0091363

DOE/RL-2010-79
Revision 0

Treatability Test Plan for Characterization of Vadose Zone Carbon Tetrachloride Source Strength Using Tomographic Methods at the 216-Z-9 Site

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

U.S. DEPARTMENT OF ENERGY

Richland Operations Office

P.O. Box 550
Richland, Washington 99352

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200-PW-1

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Approval Page

Title Treatability Test Plan for Characterization of Vadose Zone Carbon Tetrachloride Source Strength Using Tomographic Methods at the 216-Z-9 Site

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Executive Summary

At the U.S. Department of Energy (DOE) Hanford Site, carbon tetrachloride was discharged to the subsurface through three engineered waste sites from 1955 through 1973. These three waste sites, the 216-Z-9 Trench, the 216-Z-1A Tile Field, and the 216-Z-18 Crib, are part of the 200-PW-1 Operable Unit (OU). The carbon tetrachloride contaminated the vadose zone and groundwater underlying these waste sites. Soil vapor extraction (SVE) has been in use as an interim remedial action in the vadose zone since 1992 and has significantly reduced the vadose zone contamination. The SVE operational data suggests that SVE has been effective in the highly permeable, sand and gravel portions of the vadose zone and that remaining contamination is present in low permeability silt zones.

Characterization of the nature of the remaining contamination can provide input to operational strategies for continued SVE operation and establish a target for future closure of the SVE system or transition to other remedies. This treatability test is being conducted to evaluate methods for collecting this type of characterization information. The DOE Office of Groundwater and Soil Remediation (EM-32) program has developed approaches for characterizing volatile contaminants, such as carbon tetrachloride, in the vadose zone and evaluating their impact on groundwater (Truex et al., 2009; Oostrom et al., 2010; Brusseau et al., 2010). These approaches and related ongoing EM-32 development efforts are the technical basis for this treatability test.

Three tests will be conducted at the 216-Z-9 Trench as part of the treatability test. The first test will use the SVE system to measure flow rate, carbon tetrachloride concentrations, and pressure at the SVE system inlet. This data will be used to calculate the overall mass flux. The second test will use the SVE system to measure flow rate, carbon tetrachloride concentrations, and pressure at individual wells. This data will be used to calculate the location-specific carbon tetrachloride mass flux from each well. Pneumatic tomographic analyses will also be conducted in conjunction with these short-term mass flux tests to characterize soil gas flow paths. These procedures are applied at multiple locations to generate a three-dimensional map of the spatial distribution of any remaining sources. The third test will use the PneuLog® technique, a multilevel pressure,

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flow rate, and concentration monitoring system, to obtain vertical, depth-specific measurements of flow, concentration, and pressure. These data will be used to calculate the carbon tetrachloride mass flux at different elevations in the same well, producing a vertical profile of mass flux. The tests will be conducted in October 2010, following the SVE operational cycle, when the remaining mass flux is assumed to be emanating from the lower permeability zones. This treatability test will be conducted in accordance with the existing Action Memorandum (Smith and Stanley, 1992) for the SVE interim action.

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Terms

ARAR	applicable or relevant and appropriate requirement
ASIL	acceptable source impact level
CCU	Cold Creek Unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
DNAPL	dense, nonaqueous-phase liquid
DOE	U.S. Department of Energy
DQO	data quality objective
ECO	Environmental Compliance Officer
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
GAC	granular activated carbon
GC	gas chromatography
HASP	health and safety plan
HPTT	hydraulic/partitioning tracer tomography
LDR	land disposal restriction
MS	mass spectrometry
NEPA	*National Environmental Policy Act of 1969*OU operable unit
PID	photoionization detector
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	*Revised Code of Washington*
RL	DOE Richland Operations Office
SVE	soil vapor extraction
SQER	small quantity emission rate
TBP	tributyl phosphate

Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
USACE	U.S. Army Corps of Engineers
USC	*United States Code*
VOC	volatile organic compound
WAC	*Washington Administrative Code*

1 Introduction

At the U.S. Department of Energy (DOE) Hanford Site, carbon tetrachloride was discharged to the subsurface through three engineered waste sites from 1955 through 1973 (DOE/RL-2006-51). These three waste sites, the 216-Z-9 Trench, the 216-Z-1A Tile Field, and the 216-Z-18 Crib, are part of the 200-PW-1 Operable Unit (OU) (Figure 1). The carbon tetrachloride contaminated the vadose zone and groundwater underlying these waste sites. Soil vapor extraction (SVE) has been in use as an interim remedial action in the vadose zone since 1992 (SGW-44694).

The vadose zone contamination has been significantly reduced through application of SVE. The extracted vapor contaminant concentration data showed a dramatic decrease within the first two years of operations. Subsequent periodic operation of the SVE system showed an initial short-lived rebound in concentrations followed by a resumption of low extracted vapor concentrations. These data suggest that SVE has been effective in the highly permeable, sand and gravel portions of the vadose zone and that remaining contamination is present in low permeability silt zones (Brusseau et al. 2010). Characterization of the nature of the remaining contamination can provide input to operational strategies for continued SVE operation and for establishing a target for future closure of the SVE system or transition to other remedies. This treatability test is being conducted to evaluate methods for collecting this type of characterization information. The DOE Office of Groundwater and Soil Remediation (EM-32) program has developed approaches for characterizing volatile contaminants, such as carbon tetrachloride, in the vadose zone and evaluating their impact on groundwater (Truex et al., 2009; Oostrom et al., 2010; Brusseau et al., 2010). These approaches and related ongoing EM-32 development efforts are the technical basis for the treatability test. This treatability test will be conducted in accordance with the existing Action Memorandum (Smith and Stanley, 1992) for the SVE interim action.This test plan describes the investigation of field-scale mass flux and pneumatic tomography and vertical concentration profiling for source zone characterization and SVE remediation system closure evaluation. Specifically, the area of focus for this investigation is the vadose zone underlying the 216-Z-9 waste disposal area, which has undergone active SVE remediation since 1993. Dense, nonaqueous-phase liquid (DNAPL) and aqueous phases containing carbon tetrachloride were disposed to the subsurface through an engineered infiltration facility, which resulted in contamination within the underlying soil gas and groundwater (SGW-44694). Significant amounts of carbon tetrachloride mass have been removed from the vadose zone through the SVE operations over the past two decades. However, SVE operations data, subsurface monitoring, and concentration-rebound data suggest that a long-term source of carbon tetrachloride remains within the low permeability Cold Creek Unit (CCU) (PNNL-17181). Pending results of this test, the mass flux measurement techniques could be applied at the other carbon tetrachloride waste disposal sites within the 200-PW-1 OU.

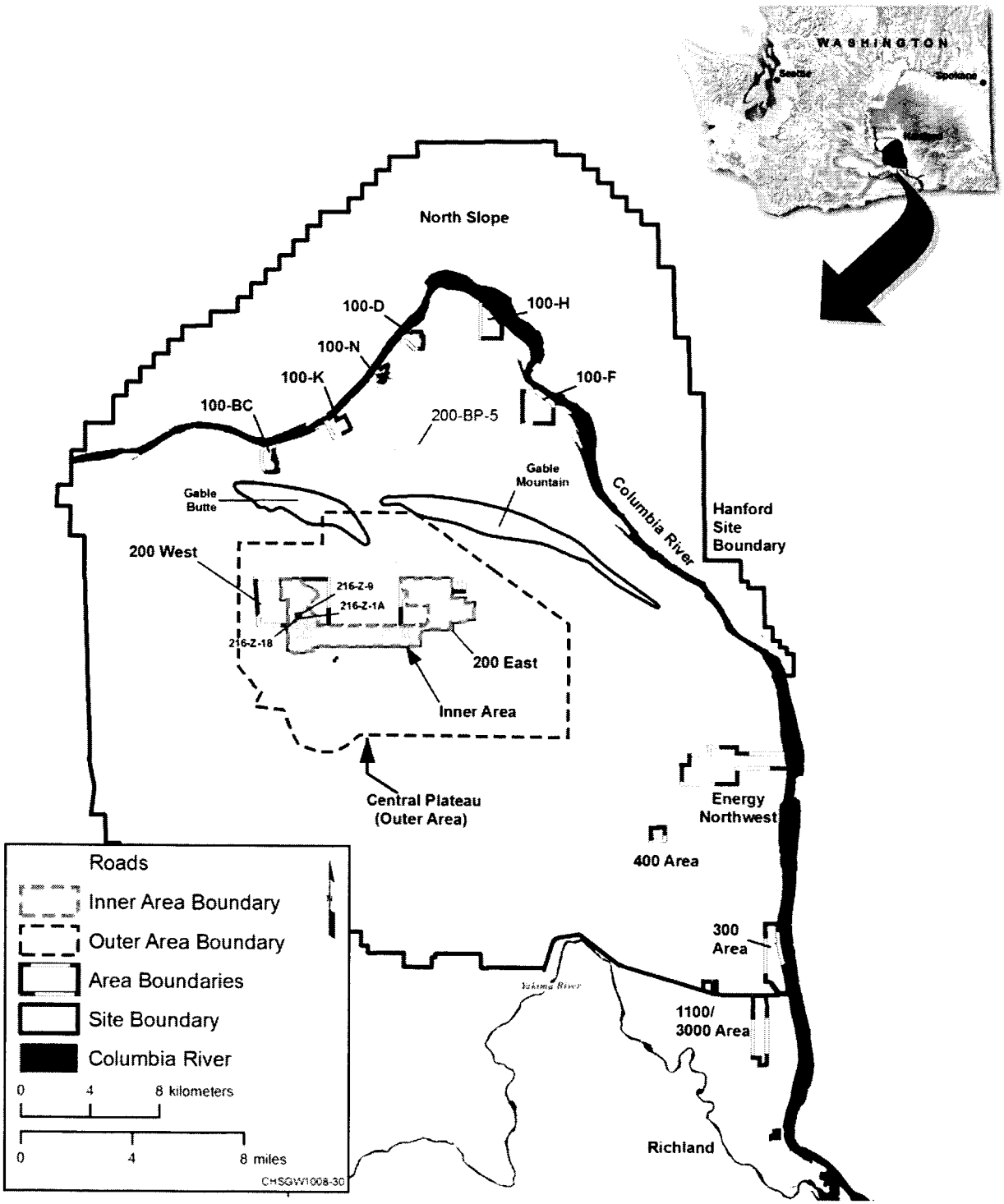

Figure 1. Location of the 200-PW-1 Operable Unit Carbon Tetrachloride Sites

2 Project Description

The U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (EPA) have outlined processes for assessing closure and transition of SVE systems using several types of analyses, including estimation of contaminant mass flux to groundwater and the resultant groundwater concentration. The approaches presented by the USACE (EM 1110-1-4001) and EPA (EPA/600/R-01/070), for closure/transition decisions protective of groundwater, can be summarized with the following elements using an organization based on the four steps outlined by the EPA.

1. Define a conceptual model of the site that is appropriate for use as a context to support SVE data analysis relative to closure/transition decisions (e.g., how is the contaminant distributed in the vadose zone and how does this relate to SVE effectiveness and closure analyses).

2. Provide design information that shows how SVE was configured and operated to address the contamination appropriately.

3. Provide SVE performance monitoring to demonstrate mass extraction and decreases in the subsurface contamination.

4. Quantify the mass flux to/from groundwater to define the impact of remaining vadose zone contamination of groundwater remediation goals and thereby set a quantitatively determined remediation endpoint for the vadose zone contamination.

This test plan describes methods for gathering data to refine the conceptual model of the 216-Z-9 site (i.e., step one from above) that is relevant to the distribution of carbon tetrachloride within the vadose zone at the time of the decision for SVE closure/transition. Additionally, the methods described herein facilitate the measurement of mass flux to groundwater for vadose zone remediation endpoint determination (i.e., step four). As described by Truex et al. (2009), carbon tetrachloride contaminant transport in the vadose zone is predominantly in the vapor phase. As such, this effort focuses on characterizing the carbon tetrachloride vadose zone source strength and distribution in terms of vapor phase transport. Characterizing the transport and fate of carbon tetrachloride vapor in the vadose zone requires knowledge of the spatial distribution of sources, subsurface heterogeneity, and mass transport processes. The tomography and mass flux techniques applied in this test are intended to provide this type of information using the existing well infrastructure and in a manner that provides data useful for evaluating SVE system closure/transition decisions. Information from other efforts not covered by this test would need to be provided to address the design and performance evaluation portion of SVE closure/transition decisions (i.e., steps 2 and 3).Tomographic surveys involve the collection of a series of two-dimensional measurements in different directions that are simultaneously evaluated to characterize a three-dimensional system. These types of measurements have been widely applied in various industries, such as the CAT Scan medical imaging technique, and they have recently been extended to the characterization of subsurface heterogeneities through hydraulic tomography (e.g., Tosaka et al., 1993; Gottlieb and Dietrich, 1995; Vasco et al., 2000; Yeh and Liu, 2000; Bohling et al., 2002; Vesselinov et al., 2001; Brauchler et al., 2003; and Zhu and Yeh, 2005 and 2006). Hydraulic tomography is a series of cross-well interference tests, using the existing infrastructure (pumping and monitoring wells) to observe responses in multiple directions. Specifically, an aquifer is stressed by extracting from or injecting into a well while the aquifer's responses (i.e., hydraulic heads) are monitored at that location and in other wells at different locations. The pumping or injecting is sequentially repeated at different locations, and the corresponding aquifer responses are monitored. The aquifer response induced by each stress is analogous to an image of hydraulic anomalies in the aquifer viewed from different locations, angles, and perspectives. Simultaneously interpreting all of these stress/response data sets produces a detailed three-dimensional evaluation of hydraulic heterogeneity in the subsurface. Thus, the resulting hydraulic

property spatial distribution from the tomographic analysis becomes more detailed and less uncertain than that produced from a single set of data.

This same tomographic survey idea can be applied to various subsurface site characterization techniques to enhance understanding of the impact of heterogeneity on physical and chemical processes. Additionally, the fusion of different types of tomographic surveys further enhances subsurface characterization. For example, the hydraulic tomographic survey methodology of utilizing system perturbation signal/response at various locations to map heterogeneity was recently combined with tracer testing to develop hydraulic/partitioning tracer tomography (HPTT), which can be used to map the spatial distributions of persistent contaminant sources in the subsurface (Zhu et al., 2009). Thus, the fusion of different types of tomographic surveys can be used to improve understanding of the impact that subsurface heterogeneity has on coupled processes such as fluid flow and transport.

The mass flux tomography method described herein consists of conducting a series of short-term vapor extraction tests to measure location-specific contaminant mass flux. Pneumatic tomographic analyses will also be conducted in conjunction with mass flux tests to characterize soil gas flow paths. These procedures are applied at multiple locations to generate a three-dimensional map of source distribution and mass flux. Vertical profiling of vapor phase contaminant concentrations at selected interfaces will provide additional data about the location of mass flux sources. These field tests will provide data to characterize the nature and distribution of carbon tetrachloride sources in the vadose zone and can be used to assess the conceptual model and associated assumptions used for evaluating the impact on groundwater contamination.

There are three primary geologic units in the vadose zone underlying the carbon tetrachloride disposal sites. The Hanford formation is present from the ground surface to a depth of about 30 m (98.4 ft). The CCU, a zone of high silt content and calcareous cemented material about 5 m (16.4 ft) thick, is laterally extensive below the Hanford formation underlying the 200-PW-1 OU sites. Below the CCU, the Ringold Formation is present through the remaining, lower portion of the vadose zone (~30 m [98.4 ft] thick) and in the unconfined aquifer.

Testing at the 216-Z-9 waste disposal area will use SVE system PW1-1, which is the system currently operating at the 216-Z-9 site. During the test, SVE system PW1-2 will continue to operate in accordance with the SVE operating plan previously approved by DOE-RL and EPA.

3 Technology Description

The contaminant mass flux or mass discharge from a source zone, also referred to as the source strength or source function, is now recognized as a key metric for assessing remediation performance (e.g., Schwarz et al., 1998; Einarson and Mackay, 2001; ITRC, 2002; Rao et al., 2002; API, 2003; EPA, 2003; SERDP, 2006). Mass discharge is a measure of both mass removal from the source zone (illustrative of source longevity) and mass delivery to the vadose zone (potential impact to soil gas and groundwater). As such, mass discharge interrelates source zone and vadose zone dynamics. The reduction in mass discharge or mass flux achieved with a specified level of source zone mass depletion (or mass removal) is a key determinant for evaluating the effectiveness of a source zone remediation effort (EPA/600/R-01/070; EM 1110-1-4001; Truex et al., 2009).

Mass flux tomography will be conducted as the primary methodology for evaluating the nature and distribution of carbon tetrachloride sources in the vadose zone, which will require a two phased approach. The first phase will measure the overall mass flux from the vadose zone using concentration rebound data analysis. The approach will use a modification of the method to measure mass flux using SVE system data that was described in Brusseau et al. (2010). This method is based on operation of the SVE system

after it has been off for a period of time (e.g., cyclic operations similar to the operational strategy over the last 10+ years). The carbon tetrachloride vapor concentration increases to a maximum value during the rebound time (i.e., when the SVE system is not being operated), because contaminant diffusive mass transfer from low permeability zones (essentially immobile) occurs into the high permeability zones (mobile) while the system is static. During SVE operation after a rebound period, these initial elevated concentrations decrease asymptotically to a steady concentration that represents the diffusive mass transfer limitation during operations. This decrease in concentration is illustrated in Figure 2. Measurements of carbon tetrachloride vapor concentrations, flow rates, and in situ pressures will be initiated directly after resumption of SVE operations following a rebound period to calculate the overall mass flux. This method will use simultaneous extraction from several wells to measure the overall mass flux from all of the sources within the SVE swept volume.

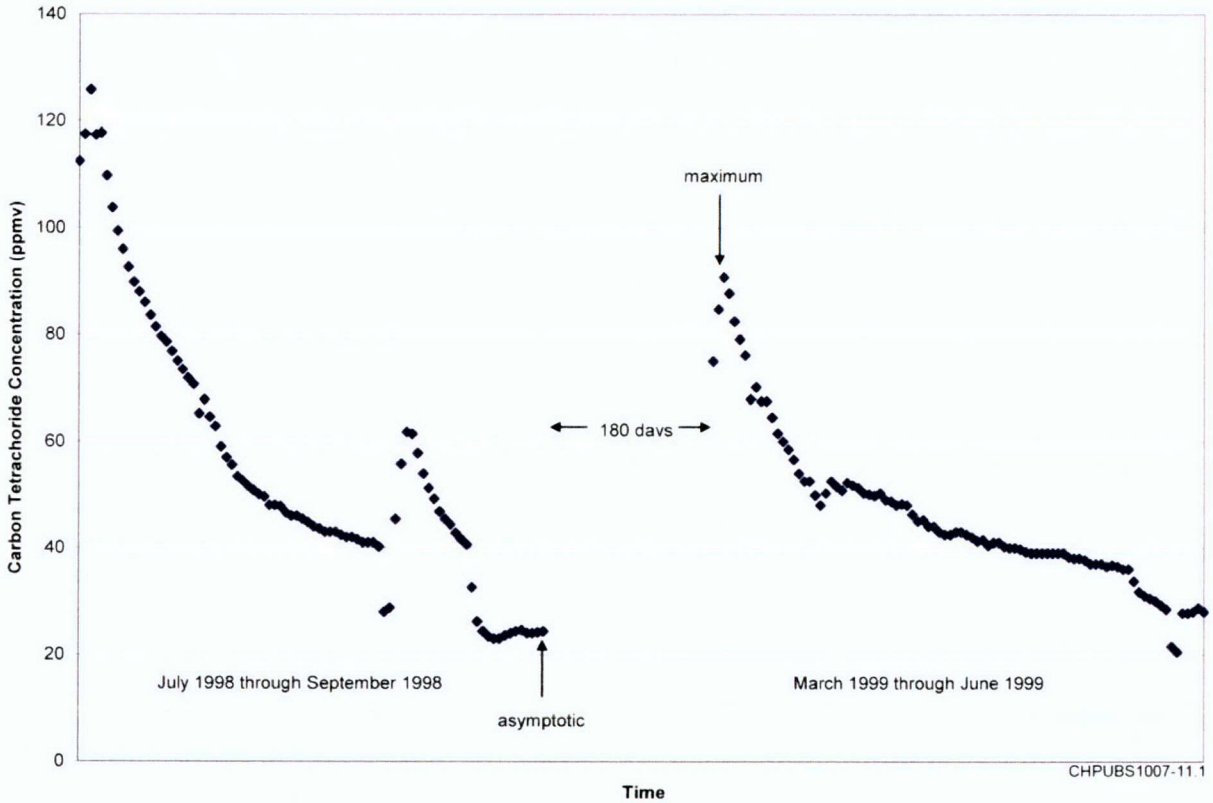

Figure 2. Vapor Concentration Behavior Illustrative of Soil Vapor Extraction Operation After a Rebound Period

Mass flux is determined by first calculating the total mass of contaminant removed (M_{pv}) in the first gas-pore-volume extracted during SVE operation after a rebound period:

$$M_{pv} = \sum_{1}^{n} CQT_S$$

where

C = the Contaminant concentration in the extracted soil gas (ML^{-3})

Q = the extraction flow rate (L^3T^{-1})

T_s = the interval between sample times (T)

N = the sample where one pore volume of gas has been extracted

The pore volumes associated with the SVE system can be estimated based on SVE operational data and airflow analysis (e.g., BHI-00882). The calculation of mass extracted is based on the assumption that the contaminant mass removed during the first pore volume equivalent of gas extraction represents primarily the mass present in the advective domain. It is further assumed that there is minimal carbon tetrachloride mass present in the advective domain prior to the start of a rebound period and, therefore, all mass removed in the first pore volume of extraction represents mass that has transferred from the low-accessibility (source) domains during the preceding rebound period. This assumption is supported by data for the spatial distributions of carbon tetrachloride concentrations, which indicated that there is only a relatively small quantity of carbon tetrachloride present in the advective domain prior to the start of a rebound period. M_{pv} is divided by the rebound time to compute mass flux.

The second phase of the mass flux tomography testing will be conducted, following the first phase, within the asymptotic portion of the concentration elution after the majority of the rebound mass has been removed, which will facilitate measurement of variability in diffusion-limited mass flux from within the swept area of each single well tested. Single well vapor extraction measurement of mass flux will be conducted at several vapor extraction wells to evaluate the spatial distribution of mass flux responses (Table 1), and the response will be monitored at the extraction well and nearby wells at various locations. Additionally, a vertical depth-specific vapor flow and concentration profiling method called PneuLog® will be utilized to characterize mass flux vertically downward and upward from the CCU into the Ringold Formation and upward between the groundwater and soil gas, respectively. Pneumatic (gas pressures and flow rate) monitoring at individual wells will be conducted to evaluate impacts of porous media permeability heterogeneity on mass flux and vapor transport behavior. Tomographic analysis of the data collected during these tests will be used to evaluate the impact of subsurface heterogeneity, including variations in source locations, on source zone mass flux and vapor transport. These single well extraction tests will be conducted within the asymptotic portion of the concentration profile (Figure 2 after the majority of the advective mass has been removed, and the mass flux from the source zones is limited by diffusive mass transfer from low permeability zones into the higher permeability zones accessed by the SVE system.

Direct comparison of vapor concentration, flow rates, and pressure profiles generated when each well is extracted independently will provide information about the proximity of source zones in relation to each well. For example, illustrative, yet hypothetical, plots of expected concentration response behaviors are presented in Figure 3 through Figure 6. Additionally, on each figure a schematic areal map view diagram

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of the well's long-term swept areal extent in relation to the location of a source zone is presented. The concentration decay after the rebound period will have already occurred (during the overall mass flux measurement). Thus, one might expect vapor concentrations to be constant assuming the well and the entire long-term swept area are both within the areal extent of the source zone (Figure 3). This behavior is expected if the source zone has a uniform distribution. However, a well that is close to a source or has a stronger pneumatic connection with the source zone may have a concentration that is higher (closer to that of the source zone vapor concentrations) than other wells. Additionally, a well that is pneumatically isolated or is far away from the source zone might have low, or negligible, concentrations.

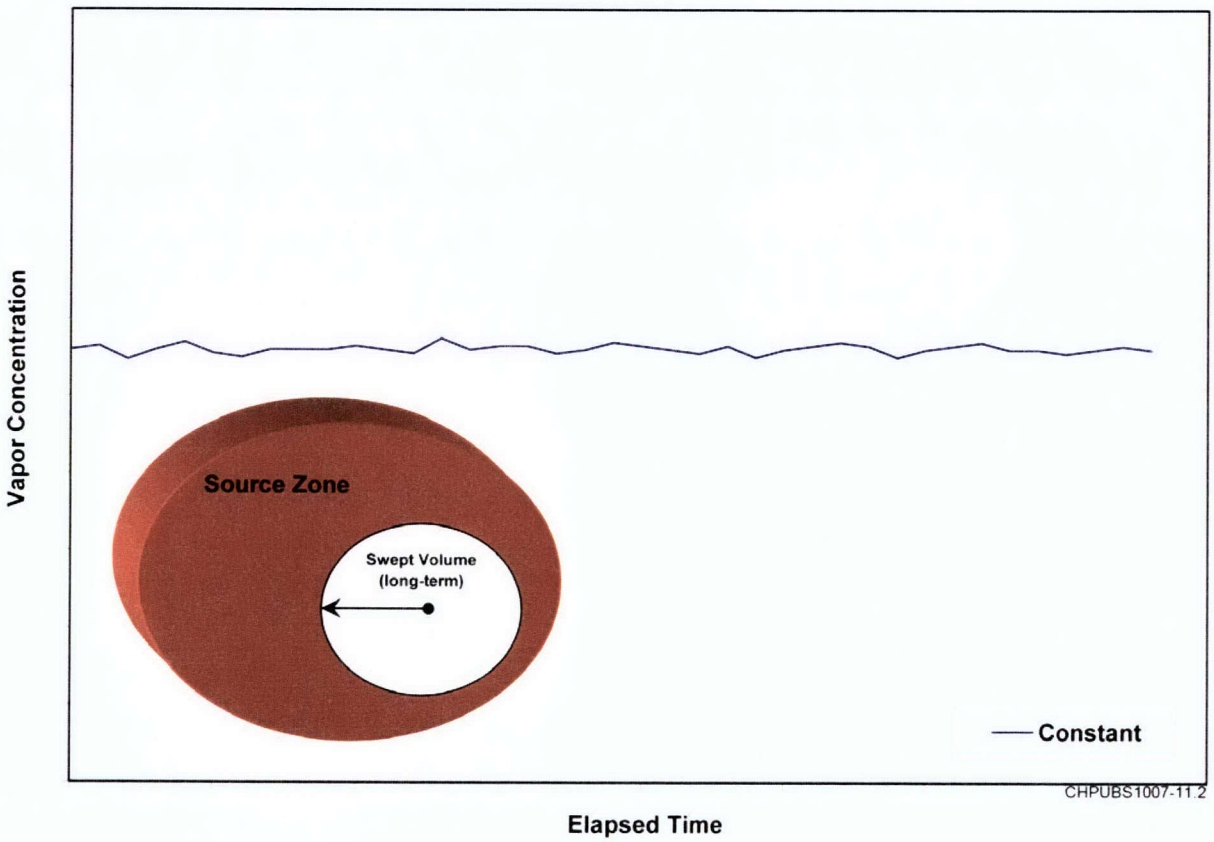


Figure 3. Conceptual Behavior for Constant Vapor Concentration Illustrative of Single-Well Extraction Tests with an Aerial Map-View Diagram of the Well's Swept Volume in Relation to the Location of a Source Zone

Another possibility is when a well is not screened within a source zone. However, that well's entire long-term swept area of influence contains at least a portion of the source zone. This is the case where the early time swept volume does not contain a source zone, but the long-term swept volume does intersect a source zone. In this case, concentrations may increase over time as the contaminants migrate to the well and the well's swept volume increases over time (Figure 4).

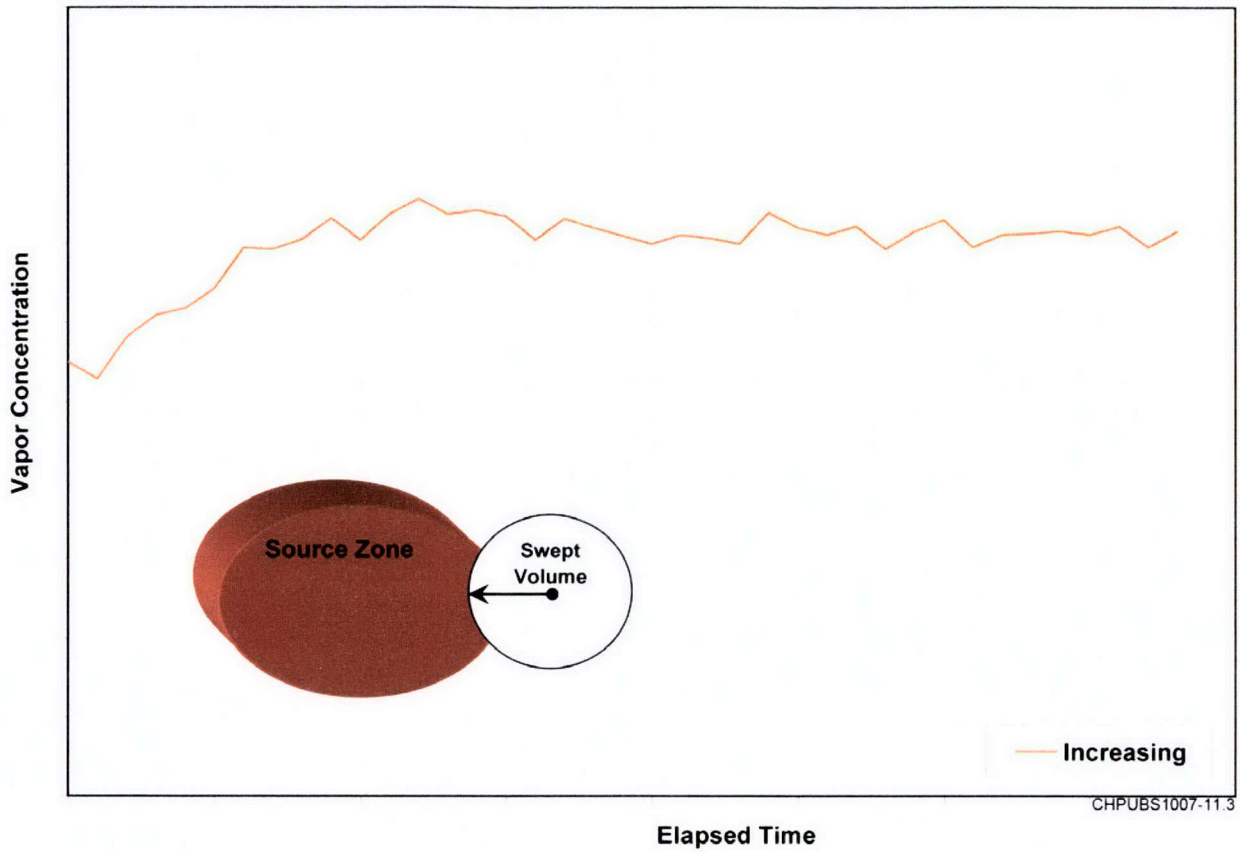


Figure 4. Conceptual Behavior for Increasing Vapor Concentration Illustrative of Single-Well Extraction Tests with an Aerial Map-View Diagram of the Well's Swept Volume in Relation to the Location of a Source Zone

Concentrations may also decrease over time if the well is screened within (or near) the source zone and the entire long-term swept area is larger than the source zone (Figure 5). This is the case where the early time swept volume does contain a source zone, but the long-term swept volume intersects areas beyond the source zone. This scenario would allow for dilution with lower concentration vapor influx over time.

Additionally, a scenario could be imagined as a combination of the two previous scenarios, which would create a concentration pulse (Figure 6). In this case, a well is not screened within a source zone. However, a source zone is within the well's entire long-term swept area of influence, but the long-term swept volume intersects areas beyond the source zone. This is the case where the early time swept volume does not contain a source zone, but the long-term swept volume does intersect a source zone and extends beyond the source zone distribution. In this case, concentrations may increase initially as the contaminants migrate to the well and the well's swept volume increases, and then concentrations would decrease through dilution as the swept volume continues to increase beyond the source zone.

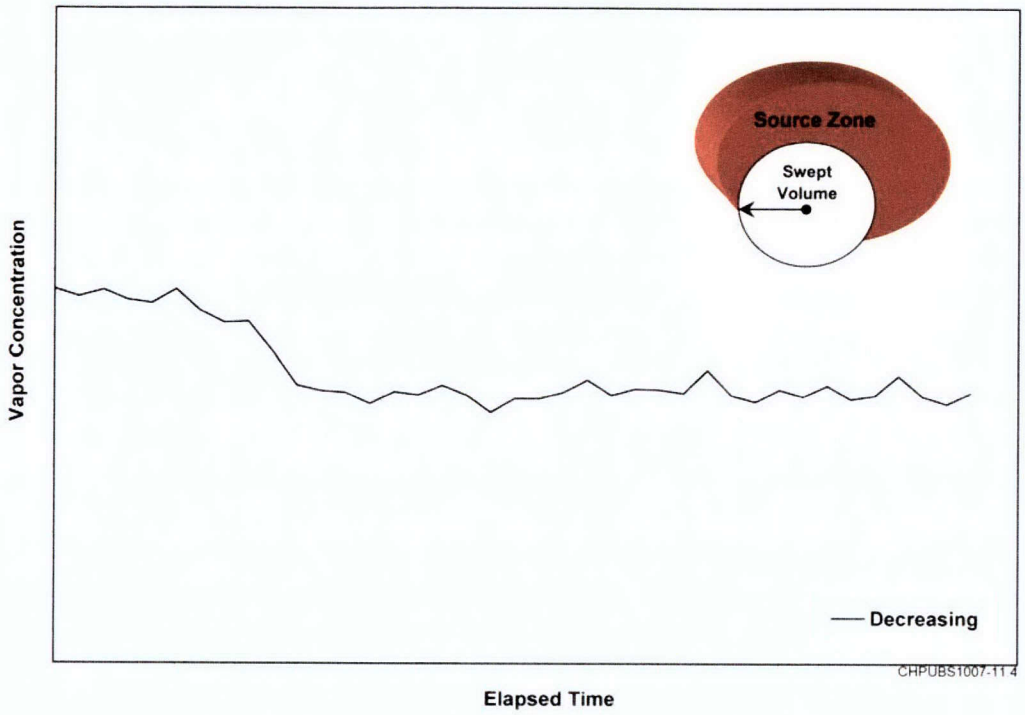


Figure 5. Conceptual Behavior for Decreasing Vapor Concentration Illustrative of Single-Well Extraction Tests with an Aerial Map-View Diagram of the Well's Swept Volume in Relation to the Location of a Source Zone

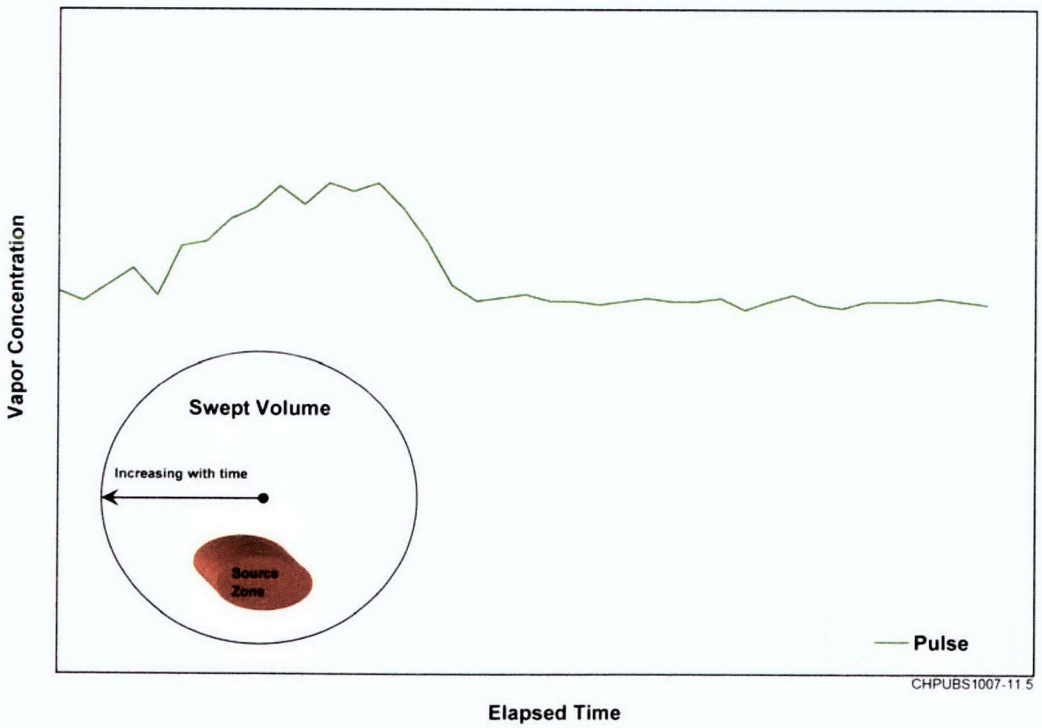


Figure 6. Conceptual Behavior for Variable Vapor Concentration Illustrative of Single-Well Extraction Tests with an Aerial Map-View Diagram of the Well's Swept Volume in Relation to the Location of a Source Zone

Comparison of individual well behavior will support evaluation of the location of remaining source zones. Interpretation of all the responses from several individual wells allows for the development of detailed conceptualization of the subsurface including the location and configuration of the remaining source zone(s).

In the current conceptual model of the vadose zone, the CCU is the primary location of the remaining source of carbon tetrachloride in the vadose zone. As such, contaminants migrating from the CCU would be limited by diffusive mass transfer, which is supported by the rebound observations (Figure 2). This mass-transfer limitation is likely to be the result of slow desorption and release of contaminants retained in the low permeability sediments, as opposed to evaporation of DNAPL. Vertical profiling of vapor concentrations outward from the CCU will help evaluate this conceptual model element. Additionally, profiling upward from the water table will be used to determine whether there is currently an impact of groundwater contaminants on the vadose zone.

4 Test Objectives

The primary objective for this treatability test is to evaluate methods for collecting characterization information suitable to support decisions for SVE system closure or transition to other remedies at the 200 West Area of the Hanford Site. Specifically, the area of focus for this investigation is the vadose zone underlying the 216-Z-9 waste disposal area. The methodology is targeted at collecting data to verify, or refine, the conceptual model of contaminant nature and distribution in the vadose zone beneath a waste disposal site. A key element of the method development is to test approaches for characterizing the magnitude and spatial distribution of mass flux.

The approximately two decades of site characterization and remediation operations have generated a substantial amount of site-specific knowledge and data related to vapor transport. However, uncertainty remains, specifically related to the location and distribution of source zones within localized low-permeability units such as the CCU (PNNL-17181). The mass flux and vapor transport associated with these zones controls the long-term contamination of the vadose zone and the groundwater. This investigation is designed to characterize the distribution of source zones, diffusive mass transfer behavior, and the vapor transport behavior within the subsurface. Additionally, a vertical depth-specific vapor flow and concentration profiling method will be utilized to characterize contaminant mass flux vertically upward and downward from the CCU into the Ringold Formation and upward between the groundwater and soil gas, respectively. This investigation is specific to the zone of influence of the SVE system which is focused beneath the former waste disposal sites (the location most likely to contain persistent contamination).

5 Experimental Design and Procedures

The treatability test will be conducted at the 216-Z-9 site, which received liquid wastes containing carbon tetrachloride from 1955 to 1962. SVE has been in operation at this site since 1993. The existing wells and SVE system will be used during the test.

5.1 Test Site Location and Description

Plutonium recovery operations within the Z-Plant aggregate area (i.e., Plutonium Finishing Plant) at the Hanford Site resulted in organic and aqueous wastes that were disposed of at several cribs, tile fields, and French drains. The organic wastes consisted of carbon tetrachloride mixed with lard oil, tributyl phosphate (TBP), and dibutyl butyl phosphonate. The main disposal areas were the 216-Z-9 Trench, the 216-Z-1A Tile Field, and the 216-Z-18 Crib (PNNL-17181). Active SVE has been removing carbon

tetrachloride and other contaminants from the vadose zone since 1992. The 216-Z-9 Trench was selected as an appropriate test site for this investigation because of its subsurface heterogeneity, persistent contaminant source despite decades of remediation, and the potential applicability of the test methods for evaluating remediation effectiveness for closure evaluation and planning.

In general, the vadose zone underlying the 216-Z-9 Trench has been characterized as containing the majority of the remaining source zone mass within the CCU (SGW-44694). The low permeability CCU, or CCU, is a mixture of caliche (or calcrete), a fine- to coarse-grained, calcium-carbonate cemented paleosol, and a cohesive, compact, massive to laminated, and stratified fine-grained sand and silt (e.g., sandy mud). Above and below this unit are the higher-permeability units called the Hanford and Ringold Formations, respectively. The Ringold is a sedimentary sequence of fluvial-lacustrine clay, silt, sand, and granule to cobble gravel deposited by the ancestral Columbia River. The Hanford contains a sequence of interbedded sand and mud, coarse to medium sand, and sandy gravel (PNNL-17181). The majority of the vapor extraction wells are screened either above or below the CCU, which has guided the testing into two distinct applications designed to measure mass flux from the CCU source zones in the upward and downward directions. However, a few wells screened across the CCU (e.g., 299-W15-86) and across the water table (e.g., 299-W15-32) have been targeted for vertical profile investigations.

5.2 Experimental Design

This section presents the technical basis and approach for the experimental design of the treatability test.

5.2.1 Technical Basis

Significant declines in the rate of mass removal are common for SVE systems. SVE is highly effective at removing subsurface contaminant mass from permeable portions of the vadose zone. However, diffusive-mass transfer typically limits the effectiveness of SVE when the remaining mass is located within lower-permeable zones. For example, the 216-Z-9 Site SVE operation from 1993 to 1996 removed several thousand kg of carbon tetrachloride before the concentrations and mass removal rate decreased substantially. From 1996 through the present, cyclic operation and rebound demonstrated significant vapor concentration rebounding due to diffusive-mass transfer from low-permeability source zones (SGW-44694; Brusseau et al., 2010).

This project has been designed to locate the distribution and configuration of the remaining source zones and the low permeability zones within the vadose zone at the 216-Z-9 Site, which will guide and support the continued operation of the SVE remediation, as well as support the quantitative assessment of the remediation closure criteria. The vapor mass flux and pneumatic tomography are innovative characterization methods that are well suited for simultaneously evaluating heterogeneous permeabilities, source zones, and vapor transport properties.

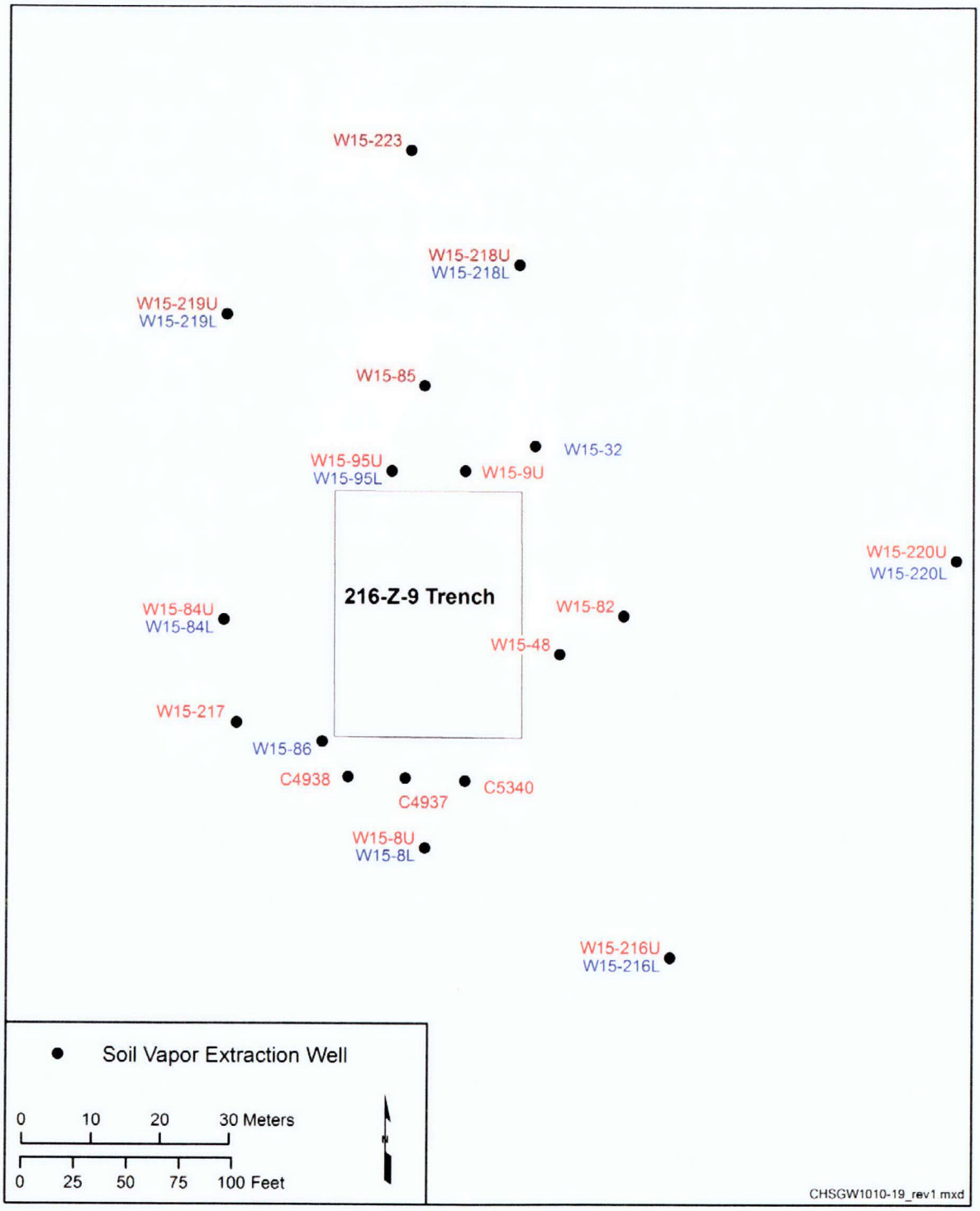
This investigation plans to use SVE wells that are screened both above and below the CCU (Table 1). Figure 7 indicates the locations of the candidate wells that will be tested and their approximate proximity to the 216-Z-9 Trench. The previous site characterization and monitoring evidence indicates that the primary remaining source of carbon tetrachloride within the vadose zone is located within the CCU and within close proximity to the 216-Z-9 Trench. For example, carbon tetrachloride concentrations measured within vapor samples collected at individual wells during SVE operations are shown for wells screened above and below the CCU in Figure 8 and Figure 9, respectively. A cross-section for the 216-Z-9 Site showing well screen intervals is provided as Figure 10, and the well screens are color coded with the concentration data shown in Figure 8 and Figure 9. The black colored wells had some of the highest concentrations both above and below the CCU, and these black colored wells were located across and adjacent to the CCU. Additionally, the other highest concentrations measured after rebound periods were measured at a well in Figure 8 (299-W15-82) close to the 216-Z-9 Trench.

Table 1. Candidate Soil Vapor Extraction Wells for Testing at the 216-Z-9 Site

Wells Above Cold Creek Unit	Depth bgs m (ft)	Wells Below Cold Creek Unit	Depth bgs m (ft)	Vertical Profiling Wells	Depth bgs m (ft)
299-W15-8U	28-34 (93-113)	299-W15-8L	50-59(165-195)	299-W15-32	59-71 (194-234)
299-W15-9U	27-34 (88-113)	299-W15-84L	50-59(165-195)	299-W15-86	33-42 (107-137)
299-W15-48	29-36 (94-120)	299-W15-86	33-42 (107-137)	299-W15-217	32-37 (106-121)
299-W15-82	23-27 (75-90)	299-W15-95L	39-48 (129-159)		
299-W15-84U	23-27 (75-90)	299-W15-216L	53-56 (175-185)		
299-W15-85	25-30 (83-98)	299-W15-218L	55-60 (181-196)		
299-W15-95U	22-30 (73-98)	299-W15-219L	51-55 (167-182)		
299-W15-216U	21-24 (70-80)	299-W15-32	59-71 (194-234)		
299-W15-216U	21-24 (70-80)	299-W15-32	59-71 (194-234)		
299-W15-217	32-37 (106-121)				
299-W15-218U	30-35 (99-114)				
299-W15-219U	27-31 (87-102)				
299-W15-220U	24-29 (80-95)				
299-W15-223	31-36 (103-117)				
C4937	18-20 (59-64)				
C4938	18-20 (59-64)				
C5340	18-20 (60-65)				

SVE monitoring data does suggest that some secondary sources may exist in localized regions both above and below the CCU. The vapor mass flux tomography tests are designed to focus on the CCU while also evaluating the configuration of these secondary sources. The wells selected cover the areal extent of the SVE swept zone surrounding the waste disposal trench. The vertical profiling wells generally are either screened across the low permeability CCU into the higher-permeability Ringold and Hanford Formations, except for Well 299-W15-32, which is screened from the vadose zone below the CCU into the groundwater system. This well will be used to quantify mass flux between the vadose zone and the groundwater. The other vertical profiling wells will be used to quantify mass flux from the CCU into the higher-permeability units (Table 1).

The monitoring of pressures and flow rates during each test will be used to evaluate the permeability distribution. The pressure rebound monitoring during flow interruption will be used for pneumatic and permeability interpretation, as well. The concentration and vapor discharge monitoring will be used to evaluate the vapor mass flux and identify source zones. The evaluation of data collected during these tomographic tests and the subsequent modeling and interpretation will be used to enhance the site conceptual model, quantify vapor transport, and support operations and closure decisions.



Notes: The prefix 299- has been omitted from all well names. Red and blue labels indicate wells that may be used for testing above the CCU and testing below the CCU, respectively. Wells 299-W15-217, 299-W15-86, and 299-W15-32 will be used for vertical profiling.

Figure 7. Location Map of Soil Vapor Extraction Wells Selected for Testing at the 216-Z-9 Site

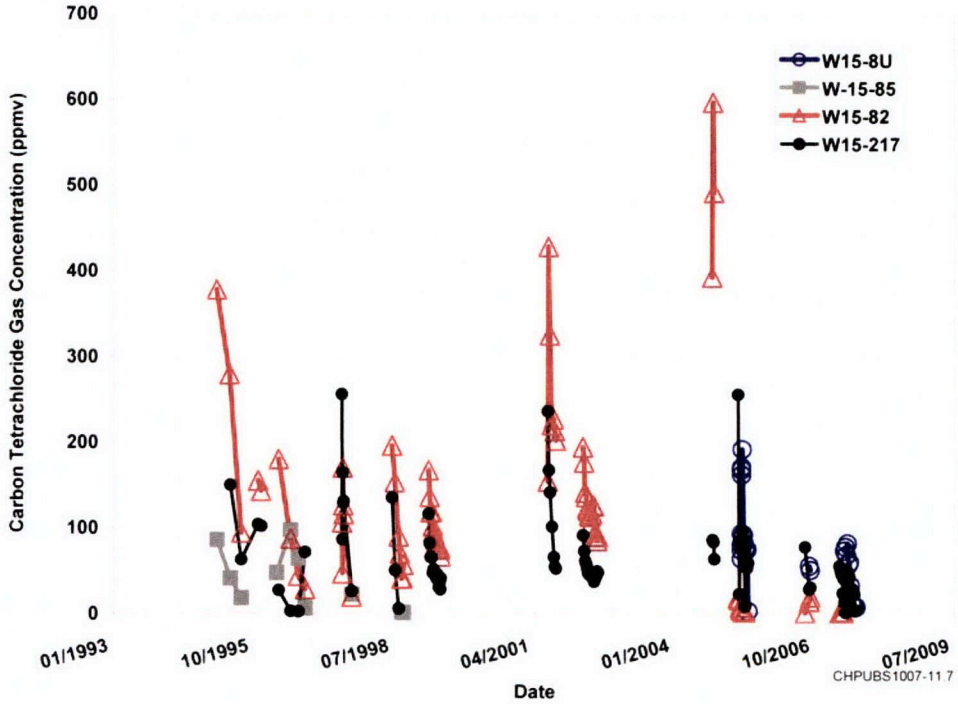


Figure 8. Vapor Concentrations as a Function of Time Measured at Wells Screened Above the Cold Creek Unit During Soil Vapor Extraction Operations at 216-Z-9 from 1995 Through 2008

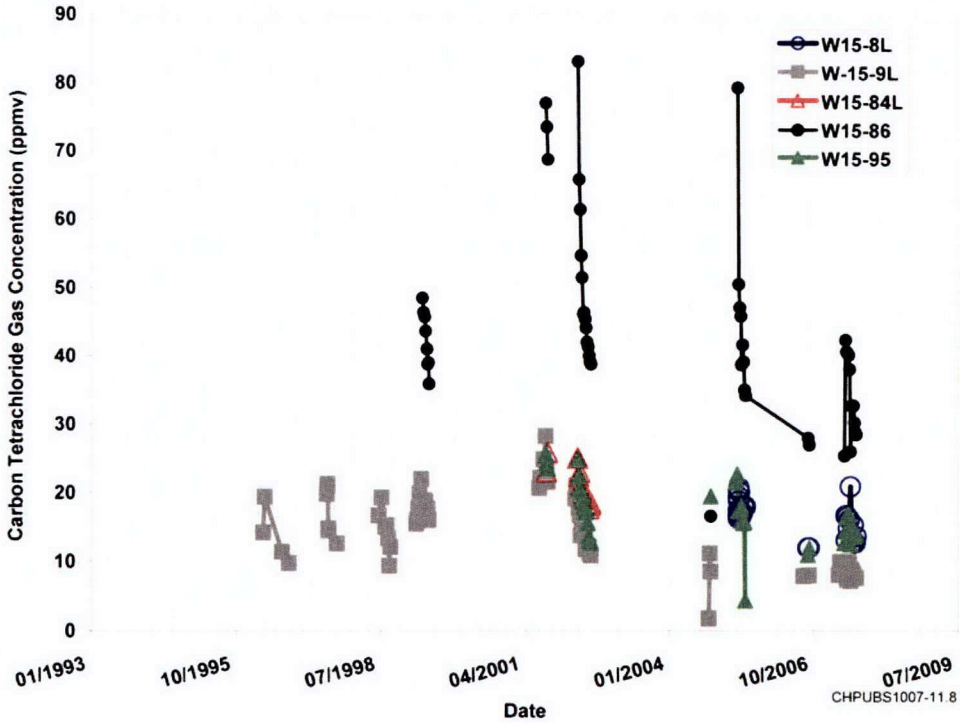
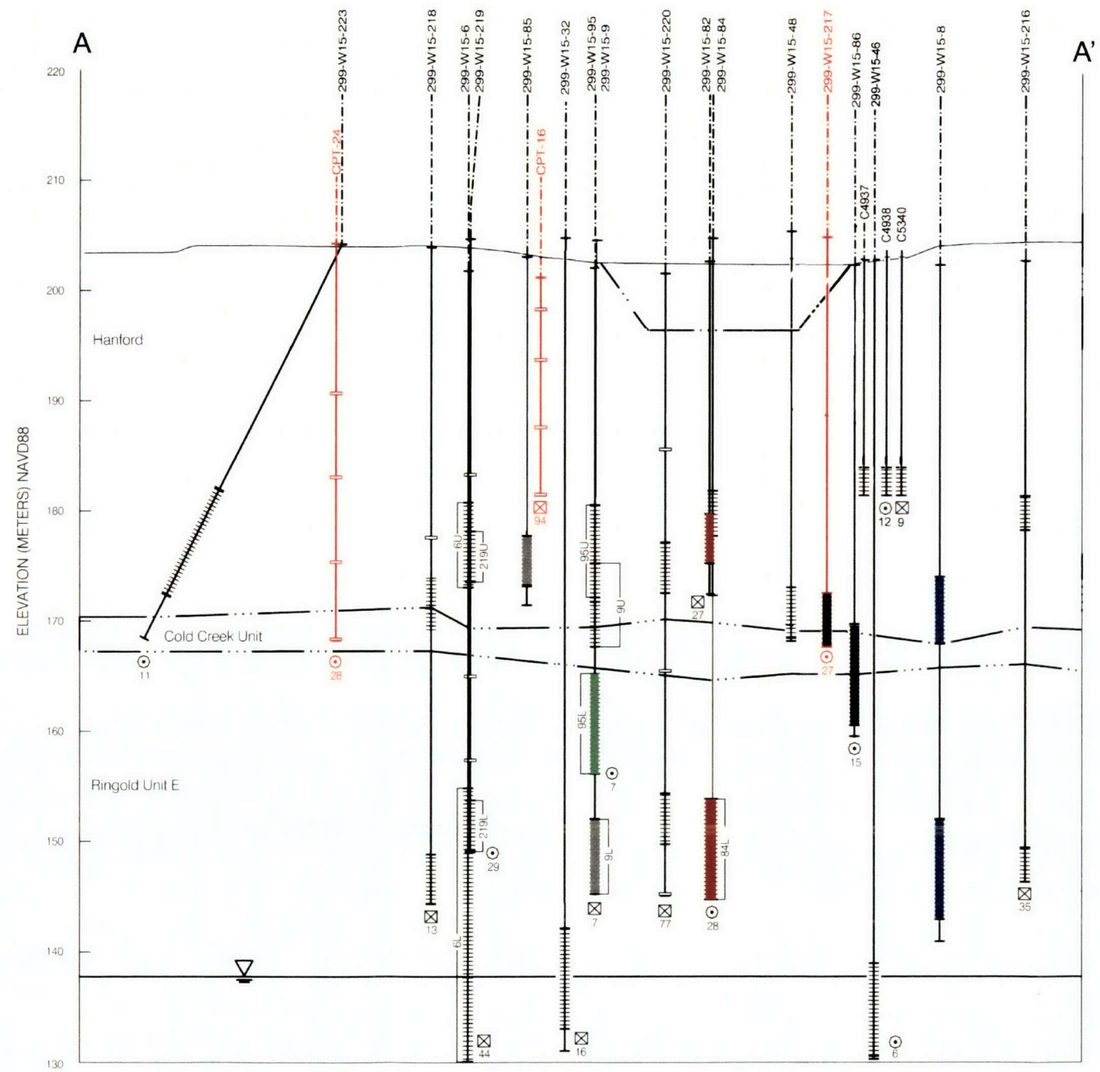
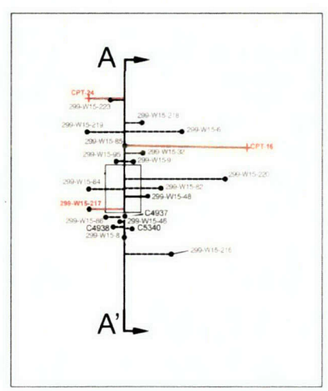


Figure 9. Vapor Concentrations as a Function of Time Measured at Wells Screened Below the Cold Creek Unit During Soil Vapor Extraction Operations at 216-Z-9 from 1995 Through 2008





SECTION LOCATION MAP

Figure 10. Cross-Section A-A' for the 216-Z-9 Site Indicating Well-Screen Locations, the 216-Z-9 Trench, Groundwater Table Elevation, and Generalized Subsurface Lithologic Units

5.2.2 Approach

Table 2 presents a test matrix for this project, which include overall mass flux, single well mass flux and pneumatic tomography, and vertical profile mass flux. The test matrix includes a brief description of the test and its use along with the data collection activities. The overall mass flux testing is part of standard operations and occurs as part of the SVE operational cycle after a rebound period. The typical cyclic SVE shutdown (rebound) period lasts approximately six months. SVE operations are then initiated to remove contaminants from the permeable portion of the SVE swept zone. Because the overall mass flux test data are collected from standard SVE system operations, it is not described further in this test plan.

Table 2. Soil Vapor Extraction Mass Flux and Vapor Tomography Testing Matrix

Number	Test	Description and Use	Data Collection
1	Overall Mass Flux	Measure mass flux after rebound period, and extract mass until concentrations reach asymptotic tailing.	Carbon tetrachloride concentration, flow rate, pressure
2	Single Well Mass Flux and Pneumatic Tomography	During asymptotic tailing period, measure mass flux from each well to identify spatial distribution of sources.	Carbon tetrachloride concentration, flow rate, pressure
3	Vertical Profile Mass Flux	Measure mass flux at discrete intervals in a well screen to determine vertical changes in flux at CCU and water table.	Carbon tetrachloride concentration, flow rate, pressure

CCU = Cold Creek Unit

After this contamination has been removed (e.g., the response in the SVE system wells approach an asymptote), it is assumed that remaining mass flux is emanating from the low permeability zones. At this point, the coupled pneumatic and single well mass flux tomography testing will begin by sequentially extracting gas from each of the wells listed in Table 1 at a constant flow rate. The flow rate, pressure, and carbon tetrachloride concentrations will be monitored during the test. This procedure will be repeated for each well. A description of the single well mass flux and pneumatic tomography is provided in Section 6.

The PneuLog® technique, a multilevel pressure, flow rate, and concentration monitoring system, will be used to obtain vertical depth-specific vapor mass flux profile measurements. This system monitors pressure, flow, and concentration responses at different elevations within the same well. The vertical profiling test is described in Section 7.

6 Single Well Mass Flux Testing

The single well mass flux test will use the SVE system to measure flow rate, carbon tetrachloride concentrations, and pressure at individual wells. This data will be used to calculate the carbon tetrachloride mass flux from each well to identify the spatial distribution of remaining sources.

6.1 Procedures

The general test approach is discussed and justified in the previous sections. This section describes the specific steps required for implementing the test and includes the following elements:

1. Pretest system
   - Conduct monitoring of SVE system prior to shut down.

- Install any additional sampling and flow/pressure monitoring equipment.
- Configure in-line gas chromatography (GC) and off-site analytical facilities for test conditions and analysis of carbon tetrachloride.
- Begin pretesting pressure monitoring and data logging.

2. Single well vapor mass flux tomography test
   - Use SVE system for individual well vapor extraction and monitoring of flow rate and concentration.
   - Collect samples (2 total) at the beginning and end of the extraction period for laboratory analysis as a confirmation of continuous flow rate and pressure monitoring data.
   - Conclude vapor extraction and repeat process at each of the other wells (Table 1).

Throughout the investigation, health and safety plans (HASPs) will be followed. Site conditions, field issues, changes to the test plan, field observations, weather conditions, sample identification/collection times, field data/monitoring, and timing of test operations will all be recorded in a field notebook. After the completion of each section of testing and at the conclusion of the field project equipment will be decontaminated/removed, and the SVE system will be reconfigured for regular operation.

6.2 Equipment and Materials

This section describes the equipment and materials needed for the single well mass flux test.

6.2.1 Pressure Monitoring and Data Acquisition Equipment

The gas pressure monitoring will be initiated and recorded with an automated data acquisition system including 16-channel data logger, Valco 16-port switching valves, and Setra 0.001 psi pressure transducers, K-type thermocouples, Omega HX93 humidity sensors, a Setra 270 barometric pressure gauge, and several Sierra 600-200 flow meters.

6.2.2 Gas Injection/Extraction Equipment

The SVE system operation currently is equipped with an explosion-proof positive displacement blower unit with in-line thermal mass flow meter, which will be configured for each of the testing.

6.2.3 Sampling and Monitoring Equipment

The SVE system operation currently is equipped with a vapor discharge in-line automated chemical analysis system that will be utilized through each of the tests described, herein. An additional water separator may be installed in each SVE unit upstream or downstream from the existing primary water separators to enhance water separation. An electric heater may also be installed upstream from the primary GAC canister in each unit to lower the relative humidity of the vapor entering the GAC canisters. These changes are expected to improve operability of the SVE units in the cooler fall and spring months. The in-line vapor extraction system is also equipped with humidity and temperature meters and a manifold with switching valves for isolating extraction from specific wells. Sample collection for laboratory analysis will follow the site monitoring methods, and use 1-L (0.26-gal) SUMMA Canisters as the sample collection devices.

6.3 Sampling and Analysis

This section describes the sampling and analysis needed for the single well mass flux test.

6.3.1 Sampling Method

The online GC analysis is currently configured to automate sample collection and analysis at specified time intervals for chemical analysis. The system automatically switches a valve that allows a portion of the system effluent gas to be routed directly into the GC for analysis. Additionally, periodic samples will be collected in 1-L (0.26-gal) SUMMA Canisters and analyzed for carbon tetrachloride at Pacific Northwest National Laboratory (PNNL) or a contract laboratory consistent with EPA/625/R-96/010b. The first sample will be collected within the first hour of vapor extraction at the individual well. The second sample will be collected just prior to terminating the vapor extraction. Because the sample will be collected from a line under vacuum, the canister will only be partially filled. The final canister vacuum will be approximately equal to the vacuum in the vapor extraction line. The final vacuum will be recorded on the chain-of-custody and then measured at the laboratory after shipment and before analysis to quantify the amount of sample. The sampling time and conditions (pressure, flow rate, temperature, and humidity) will be recorded.

Quality assurance (QA) samples to be collected include field duplicates at a rate of one duplicate per 10 samples and an ambient condition sample weekly.

6.3.2 Sample Preservation and Handling

The chain-of-custody forms will be completed and stored in a cooler with the sample, and the samples will be transported to PNNL for analysis. Ice does not need to be placed in the cooler as long as the sample is kept at mean ambient temperature. The soil gas samples shall be transported to the laboratory within 24 hours of sampling.

6.3.3 Analytical Methodology

The SVE system operation currently is equipped with a vapor discharge in-line automated chemical analysis system that is used to measure carbon tetrachloride vapor concentrations, and this system will be utilized through each of the tests described, herein. Samples will be collected and analyzed following the guidance offered in EPA/625/R-96/010b. The specific EPA method to be used is TO-15, "Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)."

6.4 Data Management

All observations, data collected, and analysis results will be compiled both electronically and on paper at PNNL. The laboratory analysis results, automated chemical analysis and monitoring data, and the pressure transducer recorded data will be transferred to spreadsheets for analysis and reporting. The electronic data will be compiled checked for QA and backed up on a duplicated hard drive.

6.5 Data Analysis and Interpretation

The results of this investigation will improve understanding of vapor transport and mass flux in complex, heterogeneous systems, evaluate three innovative approaches for characterizing the magnitude and spatial distribution of vapor flux, and support the development and testing of decision support technology for SVE system closure at the 200 West Area of the DOE Hanford Site. The initial evaluation of the data will allow us to directly measure vapor mass flux from the source zone. Observation of spatial patterns in mass flux and vertical concentration profiles will be used to determine locations and magnitudes of source zones. Pressure responses and flow rates in the extraction/injection wells and other monitoring wells will be interpreted using standard pneumatic testing procedures to evaluate the air permeability near each well, in different directions, and at different vertical elevations. Statistical analysis and geospatial analysis of these mass flux and permeability results will be used to evaluate the three-dimensional distributions of the

source zones and the low permeability zones, which will be compared to evaluate the effectiveness of the SVE system for remediating these remaining source zones. Additionally, numerical modeling coupled with tomographic analysis will be used to constrain parameter estimation of the values of mass flux and permeability throughout the vadose zone, which will be used to predict vapor transport behavior.

7 Vertical Profile Mass Flux Testing

The vertical profile mass flux test will use the PneuLog technique, a multilevel pressure, flow rate, and concentration monitoring system, to obtain vertical, depth-specific measurements of flow, concentration and pressure. These data will be used to calculate the carbon tetrachloride mass flux at different elevations in the same well, producing a vertical profile of mass flux.

7.1 Procedures

The general test approach is discussed and justified in the previous sections. This section describes the specific steps required for implementing the test. Throughout the investigation, HASPs will be followed. Site conditions, field issues, changes to the test plan, field observations, weather conditions, sample identification/collection times, field data/monitoring, and timing of test operations will all be recorded in a field notebook. After the completion of each section of testing and at the conclusion of the field project, equipment will be decontaminated/removed and the SVE system will be reconfigured for regular operation.

7.2 Equipment and Materials

PneuLog testing will use the existing site SVE system to extract and treat soil gas from one well at a time. During extraction, specialized PneuLog equipment is inserted in the well and used to take depth-discrete measurements. To make these measurements, a flow sensor is moved through the well during vapor extraction and soil gas samples are collected and analyzed continuously. The test well equipment for the pneumatic logging is illustrated in Figure 11. The PneuLog instrumentation is attached to a cable, which passes through alignment pulleys and a vacuum-tight fitting at the wellhead. The instrumentation is raised or lowered by a motorized reel. Sensors in the pulley assembly indicate the depth of the measurement. Electrical leads connect the flow sensor to a data acquisition system located on the motorized reel. A vapor sampling tube connects the sample port on the instrument to a vacuum pump, also on the reel. The sampling pump draws a continuous stream of air through the sampling tube to the surface where it is analyzed for volatile organic compounds (VOCs). A photoionization detector (PID) is used to provide a continuous reading of total VOC concentration. Canister samples will be collected and analyzed by GC to determine compound-specific concentrations at discrete depths and to calibrate the PID readings. The airflow from each soil layer is related to the cumulative airflow by a simple mass balance. To determine the airflow from a given soil layer, the cumulative airflow measured below the soil layer is subtracted from the cumulative airflow measured above the soil layer. The soil permeability of the interval is then determined from Darcy's law.

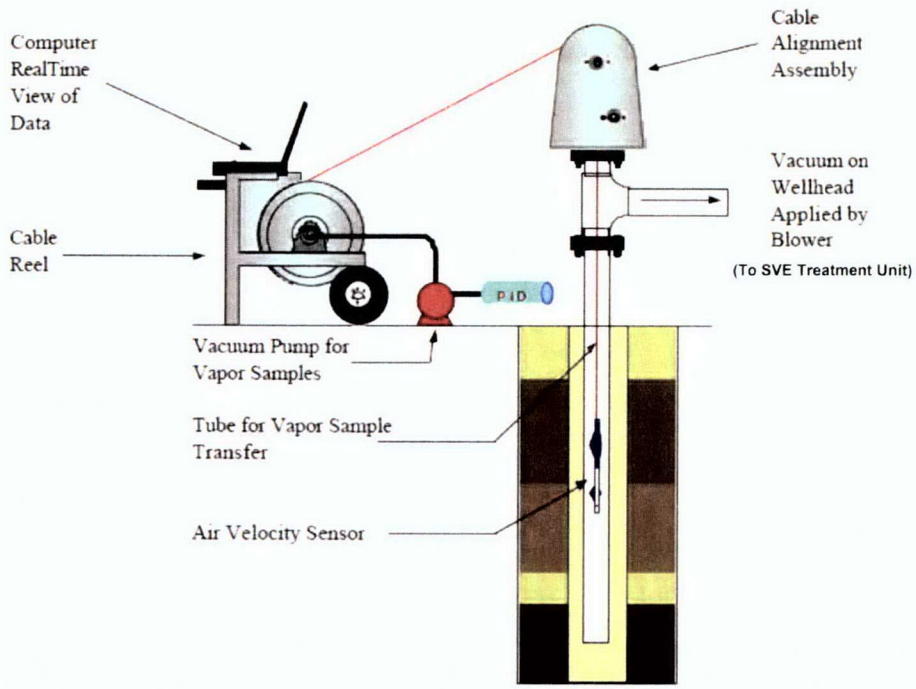


Figure 11. Schematic of PneuLog System

7.2.1 Physical Property Monitoring and Data Acquisition Equipment

The pressure monitoring of the bulk extraction line will be conducted and recorded with an automated data acquisition system including 16-channel data logger, Valco 16-port switching valves, and Setra 0.001 psi pressure transducers, K-type thermocouples, Omega HX93 humidity sensors, a Setra 270 barometric pressure gauge, and several Sierra 600-200 flow meters.

7.2.2 Gas Injection/Extraction Equipment

The SVE system operation currently is equipped with an explosion-proof positive displacement blower unit with in-line thermal mass flow meter, which will be configured for each of the testing. The down-hole equipment for the PneuLog system will be provided by the subcontractor (Praxis). This equipment will be used in all of the test wells and then properly disposed of.

7.2.3 Sampling and Monitoring Equipment

During the pneumatic logging, a small flow of air is extracted through the Teflon® tubing attached to the flow instrument in the well (Figure 11). Depth-specific samples will be drawn by a small, oil-less diaphragm pump. The total organic compound concentration in this air flow will be measured with a calibrated PID to yield the chemical concentration in soil gases extracted along the well screen depth.

® Teflon is a registered trademark of E. I. du Pont de Nemours and Company or its affiliates.

The flow data from the pneumatic well log will immediately be analyzed to yield an air production profile along the well screen and the concentration log will be analyzed to indicate the intervals with the highest chemical concentrations. The pneumatic log will then be repeated and the instrument will be paused at a depth of major change in flow or concentration, generally at the maximum concentration. At this discrete depth, a sample of the soil gas will be collected in a SUMMA Canister. A second canister sample will be collected at the top of the well. Canisters will be transported to the laboratory for analysis by GC.

The SVE system operation currently is equipped with a vapor discharge in-line automated chemical analysis system that will be utilized to provide flow, humidity, pressure, temperature, and carbon tetrachloride concentration in the bulk extraction line.

7.3 Sampling and Analysis

This section describes the sampling and analysis needed for the vertical profile mass flux test.

7.3.1 Sampling Method

Samples will be collected in 1-L (0.26-gal) SUMMA Canisters and analyzed for carbon tetrachloride at PNNL or a contract laboratory consistent with EPA/625/R-96/010b. The first sample will be collected within the first hour of vapor extraction at the individual well. The second sample will be collected just prior to terminating the vapor extraction. Because the sample will be collected from a line under vacuum, the canister will only be partially filled. The final canister vacuum will be approximately equal to the vacuum in the vapor extraction line. The final vacuum will be recorded on the chain-of-custody and then measured at the laboratory after shipment and before analysis to quantify the amount of sample. The sampling time and conditions (pressure, flow rate, temperature, and humidity) will be recorded.

QA samples to be collected include field duplicates at a rate of one duplicate per 10 samples and an ambient condition sample weekly.

7.3.2 Sample Preservation and Handling

The chain-of-custody forms will be completed and stored in a cooler with the sample, and the samples will be transported to the laboratory for analysis. Ice does not need to be placed in the cooler as long as the sample is kept at mean ambient temperature. The soil gas samples shall be transported to the laboratory within 24 hours of sampling.

7.3.3 Analytical Methodology

The SVE system operation currently is equipped with a vapor discharge in-line automated chemical analysis system that is used to measure carbon tetrachloride vapor concentrations, and this system will be utilized through each of the tests described, herein. Samples will be collected and analyzed following the guidance offered in EPA/625/R-96/010b. The specific EPA method to be used is TO-15.

7.4 Data Management

All observations, data collected, and analysis results will be compiled both electronically and on paper at PNNL. The laboratory analysis results, automated chemical analysis and monitoring data, and the pressure transducer recorded data will be transferred to spreadsheets for analysis and reporting. The electronic data will be compiled, checked for QA, as described in PNNL-17346, and backed up on a duplicated hard drive.

7.5 Data Analysis and Interpretation

Data collected during PneuLog testing will be analyzed by the subcontractor (Praxis) using standard procedures developed for this specialized testing procedure.

8 Health and Safety

The CH2M HILL Plateau Remediation Company hazardous waste operations safety and health program was developed for employees involved in hazardous waste site activities. The program was developed to comply with the *Code of Federal Regulations* (CFR) requirements of 29 CFR 1910.120 and 10 CFR 835 to ensure the safety and health of workers during hazardous waste operations.

A site-specific health and safety plan (HASP) (SGW-41472, Rev. 5) has been prepared in accordance with the health and safety program to define the chemical, radiological, and physical hazards and to specify the controls and requirements for work activities. Access and work activities will be controlled in accordance with approved work packages, as required by established internal work requirements and processes. The HASP, which will address the health and safety hazards of each phase of site operation, includes the requirements for hazardous waste operations and/or construction activities, as specified in 29 CFR 1910.120. A job-specific hazards analysis will be performed as part of the work package development. This job hazards analysis will manage worker safety during the testing with the HASP functioning as an overarching document.

Project field staff must comply with the HASP at all times. Unescorted site visitors are required to read and sign the HASP before entering the test area and must have completed the required training outlined in the HASP. Escorted visitors are briefed on health and safety concerns and must be escorted by the site superintendent (or designee) at all times when they are in the test area.

During the testing, emergency response for the 200-PW-1 OU treatability test activities will be covered by the site-specific HASP. The HASP specifies primary emergency response actions for site personnel, area alarms, implementation of the emergency action plan and emergency equipment at the task site, emergency coordinators, emergency response procedures, and spill containment procedures. A copy of the HASP will be maintained by the site superintendent (or designee).

9 Waste Management

The specific requirements for waste identification, characterization, segregation, packaging, labeling, storage, and inspection for waste generation activities associated with the 200-PW-1 OU treatability test will be managed under the waste management plan for this OU. The existing waste management plan (DOE/RL-2000-40, Rev. 8) will be used for management of waste generated during this treatability test.

10 National Environmental Policy Act Values

In accordance with DOE O 451.1B, Chg 1, and the *National Environmental Policy Act of 1969* (NEPA), *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) actions must address and incorporate NEPA values such as socioeconomic, ecological, off-site, and cumulative impacts in CERCLA documents to the extent practicable.

The NEPA values associated with this treatability test are based on the information presented in this test plan, including the site characteristics (Section 1) and conceptual design (Section 4). Applying a "sliding scale" of NEPA analysis to the 200-PW-1 OU (DOE, 2004), and considering the CERCLA applicable or relevant and appropriate requirements (ARARs) (Section 12), the principal resource areas of concern include transportation, air emissions, ecological resources, potential adverse effects to cultural and

historical resources, socioeconomics (including environmental justice concerns), and solid and liquid radioactive and hazardous waste management (Table 3).

In addition, DOE included the combined effects anticipated from ongoing *Hanford Federal Facility and Consent Order*, also known as the Tri-Party Agreement (Ecology et al., 1989a), response actions as part of the cumulative impact analysis in DOE/EIS-0391, which includes a site-wide cumulative impact groundwater analysis. This presents the public with a separate opportunity for comment as part of that NEPA process and will be used to inform the public concerning ongoing implementing cleanup actions on the Hanford Site.

Table 3. NEPA Values Evaluation

NEPA Value	Description	Evaluation
Transportation	Considers impacts of the proposed action on local traffic (i.e., traffic at the Hanford Site) and traffic in the surrounding region.	Implementation of treatability test would be expected to produce minimal impacts on local traffic. A majority of the impact would be associated with additional personnel traveling to the test site during the testing.
Air Quality	Considers potential air quality concerns associated with emissions generated during the proposed action.	Criteria and toxic air pollutant airborne releases associated with the treatability test are expected to be minor with the use of appropriate work controls (no radiological air emissions are anticipated). Any potential of airborne release of contaminants during the test will be controlled in accordance with DOE radiation control and air pollution control standards, to minimize emissions of air pollutants at the Hanford Site, and protect all communities outside the Site boundaries. Operation of trucks and other diesel-powered equipment for this treatability test would be expected, in the short-term, to introduce quantities of sulfur dioxide, nitrogen dioxide, particulates, and other pollutants to the atmosphere, typical of similar-sized downhole testing projects. These releases would not be expected to cause any air quality standards to be exceeded and (as needed) dust generated during remedial activities would be minimized by watering or other dust control measures. Vehicular and equipment emissions will be controlled and mitigated in compliance with the substantive standards for air quality protection that apply to the Hanford Site.
Natural, Cultural, and Historical Resources	Considers impacts of the proposed action on wildlife, wildlife habitat, archeological sites and artifacts, and historically significant properties.	Impacts on ecological resources in the vicinity of the treatability test will continue to be mitigated in accordance with DOE/RL-96-32 and DOE/RL-96-88, and with the applicable standards of all relevant biological species protection regulations. Because this treatability test will be conducted in the area of an ongoing interim action, a site-specific ecological resource review will not be conducted before initiation of testing activities. Because the test site has already been disturbed, and only isolated artifacts could be encountered during project activities, implementation of DOE/RL-98-10 and consultation with area Tribes as needed, will help ensure appropriate mitigation to avoid or minimize any adverse cultural or historical resource effects and address any relevant concerns. Impacts to other cultural values will be minimized

Table 3. NEPA Values Evaluation

NEPA Value	Description	Evaluation
		through implementation of DOE/RL-98-10, DOE/RL-2005-27, and consultation with area Tribes as needed. This will help ensure appropriate mitigation to avoid or minimize any adverse effects to natural and cultural resources and address any other relevant concerns. Potential impacts to cultural and historical resources are not anticipated because the test does not involve construction activities Because this treatability test will be conducted in the area of an ongoing interim action, a site-specific cultural resource review will not be conducted before initiation of testing activities.
Socioeconomic Impacts	Considers impacts pertaining to employment, income, other services (e.g., water and power utilities), and the effect of implementation of the proposed action on the availability of services and materials.	The proposed treatability test is within the scope of current DOE, Richland Operations Office environmental restoration activities and will have minimal impact on the current availability of services and materials. This work is expected to be accomplished largely using employees from the existing contractor workforce. Even if the test creates additional service sector jobs, the total expected increase in employment would be expected to be less than one percent of the current employment levels. The socioeconomic impact of the project will contribute to the continuing overall positive employment and economic impacts on eastern Washington communities from Hanford Site cleanup operations.
Environmental Justice	Considers whether the proposed response actions would have inappropriately or disproportionately high and adverse human health or environmental effects on minority or low income populations.	Per Executive Order 12898, DOE seeks to ensure that no group of people bears a disproportionate share of negative environmental consequences resulting from proposed federal actions. There are no impacts associated with the proposed treatability test that could reasonably be determined to affect any member of the public; therefore, they would not have the potential for high and disproportional adverse impacts on minority or low income groups.
Cumulative Impacts (Direct and Indirect)	Considers whether the proposed action could have cumulative impacts on human health or the environment when considered together with other activities locally, at the Hanford Site, or in the region.	The concern is associated directly with the targeted area. Because of the temporary nature of the test activities and their remote location, cumulative impacts on air quality or noise with other Hanford Site or regional construction and cleanup projects would be minimal. The soil vapor extracted from the 200-PW-1 OU during the test will be treated. The net anticipated effect could be a positive contribution to cumulative environmental effects at the Hanford Site through removal, treatment, and disposal of such hazardous substances and contaminants of concern using a treatment technology (GAC) that has been designed and legally authorized to safely contain such contaminants. The volume of soil vapor that will be generated for treatment during implementation of the treatability test is estimated to be approximately 0.1 million cubic meters (4 million cubic feet) over the expected duration of this test. Wastes generated during implementation of the treatability test would be manageable within the

Table 3. NEPA Values Evaluation

NEPA Value	Description	Evaluation
		capacities of existing facilities. For perspective, soil vapor extraction operations at the 216-Z-9 site treated 1 million cubic meters of extracted soil vapor in calendar year 2009 and in calendar year 2008.
Mitigation	Considers whether or not if adverse impacts cannot be avoided, response action planning should minimize them to the extent practicable. This value identifies required mitigation activities.	Compliance with the substantive requirements of the ARARs will mitigate potential environmental impacts on the natural environment, including migratory birds, and endangered species. DOE has also established policies and procedures for the management of ecological and cultural resources when actions might affect such resources (DOE/RL-96-32, DOE/RL-96-88, and DOE/RL-98-10). Cultural resource and biological species reviews/surveys are undertaken that also provide suggested migration activities to assure adverse effects associated with implementing the actions are minimized or avoided. Health and safety procedures, documented in the Health and Safety Plan, established by site contractors would mitigate risks to workers from the remedial activities.
Irreversible and Irretrievable Commitment of Resources	Considers the use of nonrenewable resources for the proposed response actions and the effects that resource consumption would have on future generations. (When a resource [e.g., energy minerals, water, wetland] is used or destroyed and cannot be replaced within a reasonable amount of time, its use is considered irreversible.)	During the test, normal usage of resources such as fuel and water will be irreversibly used.

ARAR = applicable or relevant and appropriate requirement
DOE = U.S. Department of Energy
GAC = granular activated carbon
NEPA = *National Environmental Policy Act of 1969*
OU = operable unit

11 Reports

The results of this investigation will be distributed as a final report covering all of the materials/methods, data, results, analysis, conclusions, and recommendations. An additional report will follow the final report. This additional report will present the results of additional modeling and data analysis using the data collected during the investigation.

12 Compliance with Applicable or Relevant and Appropriate Requirements

The ARARs that are potentially pertinent to this treatability test are listed in Table 4 (federal ARARs) and Table 5 (state ARARs). Onsite activities such as this treatability test must comply with ARARs but only need to comply with the substantive parts of those requirements.

Table 4. Identification of Federal Applicable or Relevant and Appropriate Requirements

ARAR Citation	ARAR	Requirement	Rationale for Use
Other Federal ARARs			
Archeological and Historic Preservation Act of 1960,16 USC 469a.1 through -2(d)	ARAR	Requires that the treatability test at the 200-PW-1 Groundwater OU do not cause the loss of any archaeological or historic data. This act mandates preservation of the data and does not require protection of the actual historical sites.	Archeological and historic sites have been identified within the 200 Areas; therefore, the substantive requirements of this act are applicable to actions that might disturb these sites. This requirement is action-specific.
National Historic Preservation Act of 1966,16 USC 470, Section 106, et seq.	ARAR	Requires federal agencies to consider the impacts of their undertaking on cultural properties through identification, evaluation and mitigation processes.	Cultural and historic sites have been identified within the 200 Areas; therefore, the substantive requirements of this act are applicable to actions that might disturb these types of sites. This requirement is location-specific.
Native American Graves Protection and Repatriation Act,25 USC 3001, et seq.	ARAR	Establishes federal agency responsibility for discovery of human remains, associated and unassociated funerary objects, sacred objects, and items of cultural patrimony.	Substantive requirements of this act are applicable if remains and sacred objects are found during remediation. This is a location-specific requirement.
Endangered Species Act of 1973, 16 USC 1531, et seq., subsection 16 USC 1536(c)	ARAR	Establishes requirements for actions by federal agencies that are likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. If remediation is within critical habitat or buffer zones surrounding threatened or endangered species, mitigation measures must be taken to protect the resource.	Substantive requirements of this act are applicable if threatened or endangered species are identified in areas where treatability test will occur. This is a location-specific requirement.

ARAR = applicable or relevant and appropriate requirement

OU = operable unit

USC = *United States Code*

Table 5. Identification of State Applicable or Relevant and Appropriate Requirements and To Be Considered

ARAR Citation	ARAR	Requirement	Rationale for Use
"Dangerous Waste Regulations," WAC 173-303			
"Identifying Solid Waste," WAC 173-303-016	ARAR	Identifies those materials that are and are not solid wastes.	Substantive requirements of these regulations are applicable because they define which materials are subject to the designation regulations. Specifically, materials that are generated during the treatability test would, if a solid waste, be subject to the requirements for solid wastes. This requirement is action-specific.
"Recycling Processes Involving Solid Waste," WAC 173-303-017	ARAR	Identifies materials that are and are not solid wastes when recycled.	Substantive requirements of these regulations are applicable because they define which materials are subject to the designation regulations. Specifically, materials that are generated during the treatability test would if a solid waste be subject to the requirements for solid wastes. This requirement is action-specific.
"Designation of Dangerous Waste," WAC 173-303-070(3)	ARAR	Establishes whether a solid waste is, or is not, a dangerous waste or an extremely hazardous waste.	Substantive requirements of these regulations are applicable to materials generated during the treatability test. Specifically, solid waste that is generated during this treatability test would if a dangerous waste be subject to the dangerous waste requirements. This requirement is action-specific.
"Excluded Categories of Waste," WAC 173-303-071	ARAR	Describes those categories of wastes that are excluded from the requirements of WAC 173-303 (excluding WAC 173-303-050).	This regulation is applicable to treatability test in the 200-PW-1 Groundwater OU should wastes identified in WAC 173-303-071 be generated. This requirement is action-specific.
"Conditional Exclusion of Special Wastes," WAC 173-303-073	ARAR	Establishes the conditional exclusion and the management requirements of special wastes, as defined in WAC 173-303-040.	Substantive requirements of these regulations are applicable to special wastes generated during the treatability test. Specifically, the substantive standards for management of special waste are relevant and appropriate to the management of special waste that will be generated during the treatability test. This requirement is action-specific.

Table 5. Identification of State Applicable or Relevant and Appropriate Requirements and To Be Considered

ARAR Citation	ARAR	Requirement	Rationale for Use
"Requirements for Universal Waste," WAC 173-303-077	ARAR	Identifies those wastes exempted from regulation under WAC 173-303-140 and WAC 173-303-170 through 173-303-9906 (excluding WAC 173-303-960). These wastes are subject to regulation under WAC 173-303-573.	Substantive requirements of these regulations are applicable to universal waste generated during the treatability test. Specifically, the substantive standards for management of universal waste are relevant and appropriate to the management of universal waste that will be generatted during the treatability test. This requirement is action-specific.
"Recycled, Reclaimed, and Recovered Wastes," WAC 173-303-120 Specific Subsections: WAC 173-303-120(3) WAC 173-303-120(5)	ARAR	These regulations define the requirements for recycling materials that are solid and dangerous waste. Specifically, WAC 173-303-120(3) provides for the management of certain recyclable materials, including spent refrigerants, antifreeze, and lead-acid batteries. WAC 173-303-120(5) provides for the recycling of used oil.	Substantive requirements of these regulations are applicable to certain materials that might be generated during the treatability test. Eligible recyclable materials can be recycled and/or conditionally excluded from certain dangerous waste requirements. This requirement is action-specific.
"Land Disposal Restrictions," WAC 173-303-140(4)	ARAR	This regulation establishes state standards for land disposal of dangerous waste and incorporates, by reference, federal land-disposal restrictions of 40 CFR 268 that are relevant and appropriate to solid waste that is designated as dangerous or mixed waste in accordance with WAC 173-303-070(3).	The substantive requirements of this regulation are applicable to materials generated during the treatability test. Specifically, dangerous/mixed waste that is generated during the treatability test would be subject to the relevant and appropriate substantive land-disposal restrictions. The offsite treatment, disposal or management of such waste would be subject to all applicable substantive and procedural laws and regulations, including LDR requirements. This requirement is action-specific.

Table 5. Identification of State Applicable or Relevant and Appropriate Requirements and To Be Considered

ARAR Citation	ARAR	Requirement	Rationale for Use
"Requirements for Generators of Dangerous Waste," WAC 173-303-170	ARAR	Establishes the requirements for dangerous waste generators.	Substantive requirements of these regulations are applicable to materials generated during the treatability test. Specifically, the substantive standards for management of dangerous/mixed waste are relevant and appropriate to the management of dangerous waste that will be generated during the treatability test. For purposes of this treatability test, WAC 173-303-170(3) includes the substantive provisions of WAC 173-303-200 by reference. WAC 173-303-200 further includes certain substantive standards from WAC 173-303-630 and -640 by reference. This requirement is action-specific.
"Nuclear Energy and Radiation" (RCW 70.98); WAC 246-247, "Radiation Protection -- Air Emissions"			
WAC 246-247-035 (1)(a)(ii), "National Standards. Adopted by Reference for Sources of Radionuclide Emissions" WAC 246-247-040(3), "General Standards" WAC 246-247-040(4), "General Standards"	ARAR	Establishes emission standards for radionuclides equivalent to 40 CFR 61, Subpart H, by reference. Combined Hanford Site radionuclide airborne emissions shall be controlled so as not to exceed amounts that would cause an exposure to any member of the public of greater than 10 mrem/yr effective dose equivalent.	Substantive requirements of this standard are applicable because the treatability test may activities such as excavation, decontamination, and stabilization of contaminated areas that many provide airborne emissions of radionuclides.
Clean Air Act; WAC 173-460, "Controls for New Sources of Toxic Air Pollutants"			
WAC 173-460-010, "Purpose" WAC 173-460-030, "Applicability" WAC 173-460-060, "Control Technology Requirements" WAC 173-460-070, "Ambient Impact Requirement" WAC 173-460-080, "First Tier Review" WAC 173-460-150, "Table of ASIL, SQER and de minimis emission values"	ARAR	Hazardous contaminants detected in soil at the 200-PW-1 OU area include constituents that would constitute toxic air pollutants if released to the air.	Groundwater and soil remediation activities such as treatment systems that have the potential to emit hazardous air emissions and would be considered a new source.

Table 5. Identification of State Applicable or Relevant and Appropriate Requirements and To Be Considered

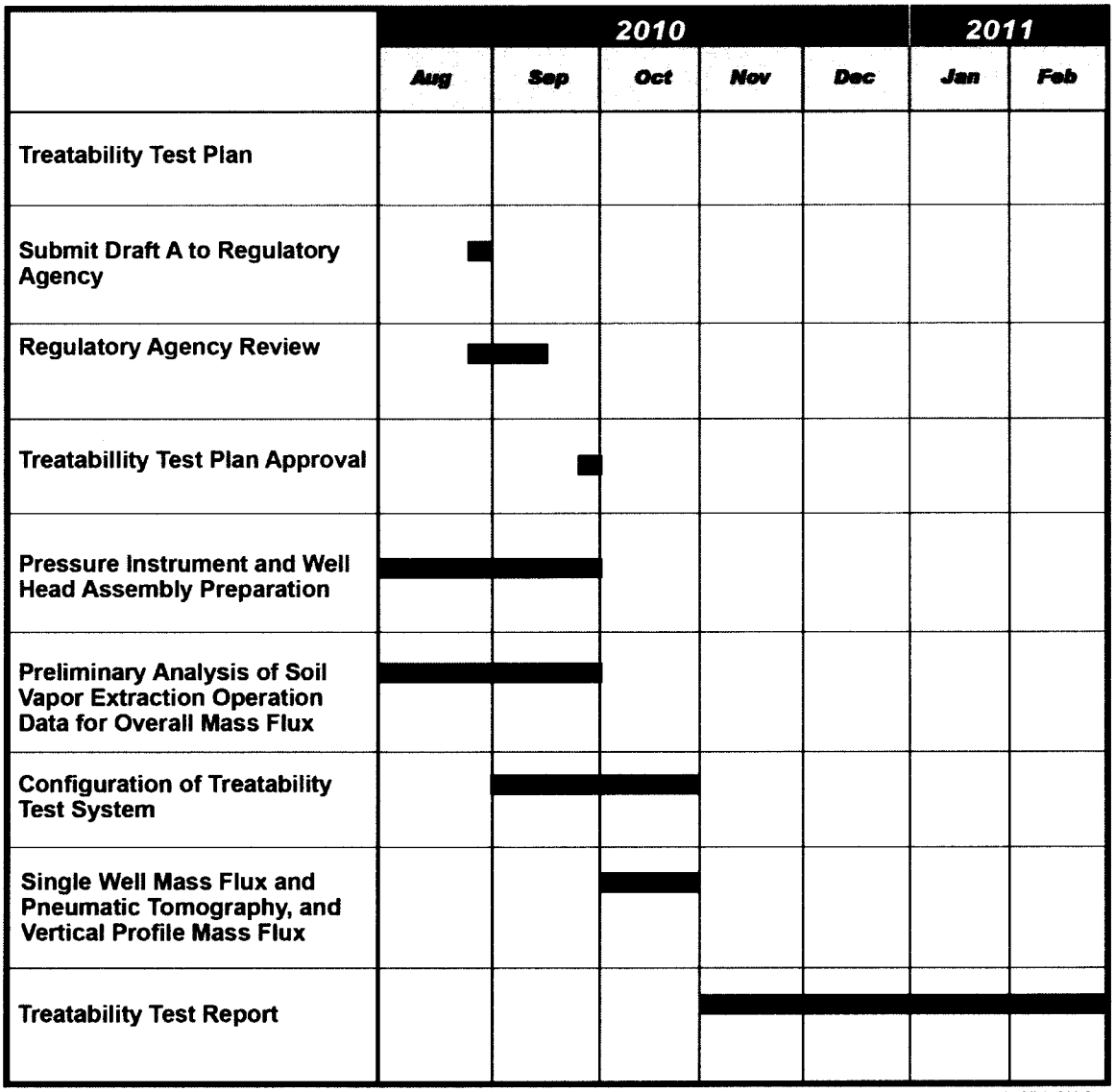
ARAR Citation	ARAR	Requirement	Rationale for Use

ARAR = applicable or relevant and appropriate requirement
ASIL = acceptable source impact level
CFR = *Code of Federal Regulations*
LDR = land disposal restriction
OU = operable unit
RCW = *Revised Code of Washington*
SQER = small quantity emission rate
WAC = *Washington Administrative Code*

13 Schedule

Figure 12 provides the overall project schedule for the 200-PW-1 OU treatability test activities described in this test plan.

Figure 12. Schedule for the 200-PW-1 Operable Unit Treatability Test



14 Management and Staffing

The following subsections address the project organization and change control for the 200-PW-1 OU treatability test.

14.1 Project Organization

The project organization is shown in Figure 13. The primary roles are described for each member of the project organization.

Regulatory Lead. EPA has approval authority as the lead regulatory agency for the 200-PW-1 OU and the work being performed under this test plan. EPA works with the DOE Richland Operations Office (RL) to resolve concerns over the work as described in this test plan in accordance with the Tri-Party Agreement (Ecology et al., 1989a).

DOE OU Lead. The DOE OU Lead is responsible for authorizing the Contractor to perform activities under CERCLA, the *Resource Conservation and Recovery Act of 1976* (RCRA), the *Atomic Energy Act of 1954*, and the Tri-Party Agreement (Ecology et al., 1989a) for the Hanford Site. It is the responsibility of the DOE Richland Operations Office (DOE-RL) to obtain lead regulatory agency approval of the test plan authorizing the field activities. The DOE OU Lead is responsible for overseeing day-to-day activities of the Contractor performing the work scope and working with the Contractor and the regulatory agencies to identify and resolve issues.

200-PW-1 OU Project Manager. The 200-PW-1 OU Project Manager (or designee) is responsible for managing sampling documents and requirements, field activities, and subcontracted tasks and ensuring that the project file is properly maintained. The 200-PW-1 OU Project Manager ensures that the sampling design requirements are converted into field instructions (e.g., work packages) providing specific direction for field activities. The 200-PW-1 OU Project Manager works closely with QA, Health and Safety, and the Field Team Lead to integrate these and other lead disciplines in the planning and implementation of the work scope. The 200-PW-1 OU Project Manager maintains a list of individuals or organizations filling each of the functional elements of the project organization. In addition, the 200-PW-1 OU Project Manager is responsible for version control of the test plan to ensure that personnel are working to the most current job requirements. The 200-PW-1 OU Project Manager also coordinates with DOE-RL and the primary contractor management on all sampling activities. The 200-PW-1 OU Project Manager supports DOE-RL in coordinating sampling activities with the regulators.

Quality Assurance Manager. The QA Manager (or designee) is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project documents (including the data quality objective [DQO] summary report, field sampling plan, and the QA project plan); and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA Engineer must be independent of the unit generating the data.

Field Team Lead. The Field Team Lead, or lead scientist, will act as the technical lead for the duration of the aquifer test. The lead scientist is responsible for ensuring and documenting that the data are collected in accordance with the treatability test plan and associated sampling and analysis plan. The lead scientist, in conjunction with the 200-PW-1 OU Project Manager, will provide clarification of test requirements and test steps, as needed.

Operations Supervisor. The Operations Supervisor is responsible for the operation of the SVE unit. The Operations Supervisor has the necessary qualifications to release (i.e., approve the daily activities) and

direct the work. The Field Team Lead and the Project Manager will work with the Operations Supervisor to implement SVE operations during the test.

Environmental Compliance Officer. The Environmental Compliance Officer (ECO) provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The ECO also reviews plans, procedures, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues that affect operations and develops cost effective solutions; and responds to environmental/regulatory issues or concerns raised by DOE-RL and/or regulatory agencies. The ECO also oversees project implementation for compliance with applicable internal and external environmental requirements.

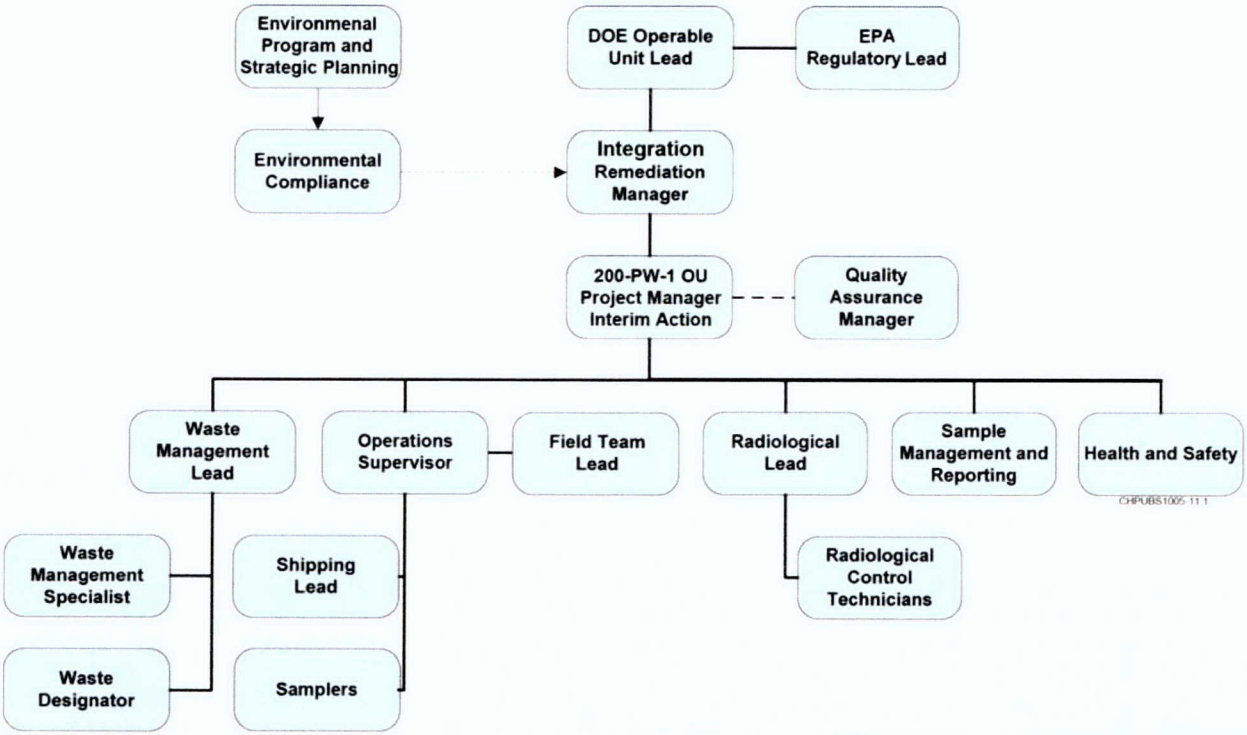


Figure 13. Project Organization for the 200-PW-1 Operable Unit Treatability Test

14.2 Change Management

Three types of changes during the treatability test could affect compliance with the requirements in the test plan.

- A **fundamental change** is a change that does not meet the requirements set forth in the test plan or that incorporates testing activities not defined in the scope of the test plan.
- A **significant change** generally involves a change to a component of the test that does not fundamentally alter the overall test approach.
- A **minor change** will not have a significant impact on the scope, performance, or cost of the test. Minor changes should be documented in the project file (e.g., through interoffice memoranda or logbooks). A non-significant change will not impact the requirements of the test plan.

Determining the significance of the change is the responsibility of DOE and the lead regulatory agency. The 200-PW-1 OU Project Manager is responsible for tracking all changes and obtaining appropriate reviews by contractor staff. The 200-PW-1 OU Project Manager will discuss the change with DOE, and DOE will then discuss with the lead regulatory agency the type of change that is necessary, up to and including changes in accordance with Section 9.3 and Section 12.0 of the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b). Appropriate documentation will follow, in accordance with the requirements for that type of change.

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Appendix A

Sampling and Analysis Plan

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Terms

ALARA	as low as reasonably achievable
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CCU	Cold Creek Unit
DOE	U.S. Department of Energy
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
ECO	environmental compliance officer
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HEIS	Hanford Environmental Information System
N/A	not applicable
OU	operable unit
ppbv	parts per billion volume
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	radiological control technician
RL	DOE Richland Operations Office
RPD	relative percent difference
SAP	sampling and analysis plan
SVE	soil vapor extraction
TPA	Tri-Party Agreement
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*

A1 Introduction

This sampling and analysis plan (SAP) provides sampling and analysis requirements for air associated with the soil vapor extraction (SVE) system treatability test at the 200-PW-1 Operable Unit (OU) on the Hanford Site (Figure A1-1). Specific test objectives and parameters are included within the Treatability Test Plan to which this SAP is included as Appendix A. Other measurements and data collected during the treatability test, such as monitoring of pressure and flow rates, are addressed in the Treatability Test Plan but are not included in this SAP.

A1.1 Soil Vapor Sampling Data Needs

The process used to identify the treatability test data needs and the data needs outcome is summarized in the Treatability Test Plan. Data will be collected as part of the investigation of field scale mass flux and pneumatic tomography and vertical concentration profiling for source zone characterization and SVE remediation system closure evaluation. Data obtained from the treatability test will be used to:

- Support the development and testing of the parameters to be used to support a method for SVE system closure at the 200 West Area of the Hanford Site.
- Collect data to verify, or refine, the conceptual model.
- Test approaches for characterizing the magnitude and spatial distribution of mass flux.
- Determine adequacy of existing system for addressing additional mass removal.

The three tests within the treatability test include overall mass flux, single well mass flux and pneumatic tomography, and vertical profile mass flux. Specific steps of these tests are included in the Treatability Test Plan. Soil vapor samples will be collected in association with single well mass flux and vertical profile testing. Samples will be analyzed for carbon tetrachloride. Table A1-1 presents the wells to be included as part of the treatability test. Figure A1-2 shows the location of these wells within the test area. Section A3.2 summarizes the treatability test activities. The sample and analysis activities are presented in Section A3.3.

Table A1-1. Candidate Soil Vapor Extraction Wells for Testing at the 216-Z-9 Site

Wells Above Cold Creek Unit	Depth bgs m (ft)	Wells Below Cold Creek Unit	Depth bgs m (ft)	Vertical Profiling Wells	Depth bgs m (ft)
299-W15-8U	28-34 (93-113)	299-W15-8L	50-59(165-195)	299-W15-32	59-71 (194-234)
299-W15-9U	27-34 (88-113)	299-W15-84L	50-59(165-195)	299-W15-86	33-42 (107-137)
299-W15-48	29-36 (94-120)	299-W15-86	33-42 (107-137)	299-W15-217	32-37 (106-121)
299-W15-82	23-27 (75-90)	299-W15-95L	39-48 (129-159)		
299-W15-84U	23-27 (75-90)	299-W15-216L	53-56 (175-185)		
299-W15-85	25-30 (83-98)	299-W15-218L	55-60 (181-196)		
299-W15-95U	22-30 (73-98)	299-W15-219L	51-55 (167-182)		
299-W15-216U	21-24 (70-80)	299-W15-32	59-71 (194-234)		

Table A1-1. Candidate Soil Vapor Extraction Wells for Testing at the 216-Z-9 Site

Wells Above Cold Creek Unit	Depth bgs m (ft)	Wells Below Cold Creek Unit	Depth bgs m (ft)	Vertical Profiling Wells	Depth bgs m (ft)
299-W15-217	32-37 (106-121)				
299-W15-218U	30-35 (99-114)				
299-W15-219U	27-31 (87-102)				
299-W15-220U	24-29 (80-95)				
299-W15-223	31-36 (103-117)				
C4937	18-20 (59-64)				
C4938	18-20 (59-64)				
C5340	18-20 (60-65)				

A1.2 Project Schedule

Activities within the scope of this SAP are included in the schedule presented in Section 13 of the Treatability Test Plan. The schedule provides the overall project schedule for the treatability test activities.

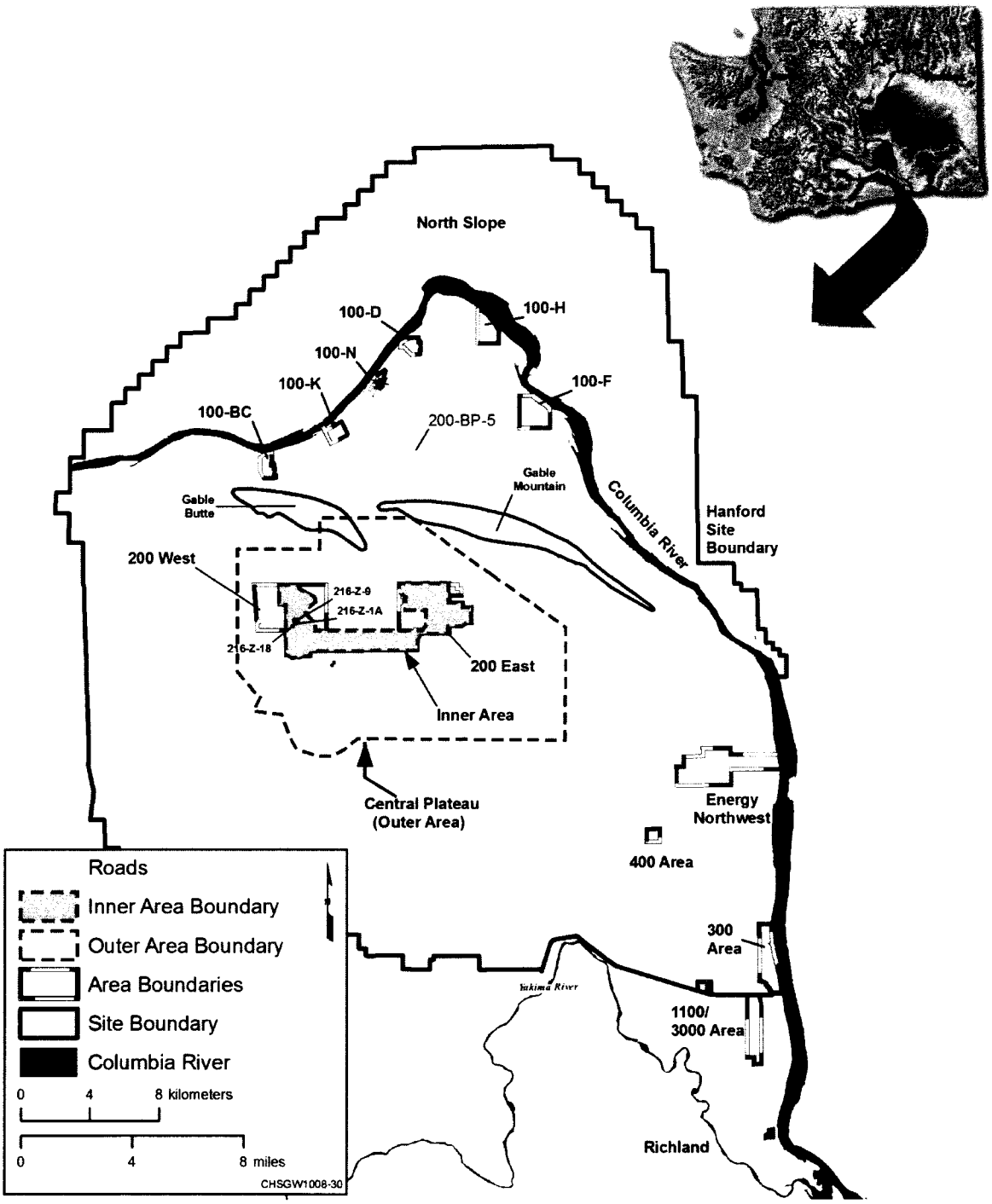
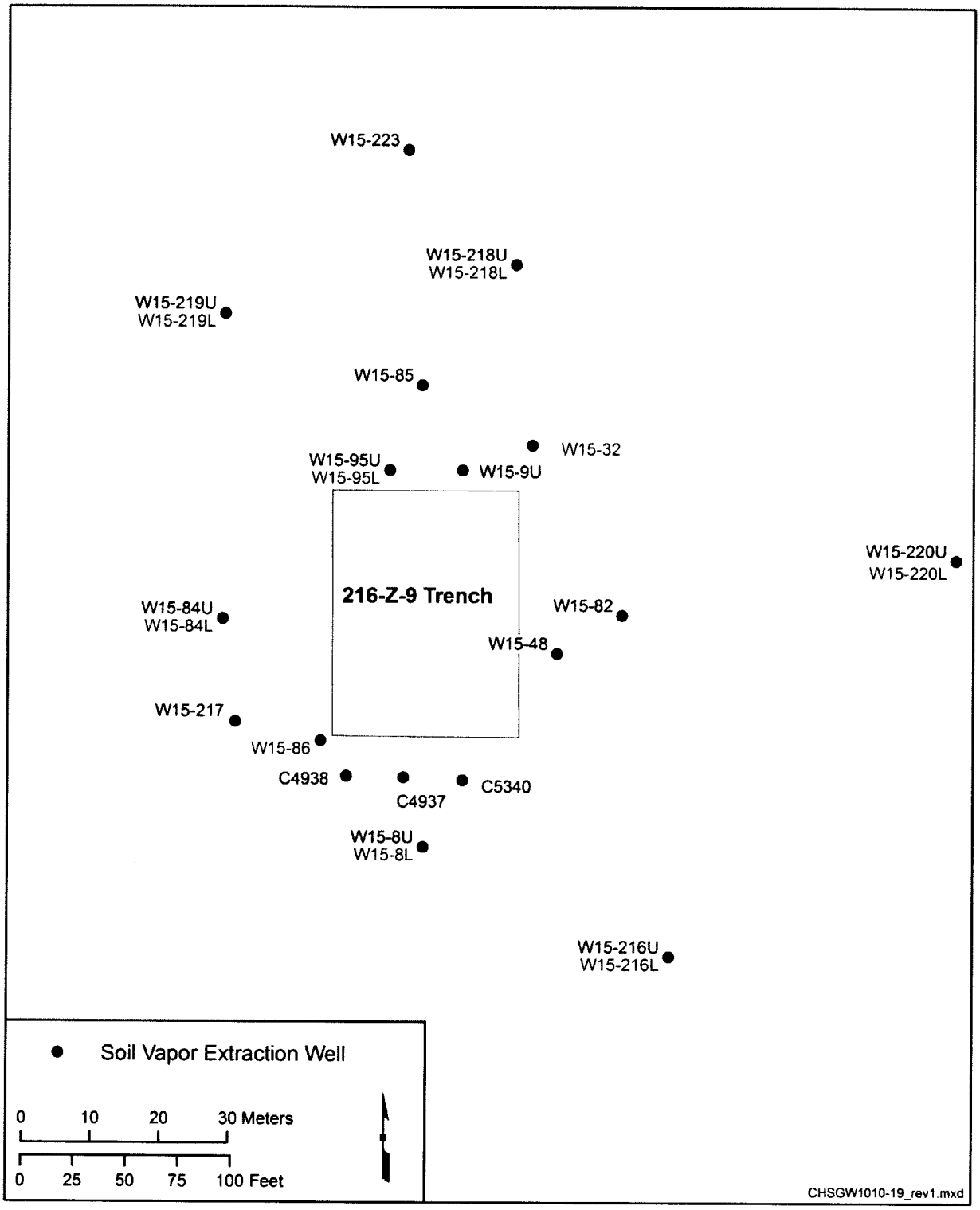


Figure A1-1. Location of the 200-PW-1 Operable Unit



Notes: The prefix 299- has been omitted from all well names. Red and blue labels indicate wells that may be used for testing above the CCU and testing below the CCU, respectively. Wells 299-W15-217, 299-W15-86, and 299-W15-32 will be used for vertical profiling.

Figure A1-2. Location Map of Soil Vapor Extraction Wells Selected for Testing at the 216-Z-9 Site

A2 Quality Assurance Project Plan

This Quality Assurance Project Plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. This QAPjP has been developed to comply with the requirements of the following:

- DOE/RL-96-68
- DOE O 414.1C
- 10 *Code of Federal Regulations* (CFR) 830, Subpart A
- EPA/240/B-01/003

Section 6.5 and Section 7.8 of the Washington State Department of Ecology (Ecology), U.S. Environmental Protection Agency (EPA), and U.S. Department of Energy (DOE) *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b), also known as the Tri-Party Agreement (TPA), require that the quality assurance (QA)/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal units, as well as for past practice processes. Therefore, this QAPjP follows the QA elements of EPA/240/B-01/003. This QAPjP demonstrates conformance to Part B requirements of ANSI/ASQC E4-1994.

In addition to the requirements cited above, EPA-505-B-04-900A was used as a resource for identification of QAPjP elements. This manual is not imposed through the TPA. However, it is a valuable resource and provides a comprehensive treatment of quality elements that could be addressed in a SAP. It was also designed to be compatible with EPA/240/B-01/003, which forms the basis for this QAPjP.

This QAPjP is divided into the following four sections that describe the quality requirements and controls applicable to this investigation:

1. **Project Management (Section A2.1)** – This section addresses elements of project management, including the project history and objectives, and roles and responsibilities of the participants. These elements ensure that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs are documented.

2. **Data Generation and Acquisition (Section A2.2)** – This section addresses aspects of project design and implementation. Implementation of these elements ensure that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and are properly documented.

3. **Assessment and Oversight (Section A2.3)** – This section addresses the activities for assessing the effectiveness of implementation of the project and associated QA/QC activities. The purpose of the assessment is to ensure that the QAPjP is implemented as prescribed.

4. **Data Validation and Usability (Section A2.4)** – This section addresses the QA activities occurring after the data collection or generation phase of the project is completed. Implementation of these elements ensures that data conform to the specified criteria, thus achieving the project objectives.

A2.1 Project Management

The following sections address the basic aspects of project management and are designed to ensure that the project has defined goals, the participants understand the goals and approaches used, and the planned outputs are appropriately documented. Project management roles and responsibilities discussed in this section apply to the major activities covered under this SAP.

A2.1.1 Project and Task Organization

The primary contractor, or its approved subcontractor, is responsible for planning, coordinating, collecting, preparing, packaging, and shipping samples to the laboratory. The project organization, with regard to sampling activities, is described in the following sections and is shown on Figure A2-1. The 200-PW-1 OU Project Manager maintains a list of individuals or organizations as points of contact for each functional element in the figure. For each functional primary contractor role, there is a corresponding oversight role within DOE.

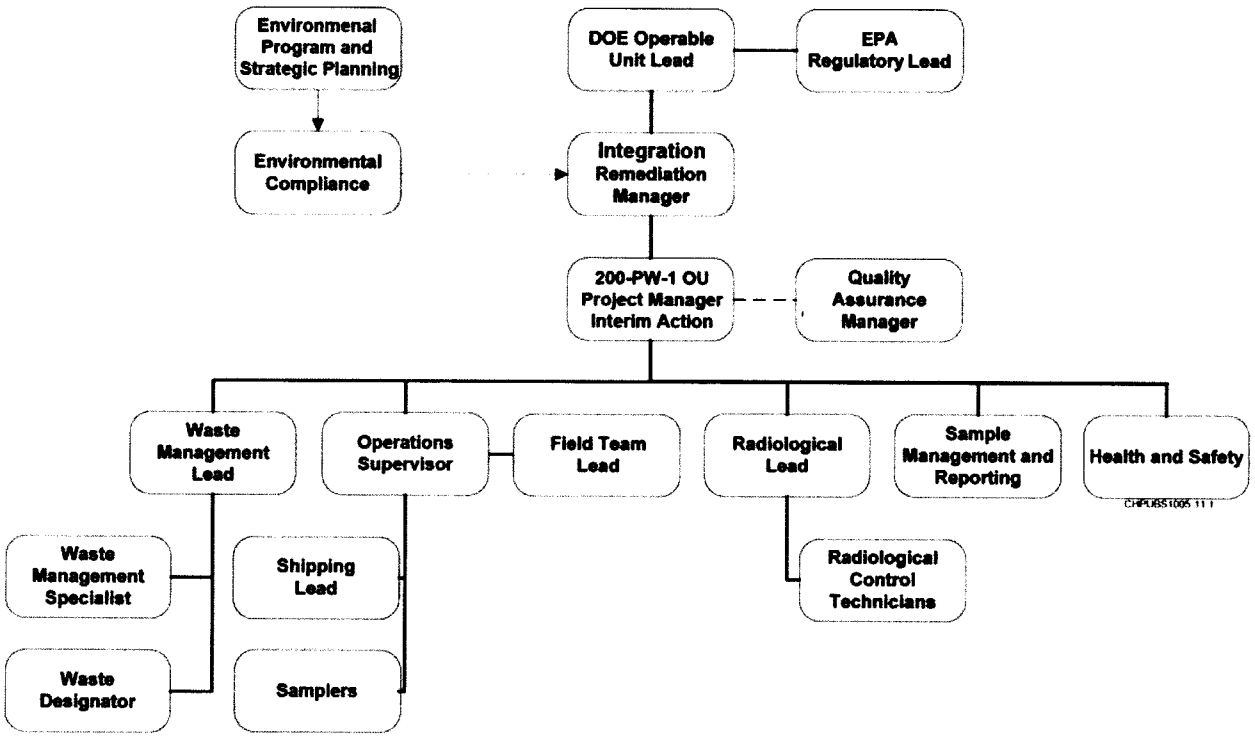


Figure A2-1. Project Organization

Regulatory Lead. The EPA has approval authority as the lead regulatory agency for the 200-PW-1 OU and the work being performed under this SAP. The EPA Regulatory Lead works with the DOE Richland Operations Office (DOE-RL) to resolve concerns over the work described in this SAP in accordance with the Tri-Party Agreement (Ecology et al., 1989a).

DOE OU Lead. The DOE OU Lead is responsible for authorizing the Contractor to perform activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the TPA for the Hanford Site. It is the responsibility of DOE-RL to obtain lead regulatory agency approval of the SAP authorizing the field sampling activities. The DOE OU Lead is responsible for overseeing day-to-day activities of the Contractor performing the work scope and working with the Contractor and the regulatory agencies to identify and resolve issues.

200-PW-1 OU Project Manager. The 200-PW-1 OU Project Manager (or designee) is responsible for managing sampling documents and requirements, field activities and subcontracted tasks, and ensuring that the project file is properly maintained. The 200-PW-1 OU Project Manager ensures that the sampling design requirements are converted into field instructions (e.g., work packages) providing specific direction for field activities. The 200-PW-1 OU Project Manager works closely with QA, Health and

Safety, and the Field Team Lead to integrate these and other lead disciplines in planning and implementing the work scope. The 200-PW-1 OU Project Manager maintains a list of individuals or organizations filling each of the functional elements of the project organization. In addition, the 200-PW-1 OU Project Manager is responsible for version control of the SAP to ensure that personnel are working to the most current job requirements. The 200-PW-1 OU Project Manager also coordinates with DOE-RL and primary contractor management on all sampling activities. The 200-PW-1 OU Project Manager supports DOE-RL in coordinating sampling activities with the regulators.

Operations Supervisor. The Operations Supervisor is responsible for operation of the SVE unit. The Operations Supervisor has the necessary qualifications to release (i.e., approve the daily activities) and direct the work. The Field Team Lead and the Project Manager will work with the Operations Supervisor to implement SVE operations during the test.

Quality Assurance Manager. The QA Manager (or designee) is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements, reviewing project documents (including the field sampling plan and QAPjP), and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA Manager must be independent of the unit generating the data.

Field Team Lead. The field team lead, or lead scientist, will act as the technical lead for the duration of the treatability test. The lead scientist is responsible for ensuring and documenting that the data are collected in accordance with the Treatability Test Plan and this SAP. The lead scientist, in conjunction with the 200-PW-1 OU Project Manager, will provide clarification of test requirements and test steps, as needed.

The field team lead is responsible for planning and coordinating field sampling resources. The field team lead ensures that samplers are appropriately trained and available. Additional related responsibilities include ensuring that the sampling design is understood and can be performed as specified by directing training, mock-ups, and practice sessions with field personnel.

The field team lead directs the samplers. The samplers collect groundwater, soil, vapor, and multimedia samples, including replicates/duplicates, and prepare sample blanks in accordance with the SAP, corresponding standard procedures, and work packages. The samplers complete field logbook entries, chain-of-custody forms, and shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

Environmental Compliance Officer. The Environmental Compliance Officer (ECO) provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The ECO also reviews plans, procedures, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues affecting operations and develops cost effective solutions; and responds to environmental/regulatory issues or concerns raised by DOE-RL and/or regulatory agencies. The ECO also oversees project implementation for compliance with applicable internal and external environmental requirements.

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 by internal primary contractor work requirements. In addition, the Health and Safety organization provides assistance to project personnel in complying with applicable health and safety standards and requirements. The Health and

Safety organization coordinates with the Radiological Lead to determine personal protective clothing requirements.

Radiological Lead. The Radiological Lead is responsible for radiological/health physics support within the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for all work planning. In addition, the Radiological Lead identifies radiological hazards and implements appropriate controls to maintain worker exposures ALARA (e.g., requiring personal protective equipment). The Radiological Lead also interfaces with the project Health and Safety contact, and plans and directs Radiological Control Technician (RCT) support for all activities.

Sample Management and Reporting. The Sample Management and Reporting organization coordinates laboratory analytical work, ensuring that the laboratories conform to Hanford Site internal laboratory QA requirements (or their equivalent), as approved by DOE, EPA, and Ecology. Sample Management and Reporting receives the analytical data from the laboratories, performs the data entry into the Hanford Environmental Information System (HEIS), and arranges for data validation. Sample Management and Reporting is responsible for informing the 200-PW-1 OU Project Manager of any issues reported by the analytical laboratory. The Sample Management and Reporting organization develops and oversees the implementation of the letter of instruction to the analytical laboratories, oversees data validation, and works with the 200-PW-1 OU Project Manager to prepare a report on the sampling and analysis results.

The Sample Management and Reporting organization is also responsible for development of the SAP, including the sampling design, preparing associated presentations, resolving technical issues, and preparing revisions to the SAP.

Contract Laboratories. The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanation of results in support of data validation. The laboratories must meet site-specified QA requirements and must have an approved QA plan in place.

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

A2.1.1 Problem Definition and Background

There are three primary objectives for this treatability test:

1. Support the development and testing of the decision support method for SVE system closure at the 200-PW-1 OU, specifically focusing the investigation on the vadose zone underlying the 216-Z-9 waste disposal area

2. Collect data to verify or refine the conceptual model of contaminant nature and distribution in the vadose zone

3. Test approaches for characterizing the magnitude and spatial distribution of mass flux

Site characterization and remediation operations have generated a substantial amount of site-specific knowledge and data related to vapor transport. However, uncertainty remains specifically related to the location and distribution of source zones within localized low-permeability units such as the Cold Creek Unit (CCU) (PNNL-17181). The mass flux and vapor transport associated with these zones controls the

long-term contamination of the vadose zone and the groundwater. The treatability test is designed to characterize the distribution of source zones, diffusive mass transfer behavior, and vapor transport behavior within the subsurface. Additionally, a vertical depth-specific vapor flow and concentration profiling method will be utilized to characterize contaminant mass flux downward from the CCU into the Ringold Formation and upward between the groundwater and soil gas, respectively.

A2.1.2 Project and Task Description

This SAP governs the soil vapor sampling and analysis associated with the treatability test. Section A3 details the sampling to be performed under this SAP to obtain the necessary analytical data. Soil vapor samples will be collected as detailed in Section A3 and analyzed in accordance with Table A2-1. Additional sampling may occur at the direction of the 200-PW-1 OU Project Manager during the treatability test. Results obtained from activities performed under the scope this SAP will be used with other treatability test data to prepare a report evaluating the test results and recommending whether the 200-PW-1 OU SVE system can be closed.

A2.1.3 Quality Objectives and Criteria

The QA objective of this plan is to develop guidance for obtaining data of known and appropriate quality. Data quality indicators (DQIs) describe data quality by evaluation against identified data quality objectives (DQOs) and the work activities identified in this SAP. The applicable QC guidelines, target detection limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. The principal DQIs are precision, bias or accuracy, representativeness, comparability, completeness, and sensitivity and are defined for the purposes of this document in the following sections.

Quality objectives and project-specific measurement requirements are presented in Table A2-1. In consultation with the laboratory, the 200-PW-1 OU Project Manager, and/or others as appropriate, the Sample Management and Reporting organization identifies the appropriate analytical methods.

A2.1.3.1 Precision

Precision is a measure of the data spread when more than one measurement exists of the same sample. Precision can be expressed as the relative percent difference (RPD) for duplicate measurements, or relative standard deviation for triplicates. Analytical precision for laboratory analyses is included in Table A2-1.

A2.1.3.2 Accuracy

Accuracy is an assessment of the closeness of the measured value to the true value. The validity of calibrations is evaluated by comparing results from the measurement of a standard to known values and/or by generation of in-house statistical limits based on three standard deviations (plus or minus three standard deviations). Table A2-1 lists the laboratory accuracy requirements for data obtained under this SAP.

A2.1.3.3 Representativeness

Representativeness is a measure of how closely analytical results reflect the actual concentration and distribution of the constituents in the matrix sampled. Sampling plan design, sampling techniques, and sample handling protocols (e.g., storage, preservation, and transportation) are discussed in subsequent sections of this SAP. The required documentation will establish the protocols to be followed and will ensure appropriate sample identification and integrity.

A2.1.3.4 Comparability

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

A2.1.3.5 Completeness

Table A2-1 identifies the sample analytes and analytical performance requirements for samples collected under the scope of this SAP. The analytical data set for the sampling will be considered incomplete if one or more carbon tetrachloride results are not reported.

A2.1.3.6 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.

Table A2-1. 200-PW-1 Soil Vapor Extraction Treatability Test Analytical Performance Requirements

Chemical Abstracts Service No.	Analyte	Analytical Method[a]	Target Detection Limit[b]	Precision Required	Accuracy Required
56-23-5	Carbon Tetrachloride	EPA Method TO-15	0.2 ppbv	≤30%[c]	70-130%[c]

a. EPA/625/R-96/010b; equivalent method may be substituted.

b. Detection limits are based on optimal conditions in a standard fixed laboratory. Interferences and matrix effects may decrease sensitivity, resulting in an increase to the value shown.

c. Accuracy criteria are the minimum for associated internal standard percent recoveries. Precision criteria are based on batch laboratory replicate analyses.

ppbv = parts per billion volume

A2.1.4 Special Training and Certification

A graded approach is used to ensure that workers receive a level of training commensurate with responsibilities and that complies with applicable DOE orders and government regulations. The field team lead, in coordination with line management, will ensure special training requirements for field personnel are met.

Typical training requirements or qualifications have been instituted by the primary contractor management team to meet training requirements imposed by the contract, regulations, DOE orders, DOE contractor requirement documents, American National Standards Institute/American Society of Mechanical Engineers, and the *Washington Administrative Code*. For example, the environmental, safety, and health training program provides workers with the knowledge and skills necessary to execute assigned duties safely. Field personnel typically have completed the following training before starting work:

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training and supervised 24-hour hazardous waste site experience
- 8-Hour Hazardous Waste Worker Refresher Training (as required)
- Hanford General Employee Radiation Training
- Hanford General Employee Training, or equivalent

Project-specific safety training, geared specifically to the project and the day's activity, will be provided. Project-specific training includes the following:

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

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

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

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

A2.1.5 Documents and Records

The 200-PW-1 OU Project Manager is responsible for ensuring the current version of the SAP is being used and for providing any updates to field personnel. Version control is maintained through the administrative document control process. Changes to the SAP affecting the DQOs will be reviewed and approved by DOE and the lead regulatory agency prior to implementation.

Three types of changes during the treatability test could affect compliance with the requirements in the test plan:

- A **fundamental change** is a change that does not meet the requirements set forth in the test plan or that incorporates testing activities not defined in the scope of the test plan.
- A **significant change** generally involves a change to a component of the test that does not fundamentally alter the overall test approach.

- A **minor change** will not have a significant impact on the scope, performance, or cost of the test. These minor changes should be documented in the project file (for example, through interoffice memoranda or logbooks). Non-significant changes will not impact the requirements of the test plan.

Determining the significance of the change is the responsibility of DOE and the lead regulatory agency. The 200-PW-1 OU Project Manager is responsible for tracking all changes and obtaining appropriate reviews by contractor staff. The 200-PW-1 OU Project Manager will discuss the change with DOE, and DOE will then discuss with the lead regulatory agency the type of change that is necessary, up to and including changes described in Section 9.3 and Section 12.0 of the TPA Action Plan (Ecology et al., 1989b). Appropriate documentation will follow, in accordance with the requirements for the type of change.

The field team lead is responsible for ensuring that the field instructions are maintained and aligned with any revisions or approved changes to the SAP. The field team lead will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook or on nonconformance report forms) in accordance with internal corrective action procedures.

The 200-PW-1 OU Project Manager, field team lead, or designee, is responsible for communicating field corrective action requirements and ensuring immediate corrective actions are applied to field activities.

Logbooks are required for field activities. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook and only authorized persons may make entries in logbooks. Logbooks will be signed by the field manager, supervisor, cognizant scientist/engineer or other responsible individual. 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.

The 200-PW-1 OU Project Manager is responsible for ensuring that a project file is properly maintained. The project file will contain the records or references to their storage locations. The project file will include the following, as appropriate:

- Field logbooks or operational records
- Data Forms
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective action reports
- Interim progress reports
- Final reports
- Laboratory data packages
- Verification and validation reports

The laboratory is responsible for maintaining, and having available upon request, the following:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Records may be stored in either electronic or hard copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure the accuracy and retrievability of stored records. Records required by the TPA will be managed in accordance with TPA requirements.

A2.2 Data Generation and Acquisition

The following sections address data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

The field team lead is responsible for ensuring that all field procedures are followed completely and that field sampling personnel are adequately trained to perform sampling activities under this SAP. The field team lead must document all deviations from procedures or other problems pertaining to sample collection, chain-of-custody, sample analytes, sample transport, or noncompliant monitoring. As appropriate, such deviations or problems will be documented in the file logbook or in nonconformance report forms in accordance with internal corrective action procedures. The field team lead or 200-PW-1 OU Project Manager is responsible for communicating field corrective action requirements and for ensuring that immediate corrective actions are applied to field activities.

A2.2.1 Sampling Process Design (Experimental Design)

The sampling design is 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 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. Probabilistic statements about parameters are not possible.

The types, number, and location of samples, are provided in Section A3.3 of this SAP.

A2.2.2 Sampling Methods

Section A3.5 describes the sampling methods. The following specific information is included:

- Field sampling methods
- Corrective actions for sampling activities
- Decontamination of sampling equipment
- Radiological field data

A2.2.3 Sample Handling and Custody

A sampling and data tracking database is used to track the samples from the point of collection through the laboratory analysis process. Samplers should note any anomalies (e.g., sample appears unusual, sample is sludge) with the samples to prevent batching across similar matrices. If anomalies are found, the samplers should write "DO NOT BATCH" on the chain-of-custody form and inform Sample Management and Reporting.

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

Section A3.6 provides the following specific sample handling information:

- Sample packaging
- Container labeling
- Sample custody requirements
- Sample transportation

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

A2.2.4 Analytical Methods

Information on the analytical method is provided in Table A2-1. The analytical method is controlled in accordance with the laboratory's QA Plan and the requirements of this QAPjP. The primary contractor participates in overseeing off-site analytical laboratories to qualify them for performing Hanford Site analytical work.

If the laboratory uses a nonstandard or unapproved method, then the laboratory must provide method validation data to confirm that the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. Deviations from the analytical methods noted in Table A2-1 must be approved by the Sample Management and Reporting organization in consultation with 200-PW-1 OU Project Manager.

Laboratories providing analytical services in support of this SAP will have a corrective action program in place that addresses analytical system failures and documents the effectiveness of corrective actions. Issues that may affect analytical results are to be resolved by the Sample Management and Reporting organization in coordination with the 200-PW-1 OU Project Manager.

A2.2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability. Field QC sampling will include the collection of field duplicate and ambient blank samples. Laboratory QC samples estimate the precision and accuracy of the analytical data. Field and laboratory QC samples are summarized in Table A2-2.

Table A2-2. Field and Laboratory Quality Control Requirements

Type	Purpose	Frequency
	Field Quality Control	
Field Duplicate	Estimate precision, including sampling and analytical variability	One per 10 samples
Ambient Blanks	Assess contamination from field conditions	One per week when test samples are collected.
	Laboratory Quality Control	
Method Blank	Assess response of an entire laboratory analytical system	At least one per batch, or as identified by the method
Internal Standard	Identify analytical accuracy; possible matrix effect on the	Required by the method to be added upon purge for each sample analyzed, including

Table A2-2. Field and Laboratory Quality Control Requirements

Type	Purpose	Frequency
	analytical method used	calibration and method blank samples
Laboratory Duplicate	Estimate analytical accuracy and precision	Required by the method, should be analyzed at frequency of at least one per batch

A2.2.5.1 Field Quality Control Samples

Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability and laboratory performance. The QC samples and the required frequency for collection are described in this section.

Ambient blanks are SUMMA Canisters filled at the sample collection site. The samples are prepared during sampling to evaluate potential contamination caused by field conditions. After collection, ambient blank canisters are sealed and placed in the same storage container with the samples from the associated sampling event.

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

A2.2.5.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, and matrix spike) are defined for EPA Method TO-15 (EPA/625/R-96/010b) and will be run at the frequency specified in the method unless superseded by agreement between the primary contractor and laboratory.

A2.2.5.3 Quality Control Requirements

Table A2-2 lists the field QC requirements for sampling.

Field duplicate samples must agree within 20 percent, as measured by the RPD, to be acceptable. Only those field duplicates with at least one result greater than five times the detection limit are evaluated. Field duplicate results not satisfying evaluation criteria will be qualified and flagged in HEIS, as appropriate.

Holding time is the elapsed time period between sample collection and analysis. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding time for EPA Method TO-15 (EPA/625/R-96/010b) is less than or equal to 30 days.

A2.2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Equipment used for collection, measurement, and testing should meet applicable standards (e.g., American Society for Testing and Materials) or should have been evaluated as acceptable and valid in accordance with the procedures, requirements, and specifications. The field team lead, or equivalent, will ensure that data generated from instructions using a software system are backed up and/or downloaded on a regular basis. Software configuration will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory directly affecting the quality of analytical data will be subject to preventive maintenance measures to ensure minimal measurement

system downtime. Laboratories and onsite measurement organizations 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 procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with the analytical method (EPA-625/R-96/010b) or with auditable DOE Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed per SW-846 requirements and will be appropriate for their use.

A2.2.7 Instrument and Equipment Calibration and Frequency

Specific field equipment calibration information is provided in Section A3.4. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

A2.2.8 Inspection and Acceptance of Supplies and Consumables

Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes described in the contractor acquisition system. Responsibilities and interfaces necessary to ensure that items procured 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.

Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratory's QA plan.

A2.2.9 Nondirect Measurements

Nondirect measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. Nondirect measurements will not be evaluated as part of the activities under the scope of this SAP.

A2.2.10 Data Management

The Sample Management and Reporting organization, in coordination with the 200-PW-1 OU Project Manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the TPA Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish their resolution with the 200-PW-1 OU Project Manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

Planning for sample collection and analysis will be in accordance with the programmatic requirements governing fixed laboratory sample collection activities, as discussed in the sampling procedures. In the event that specific procedures do not exist for a particular work evolution, or if it is determined that additional guidance is needed to complete certain tasks, a work package will be developed to provide adequate control of the activities, as appropriate. Examples of sampling procedure requirements include activities associated with the following:

- Chain-of-custody form

- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks
- Checklists
- Sample packaging and shipping

Approved work control packages and procedures will be used to document field activities including radiological and non-radiological measurements when this SAP is implemented. Field activities will be recorded in the field logbook. Section A3.3 provides guidance regarding field logbook use.

A2.3 Assessment and Oversight

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

A2.3.1 Assessments and Response Actions

Contractor management, Regulatory Compliance, QA, and/or Health and Safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this SAP, project work packages, procedures, and regulatory requirements.

If circumstances arise in the field dictating the need for additional assessment activities, then additional assessments would be performed. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project's line management chain coordinates the corrective actions/deficiencies in accordance with the contractor QA program, the corrective action management program, and associated procedures implementing these programs.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The contractor oversees offsite analytical laboratories and qualifies the laboratories for performing Hanford Site analytical work.

A2.3.2 Reports to Management

Reports to management regarding data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to the Sample Management and Reporting organization, which then initiates a sample issue resolution form in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the 200-PW-1 OU Project Manager.

A2.4 Data Validation and Usability

The elements in this section address the QA activities that occur after the data collection or generation phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying project objectives.

A2.4.1 Data Review, Verification, and Validation

The criteria for verification include, but are not limited to, review for completeness (e.g., samples were analyzed as requested), use of the correct analytical method or procedure, check for transcription errors, confirm correct application of dilution factors, and confirm correct application of conversion factors. Laboratory personnel may perform data verification.

A2.4.2 Verification and Validation Methods

The work activities will follow documented procedures and processes for data validation and verification, as summarized below. Validation of analytical data consists of assessing whether the data collected and measured truly reflect site conditions. Verification means assessing data accuracy, completeness, consistency, availability, and internal control practices to determine overall reliability of the data collected. Other data quality requirements to be met include maintaining chain-of-custody, proper sample handling, use of proper analytical techniques, and the quality and acceptability of the laboratory analyses conducted.

Checks are performed on laboratory electronic data files for formatting, allowed values, data flagging (i.e., qualifiers), and completeness. Hardcopy results are verified to check for: (1) completeness, (2) notes regarding condition of samples upon receipt by the laboratory, (3) notes regarding problems encountered during analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff will work with the laboratory to correct the problem.

The data validation process provides the requirements and guidance for validating data obtained. Validation is a systematic process of reviewing verified data against a set of criteria (e.g., those listed in Table A2-1 and the analytical method) to determine whether the data are acceptable for their intended use.

Results of laboratory and field QC evaluations and holding-time criteria are considered when determining data usability. Staff review the data to identify whether observed changes reflect changes in soil vapor characteristics or potential data errors, and they may request data reviews of laboratory, field, or other data for usability purposes. The laboratory may be asked to check calculations or re-analyze the sample. Results of the data reviews are used to flag the data appropriately in the HEIS database and/or to add comments.

A2.4.3 Reconciliation with User Requirements

The data quality assessment (DQA) process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine whether quantitative data are of the correct type and are of adequate quality and quantity to meet test objectives. The 200-PW-1 OU Project Manager is responsible for determining whether a DQA is necessary and for ensuring that, if required, one is performed. The results of the DQA will be used in interpreting the data and determining if the objectives of this activity have been met.

A3 Field Sampling Plan

This field sampling plan identifies the soil vapor sampling activities to meet the data needs associated with the treatability test.

A3.1 Sample Location and Frequency

A total of two air samples per well will be collected during single well max flux testing. Samples will be collected in 1-L (0.26-gal) SUMMA Canisters and analyzed for carbon tetrachloride consistent with EPA/625/R-96/010b. The first sample will be collected within the first hour of vapor extraction at the individual well. The second sample will be collected just prior to terminating the vapor extraction.

Two air samples will be collected at each well during the vertical profile mass flux testing. During pneumatic logging, depth-specific samples will be drawn and tested with a calibrated photoionization detector in the field, and the intervals with the highest chemical concentrations will be identified. At the discrete depth with highest chemical concentration, a sample of the soil gas will be collected in a SUMMA Canister. A second canister sample will be collected at the top of the well. Canisters will be submitted for carbon tetrachloride analysis.

A3.2 Sampling Methods

Sample collection under this SAP will be performed in accordance with site sampling procedures. Prior to sample collection, the sampling line will be purged of at least three pore volumes. The SUMMA Canister will then be attached to collect the sample and will be used in the vacuum mode. The vacuum in the clean canister (near 76 cm [30 in.] Hg) will be sufficient to pull the sample out of the gas line. A slow flow rate into the canister will be controlled manually by opening its valve slightly. The rate will be checked by monitoring the canister vacuum gauge and comparing the value to the elapsed time and the wellhead vacuum. The final canister vacuum will be approximately equal to the vacuum in the vapor extraction line. The final vacuum will be recorded on the chain-of-custody and then measured at the laboratory after shipment and before analysis. The sampling time and conditions (pressure, flow rate, temperature, and humidity) will be recorded.

A3.2.1 Decontamination of Sampling Equipment

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

Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples.

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the SUMMA Canister on or near potential contamination sources
- Handling SUMMA Canisters or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

A3.2.2 Corrective Actions and Deviations for Sampling Activities

The 200-PW-1 OU Project Manager, field team lead, or designee must document deviations from procedures or other problems pertaining to sample collection, chain-of-custody, target analyte, sample

transport, or noncompliant monitoring. Examples of deviations include samples not collected because of field conditions and additions of samples.

As appropriate, sampling activity deviations or problems will be documented in the field logbook or on nonconformance report forms in accordance with internal corrective action procedures. The 200-PW-1 OU Project Manager, field team lead, or designee, will be responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities.

Changes in sample locations not affecting the DQOs will require notification and approval of the 200-PW-1 OU Project Manager. Changes to sample locations affecting the DQOs will require concurrence from DOE and the lead regulatory agency. Changes to the SAP will be documented as noted in Section A2.1.5.

A3.3 Documentation of Field Activities

Logbooks or data forms are required for field activities. Requirements for the logbook are provided in Section A2.1.5. Data forms may be used to collect field information; however, the information recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

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

- Purpose of activity
- Day, date, time, and weather conditions
- Names, titles, and organizations of personnel present
- Deviations from the QAPjP or procedures
- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (e.g., field duplicates and ambient blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations and surveys, and equipment identification numbers, as applicable
- Equipment decontaminated, number of decontaminations, and variations to any decontamination procedures
- Equipment failures or breakdowns, and descriptions of any corrective actions
- Telephone calls relating to field activities

A3.4 Calibration of Field Equipment

The field team lead is responsible for ensuring that field equipment is calibrated appropriately. Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions,

internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results for instrument calibration activities are recorded in logbooks and/or work packages. Either hard copy or electronic calibration activity records are acceptable.

Calibrations must be performed as follows:

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

Field instrumentation, calibration, and QA checks will be performed as described:

- Calibration of radiological field instruments on the Hanford Site is performed by Pacific Northwest National Laboratory, as specified in their program documentation.
- Daily calibration checks will be performed and documented for each instrument used to characterize areas under investigation. These checks will be made on standard materials like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.
- Standards used for calibration will be traceable to nationally or internationally recognized standard agency source or measurement system, if available.

A3.5 Sample Handling

A3.5.1 Packaging

SUMMA Canisters will be used to collect samples for chemical analysis. The Radiological Engineering organization will measure both the contamination levels and dose rates associated with the 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 acceptance criteria.

A3.5.2 Container Labeling

The sample location, depth, and corresponding HEIS numbers are documented in the sampler's field logbook. A custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to indicate potential tampering.

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

- Sampling Authorization Form
- HEIS number
- Sample collection date and time
- Analysis required
- Preservation method (if applicable)
- Sample authorization form number

In addition, sample records must include the following information:

- Analysis required

- Source of sample
- Matrix (e.g., air)
- Field data (e.g., flow rate)

A3.5.3 Sample Custody

Sample custody will be maintained in accordance with existing Hanford Site protocols to ensure the maintenance of sample integrity throughout the analytical process. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody form will be initiated in the field at the time of sampling and will accompany each 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 changes for the custody of the sample, the new and previous custodians will sign the chain-of-custody form and note the date and time. The sampler will make a copy of the signed chain-of-custody form before sample shipment and will transmit the copy to the Sample Management and Reporting organization within 48 hours of shipping.

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

- Project name
- Signature of sampler
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives
- Signatures of individual involved in sample transfer
- Requested analyses (or reference thereto)

A3.5.4 Sample Transportation

Sample transportation will be in compliance with the applicable regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous waste mandated by the U.S. Department of Transportation (49 CFR 171through 49 CFR 177, Chapter 1) in association with the International Air Transportation Authority, DOE requirements, and applicable program-specific implementing procedures.

A3.6 Management of Waste

All waste (including unexpected waste) generated by sampling activities will be managed in accordance with DOE/RL-2000-40. Pursuant to 40 CFR 300.440, approval from the CERCLA DOE-RL Remedial Project Manager is required before returning unused samples or waste from offsite laboratories.

A4 Health and Safety Plan

Field operations will be performed in accordance with health and safety requirements and appropriate CH2M HILL Plateau Remediation Company Soil and Groundwater Remediation Project requirements. Work control documents will be prepared to provide further control of site operations. Safety documentation will include an activity hazard analysis and, as applicable, radiological work permits. The sampling procedures and associated activities will implement ALARA practices to minimize the radiation exposure to the sampling team, consistent with the requirements defined in 10 CFR 835.

A5 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:4.0.2.5.26.1&idno=10.

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