoD/DOE QSM, are also evaluated under the DOE/CAP-AP. Laboratories are accredited by Ecology for the analyses performed under this SAP.

2.1.1.15 Well Drilling and Well Maintenance

The well drilling and maintenance and well coordination planning managers are responsible for the following:

- Planning, coordinating, and executing drilling construction
- Well maintenance activities
- Coordinating with the OU Technical Lead about field constraints that could affect sampling design
- Coordinating well decommissioning with DOE-RL in accordance with the substantive standards of WAC 173-160

2.1.2 Quality Objectives and Criteria

The QA objective of this plan is to ensure the generation of analytical data of known and appropriate quality is acceptable and useful in order to meet the evaluation requirements stated in the sampling plan. Data descriptors known as data quality indicators (DQIs) help determine the acceptability and usefulness of data to the user. The principal DQIs (e.g., precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity) are defined for the purposes of this document in Table 2-1.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Precision (field duplicates, laboratory sample duplicates, and matrix spike duplicates)	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the relative percent difference.	• Use the same analytical instrument to make repeated analyses on the same sample. • Use the same method to make repeated measurements of the same sample within a single laboratory. • Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	If duplicate data do not meet objective: • Evaluate the apparent cause (e.g., sample heterogeneity). • Request reanalysis or remeasurement. • Qualify the data before use.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Accuracy (laboratory control samples, matrix spikes, surrogates, tracers)	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include standard recoveries, laboratory control samples, spiked samples, and surrogates.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample).	If recovery does not meet the objective: • Qualify the data before use. • Request reanalysis or remeasurement.
Representativeness (field duplicates)	Sample representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring that the approved plans were followed during sampling and analysis.	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	If the results are not representative of the system sampled: • Identify the reason for the results not being representative. • Flag for further review. • Review the data for usability. • If the data are usable, qualify the data for limited use and define the portion of the system that the data represent. • If the data are not usable, flag as appropriate. • Redefine sampling and measurement requirements and protocols. • Resample and reanalyze, as appropriate.
Comparability (field duplicate, field splits, laboratory control samples, matrix spikes, and matrix spike duplicates)	Comparability expresses the degree of confidence with which one dataset can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and QA protocols.	If the data are not comparable to other datasets: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Completeness (no QC element; addressed in data quality assessment)	Completeness is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/ acceptance criteria).	If the dataset does not meet the completeness objective: • Identify appropriate changes to the data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future completeness.
Bias (equipment blanks, full trip blanks, field transfer blanks, laboratory control samples, matrix spikes, and method blanks)	• Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. • Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	• Sampling bias may be revealed by analysis of replicate samples. • Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike).	For sampling bias: • Properly select and use sampling tools. • Institute correct sampling and subsampling practices to limit preferential selection or loss of sample media. • Use sample handling practices, including proper sample preservation, that limit the loss or gain of constituents to the sample media. • Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias. • Laboratories that are known to generate biased data for a specific analyte are asked to correct their methods to remove the bias as best as practicable. Otherwise, samples are sent to other laboratories for analysis.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Sensitivity (method detection limit, practical quantitation limit, and relative percent difference)	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	• Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). • The lower limit of quantitation[b] is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet objective: • Request reanalysis or remeasurement using methods or analytical conditions that will meet required detection or limit of quantitation. • Qualify/reject the data before use.

Source: SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*.

a. Acceptance criteria for QC elements are provided in Table 2-5.

b. For purposes of this sampling plan, the lower limit of quantitation is interchangeable with the practical quantitation limit.

QA = quality assurance QC = quality control

Data quality is defined by the degree of rigor in the acceptance criteria assigned to the DQIs. The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. DQIs are evaluated during a process to assess data usability (Section 2.4.3).

2.1.3 Methods-Based Analysis

Laboratory testing and reporting for the analytes described in Section 2.2.1 may include nontarget analytes that are part of the analytical method (i.e., methods-based reporting). The nontarget analyte results reported by the laboratory as part of the method will be considered with those for the target analyte list (Table 1-5) and used to supplement expected future data collection activities. Analytical performance requirements will be applicable to all analytes resulting from the method-based analysis process, including nondetects flagged as such by the laboratory.

2.1.4 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility for collecting and transporting samples 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 has been instituted by the contractor management team to meet training and qualification programs that satisfy multiple training drivers imposed by applicable DOE, *Code of Federal Regulations*, and *Washington Administrative Code* requirements.

Training records are maintained for each employee in an electronic training record database. The contractor's training organization maintains the training records system. Line management confirms that an employee's training is appropriate and up to date prior to performing fieldwork.

2.1.5 Documents and Records

The OU Project Manager (or designee) is responsible for ensuring the current version of the SAP is being used and providing any updates to field personnel. Version control is maintained by the administrative document control process. Table 2-2 defines the types of changes that may impact the sampling and the associated approvals, notifications, and documentation requirements.

Table 2-2. Change Control for Sampling Projects

Type of Change[a]	Action	Documentation
Minor Field Change. Changes that have no adverse effect on the technical adequacy of the sampling activity or the work schedule.	The field personnel recognizing the need for a field change will consult with the OU Project Manager (or designee) prior to implementing the field change.	Minor field changes will be documented in the field logbook. The logbook entry will include the field change, the reason for the field change, and the names and titles of those approving the field change.
Minor Change. Changes to approved plans that do not affect the overall intent of the plan or schedule.	The OU Project Manager will inform DOE-RL and the regulatory lead of the change. The lead regulatory agency and EPA determine if there is no need to revise the document.	Documentation of this change approval would be in the OU Project Manager's Meeting Minutes or comparable Tri-Party Agreement change notice[b]
Revision Necessary. The lead regulatory agency determines if changes to approved plans require revision to a document.	If it is anticipated that a revision is necessary, the OU Project Manager will inform DOE-RL and the regulatory lead. The lead regulatory agency and EPA determine if the change requires a revision to the document.	Formal revision of the sampling document.

References: DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents*.

Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)*.

Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*.

Notes: Regarding minor field changes, the project scientist in coordination with the soil and groundwater SME will approve deviations from the SAP that do not have an adverse effect on the technical integrity or adequacy of the sampling activity. The following are examples of minor field changes:

1. During groundwater sampling, most groundwater samples will be pumped, although use of another method may be authorized by the OU Technical Lead.
2. The sample depths provided in this SAP are estimated based on known characterization data and geology collected from nearby wells. For this reason, adjustments to the sample depths are anticipated. The sample depths may be altered during drilling in consultation with the OU Technical Lead.
3. During split-spoon sampling, if insufficient material is recovered or the split-spoon is overdriven, then (when feasible) a second split-spoon will be collected prior to advancing the borehole. If there is not enough sample volume recovered during split-spoon sampling, laboratory-approved minimum sample volumes will be used to run all required sample analyses. If it is not possible to collect sufficient sample volume and perform all the analyses, then DOE-RL will be consulted to concur on a path forward.
4. Groundwater samples may not be collected before a minimum of three well casing volumes have been purged and water chemistry (e.g., temperature, pH, and conductivity) has stabilized within 10% variance over three consecutive measurements unless approved by the OU Technical Lead. Note that one borehole volume is acceptable if water

Table 2-2. Change Control for Sampling Projects

Type of Change[a]	Action	Documentation
chemistry (e.g., temperature, pH, and conductivity) has stabilized within 10% variance over three consecutive measurements for the depth-discrete groundwater samples collected during drilling.		
Regarding "minor changes," the project scientist in coordination with the soil and groundwater SMEs, will consult with DOE-RL when deviations from the SAP affect the overall intent of the plan. The following are examples of minor changes: 1. Changing the type of sample being collected. For example, collecting continuous grab samples instead of continuous cores. 2. Selecting a different well construction material or well design. 3. Changing to a different drilling method.		
a. Consistent with DOE/RL-96-68, as amended. Sections 9.3 and 12.4 of Ecology et al., 1989b.		
b. The Tri-Party Agreement Action Plan, Section 9.3, defines the minimum elements of a change notice.		

DOE-RL = U.S. Department of Energy, Richland Operations Office
EPA = U.S. Environmental Protection Agency
OU = operable unit
SAP = sampling and analysis plan
SME = subject matter expert
Tri-Party Agreement = *Hanford Federal Facility Agreement and Consent Order*

Logbooks are required for sampling field activities. The logbook must be identified with a unique project name and number. Only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes. Data forms are also required for field activities and shall be controlled in accordance with internal work requirements and processes.

The FWS and SMR are responsible for ensuring that the field instructions are maintained and aligned with any revisions or approved changes to the SAP. The SMR will ensure that any deviations from the SAP are reflected in revised field sampling documents for the samplers and the analytical laboratory. The FWS will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook).

The OU Project Manager, FWS, or designee is responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities. The OU Project Manager is also responsible for ensuring that project files are appropriately set up and maintained. The project files will contain project records or references to their storage locations. Project files may include the following information:

- Operational records and logbooks
- Data forms
- Global positioning system data (a copy will be provided to SMR)
- Inspection or assessment reports and corrective action reports
- Field summary reports
- Interim progress reports
- Final reports
- Photographs

The following records are managed and maintained by SMR personnel:

- Completed field sampling logbooks
- Field and analytical data
- Completed chain-of-custody forms
- Sample receipt records
- Laboratory data packages
- Analytical data verification and validation reports
- Analytical data "case file purges" (i.e., raw data purged from laboratory files) provided by the offsite analytical laboratories

Convenience copies of laboratory analytical results are maintained in the HEIS database. Records may be stored in either electronic (e.g., in the managed records area of the Integrated Document Management System) or hardcopy format (e.g., DOE Records Holding Area). Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and irretrievability of stored records. Records required by the Tri-Party Agreement (Ecology et al., 1989a) will be managed per Tri-Party Agreement requirements.

2.2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling measurement and analysis, data collection and generation, data handling, and QA/QC activities are appropriate and documented. Requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed.

2.2.1 Analytical Methods Requirements

Table 2-3 provides information regarding analytical method requirements for samples collected. Updated EPA methods and nationally recognized standard methods may be substituted for the analytical methods identified in Table 2-3 in order to follow changed requirements in the method update. The new method shall achieve project DQOs as well as or better than the replaced method.

Table 2-3. Performance Requirements for Soil and Water Analysis

Constituent/Parameter	CAS Number	Analytical Method[a]	PQL for Water (µg/L)	PQL for Soil (µg/kg)
Anion				
Chloride	16887-00-6	EPA Method 300 or 9056	400	55,000
Nitrate	14797-55-8	EPA Method 300 or 9056	250	12,500
Sulfate	14808-79-8	EPA Method 300 or 9056	1,050	27,500
Metals				
Calcium	7440-70-2	EPA Method 6010	1,050	N/A
Magnesium	7439-95-4	EPA Method 6010	1050	N/A
Uranium	7440-61-1	EPA Method 6020	1.05	N/A

Table 2-3. Performance Requirements for Soil and Water Analysis

Constituent/Parameter	CAS Number	Analytical Method[a]	PQL for Water (µg/L)	PQL for Soil (µg/kg)
Radionuclides				
Iodine-129	15046-84-1	Low-energy gamma or gas proportional counting	5	N/A
Technetium-99	14133-76-7	Liquid scintillation counter	50	5
Technetium-99	14133-76-7	EPA Method 6020	10	N/A
Tritium	10028-17-8	Liquid scintillation counter	700	N/A
Physical Properties[b]				
Grain size distribution	N/A	Contractor procedure	N/A	N/A
Hydraulic Soil Property Analysis				
Bulk density	N/A	ASTM D7263-09(2018)e2[c]	N/A	N/A
Matric potential using filter paper	N/A	ASTM D5298-16[c]	N/A	N/A
Total porosity	N/A	Calculation using bulk density and particle density according to ASTM D7263-09(2018)e2[c]	N/A	N/A
Saturated hydraulic conductivity	N/A	Methods described in PNNL-27846[c]	N/A	N/A
Unsaturated hydraulic conductivity	N/A	Methods described in PNNL-27846[c]	N/A	N/A
Field Screening				
Radiological screening by radiological control technician	N/A	Field measurement instrument/meter	N/A	N/A
Dissolved oxygen	N/A	Field measurement instrument/meter	N/A	N/A
pH	N/A	Field measurement instrument/meter	N/A	N/A
Specific conductivity	N/A	Field measurement instrument/meter	N/A	N/A
Temperature	N/A	Field measurement instrument/meter	N/A	N/A
Turbidity	N/A	Field measurement instrument/meter	N/A	N/A

Notes: Complete reference citations are provided in Chapter 7.

Analytical methods and practical quantitation limits provided in this table do not represent EPA requirements but are intended solely as guidance.

a. For EPA Method 300, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*. For standard methods, see APHA/AWWA/WEF, *Standard Methods for the Examination of Water and Wastewater*. Equivalent methods may be substituted.

b. Physical property samples within the aquifer will be collected and analyzed by a contracted geologist according to contractor procedure.

Table 2-3. Performance Requirements for Soil and Water Analysis

Constituent/Parameter	CAS Number	Analytical Method[a]	PQL for Water (µg/L)	PQL for Soil (µg/kg)

c. Hydraulic and physical property samples within the vadose zone will be collected for WRPS. CPCCO samplers shall deliver the samples to PNNL where they may be analyzed for the indicated properties consistent with previous studies (e.g., PNNL-27846, *Physical and Hydraulic Properties of Sediments from the 200-DV-1 Operable Unit*).

ASTM	=	American Society for Testing and Materials	N/A	=	not applicable
CAS	=	Chemical Abstracts Service	PQL	=	practical quantitation limit
CPCCO	=	Central Plateau Cleanup Company	PNNL	=	Pacific Northwest National Laboratory
EPA	=	U.S. Environmental Protection Agency	WRPS	=	Washington River Protection Solutions

2.2.2 Field Analytical Methods

Field screening and survey data will be measured consistent with HASQARD (DOE/RL-96-68). Field analytical methods are performed in accordance with the manufacturers' manuals. Table 2-3 provides the parameters for field measurements.

2.2.3 Quality Control

The QC requirements specified in this SAP must be followed in the field and analytical laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross contamination and to provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects of the analytical data. Field and laboratory QC samples are summarized in Table 2-4. Acceptance criteria for field and laboratory QC are shown in Table 2-5. Data will be qualified and flagged in HEIS, as appropriate.

Table 2-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field Quality Control		
Equipment blank	Contamination from nondedicated sampling equipment	As needed[a]
Full trip blank	Contamination from containers, preservative reagents, storage, or transportation	As needed, depending on analytical requirements
Field duplicate samples	Reproducibility/sampling precision	1 in 20 samples
Field split samples	Inter-laboratory comparability	As needed determined by SMR
Laboratory Batch Quality Control[b]		
Carrier	Recovery/yield	Added to each sample and quality control sample[c]
Method blanks	Laboratory contamination	1 per analytical batch[c]
Laboratory sample duplicate	Laboratory reproducibility and precision	1 per analytical batch[c]
Matrix spikes	Matrix effect/laboratory accuracy	1 per analytical batch[c]
Matrix spike duplicate	Laboratory reproducibility, and method accuracy and precision	1 per analytical batch[c]

Table 2-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Surrogates	Recovery/yield for organic compounds	Added to each sample and quality control
Tracers	Recovery/yield	Added to each sample and quality control
Laboratory control	Method accuracy	1 per analytical batch[c]

Note: The information in this table does not represent U.S. Environmental Protection Agency or the Washington State Department of Ecology requirements; it is intended solely as guidance.

a. For portable pumps, equipment blanks are collected 1 per 20 well trips. Whenever a new type of nondedicated equipment is used, an equipment blank shall be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination procedure for the nondedicated equipment.

b. A batch is a group of up to 20 samples that behave similarly with respect to the sampling or testing procedures being employed and which are processed as a unit. Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

c. Unless not required by, or different frequency is called out in, laboratory analysis method.

SMR = Sample Management and Reporting

1

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	
Nitrate				
Nitrate by IC	MB	<MDL <5% sample concentration		Flag with "C"
	LCS	80%-120% recovery		Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	≤35% RPD	Review data[d]
	MS/MSD[c]	75%-125% recovery		Flag with "N"
	EB, FTB	<MDL <5% sample concentration		Flag with "Q"
	Field duplicate[b]	≤20% RPD	e	Review data[d]
Metals				
ICP-AES and ICP-MS metals	MB	<MDL <5% sample concentration		Flag with "C"
	LCS	80%-120% recovery		Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	≤35% RPD	Review data[d]
	MS/MSD[c]	75%-125% recovery		Flag with "N"
	EB, FTB	< MDL <5% sample concentration		Flag with "Q"
	Field duplicate[b]	≤20% RPD	e	Review data[d]

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	
Radiological Parameters				
Iodine-129	MB	< MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits[f]		Flag with "o"[a]
	DUP[b]	≤20% RPD	≤30% RPD	Review data[d]
	Carrier	40%-110% recovery		Review data[d]
	EB, FTB	<MDC <5% sample activity concentration		Flag with "Q"
	Field duplicate[b]	≤20% RPD	e	Review data[d]
Technetium-99	MB	<MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits[f]		Flag with "o"[a]
	DUP[c]	≤20% RPD	≤30% RPD	Review data[d]
	MS	75%- 125% recovery		Flag with "N"
	EB, FTB	<MDC 5% sample activity concentration		Flag with "Q"
	Field duplicate[b]	≤ 20% RPD	e	Review data[d]
Tritium	MB	<MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits[f]		Flag with "o"[a]
	DUP[b]	≤20% RPD	≤30% RPD	Review data[d]
	MS	75%- 125% recovery		Flag with "N"
	EB, ETB	<MDC 5% sample activity concentration		Flag with "Q"
	Field duplicate[b]	≤ 20% RPD	e	Review data[d]

Notes: The information in this table does not represent EPA requirements and is intended solely as guidance.

See Table 2-3 for constituent list and analytical methods.

a. The reporting laboratory will apply the "o" flag with SMR organization concurrence.

b. Applies when at least one result is greater than the laboratory PQL (chemical analyses) or greater than five times the MDC (radiochemical analyses).

c. Either a DUP or MS/MSD is to be analyzed to determine measurement precision (if there is insufficient sample volume, an LCSD is analyzed with the acceptance criteria defaulting to the <20% RPD criteria [water] or <30% RPD criteria [soil]).

d. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data.

e. A field duplicate RPD for soils is not recommended because of possible soil matrix heterogeneity effects.

f. Laboratory-determined, statistically derived control limits based on historical data are used here. Control limits are reported with the data.

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	

Data flags:

B, C = possible laboratory contamination: analyte was detected in the associated MB – laboratory applied. The B flag is used for organic analytes. The C flag is used for general chemical and inorganic analytes.

o = result may be biased: associated laboratory control sample result was outside the acceptance limits – laboratory applied.

N = result may be biased: associated MS result was outside the acceptance limits (except GC/MS) – laboratory applied.

Q = problem with associated field QC blank: results were out of limits – SMR review.

DUP = laboratory sample duplicate
EB = equipment blank
EPA = U.S. Environmental Protection Agency
FTB = full trip blank
GC/MS = gas chromatograph-mass spectrometry
IC = ion chromatography
ICP-AES = inductively coupled plasma-atomic emission spectroscopy
ICP-MS = inductively coupled plasma-mass spectrometry
LCS = laboratory control sample
LCSD = laboratory control sample duplicate
MB = method blank
MDC = minimum detectable concentration
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
PQL = practical quantitation limit
QC = quality control
RPD = relative percent difference
SMR = Sample Management and Reporting

2.2.3.1 Field Quality Control Samples

Field QC samples are collected to evaluate the potential for cross contamination and provide information pertinent to field sampling variability and laboratory performance to help ensure reliable data are obtained. Field QC samples include field duplicates, field split samples, and field blanks (equipment blanks and full trip blanks). High-purity deionized water[2] is the preferred blank matrix when water-based samples are collected, and silica sand is typically used for the field blank when soil or other solid samples are acquired. QC sample definitions and their required frequency for collection are described in the following paragraphs.

Field duplicates: Independent samples collected as close as possible to the same time and same location as the schedule sample and intended to be identical. Field duplicates are placed in separate sample containers and analyzed independently. Field duplicates are used to determine precision for both sampling and laboratory measurements.

Equipment blanks: High-purity water or silica sand as appropriate are passed through or poured over decontaminated sampling equipment identical to the sample set collected and placed in sample containers, as identified on the sample authorization form. Equipment blank sample bottles are placed in the storage containers with samples from the associated sampling event and are analyzed for the same constituents as samples from the sampling event. Equipment blanks are used to evaluate decontamination process effectiveness; these samples are not required for disposable sampling equipment.

[2] Reagent water is high-purity water that is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques (DOE/RL-96-68).

2.2.3.2 Laboratory QC Samples

Internal QA/QC programs are maintained by laboratories used by the Hanford Site. Laboratory QA includes a comprehensive QC program that includes the use of laboratory control samples, laboratory sample duplicates, matrix spikes (MSs), matrix spike duplicates (MSDs), and method blanks (MBs). These QC analyses are required by EPA methods (e.g., those in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*) and will be run at the frequency specified in the respective references unless superseded by agreement. QC checks outside of control limits are documented in analytical laboratory reports during assessments of data usability, if performed. Laboratory QC checks and their typical frequencies are listed in Table 2-4. Acceptance criteria are shown in Table 2-5.

Descriptions of the various types of laboratory QC samples are provided in the following paragraphs.

Carrier: A known quantity of nonradioactive isotope that is expected to behave similarly and is added to an aliquot of sample. Sample results are generally corrected based on carrier recovery.

Laboratory control sample: A control matrix (e.g., reagent water) spiked with analytes representing the target analytes or certified reference material used to evaluate laboratory accuracy.

Laboratory sample duplicate: An intra-laboratory replicate sample that is used to evaluate the precision of a method in a given sample matrix.

Matrix spike: An aliquot of a sample spiked with a known concentration of target analyte(s). The MS is used to assess the bias of a method in a given sample matrix. Spiking occurs prior to sample preparation and analysis.

Matrix spike duplicate: A replicate spiked aliquot of a sample that is subjected to the entire sample preparation and analytical process. MSD results are used to determine the bias and precision of a method in a given sample matrix.

Method blank: An analyte-free matrix to which the same reagents are added in the same volumes or proportions as used in the sample processing. The MB is carried through the sample preparations and analytical procedure and is used to quantify contamination resulting from the analytical process.

Tracer: A known quantity of radioactive isotope that is different from that of the isotope of interest but is expected to behave similarly and is generally added to an aliquot of sample prior to the sample preparation step. A tracer does not chemically interfere with the target radioisotope during radiochemical preparation, separation, and counting. Sample results are generally corrected based on tracer recovery.

Laboratories are required to analyze samples within the holding times specified in Table 2-6. In some cases, constituents in the samples not analyzed may be compromised by volatilization, decomposition, or by other chemical changes. Data from samples analyzed outside of the holding times are flagged in the HEIS database with an "H." Bottle/volume requirements are shown in Table 2-7.

Table 2-6. Holding Time and Preservation Guidelines for Laboratory Analytes

Constituent/ Parameter[a]	Preservation[b]		Holding Time	
	Water	Soil	Water	Soil
Anions				
Chloride and sulfate	Store ≤6°C	Store ≤6°C	28 days	28 days before extraction/ 28 days after extraction

Table 2-6. Holding Time and Preservation Guidelines for Laboratory Analytes

Constituent/ Parameter[a]	Preservation[b]		Holding Time	
	Water	Soil	Water	Soil
Nitrate	Store ≤6°C	Store ≤6°C	48 hours	28 days before extraction/ 48 hours after extraction
Metals				
Metals	HNO_3 to pH<2	None	6 months	6 months
Radionuclides				
Iodine-129	None	None	6 months	6 months
Technetium-99	HNO_3 to pH<2	None	6 months	6 months
Tritium	None	None	6 months	6 months
Geotechnical Test Methods				
Grain size distribution	None		None	
Hydraulic Test Methods				
Bulk density	None		N/A	
Matrix potential using filter paper	None		Analyze as soon as possible after collection	
Porosity	None		N/A	
Saturated hydraulic conductivity	None		N/A	
Unsaturated hydraulic conductivity	None		Analyze as soon as possible after collection	

Notes: Holding times and preservation methods are dependent on the constituents and are consistent with EPA guidance and approved analytical methods. The information in this table does not represent EPA requirements but is intended solely as guidance.

Container types and volumes are available on chain-of-custody documentation.

a. See Table 2-3 for constituent list and analytical methods.

b. For preservation identified as stored at ≤6°C, the sample should be protected against freezing unless it is known that freezing will not impact the sample integrity.

EPA = U.S. Environmental Protection Agency N/A = not applicable

1

Table 2-7. Volume/Bottle Requirements for Soil and Water Samples

Analytes	Analytical Methods	Standard and Minimum Volume Requirement for Soil		Bottle Type for Soil	Volume Requirement for Water	Bottle Types for Water
Anions						
Anions	300 or 9056	1 x 60 mL	1 x 60 mL	Glass/plastic	1 x 125 mL	Glass/plastic

Table 2-7. Volume/Bottle Requirements for Soil and Water Samples

Analytes	Analytical Methods	Standard and Minimum Volume Requirement for Soil		Bottle Type for Soil	Volume Requirement for Water	Bottle Types for Water
Metals						
Metals	6010 or 6020	1 x 250 mL	1 x 60 mL	Glass	1 x 250 mL	Glass
Technetium-99	6020	1 x 250 mL	1 x 60 mL	Glass	1 x 250 mL	Glass
Radionuclides						
Technetium-99, tritium	Liquid scintillation counter	1 x 60 mL	1 x 60 mL	Glass/plastic	1 x 500 mL	Glass/plastic
Iodine-129	Low-energy gamma spectroscopy or gas proportional counting	1 x 250 mL	1 x 60 mL	Glass/plastic	1 x 4000 mL	Glass/plastic
Soil Physical and Hydraulic Properties*						
Bulk density	ASTM D7263-09(2018)e2	4	3	Caped liners	N/A	
Matric potential using filter paper	ASTM D5298-16	1 x 60 mL	1 x 60 mL	Moisture tin	N/A	
Particle size analysis	ASTM D422-63(2007)e2	Soil	1 x 150 g	Plastic bag	N/A	
Total porosity	Calculated using bulk density and particle density according to ASTM D7263-09(2018)e2	4	3	Caped liners	N/A	
Saturated hydraulic conductivity	Methods described in PNNL-27846	4	3	Caped liners	N/A	
Unsaturated hydraulic conductivity	Methods described in PNNL-27846	4	3	Caped liners	N/A	

Notes: Complete reference citations are provided in Chapter 7.

For EPA Methods 300 and 335.4, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*. For EPA Methods 150.1, 310.1, 350.1, 376.1, and 415.1, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*. For Standard Methods, see APHA/AWWA/WEF, *Standard Methods for the Examination of Water and Wastewater*. Equivalent methods may be substituted.

*Hydraulic and physical property samples within the vadose zone will be collected for WRPS. CPCCo shall deliver the samples to PNNL, where the samples may be analyzed for the indicated properties consistent with previous studies (e.g., PNNL-27846, *Physical and Hydraulic Properties of Sediments from the 200-DV-1 Operable Unit*).

ASTM = American Society for Testing and Materials
CPCCO = Central Plateau Cleanup Company
EPA = U.S. Environmental Protection Agency
N/A = not applicable
PNNL = Pacific Northwest National Laboratory
WRPS = Washington River Protection Solutions

2.2.4 Measurement Equipment

Each measuring equipment user is responsible to ensure the equipment is functioning as expected, properly handled, and properly calibrated at required frequencies per methods governing control of the equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance will be recorded in accordance with approved methods. Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer's specifications and other approved methods.

2.2.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment should meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or have been evaluated as acceptable and valid in accordance with instrument-specific methods, requirements, and specifications. Software applications will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory will be subject to preventive maintenance measures to ensure minimization of downtime. Laboratories must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization's QA plan or operating protocols, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with HASQARD (DOE/RL-98-68) requirements.

2.2.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Section 3.5. Analytical laboratory instruments are calibrated in accordance with the laboratory's QA plan and applicable Hanford Site requirements.

2.2.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use. Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes. Responsibilities and interfaces necessary to ensure that items procured/acquired for the contractor meet the specific technical and quality requirements must be in place. The procurement system ensures purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

2.2.8 Nondirect Measurements

Data obtained from sources such as computer databases, programs, literature files, and historical databases will be technically reviewed to the same extent as data generated as part of any sampling and analysis QA/QC effort. Data used in evaluations will be identified by data sources.

2.2.9 Data Management

The SMR group, in coordination with the OU Project Manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements governing data management methods.

Electronic analytical data will be accessed through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to the SMR group through an established process. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with applicable methods. This process is used to document analytical errors and to establish their resolution with the OU Project Manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

2.3 Assessment and Oversight

Assessment and oversight activities address the effectiveness of project implementation and associated QA/QC activities. The purpose of assessing is to ensure that the QAPjP is implemented as prescribed.

2.3.1 Assessments and Response Action

Management assessments and/or independent assessments may be performed to verify compliance with the requirements outlined in this SAP, project field instructions, the QAPjP, methods, and regulatory requirements. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project line management chain coordinates the corrective actions/deficiency resolutions in accordance with the QA program, the corrective action management program, and associated methods implementing these programs. When appropriate, corrective actions will be taken by the OU Project Manager (or designee). An assessment of data usability will be performed for the identified SAP activities. Results of an assessment will be provided to the OU Project Manager. No other planned assessments have been identified. If circumstances arise in the field dictating the need for additional assessments, then additional assessments will be performed.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The SMR group oversees offsite analytical laboratories and verifies the laboratories are qualified to perform Hanford Site analytical work.

2.3.2 Reports to Management

Program and project management (as appropriate) will be made aware of deficiencies identified by assessment and oversight activities. Issues reported by the laboratories are communicated to the SMR group, which then initiates a sample issue resolution form. This process is used to document analytical or sample issues and to establish resolution with the OU Project Manager. If an assessment finding results in sampling issues that affect a regulatory requirement, DOE will be informed and the matter discussed with the regulatory agencies.

2.4 Data Review and Usability

This section addresses QA activities that may occur after data collection. Implementation of these activities determines whether the data conform to the specified criteria, thus satisfying the project objectives.

2.4.1 Data Review and Verification

Data review and verification are performed to confirm that sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific sampling locations, and reviewing sample collection dates and sample preparation and analysis dates to assess whether holding times, if any, have been met. Furthermore, review of QC data is used to determine whether analyses have met the data quality requirements specified in this SAP.

The criteria for verification include, but are not limited to, review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Field QA/QC results will be reviewed to ensure they are usable.

The OU Technical Lead performs reviews of data to help determine if observed changes reflect potential data errors, which may result in submitting a request for data review on questionable data. The laboratory may be asked to check calculations or reanalyze the sample. In extreme cases, another sample may be collected. Results of the request for the data review process are used to flag the data appropriately in the HEIS database and/or to add comments.

2.4.2 Data Validation

Data validation is an independent assessment to ensure the reliability of the data. Analytical data validation provides a level of assurance that an analyte is present or absent. Validation may also include the following:

- Verification of instrument calibrations
- Evaluation of analytical results based on MBs
- Recovery of various internal standards
- Correctness of uncertainty calculations
- Correctness of identification and quantification of analytes
- The effect of quality deficiencies on data reliability

The contractor follows the data validation process described in EPA-540-R-2017-001, *National Functional Guidelines for Inorganic Superfund Methods Data Review*, and EPA-540-R-2017-002, *National Functional Guidelines for Organic Superfund Methods Data Review*, adjusted for use with SW-846, HASQARD (DOE/RL-96-68), and radiochemistry methods. The criteria for data validation are based on a graded approach, using five levels of validation: Levels A through E. Level A is the lowest level and is the same as verification. Level E is a 100% review of all data (e.g., calibration data and calculations of representative samples from the dataset). Data validation may be performed to Level C, which is a review of the QC data and specifically requires verification of deliverables; requested versus reported analytes; and qualification of the results based on evaluation of analytical holding times, MB results, MS/MSD results, surrogate recoveries, and duplicate sample results. Level C data validation is generally equivalent to Level 2A in EPA 540-R-08-005, *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*. Level C data validation will be performed on at least 5% of the data by matrix and analyte group under the direction of the SMR group. Analyte group refers to categories such as radionuclides, volatile chemicals, semivolatiles, metals, and anions. The goal is to include each of the various analyte groups and matrices during the data validation process. The DOE-RL Project Lead or OU Project Manager may specify a higher percentage of data to be validated or that data validation be performed at higher levels.

2.4.3 Reconciliation with User Requirements

The purpose of reconciliation with user requirements is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. The data quality assessment (DQA) process is the scientific and statistical evaluation of previously verified and validated data to determine if information obtained from environmental data operations are of the right type, quality, and quantity to support their intended use (usability). The DQA process uses the entirety of the collected data to determine usability for decision making. If a statistical sampling design was utilized during field sampling activities, then the DQA will be performed following guidance in EPA/240/B-06/003,

Data Quality Assessment: Statistical Methods for Practitioners. When judgmental (focused) sampling designs are implemented in the field, DQIs such as precision, accuracy, representativeness, comparability, completeness, and sensitivity for the specific datasets (individual data packages) may be evaluated in accordance with EPA/240/R-02/004, *Guidance on Environmental Data Verification and Data Validation*. Data verification and data validation are integral to both the statistical DQA data evaluation process and the DQI evaluation process. Results of the DQA or DQI processes will be used by the contractor OU Project Manager to interpret the data and determine if the DQOs for this activity have been met.

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3 Field Sampling

The purpose of field sampling is to direct the sampling and analysis of soil, aquifer sediment, and groundwater during the drilling and construction of two interim action groundwater extraction wells (299-E25-240 and 299-E27-157). These two wells are designed to reduce and contain source contributions at the A-AX and C Farms. Groundwater monitoring at the extraction wells will be driven by the constituents and schedule provided in DOE/RL-2009-124. If additional sampling of the extraction wells is required beyond what is specified in DOE/RL-2009-124, it will be identified during the development of the remedial action performance monitoring plan.

Chapter 3 uses the sampling design identified during the systematic planning process, but includes review of expedited geophysical logging and hydraulic testing results for the unconfined aquifer to ensure no subordinate silt or silty-sand layers are present, requiring changes to the well screen slot and sand pack mesh size. In addition to the systematic sample planning, opportunistic sampling for the vadose zone and saturated zone is being completed to support inventory needs of the CSM and 200 West P&T engineering needs for resin performance planning as discussed in Sections 3.1 and 3.2. Basalt competency evaluation will be performed in at least one of the extraction wells (e.g., 299-E27-157) by drilling 4 m (13 ft) into the basalt. Hydraulic testing of fractured basalt will be completed if >1.5 m (5 ft) of fractured basalt is present as determined by the field geologist. In addition, a discrete groundwater sample will be collected as described in Table 3-1 to determine the groundwater quality within the fractured basalt if >1.5 m (5 ft) of fractured basalt is present. Once the wells are operational, multi-well aquifer testing will be performed on each of the completed extraction wells under a separate hydraulic testing plan as summarized in the RD/RAWP.

Table 3-1. Aquifer Test Information

Well	Hydrostratigraphic Unit to Be Tested	Depth to Water (ft bgs)	Estimated Saturated Open Interval (ft bgs)	Estimated Length of Pumping	Targeted Pumping Rate (gal/min)
299-E25-240	CCUg	298.5	295 to 300	6 hours	50 to 75
	CCUg	330.5	327.5 to 332.5	6 hours	50 to 75
	Rwie	340.5	340 to 345	6 hours	0.5 to 1
	Rwie	350.5	345 to 350	6 hours	0.5 to 1
	Rwia	360.5	360 to 365	6 hours	0.5 to 1
	Basalt	373[a]	373 to 378	TBD	TBD
299-E25-157	CCUg	278.8	275 to 280	6 hours	50 to 75
	CCUg	298.8	295 to 300	6 hours	50 to 75
	CCUg	317	312 to 317	6 hours	50 to 75
	Basalt	328.8*	325.8 to 330.8	TBD	TBD

Note: The maximum drawdown during aquifer testing is 20%, and pumping rates will be determined accordingly. However, given the anticipated low transmissivity of Rwia sediments, slug testing maybe required.

* Hydraulic testing will be completed if fractured basalt is observed and is >1.5 m (5 ft) thick as determined by the basalt evaluation in Section 1.7.

bgs = below ground surface
CCUg = Cold Creek gravel unit
Rwia = Ringold Formation member of Wooded Island – unit A
Rwie = Ringold Formation member of Wooded Island – unit E
TBD = to be determined

3.1 Sampling Objectives/Design

The objective of this drilling SAP is to clearly identify and describe sampling and analysis activities that will be performed to optimally design extraction wells 299-E25-240 and 299-E27-157 for removal of technetium-99 from the groundwater at the A-AX and C Farm areas. Sampling associated with this objective is limited to groundwater and grain-size analysis; however, expedited geophysical logging and hydraulic testing results will be completed and reviewed by the well drilling group and the OU technical lead for the unconfined aquifer to ensure no subordinate silt or silty-sand layers are present, requiring changes to the well screen slot and sand pack mesh size. Several opportunistic soil and groundwater samples were also identified to support inventory needs of the CSM and 200 West P&T remedial performance planning as defined by current revisions to DOE/RL-2009-124 and the remedial action performance monitoring plan. Also, several depth-discrete hydraulic tests are included for model updates. In addition, multi-well aquifer testing will be performed on each of the completed extraction wells to be performed under a separate hydraulic testing plan as summarized in the RD/RAWP.

Drilling provides the opportunity to assess subsurface conditions prior to operating groundwater extraction for capture of technetium-99 within the groundwater at the A-AX and C Farm plume area. The refinement of the CSM includes collection and analysis of vadose zone soil, aquifer sediments, groundwater, hydraulic testing, and geologic and geophysical logging. Within the scope of the groundwater sampling and testing, vertical profiling is planned within the aquifer at both wells 299-E25-240 and 299-E27-157 during drilling (Table 3-2). The vertical groundwater sampling at well 299-E25-240 will also support screen placement. Post-development groundwater sample analyses for target constituents at both wells 299-E25-240 and 299-E27-157 will be collected for process engineering at the 200 West P&T.

The sampling design for this SAP is based on judgmental sampling. In judgmental sampling, the selection of sampling units (i.e., the number and location and/or timing of collecting samples) is based on knowledge of the feature or condition under investigation (i.e., previous sampling) and on professional judgment. Judgmental sampling is distinguished from probability-based sampling in that inferences are based on professional judgment, not statistical scientific theory. Therefore, conclusions about the target population are limited and depend entirely on the validity and accuracy of professional judgment. Sample design, sample methods, locations, frequencies, constituents/contaminants of interest, procedures and documentation requirements are identified in the section. Analytical laboratory requirements are shown in Table 2-3.

3.2 Sample Location, Frequency, and Constituents to be Monitored

Sample/hydraulic test locations, depths of sample collection by media (frequency), and constituents/parameters that will be analyzed are described in this section. The scope of the sample design includes collection of soil, sediment, and groundwater for chemical, radiological, and geotechnical analysis relative to the depth in feet bgs. The scope of the hydraulic test design includes depths of test location relative to the depth in feet bgs. The sample/hydraulic test design for each well is unique and based on the DQO process presented in Section 1.3 and opportunistic sampling and testing requirements presented in Sections 1.5 and 1-8.

Table 3-2. Planned Sampling During Drilling of 200-BP-5 Removal Action Groundwater Wells

Well Name	Sample Matrix	Estimated Depth Below Ground Surface (ft)	Estimated Depth Below Water Table Surface (ft)	Anticipated Geologic Facies	Allowable Variation on Depth	Analyses/Analytes	Sample Collection Method and Purpose
299-E25-240	Vadose zone soil	40-42.5 76.5-79 124-126.5 186.5-188.5 209-211.5 274-276.5 276.5-279 279-281.5	N/A N/A N/A N/A N/A N/A N/A N/A	Hf2 Hf2 Hf2 Hf2 Hf2 CCU CCU CCU	±1 ft	Bulk density (ASTM D7263-09(2018)e2) Grain size distribution (sieve analysis) Matric potential using filter paper (ASTM D5298-16) Total porosity (ASTM D7263-09(2018)e2) Unsaturated hydraulic conductivity (PNNL-27846) Saturated hydraulic conductivity (PNNL-27846)	Use 2.5 ft split spoon or Sonic core barrel with lexan liners. Results will be used to refine the CSM. Samples are to be delivered to the 5 Bay. If samples cannot be delivered the day they are collected, the samples are to be cooled to ≤6°C until they are delivered.
	Saturated soil (well design)	298.5 308.5 318.5 330.5 340.5 350.5 360.5	10 20 30 42 52 62 72	CCUg CCUg CCUg CCUg Rwie Rwie Rwia	±1 ft	Grain size distribution (sieve analysis)	Saturated sediment grab samples from the drill cuttings at 2.5 ft intervals for consolidated sieve analysis at defined depths below water table. Results will be used to select the filter pack and well screen slot size.
	Hydraulic test	298.5 330.5 340.5 350.5 360.5 373[a]	10 42 52 62 72 85	CCUg CCUg Rwie Rwie Rwia Basalt	±2 ft	Use Solinst® 3100 Gold Baro and Leveloggers® to determine aquifer response to pumping test	Constant rate pump drawdown test or slug test if conditions cannot support constant rate pump test. Purpose is to add input for model updates.

Table 3-2. Planned Sampling During Drilling of 200-BP-5 Removal Action Groundwater Wells

Well Name	Sample Matrix	Estimated Depth Below Ground Surface (ft)	Estimated Depth Below Water Table Surface (ft)	Anticipated Geologic Facies	Allowable Variation on Depth	Analyses/Analytes	Sample Collection Method and Purpose
	Water (well design)	298.5 318.5 330.5 340.5 350.5 360.5 373[a]	10 30 42 52 62 72 85	CCUg CCUg CCUg Rwie Rwie Rwia Basalt	±2 ft	Technetium-99	Submersible pump samples preferred; however, bailed samples can be collected if submersible pump purging and sampling is not practicable, as determined by the OU Technical Lead. Filter all samples. Technetium-99 results used to determine well screen length. Analysis of technetium-99 will be 3-day turnaround time to reduce drilling standby time.
	Water	298.5 308.5 318.5 330.5 340.5 350.5 360.5 373*	10 20 30 42 52 62 72 85	CCUg CCUg CCUg CCUg Rwie Rwie Rwia Basalt	±2 ft	Chloride Iodine-129 Nitrate Sulfate Technetium-99 Tritium	Submersible pump samples preferred; however, bailed samples can be collected if submersible pump purging and sampling is not practicable, as determined by the OU Technical Lead. Filter all samples. If groundwater samples are collected during depth discrete aquifer constant-rate pumping test, collect a sample near the beginning and a sample near the end of the test (two total samples for each depth discrete interval).
	Water (post-development)	TBD	TBD	TBD	±2 ft	Calcium Chloride Iodine-129 Magnesium Nitrate	Submersible pump sample. Filter all samples.

Table 3-2. Planned Sampling During Drilling of 200-BP-5 Removal Action Groundwater Wells

Well Name	Sample Matrix	Estimated Depth Below Ground Surface (ft)	Estimated Depth Below Water Table Surface (ft)	Anticipated Geologic Facies	Allowable Variation on Depth	Analyses/Analytes	Sample Collection Method and Purpose
						Sulfate Technetium-99 Tritium Uranium	
299-E27-157	Vadose zone soil	49-51.5 76.5-79 124-126.5 186.5-188.5 209-211.5 240-242.5 242.5-245	N/A N/A N/A N/A N/A N/A N/A	Hf1-Hf2 Hf2 Hf2 Hf2 Hf2 CCU CCU	±1 ft	Bulk density (ASTM 7263-09(2018)e2) Grain size distribution (sieve analysis) Matric potential using filter paper (ASTM D5298-16) Total porosity (ASTM D7263-09(2018)e2) Unsaturated hydraulic conductivity (PNNL-27846) Saturated hydraulic conductivity (PNNL-27846)	Use 2.5 ft split spoon or Sonic core barrel with lexan liners. Results will be used to refine the CSM. Samples are to be delivered to the 5 Bay. If samples cannot be delivered the day they are collected, the samples are to be cooled to ≤6°C until they are delivered.
	Vadose zone soil (soil horizon evaluation)	49-51.5 76.5-79 209-211.5 240-242.5 242.5-245	N/A N/A N/A N/A N/A	Hf1-Hf2 Hf2 Hf2 CCU CCU	±1 ft	Chloride Nitrate Sulfate Technetium-99	Use 2.5 ft split spoon or Sonic core barrel with lexan liners. Results will be used for vadose zone soil horizon evaluation.
	Saturated soil (well design)	278.5 288.5 298.5 308.5 318.5	10 20 30 40 48	CCUg CCUg CCUg CCUg CCUg	±1 ft	Grain size distribution (sieve analysis)	Saturated sediment grab samples from the drill cuttings at 2.5 ft intervals for consolidated sieve analysis at defined depths below water table. Results will be used to select the filter pack and well screen slot size.
	Hydraulic Test	278.8 298.8 317 328.8*	10 30 48.2 60	CCUg CCUg CCUg Basalt	±2 ft	Use Solinst® 3100 Gold Baro and Leveloggers® to determine aquifer response to pumping test.	Constant rate pump drawdown test or slug test if conditions cannot support constant rate pump test.

Table 3-2. Planned Sampling During Drilling of 200-BP-5 Removal Action Groundwater Wells

Well Name	Sample Matrix	Estimated Depth Below Ground Surface (ft)	Estimated Depth Below Water Table Surface (ft)	Anticipated Geologic Facies	Allowable Variation on Depth	Analyses/Analytes	Sample Collection Method and Purpose
							Purpose is to add input for model updates.
	Water	278.8 288.8 298.8 308.8 317 328.8*	10 20 30 40 48.2 60	CCUg CCUg CCUg CCUg CCUg Basalt	±2 ft	Chloride Iodine-129 Nitrate Sulfate Technetium-99 Tritium	Submersible pump samples preferred; however, bailed samples can be collected if submersible pump purging and sampling is not practicable, as determined by the OU Technical Lead. Filter all samples. Technetium-99 results used to determine well screen length. Analysis of technetium-99 will be 3-day turnaround time to reduce drilling standby time. If groundwater samples are collected during depth discrete aquifer constant-rate pumping test, collect a sample near the beginning and a sample near the end of the test (two total samples for each depth discrete interval).
	Water (post-development)	TBD	TBD	CCUg	±2 ft	Calcium Chloride Iodine-129 Magnesium Nitrate Sulfate Technetium-99 Tritium Uranium	Submersible pump sample. Filter all samples.

Table 3-2. Planned Sampling During Drilling of 200-BP-5 Removal Action Groundwater Wells

Well Name	Sample Matrix	Estimated Depth Below Ground Surface (ft)	Estimated Depth Below Water Table Surface (ft)	Anticipated Geologic Facies	Allowable Variation on Depth	Analyses/Analytes	Sample Collection Method and Purpose

References: ASTM D5298-16, *Standard Test Method for Measurement of Soil Potential (Suction) Using Filter Paper*.

ASTM D7263-09(2018)e2, *Standard Test Methods for Determination of Density of Soil Specimens.*

PNNL-27846, *Physical and Hydraulic Properties of Sediments from the 200-DV-1 Operable Unit*.

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*Hydraulic testing and groundwater sampling to be completed if fractured basalt is observed and >1.5 m (5 ft) thick.

ASTM = American Society for Testing and Materials
CCU = Cold Creek unit
CCUg = Cold Creek unit gravel
CSM = conceptual site model
Hf1 = Hanford formation unit 1
Hf2 = Hanford formation unit 2
N/A = not applicable
OU = operable unit
PNNL = Pacific Northwest National Laboratory
Rwia = Ringold Formation member of Wooded Island-unit A
Rwie = Ringold Formation member of Wooded Island-unit C
TBD = to be determined

3.2.1 Sampling Locations

The proposed locations of groundwater extraction wells 299-E25-240 and 299-E27-157 are shown in Figure 1-2. Groundwater extraction well 299-E25-240 is located approximately 240 m (800 ft) south-southeast of the 241-A-105 high-level waste storage tank, considered the prominent past source of technetium-99 groundwater contamination at Waste Management Area (WMA) A-AX. Groundwater extraction well 299-E27-157 is located approximately 100 m (328 ft) south-southeast of tank 241-C-101, which is near several high-level waste releases that are potentially contributing to technetium-99 groundwater contamination at WMA C.

3.2.2 Frequency

The sampling intervals are presented separately for each well. At the discretion of the project scientist, field geologist, or sampler, additional samples may be collected based on field screening results and observations.

Well 299-E25-240: Vadose zone soil, aquifer sediment, hydraulic tests, and groundwater samples for well 299-E25-240 will be conducted during drilling (i.e., before final screen installation and development). The sample/hydraulic test intervals during drilling at well 299-E25-240 are provided in Table 3-2.

Well 299-E27-157: Vadose zone soil, aquifer sediments, hydraulic tests, and groundwater samples for well 299-E27-157 will be conducted during drilling (i.e., before final screen installation and development). The sample/hydraulic test intervals during drilling at well 299-E27-157 are provided in Table 3-2.

3.2.3 Constituent/Parameters

The analyses are presented separately for each well as described below. Each groundwater sample will be screened in the field for pH, temperature, conductivity, turbidity, and dissolved oxygen. When the following readings are obtained, groundwater samples shall be collected: turbidity has declined below 25 NTUs; pH, temperature, and conductivity are stable as described below; and dissolved oxygen is greater than 5,000 mg/L. Technetium-99 is the primary groundwater constituent used to determine the well screen length within the aquifer. A quick turnaround time (e.g., 3 days) is required for this analysis to reduce drilling downtime.

Well 299-E25-240. Vadose zone soil, aquifer sediment, and groundwater samples for well 299-E25-240 will be conducted during drilling (i.e., before final screen installation and development). The target analytes and parameters of interest during drilling are provided in Table 3-2. The groundwater production pump for the post-development groundwater sample will be placed after consultation with the project OU Technical Lead. The OU Technical Lead shall be contacted if screening levels cannot be achieved prior to sampling.

Well 299-E27-157. Vadose zone soil, aquifer sediment, and groundwater samples for well 299-E27-157 will be conducted during drilling (i.e., before final screen installation and development). The target analytes and parameters of interest during drilling are provided in Table 3-2. The groundwater production pump for the post-development groundwater sample will be placed after consultation with the project OU Technical Lead. The OU Technical Lead shall be contacted if screening levels cannot be achieved prior to sampling.

Field parameters used to determine stable groundwater conditions are as follows:

- pH – three consecutive measurements agree within 0.2 pH units
- Temperature – three consecutive measurements agree within 0.2°C (32.3°F)
- Conductivity – three consecutive measurements agree within 10% of each other

3.3 Sampling Methods

Soil samples collected for geotechnical and chemical analysis will be collected with a lined split-spoon sampler or similar device (i.e., Sonic split core barrel). The split-spoon and liner shall be decontaminated according to the sampling decontamination methods. The split-spoon sampler is typically 0.76 m (2.5 ft) long with the shoe and shall not be overdriven. Other methods of collecting representative archive soil samples may be used during drilling.

A submersible pump (i.e., Grundfos® and submersible electrical pumps) will likely be used to collect groundwater samples during drilling at wells 299-E25-240 and 299-E27-157. In addition, the submersible pump will be used to collect a groundwater sample after well construction from each well.

3.3.1 Decontamination of Sampling Equipment

Sampling equipment will be decontaminated in accordance with sampling equipment decontamination methods. To prevent potential contamination of the samples, care will be taken to use decontaminated equipment for each specific sampling activity.

Special care will 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

Decontamination of sampling equipment is performed using high-purity water in each step. In general, three rinse cycles are performed to decontaminate sampling equipment: a detergent rinse, an acid rinse, and a water rinse. During the detergent rinse, the equipment is washed in a phosphate-free detergent solution, followed by rinsing with high-purity water in three sequential containers. After the third high-purity water rinse, equipment that is stainless steel or glass is rinsed in a 1M nitric acid solution (pH <2). Equipment is then rinsed with high-purity water in three sequential containers (i.e., the high-purity water rinses following the acid rinse are conducted in separate water containers that are not used for detergent rinse). Following the final high-purity water rinse, equipment is rinsed in hexane and then placed on a rack to dry. Dry equipment is loaded into a drying oven. The oven is set at 50ºC (122°F) for items that are not metal or glass, or at 100°C (212°F) for metal or glass. Once reaching temperature, equipment is baked for 20 minutes and then cooled. The equipment is then removed from the oven and wrapped in clean, unused aluminum foil using surgeon's gloves. The wrapped equipment is stored in a custody-locked, controlled access area.

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The drill rig derrick, all downhole equipment, and temporary casing will be field decontaminated (e.g., high pressure and temperature wash), at a minimum, before mobilization and demobilization at each drilling location. If core barrel equipment is used to collect samples, the drive head will be decontaminated before and after the sampling event.

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. Radiological screening will be performed by the RCT or other qualified personnel. The RCT will record elevated field measurements, noting the depth. Elevated field measurements will be relayed to the field geologist for inclusion in the daily report, as applicable.

The following information will be provided to field personnel performing work in support of this SAP:

- Instructions to RCTs about the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the portable radiological field instrumentation including: a physical description of the instruments, radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the 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.
- Instructions regarding the minimum requirements for documenting radiological controls information in accordance with 10 CFR 835, “Occupational Radiation Protection.”
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of radiological information.
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related information.
- The requirements associated with preparing and transporting regulated material.
- Daily reports of radiological surveys and measurements collected during conduct of field investigation activities. Data will be cross referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

3.4 Aquifer Testing

Single well slug testing or aquifer pumping tests (aquifer testing) are planned during drilling of wells 299-E25-240 and 299-E27-157. An aquifer test is a controlled field experiment using a discharging (pumping) well. Aquifer testing is accomplished by applying a known stress to the aquifer of known or assumed dimensions and observing the water-level response over time. Hydraulic characteristics of the aquifer can then be determined by measuring water-level drawdown and water discharge rates. The testing will be evaluated and, if sufficient quality, used to determine the transmissivity and hydraulic conductivity within the CCUg, Rwie, and Rwia. The data will be evaluated using aquifer test analysis software and will provide inputs to various model updates (e.g., geoframework and groundwater) being developed for the 200 Areas.

If highly permeable units (which may be encountered in CCUg) exhibit drawdown and recovery that are not discernable using available measuring equipment, the hydraulic conductivity and transmissivity results will be reported as “greater than” values.

Groundwater samples will be collected during the aquifer tests at the approximate beginning and end of each test (two total samples per test). The analytical results will be compared to the samples collected during drilling at similar depths. These comparisons will be presented in the borehole summary report (Chapter 4).

Aquifer testing is planned to be performed during drilling using a 1.5 m (5 ft), 65-slot temporary well screen to assess the hydraulic properties within the CCUg, Rwie, and Rwia at the depth intervals shown in Table 3-2.

A constant-rate pumping test will be performed at wells 299-E25-240 and 299-E27-157. If drawdown greater than 20% is encountered during the pump test, two slug tests (insertion and withdrawal) will be conducted to determine hydraulic conductivity. Drawdown test data will be evaluated during testing to determine when it is appropriate to end the pumping test, in consultation with the OU technical lead. The pumping test duration will not exceed one day shift.

For the constant-rate test, the initial pumping rate may be adjusted during the first few minutes of the test if excessive drawdown is observed. Following flow rate adjustment (if needed), the test must be left undisturbed throughout its duration. Table 3-1 summarizes the aquifer test information, including targeted pumping rates.

Equipment used for aquifer testing includes the following:

- **Submersible pump:** Used to extract groundwater from the aquifer.
- **Flow meter:** Used to document the pumping rate (e.g., in gal/min) and totalizer reading (total cumulative gallons).
- **Gate valve or flow controller:** Used to adjust the flow rate at the surface. The gate valve (if used) must be placed downstream of the flow meter.
- **Data logging system:** This includes a self-powered data logger and transducer(s). The system is used to automatically record changes in water levels over time.
- **E-tape:** Used for recording manual water levels.

A pressure transducer will be used in the pumping well to measure water levels before, during, and after testing. Water levels from transducer readings will be confirmed with manual measurements both before the constant-rate pumping test begins and after the recovery test is completed. The riser pipe method of installing the water-level transducer (i.e., transducer is installed simultaneously with the pump) will be used in the pumping well. Measurement of the transducer and pump intake distance below the first section of riser pipe will be made to determine the location below ground surface and the water table. Arrangements will be made with the Hanford Meteorological Station to provide hourly measurements of barometric pressure during the test.

Following installation of the pump and pressure transducer, the water level is measured manually. Water levels then are allowed to stabilize, and the transducer collects water-level measurements without disturbance during this period. Before starting the aquifer test, the water level is again measured manually, and the water-level transducer data are evaluated to ensure that static water levels have been achieved. Once static water levels have been verified, aquifer testing may begin. No downhole adjustments or other subsurface activities (other than manual water-level measurements) may be made after the transducers are installed and set to collect pre-test, test, and post-test measurements.

The following list of details will be recorded in the field geologist's notes before, during, and after testing:

- Depth of transducers below the water table
- Diameter of down hole pipes used to convey groundwater
- Top and bottom of screen, if used
- Slot size of temporary screen, if used
- Depth of top and bottom of packer, if used
- Air pressure, if pneumatic methods are used
- Method used to check flow rate
- Synchronization of transducers

3.5 Documentation of Field Activities

Logbooks are required for field sampling activities. The logbook must be identified with a unique project name and number. Only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes. Data forms may also be used to document field activities and shall be controlled in accordance with internal work requirements and processes.

Logbooks will be used in accordance with HASQARD (DOE/RL-96-68) requirements. Logbook entries will be reviewed by the FWS, cognizant scientist/engineer, or other responsible manager. The review will be documented with a signature and date. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

Data forms for sampling will be used to collect some field information; however, information recorded on data forms must follow the same requirements as those for logbooks. The data forms or procedures used must be referenced in the logbooks.

A summary of information to be recorded in logbooks or on the data forms are as follows:

- Day and date; time task started; weather conditions; and names, titles, and organizations of personnel performing the task.
- Purpose of visit to the task area.
- Site activities in specific detail (e.g., maps and drawings) or the forms or procedures used to record such information (e.g., soil boring log or well completion log). Also, details of any field tests that were conducted; reference to any forms that were used, other data records, and methods followed in conducting the activity.
- Details of any field calibrations and surveys that were conducted. Reference any forms that were used, other data records, and the methods followed in conducting the calibrations and surveys.
- Details of any samples collected and the preparation (if any) of splits, duplicates, MSs, or blanks. Reference the methods followed in sample collection or preparation; list location of the sample collected; sample type; each label or tag numbers; sample identification; sample containers and volume; preservation method; packaging; chain-of-custody form number; and analytical request form

number pertinent to each sample or sample set; and note the time and the name of the individual to whom the custody of samples was transferred.

- Time, equipment type, serial or identification number, and methods followed for decontaminations and equipment maintenance performed. Reference the page numbers of any logbook where detailed information is recorded.
- Any equipment failures or breakdowns that occurred, with a brief description of repairs or replacements

3.5.1 Corrective Actions and Deviation for Sampling Activities

The OU Project Manager, FWS, appropriate field crew supervisors, and SMR personnel must document deviations from protocols, issues pertaining to sample collection, chain-of-custody forms, target analytes, contaminants, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected due to field conditions.

As appropriate, such deviations or issues will be documented (e.g., in the field logbook) in accordance with internal corrective action methods. The OU Project Manager, FWS, or SMR personnel will be responsible for communicating field corrective action requirements and for ensuring corrective actions are applied to field activities as soon as practical.

Changes in sample activities that require notification, approval, and documentation will be performed as specified in Table 2-2.

3.6 Calibration of Field Equipment

Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or field instructions that provide direction for equipment calibration or verification of accuracy by analytical methods. Calibration records shall include the raw calibration data, identification of the standards used, associated reports, date of analysis, and analyst's name or initials. The results from all instrument calibration activities are recorded in accordance with HASQARD (DOE/RL-96-68) requirements.

Field instrumentation calibration and QA checks will be performed as follows:

- Prior to initial use of a field analytical measurement system.
- At the frequency recommended by the manufacturer or methods, or as required by regulations.
- Upon failure to meet specified QC criteria.
- Calibration of radiological field instruments on the Hanford Site is performed by the Hanford Mission Integration Solutions prime contractor, as specified by their calibration program.
- Daily calibration checks will be performed and documented for each instrument used. 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.
- Using standards for calibration that are traceable to a nationally recognized standard agency source or measurement system. Manufacturer's recommendations for storage and handling of standards (if any) will be followed. Expired standards will not be used for calibration.

3.7 Sample Handling

Sample handling and transfer will be in accordance with established methods to preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape will be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date. If during the chain-of-custody process it is discovered that the custody tape has been tampered with or broken on the sample bottle, the sample will be analyzed but the results will include a flag to indicate that the custody was broken. If the custody tape has been tampered with or broken on the cooler, the sample custodian shall note this on the sample receiving documentation.

A sampling and analytical database is used to track samples from the point of collection through the laboratory analysis process.

3.7.1 Containers

Samples shall be collected, where and when appropriate, in break-resistant containers. The field sample collection record shall indicate the laboratory lot number of the bottles used in sample collection. When commercially pre-cleaned containers are used in the field, lot identification shall be retained for documentation.

Containers shall be capped and stored in an environment that minimizes the possibility of sample container contamination. If contamination of the stored sample containers occurs, corrective actions shall be implemented to prevent reoccurrences. Contaminated sample containers cannot be used for a sampling event. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. Container types and sample amounts/volumes are identified on the chain-of-custody form.

If required, the Radiological Control 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 can be received by the analytical laboratory in accordance with the laboratory's radioactivity 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 FWS (in consultation with the SMR group), can send smaller sample volumes to the laboratory.

3.7.2 Container Labeling

Each sample is identified by affixing a standardized label or tag to the container. This label or tag shall contain the sample identification number. The label shall identify or provide reference to associate the sample with the date and time of collection, preservative used (if applicable), analysis required, and collector's name or initials. Sample labels may be either pre-printed or handwritten in indelible or waterproof ink.

3.7.3 Sample Custody

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

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 for the custody of the sample changes, new and previous custodians will sign the record and note the date and time. The field sampling team will make a copy of the signed record before sample shipment and transmit the copy to the SMR group.

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

- Project name
- Collectors' names
- Unique sample number
- Date, time, and location (or traceable reference thereto) of sample collection
- Matrix
- Preservatives
- Chain-of-possession information (i.e., signatures and printed names of each individual involved in the transfer of sample custody and storage locations, and dates/times of receipt and relinquishment)
- Requested analyses (or reference thereto)
- Number of sample containers per unique sample identification number
- Shipped-to information (i.e., analytical laboratory performing the analysis)

Samplers should note any anomalies with the samples. If anomalies are found, samplers should inform the SMR group so special direction for analysis can be provided to the laboratory if deemed necessary.

3.7.4 Sample Transportation

Packaging and transportation instructions shall comply with applicable transportation regulations and DOE requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT) as described in 49 CFR 171, "Transportation," "General Information, Regulations, and Definitions," through 177, "Carriage by Public Highway."[3] Carrier-specific requirements defined in the current edition of International Air Transportation Association (IATA), *Dangerous Goods Regulations*, shall also be used when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents above regulated amounts shall be considered hazardous material in transportation and transported according to DOT/IATA requirements. If the sample material is known or can be identified, then it will be packaged, marked, labeled, and shipped according to the specific instructions for that material. Appropriate laboratory notifications will be made, if necessary, through the SMR project coordinator.

[3] Transportation regulations 49 CFR 174, "Carriage by Rail," and 49 CFR 176, "Carriage by Vessel," are not applicable, as these two transportation methods are not used.

Materials are classified by DOT/IATA as radioactive when the isotope-specific activity concentration and the exempt consignment limits described in 49 CFR 173, “Shippers—General Requirements for Shipments and Packagings,” are exceeded. Samples shall be screened, or relevant historical data will 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/IATA requirements.

Prior to shipping radioactive samples to the laboratory, the organization responsible for shipping shall notify the laboratory of the approximate number of and radiological levels of the samples. The laboratory is responsible for ensuring that the applicable license limits are not exceeded. Prior to sample receipt, the laboratory shall provide SMR with written acceptance for samples with elevated radioactive contamination or dose.

4 Reporting

An overview of the well drilling and construction activities performed during installation of these two extraction wells will be provided in a borehole summary report. The report will provide discussions on the following:

- Regional geology to A-AX and C Farms
- Downhole geology encountered while drilling the two wells
- Drilling details
- Borehole logging results
- Air monitoring results
- Well construction details
- Well development details
- Waste management
- Civil survey details
- Well acceptance

A field summary report will provide an overview discussion of the drilling and the various groundwater sample and hydraulic test results. This information will also be summarized in the annual pump and treat report.

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5 Management of Waste

Waste materials are generated during sample collection, processing, and subsampling activities. Waste will be managed in accordance with DOE/RL-2017-64, *Post Remedial Investigation Waste Control Plan and Removal Action Waste Management Plan for the 200-BP-5 Groundwater Operable Unit,* for well 299-E27-157 and DOE/RL-2004-18, *Waste Control Plan for the 200-PO-1 Operable Unit* (modified by TPA-CN-595, *Tri-Party Agreement Change Notice Form: DOE/RL-2004-18, Waste Control Plan for the 200-PO-1 Operable Unit, Revision 1*), for well 299-E25-240. For waste designation purposes, existing wells near wells 299-E27-157 and 299-E25-240 may be surveyed in HEIS, and the maximum concentration for each analyte within the most recent 5 years used to create a waste profile, if required. These waste control plans establish the requirements for the management and disposal of waste associated with groundwater wells in the 200-BP-5 and 200-PO-1 OUs. Waste from drilling and sampling activities will be handled in accordance with CERCLA requirements.

Miscellaneous solid waste that has contacted suspect dangerous waste will be managed as dangerous waste. Purgewater and decontamination fluids will be collected and managed in accordance with DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan* (modified by TPA-CN-0842, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-80, Investigation-Derived Waste Purgewater Management Work Plan, Rev. 0*), and DOE/RL-2011-41, *Hanford Site Strategy for Management of Investigation Derived Waste*. Packaging and labeling during waste storage and transportation will meet the applicable substantive federal and/or state requirements. Waste materials requiring collection will be placed in containers appropriate for the material and the receiving facility in accordance with the applicable waste management or waste control plan and applicable substantive federal and/or state requirements.

Offsite analytical laboratories are responsible for the disposal of unused sample quantities and wastes generated from analytical processes.

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6 Health and Safety

DOE established the hazardous waste operations safety and health program pursuant to the *Price-Anderson Amendments Act of 1988* to ensure the safety and health of workers involved in mixed-waste site activities. The program was developed to comply with the requirements of 10 CFR 851, "Worker Safety and Health Program," which incorporates the standards of 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response"; 10 CFR 830, "Nuclear Safety Management"; and 10 CFR 835. The health and safety program defines the chemical, radiological, and physical hazards and specifies the controls and requirements for daily work activities on the overall Hanford Site. Personnel training; control of industrial safety and radiological hazards; personal protective equipment; site control and general emergency response to spills, fire, accidents, injury, and site visitors; and incident reporting are governed by the health and safety program. Site-specific health and safety plans will be used to supplement the general health and safety program.

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