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SAMPLING AND ANALYSIS PLAN FOR PHASE 2 CHARACTERIZATION OF VADOSE ZONE SOIL IN WASTE MANAGEMENT AREA C

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Abstract: This plan specifies requirements for field sampling, laboratory analysis, and data reporting for soil samples to be taken from the vadose zone in and around Waste Management Area C. The data will be used to support a corrective measure study required for closure of the waste management area.

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Revision 2

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LIST OF TERMS

Abbreviations and Acronyms

AEA	Alpha energy analysis
Bgs	Below ground surface
CAS	Chemical Abstracts Service
COPC	Constituents of potential concern
CVAA	Cold vapor atomic absorption
DOE	U. S. Department of Energy
DQO	Data Quality Objectives
Ecology	State of Washington Department of Ecology
EPA	U. S. Environmental Protection Agency
GC/ECD	Gas chromatography/electron capture detection
GC/FID	Gas chromatography/flame ionization detection
GC/MS	Gas chromatography/mass spectrometry
GEA	Gamma energy analysis
HASQARD	Hanford Analytical Services Quality Assurance Requirements Documents
HEIS	Hanford Environmental Information System
HRGC/HRMS	High resolution gas chromatography/high resolution mass spectrometry
IC	Ion chromatography
ICP/AES	Inductively coupled plasma/atomic emission spectroscopy
ICP/MS	Inductively coupled plasma/mass spectrometry
LCS	Laboratory control sample
QA	Quality assurance
PCB	polychlorinated biphenyls
QC	Quality control
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and analysis plan
SGE	Surface geophysical exploration
SST	Single-shell tank
SVOA	Semi-volatile organic analysis
SVOC	Semi-volatile organic compound
TBD	To be determined
TIC	Tentatively identified compound
TBP	tributyl phosphate
UPR	Unplanned release
VOA	Volatile organic analysis
VOC	Volatile organic compound
WAC	Washington Administrative Code
WIDS	waste information data system
WMA	Waste management area

1.0 SAMPLING AND ANALYSIS OBJECTIVES

This sampling and analysis plan (SAP) specifies requirements for field sampling, laboratory analysis, and data reporting for soil samples that will be taken in and around Waste Management Area C (WMA C). The requirements are based on objectives developed using a data quality objective (DQO) process. Results of the DQO process are documented in RPP-RPT-38152, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/Corrective Measures Study*. The State of Washington Department of Ecology (Ecology), the U. S. Department of Energy (DOE), and its contractors participated in the DQO process. This SAP and RPP-PLAN-39114, *RCRA Facility Investigation/ Corrective Measures Study Work Plan for Waste Management Area C* provide information that is consistent with guidelines for contents as described in Washington Administrative Code (WAC) 173-340-820, "Sampling and Analysis Plans."

More specifically, this SAP provides overall requirements for soil characterization that will be performed to support development of a Resource Conservation and Recovery Act (RCRA) facility investigation/corrective measures study for WMA C. In addition to information in this SAP, operational details will be needed to perform field sampling and laboratory analysis of the samples. Operational instructions and a summary of requirements will be provided to performing organizations in the forms of sampling and analysis work instructions. These operational documents will meet requirements in this SAP and will be provided to Ecology for information prior to sample collection.

As stated in the DQO, information regarding treatment, management, and disposal of the radioactive source, byproduct material, and/or special nuclear components of mixed waste (as defined by the *Atomic Energy Act of 1954*, as amended) is not provided in this SAP for the purpose of regulating the radiation hazards of such components under the authority of this SAP or the "Hazardous Waste Management Act" (70.105 RCW), but is provided for informational purposes only.

This SAP addresses only characterization of soil contaminants identified in the DQO process as documented in RPP-RPT-38152. Requirements for collecting biological data (e.g., tissue sample data) for an ecological risk assessment and obtaining other input data for the facility investigation/corrective measures study are provided in RPP-PLAN-39114.

2.0 FACILITY DESCRIPTION

Waste Management Area C encompasses the 241-C tank farm located in the east central portion of the 200 East Area. It includes equipment, soil, and groundwater contaminated by C Farm operations. In general, the WMA C boundary is represented by the fence line surrounding the C farm tanks. The boundary for vadose zone soil sampling, as defined by the DQO, includes the WMA and the immediate surrounding areas (See Figure 2-1).

A description of the equipment, soil, and groundwater in WMA C is provided in Section 2 of RPP-PLAN-39114. Section 2 also provided information on past unplanned releases of contaminants in this area. In general, the tank waste contaminants in the WMA C vadose zone soil are expected to originate from these releases.

Figure 2-1. Aerial Boundary of Waste Management Area C and Data Quality Objectives Study Area

3.0 SAMPLING REQUIREMENTS

Surface and subsurface soil samples will be taken and analyzed as part of this characterization effort. Sample analysis results will be used to evaluate human health and ecological risks. Prior to implementing sampling activities, surface radiation surveys will be conducted to identify areas of surface contamination that might affect soil sampling activities and health and safety of workers. Geophysical surveys such as ground penetrating radar will be conducted prior to sub-surface sampling to verify buried equipment and identify subsurface anomalies. In addition to soil sampling, surface geophysical exploration (SGE) will be performed. Results from soil samples and SGE will be used to evaluate nature and extent of contaminants. Detailed descriptions of and requirements for these survey techniques are provided in Section 4 of RPP-PLAN-39114.

3.1 SUBSURFACE SAMPLING

3.1.1 Sampling Technique

After completion of geophysical survey(s), identified sites will be investigated by the use of a small diameter single tubing string. This tubing will be pushed to the target depth or refusal and geophysically logged with bismuth germanium oxide or sodium iodine, and gamma and neutron-neutron moisture instrumentation. The logging data will be reviewed by technical personnel to determine sample collection points. At each sample location, the initial push of approximately 200 feet will be performed. The exploratory push hole will be decommissioned per applicable WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," requirements (e.g., filled with bentonite or bentonite/cement grout as required) as the push tubing is extracted. An average of seven samples per location is planned: three in the top 15 ft (not including a surface sample) and four below 15 ft. After the depths of individual samples are selected, a second push at approximately the same location will be performed. Soil samples will be selected from the pre-determined depths and sent to laboratories where the samples will be analyzed according to the two-step approach described in Section 4.1. If necessary, a third push will be performed to collect samples for some Step 2 analyses. Direct push sampling techniques are described below.

Single-String Sampling System: The single-string sampling system consists of three stainless steel liners contained within a sampler body that is deployed by small-diameter push rods. The three liners are each 4.22 cm (1.66 in.) outside diameter x 3.89 cm (1.53 in.) inside diameter x 15.24 cm (6 in.) long. The probe driving equipment is positioned at the appropriate location and the sampler is advanced to the targeted depth. By use of a key release mechanism, the removable tip is released and the open sampler is advanced through the selected sample interval. The entire rod string including the sampler is then retrieved to surface. The sampler is removed from the push tubing and the stainless steel liners are extracted from the sampler mechanism. The sampling push hole is then re-entered with push tubing and decommissioned per WAC 173-160 requirements.

Dual-String Sampling System: The dual-string sampling system consists of inner and outer strings that are deployed by small-diameter push rods. When the targeted sampling depth is

achieved, the rods are pulled back and the removable tip is removed from the inner rods. A sampler is attached to the inner string and returned to the bottom of the outer casing/push tubing and positioned against the inner receiver face of the drive shoe. The inner and outer tubing strings are "locked" together by use of a proprietary method, and the entire assembly is advanced through the targeted sample interval.

The sampler body holds three stainless steel liners. The liners are removed from the sampler body and surveyed. Trained sample-handling technicians document recovery, sample condition, and volume recovery percent. They then package and transport the sample under chain-of-custody control to the selected laboratory for analysis. The "dummy" tip is reattached to the inner string and returned to bottom and placed in the casing shoe, and the entire assembly is advanced to the next designated sample depth. This process is repeated until all sample depths are achieved or the tubing meets refusal.

Upon completion of the final sample extraction, or upon meeting refusal, the dummy tip or sampler is removed and the borehole is decommissioned per WAC 173-160 requirements.

3.1.2 Sampling Strategy

The sampling strategy at each vertical direct push site is summarized below (RPP-ENV-38838, *Tank Farm Vadose Zone Program Characterization Processes*). Note that the specified depths are only approximate and are subject to constraints in the field.

1. At each site, a minimum of two direct push probe holes pushes will be completed. The initial probe hole is logged for both gross gamma and neutron moisture. Following logging, deep electrodes are installed for SGE. The second push is for soil sampling based on the data derived from the first push.

2. The depth of the first push will be no greater than 200 ft below ground surface (bgs) or refusal at all sites except H, I, and S (See Table 3-1). This target depth is based on the observation of ^{99}Tc and nitrate at 160 ft bgs at borehole C4297 and ^{60}Co between 150 and 160 ft bgs at well 299-E27-4. The depth at site S will be to 260 ft bgs or refusal based on ^{60}Co detected at nearby well 299-E27-14. It is expected that the direct push method can reach these depths based on three pushes of 200 ft bgs or more at unplanned releases (UPRs) 81 and 86.

3. At sites H and I, the depth of the direct push will be 15 ft unless data from sites F and G indicate that the direct pushes at sites H and I should be deeper.

4. Deep electrodes are placed at the base of the initial probe hole and at a depth of approximately 55 ft bgs.

5. For the second probe hole at depths less than 15 ft bgs, three samples are targeted to be taken at 5-, 10- and 14-ft bgs in the vadose zone. These depths are only approximate and were selected such that they are somewhat evenly spaced apart. The purpose of collecting samples in the first 15 ft is to provide data for the direct exposure pathway and to provide initial data for ecological risk.

Table 3-1. Sampling Design (3 sheets)

Sampling Site Designation	Location	Deployment	Number of Direct Pushes	Average Number of Samples per Direct Push	Number of Surface Samples	Known or Suspected Event	Access Availability	Planned Analyses
A	Spare inlet 241-C-101	Direct push, slant; Surface grab	1-2	7	1 sample plus one collocated duplicate	Tank over fill. Loss through spare inlet	Fair	Step 1 analyses (and Step 2 analyses if necessary)
B	241-C-101, south side	Direct push, vertical or slant; Surface grab	1	7	1 sample plus one collocated duplicate	Tank release	Good	Step 1 analyses (and Step 2 analyses if necessary)
C	241-C-203	Direct push, slant; Surface grab	3	3: 0-15 ft 15: >15 ft	1 sample plus one collocated duplicate	Tank leak and/or tank over fill. Loss through spare inlet	Fair	Step 1 analyses (and Step 2 analyses if necessary)
D	241-C-201 241-C-202 241-C-204	Direct push, slant; Surface grab	1-2/tank	7	1 sample plus one collocated duplicate	200 series tank leaks	Fair	Step 1 analyses (and Step 2 analyses if necessary)
E	Between 241-C-106 and 200-C-109	Direct push, vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Suspected release	Fair	Step 1 analyses (and Step 2 analyses if necessary)
F	Building C-801 chemical drain	Direct push, vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Suspected release site	Good	Step 1 analyses (and Step 2 analyses if necessary)
G	Between Building C-801 and 241-C-103	Direct push, vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Suspected transfer line release site	Good	Step 1 analyses (and Step 2 analyses if necessary)
H	Northeast side of E-91	Direct push, vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Surface release	Good	Step 1 analyses (and Step 2 analyses if necessary)
I	Northeast side of E-115	Direct push, vertical or slant; Surface grab	1	7	1 sample plus one collocated duplicate	Surface release	Good	Step 1 analyses (and Step 2 analyses if necessary)
J	241-C-104	Direct push, slant; Surface grab	1	7	1 sample plus one collocated duplicate	Tank release	Fair	Step 1 analyses (and Step 2 analyses if necessary)

Table 3-1. Sampling Design (3 sheets)

Sampling Site Designation	Location	Deployment	Number of Direct Pushes	Average Number of Samples per Direct Push	Number of Surface Samples	Known or Suspected Event	Access Availability	Planned Analyses
K	241-C-108	Direct push, vertical or slant; Surface grab	1	7	1 sample plus one collocated duplicate	Transfer line leak, hot dry well (09-02)	Poor	Step 1 analyses (and Step 2 analyses if necessary)
L	241-C-103 and 241-C-106	Drywell logging and direct push, vertical; Surface grab	2	7	1 sample plus one collocated duplicate	Potential transfer line leak and tank over fill	Fair	All analyses listed in Section 4.0
M	241-C-104, 108, 109, 110, 111, and 112	Drywell logging	NA	NA	NA		Fair to Good	NA
N	UPR-86, UPR-82 and UPR 81	SGE	NA	NA	NA		Good	NA
O	WMA C	SGE	NA	NA	NA		Good	NA
P	UPR-81	Balance of direct pushes to complete characterization; Surface grab	3	7	1 sample plus one collocated duplicate	Known release site	Good	All analyses listed in Section 4.0
Q	UPR-82	(1) 4 adjacent direct pushes to support placement of strings of deep electrodes for 3D SGE per Sampling Site Designation N; (2) Direct push through center depending on SGE results; Surface grab[a]	1	7	1 sample plus one collocated duplicate	Known release site	Poor due to shotcrete cover	Step 1 analyses (and Step 2 analyses if necessary)
R	241-C-301 Catch Tank	Direct push vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Unlined concrete catch tank	Good	Step 1 analyses (and Step 2 analyses if necessary)

Table 3-1. Sampling Design (3 sheets)

Sampling Site Designation	Location	Deployment	Number of Direct Pushes	Average Number of Samples per Direct Push	Number of Surface Samples	Known or Suspected Event	Access Availability	Planned Analyses
S	UPR-72 and C-8 Drain	Direct push vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Buried radioactive material and French drain from 241 CR Building are in this area	Good	Step 1 analyses (and Step 2 analyses if necessary)
T	TBD, based upon SGE data for entire WMA	TBD, direct push vertical and/or slant	TBD	7	1 sample plus one collocated duplicate	Previously unknown release sites	TBD	Step 1 analyses (and Step 2 analyses if necessary)
U	C-110	Direct push, slant or vertical	1	7	1 sample plus one collocated duplicate	Characterize C-110 release and conceptual Model 1 and alternate Models 1 & 3	Fair	Step 1 analyses (and Step 2 analyses if necessary)
V	C-111	Direct push vertical	1	7	1 sample plus one collocated duplicate	Characterize C-111 release and conceptual Model 1 and alternate Models 1 & 3	Good	Step 1 analyses (and Step 2 analyses if necessary)
W	299-E27-12, 299-E27-13, 299-E27-14, 299-E27-15	Log groundwater monitoring wells outside of WMA C	NA	NA	NA	Log wells to collect data on U, ^{60}Co, ^{137}Cs and moisture	Good	NA

[a]Sampling design details for Sampling Site Designation Q are applicable to the single direct push that may be undertaken for sampling. Additional probe holes will be placed to support logging/electrode placement.

TBD = to be determined.

6. For depths greater than 15 ft bgs, the depth location for sampling individual horizons will be selected by reviewing the gamma and moisture logs of the first direct push and the following information: any leak loss inventory information pertinent to the site, geologic summary of the area, operational history, and historical characterization data at that site. The selection of sampling horizons will be done in an open meeting in which Tank Operation Contract staff, DOE, Ecology, U.S. Environmental Protection Agency, and other site contractors are invited.

The sampling strategy for the sites with slant probe holes is the same as for vertical probe holes with the following exceptions:

1. The angle of the slant probe hole will be determined after ground penetrating radar survey has been completed.

2. The length of slant direct pushes at the C-100 series tanks will be no greater than 200 ft total length (inclined path) of the slant probehole or refusal, while for the C-200 series tanks the length will be no greater than 160 ft total length (inclined path) of the slant probehole or refusal. The exact length depends upon the setup location and the angle of the direct push. The goal of the probe holes is to determine if tank fluids have leaked into the environment. The target zone for sampling is between 5 and 10 ft below tank bottom. Additionally, the direct push probe holes placed at the C-200 series tanks will be extended to sample soils beneath the pipelines running between the C-200 series and the C-100 series tanks.

3. For slant probe holes, three soil samples (direct exposure and ecological risk) will be taken in the upper 15-ft of the vadose zone. The location along the length of these probe holes will be determined by the angle of the probe hole, but samples will be collected at approximately 5-, 10-, and 14- ft bgs. Deeper samples will be taken using the same method as outlined in step 5 of the vertical probe holes.

4. One deep electrode will be installed at the base of the initial slant probe hole.

If contamination is found in any of the soil sampling probe holes at their total depth, additional characterization technologies may be deployed upon agreement from Ecology to define the maximum depth of contamination. Sampling below the 200 ft bgs probably will require a borehole. If drilling of the borehole extends all the way into groundwater, Ecology and DOE will meet to determine if a groundwater well will be installed at the location or if the borehole will be decommissioned in accordance with WAC 173-160.

3.2 SURFACE SAMPLING

Surface soil samples will be taken at the sites where direct push samples are planned (see Table 3-1). Soil in the top 12 inches will be collected using spatula, scoop, or miniature core samplers. The samples will be sent to laboratories where they will be analyzed according to a two-step approach as described in Section 4.1. Although every attempt will be made to collect this sample, the gravel surface in tank farms may prevent taking a sample that contains environmentally sensitive media (i.e., soil particles less than 2 mm in diameter). If this is the

case, pictures of the sampling site showing the gravelly nature of the land surface and the reason as to why a sample will not be taken will be documented in borehole/site completion reports.

3.3 SOIL SAMPLING DESIGN

3.3.1 Sample Number and Locations

A random sampling approach cannot be applied in WMA C because of the extensive amount of interferences caused by buried infrastructure and topographic constraints. Also, significant knowledge exists regarding locations and sources for known and suspected releases in and around WMA C. Therefore, a non-probabilistic (biased) sampling strategy that targets locations where contaminants are most likely to be encountered will be employed. This approach provides the highest potential for confirming and characterizing these known and suspected releases. In addition, an attempt will be made to identify any unknown releases by using SGE across the entire tank farm. SGE will be used as an alternative technique to random sampling for investigating unknown releases because, regardless of infrastructure interference, the target area is simply too large to permit, in terms of time and resources, a statistically valid random sampling effort.

Candidate sample locations are identified in the WMA C DQO (RPP-RPT-38152). Rationale for selecting sample locations is described in detail in Section 4.4 of RPP-PLAN-39114. Figure 3-1 shows the location of known and suspected releases in and around WMA C and the location of the candidate sample sites. Figure 3-2 shows the candidate sample locations in relationship to existing surface features and Figure 3-3 shows the candidate sample locations relative to subsurface interferences. The final sample locations will be established based on collected geophysical data and facility walkdowns conducted prior to deployment of the sampling equipment to the sample site. Table 3-1 presents a general description of the candidate sampling locations.

A number of locations are expected to require a slant direct push. These locations are associated with the single-shell tank (SST) C-101 (site A), C-104 (site J), C-110 (site U), and the C-200 tanks (sites C and D). Target areas are beneath the spare inlet nozzles on these tanks which are suspected to be a release site from tank overfilling. In addition, pipelines and cascade lines are targeted which could have produced releases adjacent to these tanks. Target areas and associated depth of samples are further defined in the WMA C Work Plan. Four samples will be collected in the top 15 ft (one at the surface and one each at 5 ft, 10 ft and 14 ft bgs) at each location and up to four additional samples will be collected at depths >15 ft.

At C-203, three slant direct pushes will be made and a total of 15 samples (averaging 5 per direct push) will be collected at depths >15 ft bgs. The remaining C-200 series tanks will each have one direct push with a minimum of 4 samples taken at depths greater than 15 ft bgs. If data indicate a release occurred then two slant direct pushes at each of the remaining C-200 tanks will be made to collect vadose zone samples.

At each of the direct push locations, an array of SGE electrodes will be placed in anticipation of conducting an SGE evaluation of the entire tank farm.

Figure 3-1. Candidate Sample Locations and Surface Geophysical Exploration Interrogation Areas

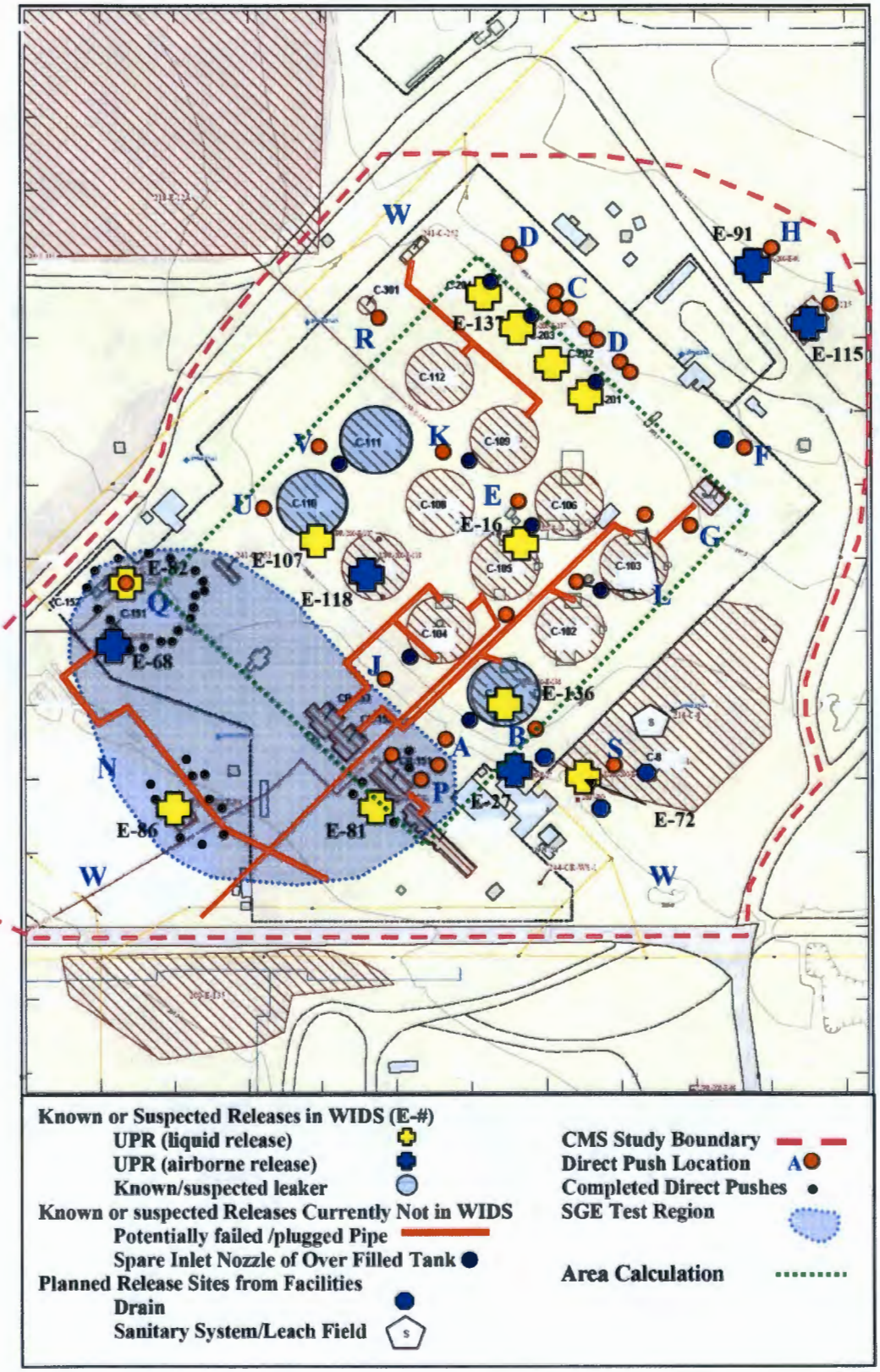
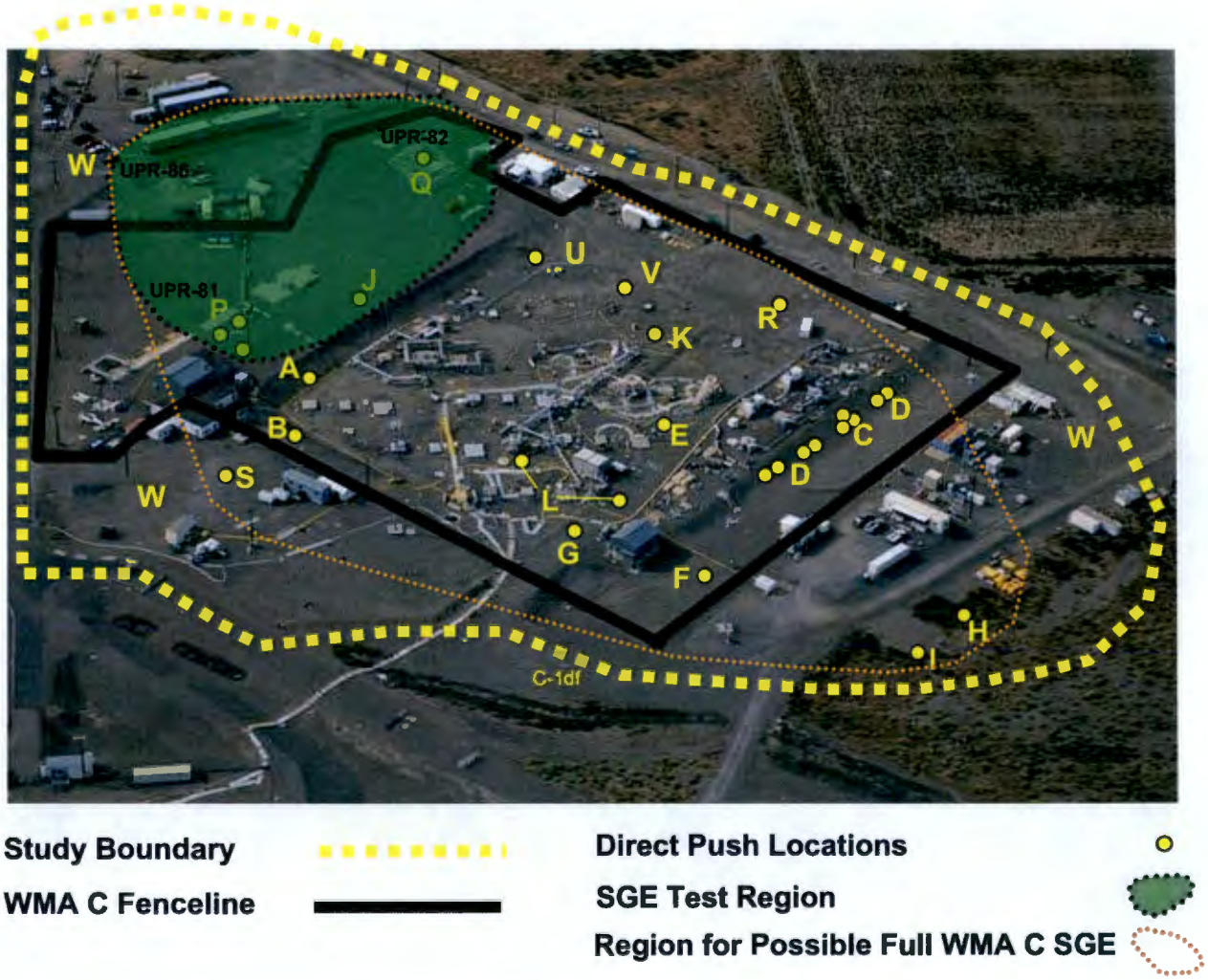


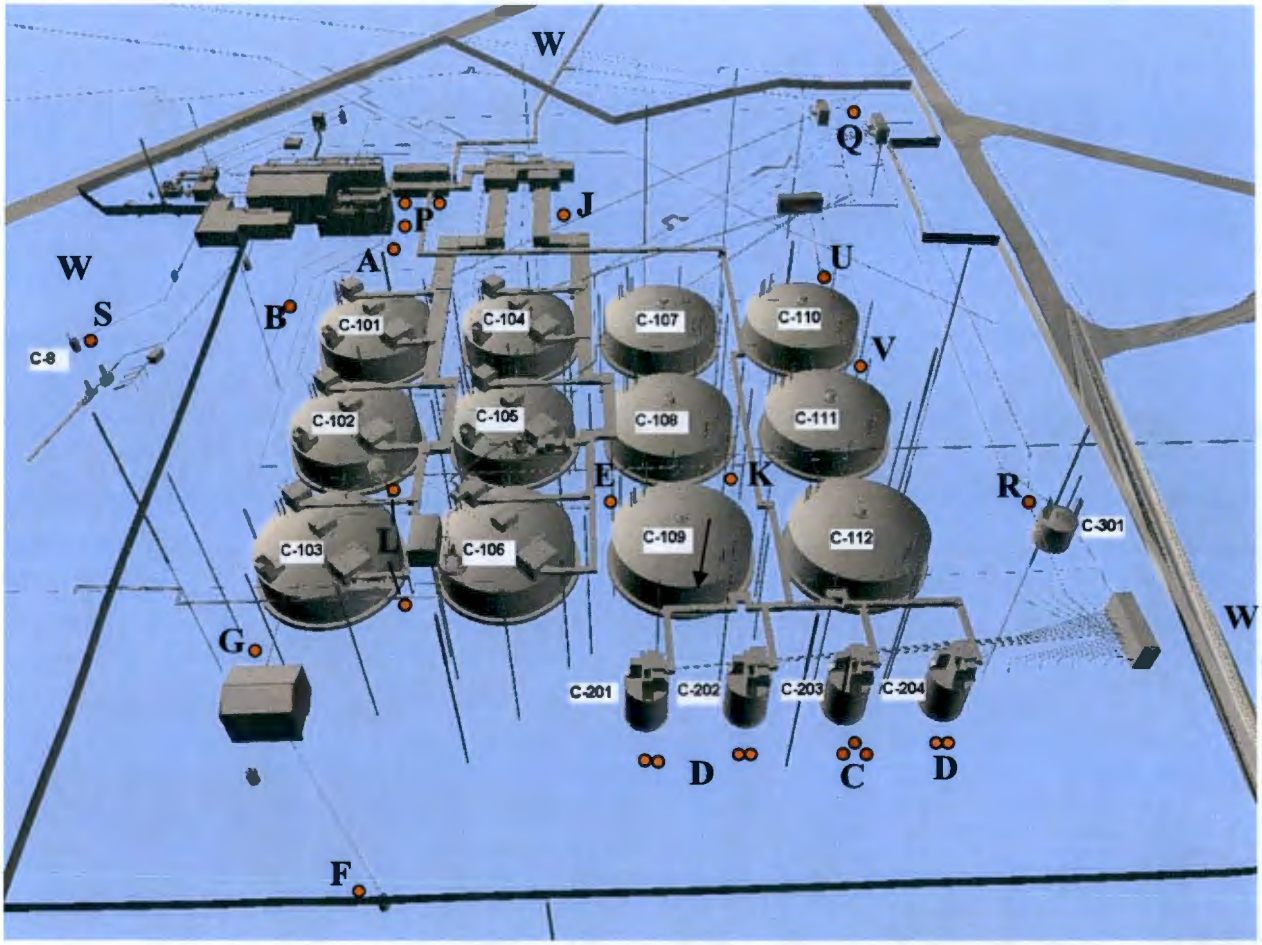
Figure 3-2. Aerial Map of Candidate Sample Locations and Surface Geophysical Exploration Interrogation Areas on Aerial Map



3.4 SAMPLE HANDLING AND SHIPPING

Whenever possible, soil samples shall be maintained and shipped at 4 degrees Celsius. The samples shall be shipped to the laboratory as soon as possible to meet applicable holding times. However, it is recognized that some samples may have elevated levels of radioactivity. These samples must be stored and transported in shielded shipping containers that may not allow the samples to be maintained at 4 degrees Celsius. Also, fewer samples may be shipped to the laboratory in a shipment. The additional shipments may jeopardize sample holding times recommended in SW-846, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*. To minimize impact on sample integrity, these highly radioactive samples shall not be exposed to high temperatures and they shall be shipped to the laboratory for analysis as soon as possible. Samples not meeting temperature or holding time requirements shall be discussed in the laboratory data report. The impact on subsequent use or interpretation of these data will be evaluated on a case-by-case basis by the Tank Operation Contractor.

Figure 3-3. Candidate Sample Locations and Infrastructure Constraints



Radiological control technician(s) will measure contamination levels on the outside of each sample jar and dose rates on each sample jar. The radiological control technician(s) also will measure radiological activity on the outside of the sample container (through the container) and will document the highest contact radiological reading in millirem per hour. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation regulations (49 CFR, "Transportation") and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria.

3.5 SAMPLE IDENTIFICATION

A sample and data-tracking database will be used to track the samples from the point of collection through laboratory analysis process. The Hanford Environmental Information System (HEIS) database will be the repository for the laboratory analytical results. HEIS sample numbers will be issued to the sampling organization for this project in accordance with onsite organizational procedures. Each radiological/nonradiological and physical properties sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook.

Each sample container will be labeled with the following information using a waterproof marker on firmly affixed water-resistant labels:

- Sample identification number
- Sample collection date and time
- Name or initials of person collecting the sample
- Preservation method (if applicable)
- Sample location (direct push hole number and depth of collection).

A list of sample analyses is not required for sample labels because the list could be quite large. The laboratory will consult the sampling and analysis work instruction document(s) for appropriate analyses and additional guidance for preparing the sample for analysis.

3.6 SAMPLE CUSTODY

A chain-of-custody form shall be used for each sample and will accompany each sample from sampling through analysis. At a minimum, the following sampling information shall be included on the chain-of-custody form:

- Project name
- Signature of the collector
- Date and time of collection
- Sample type (e.g., soil, etc.)
- Requested analysis or provide a reference for sample analysis
- Signatures of persons involved in the chain of possession
- Date and time relinquished to the laboratory
- Unique sample identification number assigned to the sample
- Sample location (direct push hole number and depth of collection)
- A notation of pertinent sampling information including unusual characteristics or sampling problems
- A brief description of the sample matrix such as color or consistency if possible.

Each sample will be shipped to the laboratories in an approved shipping container per approved procedure. A custody seal will be affixed to the lid of each sample container.

4.0 SAMPLE ANALYSIS REQUIREMENTS

Note that in this SAP, the specified U. S. Environmental Protection Agency (EPA) SW-846, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, analytical methods are shown without suffices indicating method revisions. For these methods, the most recent revisions are preferred.

4.1 OPTIMIZATION OF SAMPLE ANALYSIS

Based on Phase 1 soil sampling results, it is expected that many of the soil samples that will be collected in Phase 2 are not contaminated. Therefore, sample analyses will be optimized so that the use of limited laboratory resources would weigh more heavily toward samples that are contaminated. More specifically, a limited set of analyses will be performed on each sample to determine if the sample is contaminated. If a sample is determined to be so, more extensive analyses will be performed on the sample. This two-step optimization approach is described further in Section 4.1.2.

In addition, organic contaminants are not expected to be present in the WMA C vadose zone soil samples in significant amounts. Organic analyses will be performed on samples to be collected from 5 sites. Results will be used to determine if certain organic analytes should be removed from the list of constituents-of-potential-concern (COPCs). The organics optimization approach is described in Section 4.1.1. A flow diagram for the overall optimization of sample analyses is provided in Figure 4-1.

4.1.1 Organic Analyses Optimization

Five of the twenty-seven sites identified for characterization have been selected to evaluate potential for organic contamination. The five candidate direct push sites are associated with UPR-81 (three locations) (site P) and on the northwest and northeast side of SST C-103 (2 locations) (site L). For these two sites, the waste information data system (WIDS) indicates that the release occurred in the waste transfer line near the 241-CR-151 Diversion Box on October 15, 1969. The release is associated with the 241-CR-151 Diversion Box, the 241-C-102 tank and the PUREX 202-A Building. The source of the release was in an underground transfer line from the 202-A Building to the 241-C-102 tank via the 241-CR-151 diversion box. LAUR-93-3605, *Analysis of the History of 241-C Farm* states:

"An organic layer was noted in C-102 in 1969 and reported (Anderson, T. D. "Organics in 102-C Tank," letter to W. L. Godfrey, October 2, 1969) to be 36 kgal. This organic layer was subsequently transferred to C-103 in a P-10 pumping of C-102 in 1975. There is a recorded transfer of 111 kgal in '75-4, but the level change in C-102 indicated that only 25 kgal was transferred, with another 8 kgal in '78-3, for a total of 33 kgal. Presumably, this combined 33 kgal transfer was largely the organic layer, and would have left 3 kgal in C-102."

Figure 4-1. Optimization of Sample Analyses (2 sheets)

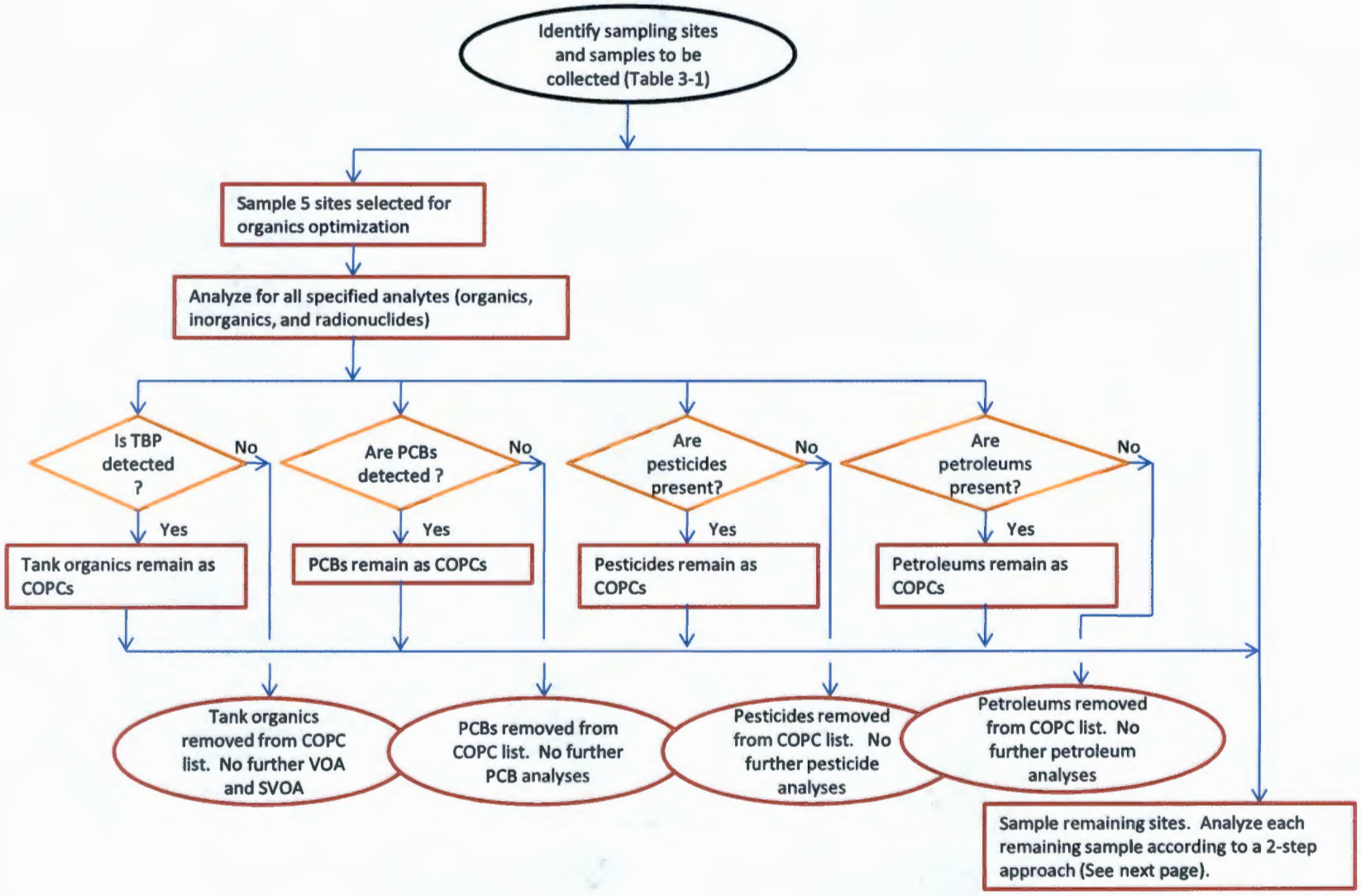
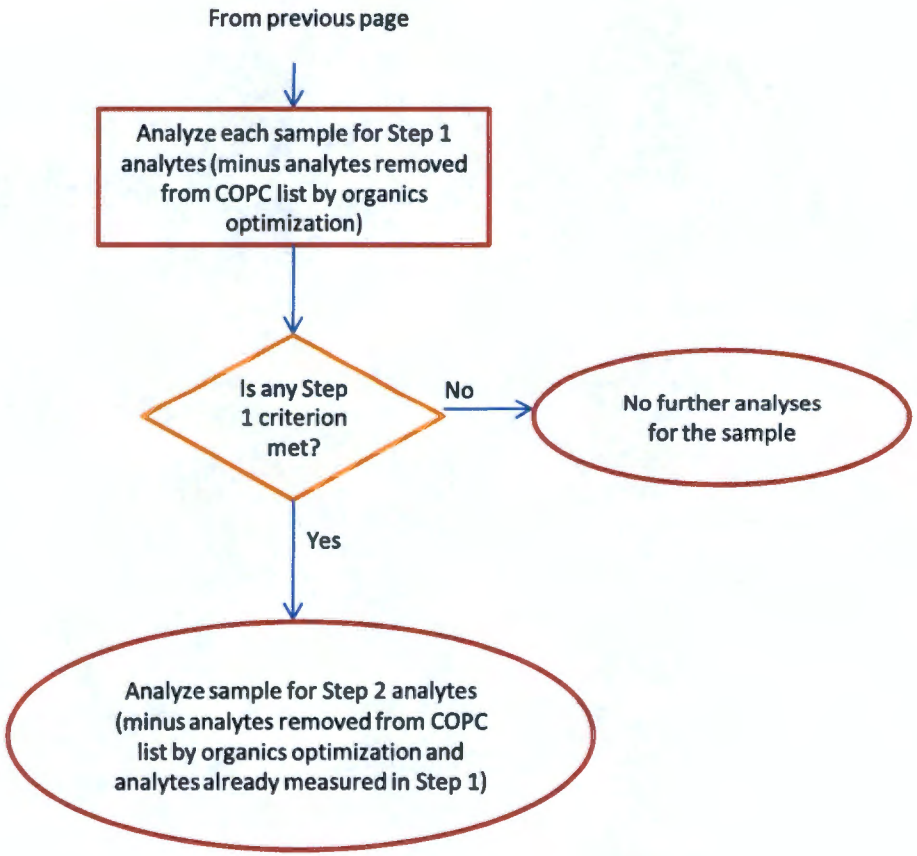


Figure 4-1. Optimization of Sample Analyses (2 sheets)



The event description in RPP-PLAN-39114 Rev. 1 Table 2-8 for row Date = 3-1965 Waste Type = PUREX CWP2 is given below.

"A liquid level rise in Tank 103-C, the cesium feed tank, was apparently caused by a failed line in the encasement between the 152-CR diversion box and Tank 102-C which permitted coating waste from the PUREX Plant to leak into the encasement and drain to Tanks 101-C, 102-C, and 103-C via the tank Pump pits. Coating waste has been routed through a spare line to Tank 102-C and no further leaks have been detected. The coating waste solution accumulated in Tank 103-C did not significantly affect cesium loading capability as a cask was loaded normally following the incident.

Note: Pipeline 8041 is inside a concrete encasement was used to route the PUREX CW to SST C-102 (see drawing H-2-44501, sheet 92). This encasement traverses from diversion box 241-CR-152 along the west side of SSTs C-101, C-102, and C-103. In order for the PUREX CW to drain into SSTs C-101, C-102, and C-103, the encasement containing the failed transfer pipeline must have partially filled with waste. The integrity of this encasement is unknown and may have leaked waste to the soil. Drawing H-2-2338, sheet 45 indicates pipeline 8041 is out of service. Pipeline 8041 connects from nozzle U-3 in the 241-CR-152 diversion box and nozzle U-2 in pit 02C atop SST C-102."

Based upon this information it would appear that the potential exists that more than one release may have occurred in and around CR-151, CR-152 and C-101/102/103 tanks from 1965 to 1969. While waste is referenced as PUREX coating waste in WIDS or PUREX cladding waste in RPP-PLAN-39114, the presence of organics is documented in tank C-102 during this time frame. While these data are inconclusive that a release of organic contaminated wasted occurred, the rationale for selecting sites in the DQO was to identify areas of known or suspected releases having some potential for containing organic contamination. It was felt that sample locations "L" and "P" satisfied these criteria; these are located at each end of the encasement.

At these five locations, following the spectral gamma and neutron logging, samples will be collected and analyzed for the entire suite of analytes. Tributyl phosphate (TBP) will be used as the indicator organic for the occurrence of any organic contamination associated with tank waste. Tributyl phosphate is a known tank waste contaminant because it was used extensively as a solvent in the reprocessing of spent nuclear fuel. Tributyl phosphate was chosen because it has the highest probability of being found. It is the only organic constituent other than acetone and 2-Butanone found above detection limits in all tank residual samples and it is found at higher concentrations 75 to 73,000 μg/g (mg/kg) which is 10 to 100,000 times higher than all other organics including polychlorinated biphenyls (PCB). It was presented during the DQO process that if TBP is not found then it is unlikely that other organic (i.e., volatile organic analysis [VOA], semi-volatile organic analysis [SVOA], diesel range organics/gasoline range organics, PCBs) contaminants related to tank waste would be found. The DQO team agreed to use this compound as an indicator for tank waste organics.

Furthermore, if the data for the organic analytes from the pre-retrieval samples taken at the C-200 Tanks is examined, the Best Basis Inventory reports the following organic analytes were found above the MDL in the pre-retrieval samples: Butylbenzylphthalate, 1-Butanol, Acetone,

Aroclor 1254, 2-Butanone, Xylenes (total), Xylene (m & p), Trichloroethene, Xylene (o), Hexone, Methylenechloride, and Toluene. The mean concentrations for Butylbenzylphthalate, 1-Butanol, and Acetone were 66.7 µg/g, 16.8 µg/g, and 1.01 µg/g, respectively. The only PCB above MDL was Aroclor-1254 with a mean concentration of 0.46 µg/g. 2-Butanone had a mean concentration of 0.29 µg/g, with the rest of the non-detected organic analytes having a mean concentration of less than 0.1 µg/g. Tri-butyl phosphate was found as a tentatively identified compound (TIC) in the pre-retrieval samples from tanks C-203 and C-204 with the highest concentration found at C-204 at greater than 200,000 µg/g. Tri-butyl phosphate in the post-retrieval samples for these tanks had results ranging from ~5,000 mg/kg (C-201) to ~73,000 mg/kg (C-204).

Other organic compounds found above detection limits in some, but not all tank residuals, are Butylbenzylphthalate (3.27 mg/kg (C-103)), Di-n-butylphthalate (6.11 mg/kg C-103, 6.08 mg/kg C-204), Hexone (2.27E-02 mg/kg C-202), and Xylenes (Total) (2.0E-02 mg/kg C-203).

If TBP is not detected in any of the samples then organics associated with tank waste will be eliminated from the list of COPCs and samples taken at other locations in WMA C will not be analyzed for organics. If TBP is detected in any of the samples then organics associated with tank waste will remain on the list of COPCs and these organic compounds will be analyzed as part of the Step 2 suite of analytes if a Step 1 tank waste indicator is met. Tributyl phosphate is selected as a specific tank waste contaminant. Other volatile and semivolatile compounds are rejected as either not being indicators of tank waste or are common laboratory contaminants.

Samples taken from the five sites will be analyzed for pesticides and petroleum compounds. If pesticides are not present in any of the samples from these sites, then pesticides will be eliminated from the list of COPCs and other soil samples that will be taken from WMA C will not be analyzed for these compounds. If a pesticide is present in any of the samples from the five sites, then pesticides will remain on the list of COPCs for Step 1 analyses.

Similarly, if gasoline-range organics and diesel-range organics are not present in any of the samples from the five sites, these petroleum organics will be eliminated from the list of COPCs. If they are present in any of the samples, gasoline-range organics will remain on the list of COPCs for Step 1 analyses of near surface samples; diesel-range organics will be analyzed by gas chromatography/flame ionization detection (GC/FID) only if gas chromatography/mass spectrometry (GC/MS) indicates that they are present in a sample.

Polychlorinated biphenyls are of specific concern to direct contact and ecological risk and will be analyzed in near surface samples only. Three vadose zone samples will be collected in the region of 0 to 15 ft bgs at the five direct push locations discussed above (15 samples) and analyzed for Aroclors and congeners. If polychlorinated biphenyls are not detected in any of the samples then they will be eliminated from the list of COPCs and will not be analyzed at other locations in WMA C. If polychlorinated biphenyls are detected in any of the samples then they will remain on the list of COPCs and will be analyzed as part of the Step 2 suite of analytes following a detection of the Step 1 tank waste trigger constituents. Results from the initial five samples will be used in an attempt to establish a correlation between PCB Aroclors and

congeners. The correlation will be used to evaluate whether or not future analysis of PCB congeners is necessary.

Note: The WMA C DQO identifies sites P and L as candidate sites where samples will be collected for organic optimization. Before sampling soils at other candidate sites, organic analyses on samples taken from sites P and L should be completed to evaluate if further organic analyses at the other sites are warranted. However, while preparing this SAP, tank farm schedule was modified to include retrieval of waste in the 244-CR Vault. The waste retrieval activity is expected to restrict access to site P. Furthermore, above ground infrastructure near tank 241-C-103 may prevent early sampling at site L. Therefore, discussions with DOE and Ecology will be initiated during the Ecology review of this SAP to identify different sampling sites within WMA C boundary for organic optimization.

4.1.2 Two-Step Sample Analyses Optimization

In accordance with the WMA C DQO, sample analysis will be performed using a two-step approach to optimize cost-effectiveness. Step 1 will employ a method-based screening process to determine if the soil has been contaminated with tank waste. A select set of threshold indicator constituents will be used to indicate the presence of tank waste. The criteria for selecting these "threshold indicator constituents" are based on them being historically associated with tank waste, indicative of tank farm constituents released into the environment and drive human health risk, and were the most detected constituents in Phase 1 investigations. If any one of the tank waste indicator threshold is met, then samples at that location will be analyzed for the full suite of Step 2 analytes. The Step 1 analytes and their threshold values are as follows:

^{238}U	Detected at or above 1.39 pCi/g
^{239}Pu	Detected at or above 0.0233 pCi/g
^{137}Cs	Detected at or above 1.37 pCi/g
^{90}Sr	Detected at or above 0.262 pCi/g
NO_3 (as NO_3)	Detected at or above 232 µg/g
Cr (for ^{6}Cr)	Detected at or above 26.8 µg/g
^{99}Tc	Detected at the Method Detection Limit
^{129}I	Detected at the Method Detection Limit
Cyanide (CN)	Detected at the Method Detection Limit
TBP	Detected at the Method Detection Limit.

Uranium-238, ^{239}Pu, ^{137}Cs, ^{90}Sr, NO_3, and Cr are present at low level in Hanford background soil. The stated thresholds are met only if the contaminants are detected and the detected concentrations are at or above the stated values. Although elevated pH is an indicator of the passage of tank waste through soil, it may not represent all tank waste contamination pathways as have been indicated in the past (RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX*). The stepped approach will also be further evaluated following the examination of the sample results from the first five direct pushes. The approach may be modified after consultation with Ecology.

The following methods will be performed on samples to get the above analytes: Inductively coupled plasma/mass spectrometry (ICP/MS) for ^{238}U, ^{239}Pu, and ^{99}Tc; inductively coupled plasma/atomic emissions spectroscopy (ICP/AES) for Cr; ion chromatography (IC) for NO_3; gamma energy analysis (GEA) for ^{137}Cs; separation/beta counting for ^{90}Sr; separation/GEA for ^{129}I; spectrophotometric for cyanide (CN); and SVOA by GC/MS for TBP. Alpha energy analysis (AEA) may be used as an alternative method for ^{239}Pu. Cobalt-60 concentration will be obtained by GEA along with ^{137}Cs. Cobalt-60 and ^{99}Tc sample results will be used to assess the relationship of these radionuclides in the soil.

The above thresholds may not be applicable to a screening of petroleum contaminants. Semivolatile organic analysis (EPA Method 8270) will be used to analyze for TBP in Step 1. This method is also capable of analyzing for diesel-range organics. Results will be used to evaluate whether or not diesel-range organics are present in the soil in significant amounts that requires further analyses for this analyte by another analytical method such as GC/FID (EPA Method 8015). Gasoline-range organics will be analyzed by purge-and-trap GC/MS (EPA Method 8260) in Step 1.

Similarly, pesticide usage is not associated with tank waste generation and storage. Pesticide compounds will be analyzed by gas chromatography/electron capture detection (GC/ECD) (EPA Method 8081) in Step 1.

Petroleum and pesticide data will be used for an ecological risk assessment. Therefore, only samples taken in the near surface zone (i.e., in the top 15 ft) will be analyzed for these organics.

In summary, sample analysis will be performed using a two-step approach. Step 1 analytes and methods are a subset of Step 2 analytes and methods. If a Step 1 threshold is met or exceeded, then all Step 2 methods (minus methods already performed in Step 1) will be performed. Step 2 analytical parameters for major constituent categories (inorganic chemicals, organic chemicals, and radionuclides) are discussed in Sections 4.2 through 4.4.

4.2 INORGANIC ANALYTES

Inorganic chemicals will be analyzed using the following methods: ICP/AES for cations, IC for anions and ammonia, cold vapor atomic absorption (CVAA) for mercury, spectrophotometric analysis for cyanide, ion selective electrode for sulfide, and pH. The ICP/AES and IC methods are capable of analyzing multiple constituents. Primary and secondary constituents for these methods are shown in Tables 4-1 and 4-2.

Table 4-1. Primary Inorganic Constituents and Analytical Methods (2 Sheets)

Constituent	Analytical Method	Alternate Method
Aluminum – Al	6010 (ICP/AES)	6020 (ICP/MS)
Antimony – Sb	6020 (ICP/MS)	6010 (ICP/AES)
Arsenic – As	6020 (ICP/MS)	6010 (ICP/AES)
Barium – Ba	6010 (ICP/AES)	6020 (ICP/MS)
Beryllium – Be	6010 (ICP/AES)	6020 (ICP/MS)

Table 4-1. Primary Inorganic Constituents and Analytical Methods (2 Sheets)

Constituent	Analytical Method	Alternate Method
Cadmium – Cd	6020 (ICP/MS)	6010 (ICP/AES)
Calcium[a] – Ca	6010 (ICP/AES)	6020 (ICP/MS)
Chromium – Cr	6010 (ICP/AES)	6020 (ICP/MS)
Cobalt – Co	6020 (ICP/MS)	6010 (ICP/AES)
Copper – Cu	6010 (ICP/AES)	6020 (ICP/MS)
Iron – Fe	6010 (ICP/AES)	6020 (ICP/MS)
Lead – Pb	6010 (ICP/AES)	6020 (ICP/MS)
Lithium[a] – L	6010 (ICP/AES)	6020 (ICP/MS)
Manganese – Mn	6010 (ICP/AES)	6020 (ICP/MS)
Magnesium[a] – Mg	6010 (ICP/AES)	6020 (ICP/MS)
Molybdenum[a] – Mo	6010 (ICP/AES)	6020 (ICP/MS)
Nickel – Ni	6020 (ICP/MS)	6010 (ICP/AES)
Phosphorus[a] – P	6010 (ICP/AES)	6020 (ICP/MS)
Potassium[a] – K	6010 (ICP/AES)	6020 (ICP/MS)
Selenium – Se	6010 (ICP/AES)	6020 (ICP/MS)
Silver – Ag	6020 (ICP/MS)	6010 (ICP/AES)
Sodium[a] – Na	6010 (ICP/AES)	6020 (ICP/MS)
Strontium – Sr	6010 (ICP/AES)	6020 (ICP/MS)
Thallium – Tl	6020 (ICP/MS)	6010 (ICP/AES)
Uranium – U	6020 (ICP/MS)	6010 (ICP/AES)
Vanadium – V	6020 (ICP/MS)	6010 (ICP/AES)
Zinc – Zn	6010 (ICP/AES)	6020 (ICP/MS)
Mercury – Hg	7470, 7471 (CVAA)	6020 (ICP/MS)
Fluoride – F^-	9056 (IC)	
Nitrite – NO_2^-	9056 (IC)	
Nitrate – NO_3^-	9056 (IC)	
Chloride – Cl^-	9056 (IC)	
Sulfate – SO_4^{2-}	9056 (IC)	
Acetate[b] – $C_2H_3O_2^-$	9056 (IC)	
Formate[b] – CHO_2^-	9056 (IC)	
Glycolate[b] – $C_2H_3O_3^-$	9056 (IC)	
Oxalate[b] – $C_2O_4^{2-}$	9056 (IC)	
Cyanide – CN^-	9014 (spectrophotometric)	IC/MS
Ferrocyanide – $Fe(CN)_6^{4-}$	Estimated from total cyanide.	
Sulfide – S^{2-}	9215 (ion selective electrode)	9034 (titration)
Ammonium – NH_4^+	EPA 300.7 (IC)	
pH	9045	

Abbreviations: CVAA = cold vapor atomic absorption, IC = ion chromatography, ICP/AES = inductively coupled plasma/atomic emissions spectroscopy, ICP/MS= inductively coupled plasma/mass spectrometry, IC/MS=ion chromatography/mass spectrometry

[a] Calcium, lithium, molybdenum, magnesium, sodium, phosphorous, and potassium were moved from secondary constituents to primary at the request of Ecology to help in the evaluation of whether or not tank fluids have passed through the sediments.

[b] Acetate, formate, glycolate, and oxalate are technically organic anions but are included in this table because they can be analyzed by the same method as some inorganic anions.

Table 4-2. Secondary Inorganic Constituents

Constituent	Constituent
Method 6010 (ICP/AES)	**Method 9056 (IC)**
Boron – B	Bromide – Br^-
Bismuth – Bi	Phosphate – PO_4^{3-}
Calcium – Ca	
Lithium – Li	
Molybdenum – Mo	
Magnesium – Mg	
Sodium – Na	
Phosphorus – P	
Potassium – K	
Rhodium – Rh	
Sulfur – S	
Silicon – Si	
Tin – Sn	
Tantalum – Ta	
Tungsten – W	
Yttrium – Y	
Zirconium – Zr	
Cerium – Ce	
Europium – Eu	
Lanthanum – La	
Niobium – Nb	
Neodymium – Nd	
Palladium – Pd	
Praseodymium – Pr	
Rubidium – Rb	
Ruthenium – Ru	
Samarium – Sm	
Tellurium – Te	
Thorium – Th	
Titanium – Ti	

IC = ion chromatography
ICP/AES = inductively coupled plasma/atomic emission spectroscopy

Note that chromium and cyanide data will be used as conservative estimates of hexavalent chromium and ferrocyanide, respectively. If the estimates are overly conservative and calculations using the estimates result in unacceptably high risk, analysis for hexavalent chromium and ferrocyanide may be performed.

4.3 ORGANIC ANALYTES

Organic chemicals will be analyzed by the following methods: GC/MS for volatile organic compounds (VOCs), extraction and GC/MS (or GC/FID) for semivolatile organic compounds (SVOCs), and GC/ECD for PCBs. In addition, a number of samples will be analyzed by high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS) for PCB congeners.

For VOCs and SVOCs, primary and secondary constituents are shown in Tables 4-3, 4-4, and 4-5. Analytical strategy for VOCs and SVOCs is summarized in the following.

The primary constituents will be analyzed to the quality control (QC) requirements specified in this SAP. This means they will be included in the calibration of the gas chromatographs and method detection limits (MDL) will be determined for each constituent.

Detected organic constituents that are not part of the calibration mix (primary constituents) are TICs. If a TIC is determined to be real (i.e., not an artifact of analytical methods), it will be evaluated against a gas chromatographic library containing the secondary compounds of interest. This library of compounds (called the "Hanford library") is composed of constituents that have been identified as possibly being present in Hanford Site waste in the Regulatory DQO (PNNL-12040, *Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privatization Project*) but not identified as primary constituents.

The "Hanford library" was developed by running single standards of the constituents on the laboratory's GC/MS systems. The results of these analyses provide accurate retention time information and mass response factors for these compounds and permit a better evaluation of the TIC. If a TIC is identified in the "Hanford library" of compounds, a semiquantitative estimate (based on an archived one-point calibration) of its concentration is made.

If the TIC is not found in the "Hanford library" of compounds, then the TIC will be evaluated against the standard National Institute of Standards and Technology (NIST) library of compounds. This library has over 100,000 compounds. However, because they are collected on different instruments from those used for the actual analysis, the retention times and response factors will be different. Before the analyst can name or identify the TIC, the analyst must be confident that the chromatogram and mass spectra match well enough to name the compound. If the analyst cannot confidently name the compound, it is identified as an unknown and no further action is required. When a TIC is identified in the NIST library, then the TIC will be evaluated in a similar manner as a "Hanford library" TIC.

The TICs are identified using the reconstructed ion chromatogram. The reconstructed ion chromatogram is evaluated for TICs by identifying peaks that have not already been identified as target compounds according to the following criteria. The criteria discussed in the following are from revision three of Volume 4 of DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD).

Table 4-3. Primary Volatile Organic Compound Parameters

Constituent	CAS#[a]	Comments
1,1,1-Trichloroethane	71-55-6	
1,1,2,2-Tetrachloroethene	127-18-4	
1,1,2,2-Tetrachloroethane	79-34-5	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	
1,1,2-Trichloroethane	79-00-5	
1,1,2-Trichloroethylene	79-01-6	
1,1-Dichloroethene	75-35-4	
1,2-Dichloroethane	107-06-2	
Chloroethene(vinyl chloride)	75-01-4	
2-Butanone(MEK)	78-93-3	
2-Nitropropane	79-46-9	
2-Propanone (Acetone)	67-64-1	
4-Methyl-2-pentanone (MIBK)	108-10-1	
Benzene	71-43-2	
Carbon disulfide	75-15-0	
Carbon tetrachloride	56-23-5	
Chlorobenzene	108-90-7	
Chloroform	67-66-3	
Dichloromethane (methylene chloride)	75-09-2	
Ethyl Acetate	141-78-6	
Ethylbenzene	100-41-4	
Diethyl ether	60-29-7	
Isobutanol	78-83-1	
Methanol	67-56-1	
n-Butyl alcohol (1-butanol)	71-36-3	
Toluene	108-88-3	
trans-1,3-dichloropropene	10061-02-6	
Trichlorofluoromethane	75-69-4	
Xylenes	1330-20-7	
o-Xylene	95-47-6	
m-Xylene	108-38-3	May be analyzed as m- and p-xylene
p-Xylene	106-42-3	May be analyzed as m- and p-xylene
Cis-1,2-dichloroethene[b]	156-59-2	
Trans-1,2-dichloroethene[b]	156-60-5	

[a] CAS = Chemical Abstracts Service.

[b] Corrected misidentified constituents from RPP-RPT-38152, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/Corrective Measures Study.*

Table 4-4. Primary Semivolatile Organic Parameters

Constituent	CAS#	Comments
1,2,4-Trichlorobenzene	120-82-1	
2,4-Dinitrotoluene	121-14-2	
2,4,5-Trichlorophenol	95-95-4	
2,4,6-Trichlorophenol	88-06-2	
2,6-Bis (tert-butyl)-4-methylphenol	128-37-0	
2-Chlorophenol	95-57-8	
2-Ethoxyethanol	110-80-5	
2-Methylphenol (o-cresol)	95-48-7	
4-Methylphenol (p-cresol)	106-44-5	
Acenaphthene	83-32-9	
Butylbenzylphthalate	85-68-7	
Cresylic acid (cresol, mixed isomers)	1319-77-3	
Cyclohexanone	108-94-1	
Di-n-butylphthalate	84-74-2	
Di-n-octylphthalate	117-84-0	
N-nitroso-di-n-propylamine	621-64-7	
Ethylene glycol	107-21-1	Analyzed separately by GC/FID
Fluoranthene	206-44-0	
Hexachlorobutadiene	87-68-3	
Hexachloroethane	67-72-1	
m-Cresol (3-Methylphenol)	108-39-4	
Naphthalene	91-20-3	
Nitrobenzene	98-95-3	
n-Nitrosomorpholine	59-89-2	
o-Dichlorobenzene	95-50-1	
o-Nitrophenol	88-75-5	
p-Chloro-m-cresol (4-Chloro-3-methylphenol)	59-50-7	
Pyrene	129-00-0	
Pyridine	110-86-1	
Tributyl phosphate	126-73-8	
Benzo(a) anthracene	56-55-3	
Benzo(b)fluoranthene	205-99-2	
Benzo(k)fluoranthene	207-08-9	
Benzo(a)pyrene	50-32-8	
Chrysene	218-01-9	
Indeno (1,2,3-cd) pyrene	193-39-5	
Dibenz(a,h)anthracene	53-70-3	
Dibutyl phosphate	107-66-4	May be analyzed by high-performance liquid chromatography
Monobutyl phosphate	Not available	May be analyzed by high-performance liquid chromatography
Bis(2-ethylhexyl)phthalate	117-81-7	

CAS = Chemical Service Abstract

Table 4-5. Secondary Organic Constituents - "Hanford Library." (2 sheets)

Method 8260 VOC	CAS#	Method 8270 SVOC	CAS
cis-1,3-Dichloropropene	10061-01-5	p-Nitrochlorobenzene	100-00-5
Ethylene dibromide (1,2, Dibromoethane)	106-93-4	1,4-Dinitrobenzene	100-25-4
Butane	106-97-8	1,4-Dichlorobenzene	106-46-7
1,3-Butadiene	106-99-0	Phenol	108-95-2
Acrolein (propenal)	107-02-8	Hexachlorobenzene	118-74-1
3-Chloropropene (Allyl chloride)	107-05-1	N,N-Diphenylamine	122-39-4
Propionitrile (Ethyl cyanide)	107-12-0	Pentachloronaphthalene	1321-64-8
Acrylonitrile	107-13-1	Hexachloronaphtahlene*	1335-87-1
2-Pentanone	107-87-9	Tetrachloronaphthalene	1335-88-2
Methylcyclohexane	108-87-2	Octachloronaphthalene	2234-13-1
n-Pentane	109-66-0	Isodrin*	465-73-6
5-Methyl-2-hexanone	110-12-3	Benzo[a]pyrene*	50-32-8
2-Heptanone	110-43-0	Dibenz[a,h]anthracene*	53-70-3
n-Hexane	110-54-3	1,3-Dichlorobenzene	541-73-1
Cyclohexane	110-82-7	3-Methyl-2-butanone	563-80-4
n-Octane	111-65-9	N-Nitroso-N,N-dimethylamine	62-75-9
4-Heptanone	123-19-3	Hexafluoroacetone	684-16-2
Acetic acid, n-butylester	123-86-4	Pentachloronitrobenzene (PCNB)	82-68-8
1,4-Dioxane	123-91-1	Pentachlorophenol	87-86-5
n-Heptane	142-82-5	2-sec-Butyl-4,6-dinitrophenol (Dinoseb)	88-85-7
Cyclopentane	287-92-3	1,1'-Biphenyl	92-52-4
Ethyl alcohol	64-17-5	Acetophenone	98-86-2
2-Propyl alcohol	67-63-0	Toxaphene*	8001-35-2
n-propyl alcohol (1-propanol)	71-23-8	Nitric acid, propyl ester	627-13-4
Bromomethane	74-83-9	Aldrin*	309-00-2
Chloroethane	75-00-3	alpha-BHC*	319-84-6
Acetonitrile	75-05-8	beta-BHC*	319-85-7
1,1 Dichloroethane	75-34-3	gamma-BHC (Lindane)*	58-89-9
Dichlorofluromethane	75-43-4	Dieldrin*	60-57-1
Chlorodifluoromethane	75-45-6	Endrin*	72-20-8
3-Methy-2-butanone*	563-80-4	1,1-Dimethylhydrazine	57-14-7
Hexafluoroacetone*	684-16-2	Methylhydrazine	60-34-4
2-Butenaldehyde (2-Butenal)	4170-30-3	n-Nitrosomethylethylamine	10595-95-6
Methyl isocyanate	624-83-9	n-Nitrosodi-n-butylamine	924-16-3
n-Propionaldehyde	123-38-6		
3-Heptanone	106-35-4		

Table 4-5. Secondary Organic Constituents - "Hanford Library." (2 sheets)

Method 8260 VOC	CAS#	Method 8270 SVOC	CAS
Chloromethane	74-87-3		
n-Nonane	111-84-2		
Styrene	100-42-5		
Tetrahydrofuran	109-99-9		
Cyclohexene	110-83-8		
2-Methyl-2-propenenitrile	126-98-7		
2-Hexanone	591-78-6		
Triethylamine	121-44-8		
Oxirane	75-21-8		
2-Methyl-2-propanol	75-65-0		
Dichlorodifluoromethane	75-71-8		
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2		
Heptachlor	76-44-8		
1,2-Dichloropropane	78-87-5		
1-Methylpropyl alcohol	78-92-2		
3-Pentanone	96-22-0		

* Constituent may be analyzed by an alternate method.
CAS = Chemical Abstracts Service SVOC = Semi-volatile organic compound VOC = Volatile organic compound

The library match for a TIC should be higher than 75% before this detailed evaluation is initiated. The method-specified tune criteria should be met. Special attention to the tune at low masses should be taken when evaluating volatile compounds. The concentration of a TIC should be greater than 10% of the nearest internal standard or estimated 5 nanograms on column injection, whichever is smaller. Early (injection peak) and late eluting peaks (column bleed and coeluting compounds) should have adequate background subtraction to permit use of these TIC criteria. If isotopic patterns are present, the mass ratios should agree with the reference spectrum within 10%. The base mass peak for the sample should be the same as the reference spectrum. If a molecular ion is present in the reference spectrum, the sample should also have a molecular ion mass. Reference spectrum ions greater than 20% should be in the sample spectrum. Sample ions greater than 20% that are not in the reference spectrum need to be evaluated. Major sample ions (greater than 20%) should match relative intensities to the base peak to those same ratios for the reference spectrum within 10-30%.

The TIC evaluation is limited to the 30 largest TICs for the volatile organic analysis and the 30 largest for the semivolatile analysis meeting the criteria discussed here.

A TIC compound may be upgraded to a positively identified compound. This is achieved by obtaining the compound, analyzing it under the same conditions as the initial identification, and matching retention time and mass spectrum. The upgrade will be performed if a TIC is a significant risk contributor.

Polychlorinated biphenyls will be analyzed by GC/ECD and HRGC/HRMS. In addition, percent water is required for solids so the PCB concentration can be reported on a dry weight basis.

Polychlorinated biphenyls Aroclors will be measured by GC/ECD. If necessary, total PCB concentrations would be calculated by summing the concentrations of seven Aroclors (1016, 1221, 1232, 1242, 1248, 1254, and 1260) found in a sample. The total PCBs in a sample are calculated by summing only detected Aroclors. If no Aroclors are detected, the total PCB concentration is considered the detection limit for the single most common Aroclor expected in the sample. Tank results indicate Aroclor 1254 is by far the most common Aroclor in Hanford Site tank waste. The policy of determining total PCB concentrations is the policy of the EPA Manchester Laboratory for determining total PCB concentrations in a sample. In addition, this method was specified by agreement in a meeting with representatives from EPA Region 10, EPA Manchester Laboratory, Ecology, Department of Energy (DOE), Pacific Northwest National Laboratory, and the Tank Operation Contract. In addition, PCB congeners will be analyzed by HRGC/HRMS. The HRGC/RHMS results will be used to evaluate congener estimates based on GC/ECD analyses.

Monobutyl phosphate and dibutyl phosphate degrade when injected into a GC. Special preparations will be required to allow these chemicals to be analyzed by GC/MS. Alternatively, these chemicals may be analyzed by high-performance liquid chromatography.

Pesticide and petroleum analytes are shown in Table 4-6. Only samples taken in the top 15 ft will be analyzed for these organics.

Table 4-6. Pesticides and Petroleum Analytes

Constituent	Analytical Method	Alternate Method
Aldrin	Gas chromatography/electron capture detection (EPA Method 8081)	Gas chromatography/mass spectroscopy (EPA Method 8270)
Benzene hexachloride (including lindane)		
Chlordane		
DDT/DDD/DDE (total)		
Dieldrin		
Endrin		
Hexachlorobenzene		
Heptachlor/heptachlor epoxide (total)		
Pentachlorophenol		
Gasoline-range organics	Purge-and-trap gas chromatography/ mass spectroscopy (EPA Method 8260)	Gas chromatography/flame ionization detection (EPA Method 8015)
Diesel-range organics	Gas chromatography/flame ionization detection (EPA Method 8015)	Gas chromatography/mass spectroscopy (EPA Method 8270)

4.4 RADIOLOGICAL PARAMETERS

Radionuclides will be analyzed by the following methods: GEA for gamma emitters, ICP/MS for uranium and neptunium isotopes, liquid scintillation for ^{99}Tc, alpha energy analysis for plutonium, americium, and curium isotopes, liquid scintillation for ^{14}C, tritium, and ^{79}Se, separation and GEA for ^{129}I, and beta counting for ^{90}Sr. Primary constituents for these methods are shown in Table 4-7.

Table 4-7. Primary Radiological Parameters

Constituent	Analytical Method	Alternate Method
^{137}Cs	GEA	
^{60}Co	GEA	
^{152}Eu	GEA	
^{154}Eu	GEA	
^{155}Eu	GEA	
^{14}C	Water leach followed by liquid scintillation counting	
^{3}H	Water leach followed by liquid scintillation counting	
^{129}I	Low energy gamma counting	ICP/MS
^{63}Ni	Separation by complex formation followed by liquid scintillation counting	
^{90}Sr	Beta proportional counting	
^{99}Tc	ICP/MS	Acid leach followed by liquid scintillation counting
^{125}Sb	GEA	
^{79}Se	Precipitation/ion exchange followed by liquid scintillation counting	
^{126}Sn	ICP/MS	
^{233}U	ICP/MS	
^{234}U	ICP/MS	
^{235}U	ICP/MS	
^{236}U	ICP/MS	
^{238}U	ICP/MS	
^{237}Np	ICP/MS	Alpha counting
^{238}Pu	Alpha counting	ICP/MS
$^{239/240}Pu$	Alpha counting	ICP/MS as ^{239}Pu and ^{240}Pu
^{241}Pu	Calculate from ^{238}Pu and $^{239/240}Pu$	Extraction followed by ICP/MS
^{241}Am	Alpha counting	ICP/MS
^{242}Cm	Alpha counting	
^{243}Cm	Alpha counting	
^{244}Cm	Alpha counting	
^{228}Th	Calculation	GEA
^{230}Th	ICP/MS	
^{232}Th	ICP/MS	
^{234}Th	ICP/MS	

GEA = Gamma energy analysis
ICP/MS = Inductively coupled plasma/mass spectrometry

The only truly multiple constituent analytical method for radiochemistry is GEA. Therefore, the secondary constituents are those found in the GEA library. If a constituent in the GEA library is detected, the concentration will be reported.

Thorium-230 and ^{232}Th can be determined by alpha analysis but are normally measured by ICP/MS because of their long half-life. Thorium-228 concentration is generally determined by alpha counting or by calculation based on ^{232}Th and ^{232}U concentrations.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

Quality requirements for WMA C soil sampling and analysis are described in DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents*. Hanford onsite laboratories performing analyses in support of this SAP will have approved and implemented quality assurance (QA) plans. As required by TFC-PLN-02, *Quality Assurance Program* Description, these QA plans will meet the minimum requirements of DOE/RL-96-68 as the baseline for laboratory quality systems. If subcontracting any portion of the analytical requirements to a commercial laboratory off the Hanford site, the subcontractor's implementing quality assurance program shall comply with DOECAP, *Consolidated Audit Program Quality Systems for Analytical Services*.

All sampling and analysis activities will be performed using approved methods, procedures, and work packages that are written in accordance with approved operational and laboratory QA plans, which are consistent with the requirements of this SAP. Sampling and analysis activities shall be performed by qualified personnel using properly maintained and calibrated equipment.

5.1 QUALITY CONTROL FOR FIELD SAMPLING

Prior to sampling, sampling equipment shall be cleaned using a procedure that is consistent with SW-846 sampling equipment cleaning protocol. Only new (unused) pre-cleaned, quality-assured sample containers or containers cleaned onsite per the SW-846 protocol shall be used for sampling.

Field QC samples shall be collected to evaluate the potential for cross-contamination and laboratory performance. Soil sampling will require the collection of field duplicates, equipment rinsate blank, and trip blank samples, where appropriate. Field QC sample types and frequency for collection are described in the following subsections.

Field Duplicates

Field duplicates (i.e., samples taken at the same location) are used to evaluate precision of the sampling process. However, it is not possible to obtain direct pushes exactly at the same location. Therefore, field duplicates will not be required for direct push samples.

For surface soil samples, collocated samples will be taken. The duplicate samples shall be shipped to the laboratory in the same manner as the primary samples. They will be analyzed using the two-step approach described in Section 4.1.

Equipment Rinsate Blanks

Equipment rinsate blanks are used to verify the adequacy of sampling equipment decontamination procedures and shall be collected for each sampling method or type of equipment used. Equipment blanks shall consist of deionized water washed through decontaminated sampling equipment. Equipment rinsate blanks shall be analyzed using the two-step approach described in Section 4.1.

Trip Blanks

Trip blanks for volatile organics will be prepared at a frequency of one per day of sampling during which samples are collected for VOCs. Trip blanks shall be prepared by adding laboratory-grade or reagent grade deionized water to a clean sample container. The trip blanks shall travel to the field with the associated bottle sets and will be returned to the laboratory with the samples. They will remain unopened during their transport and handling. Trip blanks are prepared as a check for possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for VOCs only.

Field Blanks

A field blank is prepared on-site during the sample collection activities using the same reagent water source used to prepare the trip blank. Field blanks for VOCs will be prepared at a frequency of one per day of sampling during which samples are collected for VOCs. The results from this analysis are used to assess sample contamination originating predominantly from field sampling conditions.

Temperature Blanks

A temperature blank, with a water filled vial or a suitable thermometer, should be included with each cooler of samples designated for transport. Upon sample receipt, the laboratory will use the temperature blank or thermometer to determine the internal temperature of each cooler. Acceptable temperatures are 4 ±2 °C for refrigerated aqueous and solid samples and < -7 °C to >-20 °C for frozen samples.

Prevention of Cross-Contamination

Special care should be taken to prevent cross-contamination of soil samples. Particular care will be exercised 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 them on or near potential contamination sources, such as uncovered ground.
- Handling bottles or equipment with dirty hands.
- Improperly decontaminating equipment before sampling or between sampling events.

5.2 REQUIRED QUALITY CONTROL FOR ANALYSIS

As applicable, a duplicate analysis, a matrix spike, a laboratory blank, and a laboratory control sample (LCS) are required for each batch of samples. In addition, a matrix spike duplicate is required for VOA, SVOA, PCB, and Hg analyses. The matrix spike duplicate is needed due to the high number of "less than" for these analyses. Instances where these requirements are not applicable are shown in Table 5-1. Evaluation criteria for these QC analyses also are shown in

Table 5-1. Where allowed by applicable SW-846 methods, statistical process control limits may be used instead of the specified criteria.

The QC criteria in Table 5-1 are goals for demonstrating reliable method performance. The laboratory's internal QA system will be used to evaluate the analytical data and processes whenever a criterion is exceeded. The laboratory may reanalyze based on the internal evaluation. Otherwise, the data will be further evaluated in accordance with the strategies described RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*. Primary constituent data not meeting the QC requirements will be noted accordingly and discussed in the narrative of the laboratory data report.

Table 5-1. Quality Control Parameters for Constituents. (2 sheets)

Constituents	Method	QC Acceptance Criteria		
		LCS % Recovery[a]	Spike % Recovery[b]	% RPD[c]
Al, Ag, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, Sb, Se, Sr, Tl, U, V, Zn	ICP/AES	80–120%	75–125%	≤30%
Hg	CVAA	80–120%	75–125%	≤30%
F^-, NH_4^+, NO_2^-, NO_3^-, Cl^-, SO_4^{2-}, $C_2H_3O_2^-$, CHO_2^-, $C_2H_3O_3^-$, $C_2O_4^{2-}$	IC	80–120%	75–125%	≤30%
CN^-	9014 (spectrophotometric)	80–120%	75–125%	≤30%
S^{2-}	9215	80–120%	75–125%	≤30%
pH	pH	± 0.1 pH Units	N/A	N/A
PCB by Aroclors	GC/ECD	70–130%	70–130%	≤30%
PCB by congeners	HRGC/HRMS	TBD	TBD	TBD
VOC	GC/MS	70–130%	70–130%	≤30%
SVOC	GC/MS (or GC/FID for ethylene glycol)	70–130%	70–130%	≤30%
Pesticides	GC/MS or GC/ECD	70–130%	70–130%	≤30%
Gasoline-range organics and diesel range organics	GC/MS or GC/FID	70–130%	70–130%	≤30%
% H_2O	Gravimetric	80–120%	N/A	≤30%
Bulk Density	Gravimetric	N/A	N/A	≤30%
^{235}U, ^{238}U, ^{237}Np, ^{232}Th, ^{126}Sn	ICP/MS	80–120%	75–125%	≤30%
^{233}U, ^{234}U, ^{236}U, ^{230}Th, ^{234}Th	ICP/MS	N/A[e]	N/A[e]	≤30%
^{228}Th	Calculation	N/A	N/A	N/A
^{60}Co, ^{137}Cs, ^{125}Sb	GEA	80–120%	N/A[f]	≤30%
^{152}Eu, ^{154}Eu, ^{155}Eu	GEA	N/A	N/A[f]	≤30%
^{129}I	GEA	80–120%	N/A[g]	≤30%
^{14}C, ^{3}H	Liquid scintillation counting	80–120%	75–125%	≤30%

Table 5-1. Quality Control Parameters for Constituents. (2 sheets)

Constituents	Method	QC Acceptance Criteria		
		LCS % Recovery[a]	Spike % Recovery[b]	% RPD[c]
^{63}Ni	Liquid scintillation counting	80–120%	N/A[g]	≤30%
^{90}Sr	Beta counting	80–120%	N/A[g]	≤30%
^{99}Tc	Liquid scintillation counting	80–120%	75–125%	≤30%
^{79}Se	Liquid scintillation counting	NP	N/A[g]	≤30%
^{238}Pu	Alpha counting	N/A[(f)]	N/A[g]	≤30%
$^{239/240}Pu$	Alpha counting	80–120%	N/A[g]	≤30%
^{241}Pu	Calculation from ^{238}Pu and $^{239/240}Pu$	N/A	N/A	N/A
^{241}Am	Alpha counting	80–120%	N/A[g]	≤30%
^{242}Cm, $^{243/244}Cm$	Calculation from ^{241}Am	N/A	N/A	N/A

CVAA = cold vapor atomic absorption
GEA = gamma energy analysis
GC/ECD = gas chromatography/electron capture detection
GC/FID = gas chromatography/flame ionization detection
GC/MS = gas chromatography/mass spectrometry
HRGC/HRMS = high-resolution gas chromatography/high-resolution mass spectroscopy
IC = ion chromatography
ICP/AES = inductively coupled plasma/atomic emission spectroscopy
ICP/MS = inductively coupled plasma/mass spectroscopy
QC = quality control
TBD = to be determined
TGA = thermogravimetric analysis
N/A = not applicable
NP = not performed

[a] LCS = Laboratory control sample. This sample is carried through the entire analytical method. The accuracy of a method is usually expressed as the percent recovery of the LCS. The LCS is a matrix with known concentration of constituents processed with each preparation and analyses batch. It is expressed as percent recovery; i.e., the amount measured, divided by the known concentration, times 100.

[b] For some methods, the sample accuracy is expressed as the percent recovery of a matrix spike sample. It is expressed as percent recovery; i.e., the amount measured, less the amount in the sample, divided by the spike added, times 100. One matrix spike is performed per analytical batch. Samples are batched with similar matrices. For other constituents, the accuracy is determined based on use of serial dilutions.

[c] RPD = Relative percent difference between the samples. Sample precision is estimated by analyzing duplicates taken separately through preparation and analysis. Acceptable sample precision is usually ≤ 30% if the sample result is at least 10 times the instrument detection limit.

RPD = [(absolute difference between primary and duplicate)/mean] x 100.

[d] reserved.

[e] No standards are run for these constituents.

[f] The measurement is a direct reading of the energy and the analysis is not affected by the sample matrix; therefore, a matrix spike is not required.

[g] Matrix spike analyses are not required for this method because a carrier or tracer is used to correct for constituent loss during sample preparation and analysis. The result generated using the carrier or tracer accounts for any inaccuracy of the method on the matrix. The reported results reflect this correction.

5.3 ANALYTICAL DETECTION LIMITS

Required detection limits as specified in the WMA C DQO are shown in Tables 5-2 and 5-3 for waste classification and ecological risk assessment, respectively. Where multiple required detection limits are specified for a single analyte, the laboratory shall meet the lower limit. Target detection limits are shown in Tables 5-4 and 5-5. Basis for the target detection limits is provided in the DQO. The laboratories are required to meet the required detection limits and shall strive to meet the target detection limits whenever possible.

Table 5-2. Required Detection Limits for Radionuclides (2 sheets)

Analyte	Analytical Method	Alternate Analytical Method	Source 10 CFR 61.55 Class C Waste (pCi/g)	Biota Concentration Guide for Terrestrial Animal (pCi/g)	Required Detection Limits (pCi/g)
^{241}Am	Alpha counting	Not available	9.00E+03	3.9E+03	3.9E+02
^{14}C	Liquid scintillation counting	Not available	5.33E+06	4.8E+03	4.8E+02
^{242}Cm	Alpha counting	Not available	9.00E+03	2.1E+03	2.1E+02
^{243}Cm	Alpha counting	Not available	9.00E+03	Not available	9.00E+02
^{244}Cm	Alpha counting	Not available	9.00E+03	4.1E+03	4.1E+02
^{60}Co	GEA	Not available	Not available	6.9E+02	6.9E+01
^{137}Cs	GEA	Not available	3.07E+09	2.1E+01	2.1
^{152}Eu	GEA	Not available	Not available	1.5E+03	1.5E+02
^{154}Eu	GEA	Not available	Not available	1.3E+03	1.3E+02
^{155}Eu	GEA	Not available	Not available	1.6E+04	1.6E+03
^{3}H	Liquid scintillation counting	Not available	Not available	1.7E+05	1.7E+04
^{129}I	Low energy gamma counting	Not available	5.33E+04	5.7E+03	5.7E+02
^{63}Ni	Liquid scintillation counting	Not available	4.67E+08	Not available	4.67E+07
^{237}Np	ICP/MS	Alpha Counting	9.00E+03	3.9E+03	3.9E+02
^{238}Pu	Alpha counting	ICP/MS	9.00E+03	5.3E+03	5.3E+02
^{239}Pu	Alpha counting	ICP/MS	9.00E+03 (as $^{239/240}$Pu)	6.1E+03	6.1E+02 (as $^{239/240}$Pu)
^{240}Pu	Alpha counting	ICP/MS	9.00E+03 (as $^{239/240}$Pu)	Not available	9.00E+02 (as $^{239/240}$Pu)
^{241}Pu	Calculate from ^{238}Pu and $^{239/240}$Pu	ICP/MS	3.50E+09	Not available	3.50E+08
^{125}Sb	GEA	Not available	Not available	3.5E+03	3.5E+02

Table 5-2. Required Detection Limits for Radionuclides (2 sheets)

Analyte	Analytical Method	Alternate Analytical Method	Source 10 CFR 61.55 Class C Waste (pCi/g)	Biota Concentration Guide for Terrestrial Animal (pCi/g)	Required Detection Limits (pCi/g)
^{79}Se	Liquid scintillation counting	Not available	Not available	Not available	Not available
^{90}Sr	Beta proportional counting	Not available	4.67E+09	2.3E+01	2.3
^{99}Tc	Liquid scintillation counting	ICP/MS	2.00E+06	4.5E+03	4.5E+02
^{126}Sn	ICP/MS	Not available	Not available	Not available	Not available
^{228}Th	Calculation	GEA	Not available	5.3E+02	5.3E+01
^{230}Th	ICP/MS	Not available	Not available	1.0E+04	1.0E+03
^{232}Th	ICP/MS	Not available	Not available	1.5E+03	1.5E+02
^{233}U	ICP/MS	Not available	9.00E+03	4.8E+03	4.8E+02
^{234}U	ICP/MS	Not available	9.00E+03	5.1E+03	5.1E+02
^{235}U	ICP/MS	Not available	9.00E+03	2.8E+03	2.8E+02
^{236}U	ICP/MS	Not available	Not available	Not available	Not available
^{238}U	ICP/MS	Not available	9.00E+03	1.6E+03	1.6E+02

GEA = gamma energy analysis ICP/MS = inductively coupled plasma/mass spectroscopy

Table 5-3. Required Detection Limits for Non-Radionuclides[1] (3 sheets)

Analyte	Soil Concentration for Protection of Terrestrial (mg/kg)			SST Priority [2]	Required Detection Limit(mg/kg)
	Plants	Soil Biota	Wildlife		
METALS:					
Aluminum (soluble salts)	50			Primary	5
Antimony	5			Primary	0.5
Arsenic III[3]			7	Primary	0.7
Arsenic V[3]	10	60	132	Primary	1
Barium	500		102	Primary	10.2
Beryllium	10			Primary	1
Boron	0.5			Secondary	6
Bromine[4]	10			Primary	1
Cadmium	4	20	14	Primary	0.4
Chromium (total)	42	42	67	Primary	0.15[10]

Table 5-3. Required Detection Limits for Non-Radionuclides[1] (3 sheets)

Analyte	Soil Concentration for Protection of Terrestrial (mg/kg)			SST Priority [2]	Required Detection Limit(mg/kg)
	Plants	Soil Biota	Wildlife		
Cobalt	20			Primary	2
Copper	100	50	217	Primary	5
Fluorine[5]	200			Primary	20
Iodine[6]	4				
Lead	50	500	118	Primary	5
Lithium	35			Secondary	3.5
Manganese	1,100		1,500	Primary	110
Mercury, inorganic	0.3	0.1	5.5	Primary	0.01
Molybdenum	2		7	Secondary	4
Nickel	30	200	980	Primary	3
Selenium	1	70	0.3	Primary	0.03
Silver	2			Primary	0.2
Technetium[6]	0.2				
Thallium	1			Primary	0.1
Tin	50			Secondary	6
Uranium	5			Primary	0.5
Vanadium	2			Primary	0.2
Zinc	86	200	360	Primary	8.6
PESTICIDES:[7]					
Aldrin			0.1	Secondary	0.01
Benzene hexachloride (including lindane)			6	Primary	0.6
Chlordane		1	2.7		0.1
DDT/DDD/DDE (total)			0.75		0.075
Dieldrin			0.07	Secondary	0.007
Endrin			0.2	Secondary	0.02
Hexachlorobenzene			17		1.7
Heptachlor/heptachlor epoxide (total)			0.4		0.04
Pentachlorophenol	3	6	4.5	Secondary	0.3
OTHER CHLORINATED ORGANICS:					
1,2,4-Trichlorobenzene		20		Primary	2
1,2-Dichloropropane		700		Secondary	
1,4-Dichlorobenzene		20		Secondary	
2,4,5-Trichlorophenol	4	9		Primary	0.4
2,4,6-Trichlorophenol		10		Primary	1

Table 5-3. Required Detection Limits for Non-Radionuclides[1] (3 sheets)

Analyte	Soil Concentration for Protection of Terrestrial (mg/kg)			SST Priority [2]	Required Detection Limit(mg/kg)
	Plants	Soil Biota	Wildlife		
Chlorobenzene		40		Primary	4
PCB mixtures (total)[8]	40		0.65	Primary	0.065
OTHER NONCHLORINATED ORGANICS:					
Acenaphthene	20			Primary	2
Benzo(a)pyrene			12	Secondary	1.2
Di-n-butyl phthalate	200			Primary	20
OTHER NONCHLORINATED ORGANICS: cont'd					
Nitrobenzene		40		Primary	4
Phenol	70	30		Secondary	
Styrene	300			Secondary	
Toluene	200			Primary	20
PETROLEUM[9]:					
Gasoline Range Organics		100	5,000 except that the concentration shall not exceed residual saturation at the soil surface		10
Diesel Range Organics		200	6,000 except that the concentration shall not exceed residual saturation at the soil surface		20

[1] Blank cells indicate that no value is available.
[2] Only Primary and Secondary contaminants from the SST DQO (RPP-23403, Rev. 3) are included in this table except for pesticides where all pesticides listed WAC 173-340-900 Table 749-3 are included. For primary analytes, if detected a numerical value is reported, if not detected, analyte is reported with a less than minimum detection limit (MDL). For secondary organic analytes, if detected a numerical value is reported as an estimate, if not detected, the analyte is not reported. This is the same process used in SST DQO RPP-23403, Rev. 3.
[3] Total arsenic is reported (same as SST DQO (RPP-23403, Rev. 3)
[4] Bromine is reported as bromide (same as SST DQO (RPP-23403, Rev. 3, where it was classed as secondary)
[5] Fluorine is reported as fluoride (same as SST DQO (RPP-23403, Rev. 3, where it was classed as primary)
[6] Included in the radionuclide analysis, radionuclide will be converted from radioactivity to mass using specific activity. Iodine-129 and Technetium-99 were both classed as primary in SST DQO (RPP-23403, Rev. 3)
[7] In addition to the SVOA analysis, EPA Method 8081 for pesticides will also be performed to meet the reporting requirements for ecological indicator soil concentrations.
[8] PCBs reported as individual Arochlors and total PCB
[9] Petroleum contaminants are not included in the SST DQO but will be measured in soil for ecological risk assessment.
[10] This required detection limit is based on a maximized sample size. If a maximized sample size cannot be collected, the detection limit will be higher than indicated.

Table 5-4. Target Detection Limits for Primary Radionuclides

CAS# or Constituent Identifier	Analyte	Survey or Analytical Method	Target Detection Limits (pCi/g)
14234-35-6	Antimony-125	Gamma GS	0.3
14596-10-2	Americium-241	^{241}Am alpha energy analysis	1
14762-75-5	Carbon-14	C-14 LSC (low level)	1
10045-97-3	Cesium-137	Gamma GS	0.1
10198-40-0	Cobalt-60	Gamma GS	0.05
15510-73-3	Curium-242	^{241}Am/^{244}Cu alpha energy analysis	1.0
15757-87-6	Curium-243	^{241}Am/^{244}Cu alpha energy analysis	1.0
13981-15-2	Curium-244	^{241}Am/^{244}Cu alpha energy analysis	1.0
14683-23-9	Europium-152	Gamma GS	0.1
15585-10-1	Europium-154	Gamma GS	0.1
14391-16-3	Europium-155	Gamma GS	0.1
15046-84-1	Iodine 129	^{129}I LSC	2
13994-20-2	Neptunium-237	ICP/MS	1
13981-37-8	Nickel-63	^{63}Ni LSC	30
13981-16-3	Plutonium-238	Alpha energy analysis	1
Pu-239/240	Plutonium-239/240	Alpha energy analysis	1
13982-63-3	Radium-226	Gamma GS	0.2
15758-85-9	Selenium-79	^{79}Se LSC	10
Rad-Sr	Strontium-90	^{89,90} Sr total Sr - gas proportional counting	1
14133-76-7	Technetium-99	Liquid scintillation counting	1
14274-82-9	Thorium-228	TBD	1
14269-63-7	Thorium-230	ICP/MS	1
Th-232	Thorium-232		1
10028-17-8	Tritium	Tritium – H-3 LSC(mid level)	30
13966-29-5	Uranium-233/234	ICP/MS	1
15117-96-1	Uranium-235		1
U-238	Uranium-238		1

CAS = Chemical Abstracts Service
GS = gamma spectroscopy.
LSC = liquid scintillation counter.
ICP/MS = inductively coupled plasma/mass spectrometry
TBD = to be determined

Table 5-5. Target Detection Limits for Primary Chemicals (4 sheets)

CAS# or Constituent Identifier.	Analyte	Survey or Analytical Method	Target Detection Limits (mg/kg)
7429-90-5	Aluminum	EPA Method 6010	5
7440-36-0	Antimony	EPA Methods 6010, 6020, or 200.8 (trace)	0.6
7440-38-2	Arsenic	EPA Methods 6010, 6020, or 200.8	1
7440-39-3	Barium	EPA Methods 6010, 6020, or 200.8	20
7440-41-7	Beryllium	EPA Methods 6010, 6020, or 200.8	0.5
7440-43-9	Cadmium	EPA Methods 6010, 6020, or 200.8	0.5
7440-47-3	Chromium (III)/chromium (total)	EPA Methods 6010, 6020, or 200.8	1
7440-48-4	Cobalt	EPA Methods 6010, 6020, or 200.8	2
7440-50-8	Copper	EPA Methods 6010, 6020, or 200.8	1
7439-89-6	Iron	EPA Methods 6010, 6020, or 200.8	5
7439-92-1	Lead	EPA Methods 6010, 6020, or 200.8	5
7439-96-5	Manganese	EPA Methods 6010, 6020, or 200.8	1.9
7439-97-6	Mercury	EPA Methods 7470, 7471, 6020, or 200.8	0.2
7439-98-7	Molybdenum	EPA Methods 7470, 7471, 6020, or 200.8	19
7440-02-0	Nickel	EPA Methods 6010, 6020, or 200.8	4
7782-49-2	Selenium	EPA Methods 6010, 6020, or 200.8	1
7440-22-4	Silver	EPA Methods 6010, 6020, or 200.8	2
7440-24-6	Strontium	EPA Methods 6010, 6020, or 200.8	1
7440-28-0	Thallium	EPA Methods 6010, 6020, or 200.8	0.5
7440-61-1	Uranium	EPA Methods 200.8, 6020, or kinetic phosphorescence absorption	1
7440-62-2	Vanadium	EPA Methods 6010, 6020, or 200.8	2.5
7440-66-6	Zinc	EPA Methods 6010, 6020, or 200.8	1
57-12-5	Cyanide (includes ferrocyanide)	EPA Methods 9010C total cyanide or 335	0.5
16984-48-8	Fluoride	IC, EPA Method 9056 or 300.0	5
14797-55-8	Nitrate	IC, EPA Method 9056 or 300.0	2.5
14797-65-0	Nitrite	IC, EPA Method 9056 or 300.0	2.5
16887-00-6	Chloride	IC, EPA Method 9056 or 300.0	0.3
14808-79-8	Sulfate	IC, EPA Method 9056 or 300.0	2.7
71-50-1	Acetate	IC, EPA Method 9056 or 300.0	4.5
64-18-6	Formate	IC, EPA Method 9056 or 300.0	10.0

Table 5-5. Target Detection Limits for Primary Chemicals (4 sheets)

CAS# or Constituent Identifier.	Analyte	Survey or Analytical Method	Target Detection Limits (mg/kg)
79-14-1	Glycolate	IC, EPA Method 9056 or 300.0	3.8
144-62-7	Oxalate	IC, EPA Method 9056 or 300.0	2
18496-25-8	Sulfide	EPA Method 9030	5
NA	Ammonium (NH_4)	EPA Method 300.7	0.5
67-64-1	Acetone	EPA Method 8260	0.02
71-43-2	Benzene	EPA Method 8260	0.0015
75-15-0	Carbon disulfide	EPA Method 8260	0.005
56-23-5	Carbon tetrachloride	EPA Method 8260	0.0015
108-90-7	Chlorobenzene	EPA Method 8260	0.005
67-66-3	Chloroform (trichloromethane)	EPA Method 8260	0.005
108-94-1	Cyclohexanone	EPA Method 8270	0.5
107-06-2	1,2-Dichloroethane	EPA Method 8260	0.0015
75-35-4	1,1-Dichloroethylene	EPA Method 8260	0.01
75-09-2	Dichloromethane (methylene chloride)	EPA Method 8260	0.002
10061-02-6	Dichloropropene; 1,3,- (trans-)	EPA Method 8260	0.005
141-78-6	Ethyl acetate	EPA Method 8015	5
60-29-7	Diethyl ether	EPA Method 8015, 8260	5
100-41-4	Ethyl benzene	EPA Method 8260	0.005
67-72-1	Hexachloroethane	EPA Method 8270	0.33
108-10-1	Methyl isobutyl ketone (MIBK hexone)	EPA Method 8260	0.01
78-93-3	Methyl ethyl ketone (MEK)	EPA Method 8260	0.01
79-46-9	Nitropropane; 2-	EPA Method 8260	0.002
79-34-5	Tetrachloroethane; 1,1,2,2-	EPA Method 8260	0.005
127-18-4	Tetrachloroethene (PCE)	EPA Method 8260	0.005
108-88-3	Toluene	EPA Method 8260	0.005
76-13-1	trichloro-1,2,2-trifluoroethane; 1,1,2-	EPA Method 8260	0.010
71-55-6	1,1,1-Trichloroethane (TCA)	EPA Method 8260	0.005
79-00-5	1,1,2-Trichloroethane	EPA Method 8260	0.002
107-21-1	Ethylene glycol	EPA Method 8015	5

Table 5-5. Target Detection Limits for Primary Chemicals (4 sheets)

CAS# or Constituent Identifier.	Analyte	Survey or Analytical Method	Target Detection Limits (mg/kg)
156-59-2	Cis-1,2,-dichlorobenzene	EPA Method 8260	0.0003
156-60-5	Trans-1,2-dichlorobenzene	EPA Method 8260	0.0004
83-32-9	Acenaphthene	EPA Method 8270	0.33
117-81-7	Bis(2-ethylhexyl)phthalate	EPA Method 8270	2.95
71-36-3	Butanol; n- (n-butyl alcohol)	EPA Method 8260, 8015	5
85-68-7	Butylbenzylphthalate	EPA Method 8270	0.33
95-57-8	Chlorophenol; 2-	EPA Method 8270	0.33
M + P CRESOL	Cresol; m + p (3/4-Methylphenol)	EPA Method 8270	0.33
95-48-7	Cresol; o- (2-Methylphenol)	EPA Method 8270	0.33
1319-77-3	Cresylic acid (cresol, mixed isomers)	EPA Method 8270	0.5
84-74-2	Dibutylphthalate (Di-n-butylphthalate)	EPA Method 8270	0.33
117-84-0	Di-n-octylphthalate	EPA Method 8270	0.33
95-50-1	Dichlorobenzene; 1,2-(ortho-)	EPA Method 8270	0.33
121-14-2	Dinitrotoluene; 2,4-	EPA Method 8270	0.33
110-80-5	Ethoxyethanol; 2-	TBD	TBD
206-44-0	Fluoranthene	EPA Method 8270	0.33
87-68-3	Hexachlorobutadiene	EPA Method 8270	0.33
78-83-1	Isobutyl alcohol (Isobutanol)	EPA Methods 8260 or 8015	5
128-37-0	methylphenol; 2,6-Bis(tert-butyl)-4-	EPA Method 8270	1.2
59-50-7	methylphenol; 4-Chloro-3-(p-Chloro-m-cresol)	EPA Method 8270	0.33
91-20-3	Naphthalene	EPA Method 8270	0.33
98-95-3	Nitrobenzene	EPA Method 8270	0.33
88-75-5	Nitrophenol; o-	EPA Method 8270	0.66
621-64-7	Nitroso-di-n-propylamine	EPA Method 8270	0.33
79-01-6	Trichloroethylene (TCE)	EPA Method 8260	3.7E-4
75-69-4	Trichlorofluoromethane	EPA Method 8260	0.01
75-01-4	Vinyl chloride	EPA Method 8260	0.01
1330-20-7	Xylenes	EPA Method 8260	0.01

Table 5-5. Target Detection Limits for Primary Chemicals (4 sheets)

CAS# or Constituent Identifier.	Analyte	Survey or Analytical Method	Target Detection Limits (mg/kg)
108-38-3	Xylene; m-	EPA Method 8260	5.1E-4
95-47-6	Xylene; o-	EPA Method 8260	2.4E-4
106-42-3	Xylene; p-	EPA Method 8260	5.1E-4
120-82-1	1,2,4 - Trichlorobenzene	EPA Method 8270	0.33
59-89-2	Nitrosomorpholine; N-	EPA Method 8270	0.33
129-00-0	Pyrene	EPA Method 8270	0.33
110-86-1	Pyridine	EPA Method 8270	0.66
95-95-4	Trichlorophenol; 2,4,5-	EPA Method 8270	0.33
88-06-2	Trichlorophenol; 2,4,6-	EPA Method 8270	0.33
		EPA Method 8041	0.165
126-73-8	Tributyl phosphate	EPA Method 8270	3.3
107-66-4	Dibutyl phosphate	EPA Method 8270	TBD
--	Monobutyl phosphate	EPA Method 8270	TBD
56-55-3	Benzo (a) anthracene	EPA Method 8270	0.33
205-99-2	Benzo (b) fluorathene	EPA Method 8270	0.33
207-08-9	Benzo (k) fluorathene	EPA Method 8270	0.33
50-32-8	Benzo (a) pyrene	EPA Method 8270	0.33
218-01-9	Chrysene	EPA Method 8270	0.33
53-70-3	Dibenzo (ab) anthracene	EPA Method 8270	0.33
193-39-5	Indeno (123-cd) pyrene	EPA Method 8270	0.33
2674-11-2	Aroclor 1016	PCBs, EPA Method 8082	0.02
11104-26-2	Aroclor 1221	PCBs, EPA Method 8082	0.02
11141-16-5	Aroclor 1232	PCBs, EPA Method 8082	0.02
53969-21-9	Aroclor 1242	PCBs, EPA Method 8082	0.02
126572-29-6	Aroclor 1248	PCBs, EPA Method 8082	0.02
11097-6999-1	Aroclor 1254	PCBs, EPA Method 8082	0.02
11096-82-5	Aroclor 1260	PCBs, EPA Method 8082	0.02
Not available	PCB congeners	PCBs, EPA Method 1668	TBD

CAS = Chemical Abstracts Service
EPA = U.S. Environmental Protection Agency.
IC = ion chromatography.
N/A = not applicable.
PCB = polychlorinated biphenyl.
TBD = to be determined

6.0 DATA REPORTING

If soil sample analysis is performed at the 222-S Laboratory, the data report(s) will be in Format VI. A description of a Format VI report is provided below. Additional details of a Format VI report can be found in ATL-MP-1011, *Quality Assurance Project Plan for 222-S Laboratory*.

Format VI Report with QA Verification:

- Narrative – contains a description of sample receipt, sample breakdown, and has a section corresponding to each method describing any analytical/QC deviations from the work plan.

- Results Table (Data Summary Report) – printout containing sample and duplicate results, relative percent difference, standard and spike recoveries, blank results, and data qualifiers (flags).

- Sample section that contains sample breakdown diagrams, chains of custody, and geologist's descriptions.

- Section that contains all e-mail correspondence documenting issues that arose during sampling and analysis, and subsequent decisions that affected initial work instructions.

- Laboratory will perform a QA review of the data package. Typical QA reviews require a minimum 10% review.

The data package will also include TICs found in VOA and SVOA. A discussion of the TIC evaluation process shall be provided in the narrative. A Format VI data package is subject to internal laboratory QA verification and review including peer review prior to release.

If sample analysis is performed at other laboratories, format for the data reports will be equivalent to a 222-S Laboratory Format VI report.

In addition to the data package(s), an electronic version of the analytical results shall be provided to the HEIS database.

7.0 CHANGE CONTROL

Field activity and laboratory work scope changes may be required because of unexpected field conditions, new information, health and safety concerns, or other circumstances. Changes to work scope may result in modifications to this SAP. Work scope changes that do not result in deviation from the SAP requirements, can be made in the field or laboratory with the approval of the project manager or assigned task lead. These work scope changes will be documented in the sampling work package and/or Format VI laboratory report(s). Justification for the changes to work scope shall be provided in sufficient detail to understand the basis for the change. Alternately, if field or laboratory conditions result in substantial work scope changes, the SAP may be revised with DOE and Ecology approval.

Field sampling and survey methods and analytical strategies (e.g., constituent listings and data analysis) may be updated as new technologies or data become available. The impact of these updates to the SAP will be judged as they are identified to determine if revisions to the SAP will be necessary. Ecology, DOE, and its contractors will participate in the SAP update evaluation process and any subsequent revisions to the SAP.

8.0 REFERENCES

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations*, as amended.

49 CFR, "Transportation," Title 49, *Code of Federal Regulations*, as amended.

ATL-MP-1011, 2008, *Quality Assurance Project Plan for 222-S Laboratory*, as revised, Advanced Technologies and Laboratories International, Inc., Richland, Washington.

DOECAP, 2007, *Quality Systems For Analytical Services Document Revision 2.3*, as revised, U.S. Department of Energy, Oak Ridge Office, Oak Ridge, Tennessee.

DOE/RL-96-68, 2008, *Hanford Analytical Services Quality Assurance Requirements Documents*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

LAUR-93-3605, 1993, *Analysis of the History of 241-C Farm*, Los Alamos National Laboratory, Los Alamos, New Mexico.

PNNL-12040, 1998, *Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privatization Project*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

RPP-23403, 2006, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-ENV-38838, 2008, *Tank Farm Vadose Zone Program Characterization Processes*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-PLAN-39114, 2008, *RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C*, Rev. 0, Washington River Protection Solutions, LLC., Richland, Washington.

RPP-RPT-38152, 2008, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/Corrective Measures Study*, Rev. 0, Cenibark International, Inc., Richland, Washington.

SW-846, 1986, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, as amended, http://www.epa.gov/epaoswer/hazwaste/test/main.htm, U.S. Environmental Protection Agency, Washington, D. C.

TFC-PLN-02, 2008, *Quality Assurance Program Description*, Rev. E-2, Washington River Protection Solutions, LLC, Richland, Washington.

WAC-173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Codes*, as amended.

WAC-173-340-820, "Sampling and Analysis Plans," *Washington Administrative Codes*, as amended.

APPENDIX A

QUALITY ASSURANCE PROJECT PLAN FOR PHASE 2 CHARACTERIZATION OF VADOSE ZONE SOIL IN WASTE MANAGEMENT AREA C

QUALITY ASSURANCE PROJECT PLAN FOR PHASE 2 CHARACTERIZATION OF VADOSE ZONE SOIL IN WASTE MANAGEMENT AREA C

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The QAPjP complies with the requirements of the following:

- ASME NQA-1, *2004 Quality Assurance Requirements for Nuclear Facility Applications (QA)*
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD)
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5.*
- TFC-PLN-02, "Quality Assurance Program Description" (QAPD)

A-1.0 PROJECT MANAGEMENT

This section addresses the basic areas of project management, and it ensures that the project has a defined goal, that the participants understand the goal and approach to be used, and that the planned outputs have been appropriately documented. The QAPjP is organized according to the elements described in EPA/240/B-01/003.

A-1.1 PROJECT/TASK ORGANIZATION

The project organization is described in the subsections that follow and is shown in Figure A-1.

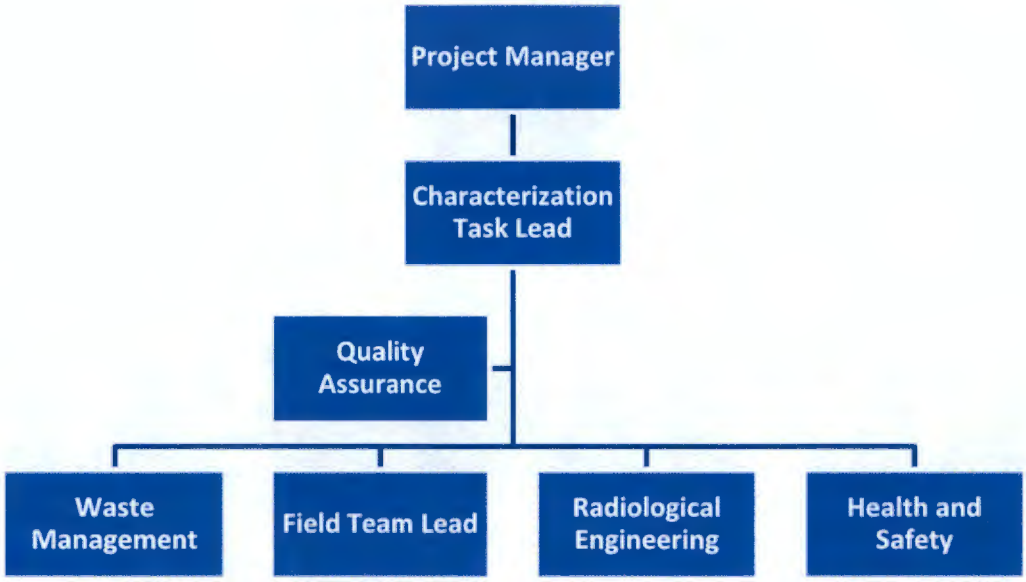
Project Manager

The Project Manager provides oversight for all activities and coordinates with DOE and Ecology in support of sampling activities. In addition, support is provided to the task lead to ensure that the work is performed safely and cost-effectively.

Characterization Task Lead

The Characterization Task Lead is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The task lead ensures that the field team lead, samplers, and others responsible for implementation of this SAP and the QAPjP are provided with current copies of this document and any revisions thereto. The task lead works closely with quality assurance, health and safety, and the field team leader to integrate these and the other lead disciplines in planning and implementing the work scope. The task lead also coordinates with and reports to DOE, Ecology, and the Tank Operation Contractor on all sampling activities.

Figure A-1. Project Organization



The task lead is responsible for selecting the laboratories that perform the analyses and requests assessments/surveillances of the laboratories. The task lead receives the analytical data from the laboratories, and arranges for data entry into the Hanford Environmental Information System (HEIS) database. The task lead is also responsible for a review of sample data against existing knowledge and data quality assessments according to guidelines in EPA/600/R-96/084, *Guidance for Data Quality Assessment, Practical Methods for Data Analysis, EPA QA/G-9, QA00 Update.*

Quality Assurance

Quality Assurance is responsible for quality assurance issues on the project. Responsibilities include oversight of implementation of the project quality assurance requirements; review of project documents, including SAPs (and the QAPjP); and participation in quality assurance assessments and surveillances on sample collection and analysis activities, as appropriate.

Waste Management

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. Other responsibilities include identifying waste management sampling/characterization requirements to ensure regulatory compliance interpretation (e.g., with WAC 173-303, "Dangerous Waste Regulations") of the characterization data to generate waste designations, profiles, and other documents that confirm compliance with waste disposal requirements.

Field Team Leader

The field team leader has the overall responsibility for the planning, coordination, and execution of the field sampling activities. Specific responsibilities include converting the sampling design

requirements into field work plans or task instructions that provide specific direction for field activities. Responsibilities also include directing training, mock-ups, and practice sessions with field personnel to ensure that the sampling design is understood and can be performed as specified. The field team leader communicates with the Characterization Task Lead to identify field constraints that could affect the sampling design. In addition, the field team leader directs the procurement and installation of materials and equipment needed to support the field work.

The field team leader oversees field-sampling activities that include sample collection, packaging, provision of certified clean sampling bottles/containers, documentation of sampling activities in controlled logbooks, chain-of-custody documentation, and packaging and transportation of samples to the laboratory or shipping center.

Radiological Engineering

The Radiological Engineering lead is responsible for radiological engineering and 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, radiological hazards are identified and appropriate controls are implemented to maintain worker exposures to the hazards at levels as low as reasonably achievable. Radiological Engineering interfaces with the project safety and health representative and plans and directs radiological control technician support for all activities.

Health and Safety

Responsibilities include coordination of industrial safety and health support within the project as carried out through safety and health plans, job hazard analyses, and other pertinent safety documents required by Federal regulation or by internal Tank Operation Contractor work requirements. In addition, assistance is provided to project personnel in complying with applicable health and safety standards and requirements. Personnel protective clothing requirements are coordinated with Radiological Engineering.

A-1.2 PROBLEM DEFINITION/BACKGROUND

See Sections 1.0 and 2.0 of the SAP.

A-1.3 PROJECT/TASK DESCRIPTION

See Sections 3.0 and 4.0 of the SAP.

A-1.4 QUALITY OBJECTIVES AND CRITERIA

See Sections 4.0 and 5.0 of the SAP.

A-1.5 SPECIAL TRAINING/CERTIFICATION

Sampling and laboratory personnel shall complete the necessary training and must receive appropriate certification to perform assigned tasks in support of the characterization project. The environmental safety and health training program provides workers with the knowledge and skills necessary to safely execute assigned duties. Field personnel typically will 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
- Radiological worker training.

A graded approach is used to ensure that workers receive a level of training commensurate with their responsibilities that complies with applicable U.S. Department of Energy orders and government regulations. Specialized employee training includes prejob briefings, on-the-job training, emergency preparedness, plan-of-the-day activities, and facility/worksite orientations.

A-1.6 DOCUMENTS AND RECORDS

All information pertinent to field sampling and surveying will be recorded in field checklists and bound logbooks in accordance with existing sample collection protocols. The sampling team will be responsible for recording all relevant sampling information. Entries made in the logbook will be dated and signed by the individual who made the entry. Program requirements for managing the generation, identification, transfer, protection, storage, retention, retrieval, and disposition of records within the Tank Farms Contractor will be followed.

Requirements for laboratory data reporting are discussed in Sections 6.0 and 7.0 of the SAP.

A-2.0 DATA GENERATION AND ACQUISITION

A-2.1 SAMPLING PROCESS DESIGN

See Section 3.0 of the SAP.

A-2.2 SAMPLING METHODS

See Section 3.0 of the SAP.

A-2.3 SAMPLE HANDLING AND CUSTODY

See Section 3.0 of the SAP.

A-2.4 ANALYTICAL METHODS

See Table 5-1 of the SAP.

A-2.5 QUALITY CONTROL

Quality control sample requirements and acceptance criteria for these samples are specified in Section 5.0 of the SAP. Overall quality assurance and quality control requirements for characterization are discussed in this section.

A-2.5.1 Quality Assurance Objective

The quality assurance objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality is assessed by representativeness, comparability, accuracy, and precision. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. Each of these is addressed in the following subsections.

Representativeness

Representativeness is a measure of how closely the results reflect the actual concentration and distribution of the chemical and radiological constituents in the matrix sampled. Sampling design has been developed and sampling techniques have been selected with the goal of optimizing representativeness of the samples.

Comparability

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

Accuracy

Accuracy is an assessment of the closeness of the measured value to the true value. Accuracy of chemical test results is assessed by spiking samples with known standards and establishing the average recovery. A matrix spike is the addition to a sample of a known amount of a standard compound similar to the compounds being measured. Sample accuracy is expressed as the percent recovery of a spiked sample. Table 5-1 provides the accuracy criteria for laboratory analyses.

Precision

Precision is a measure of the data reproducibility when more than one measurement has been taken on the same sample. Precision can be expressed as the relative percent difference for duplicate measurements or relative standard deviation for triplicates. Table 5.1 lists the analytical precision criteria for fixed laboratory analyses.

Detection Limits

Detection limits are functions of the analytical method used to provide the data and the quantity of the sample available for analyses. Required and target detection limits for the COPCs are presented on Tables 5-2 through 5-5.

Laboratory Quality Control

The laboratory method blanks, duplicates, laboratory control sample/blank spike, and matrix spikes are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* and will be run at the frequency specified in Chapter 1 of SW-846. In the event sample material is not sufficient to perform all analyses, sample quantity will be prioritized and allocated to completion of the method analysis. If insufficient sample is available for completion of laboratory QC analyses, the laboratory will be make note of the condition in the data package narrative and the associated data results will have laboratory qualifies added as appropriate.

A-2.5.2 Sample Preservation, Containers, and Holding Times

Sample preservation, containers, and holding times for radiological and nonradiological analytes are shown in Table A-1.

Table A-1. Sample Preservation, Container, and Holding Time Guidelines

Analytes	Matrices	Bottle		Preservation	Packing Requirements	Holding Time
		Type	Lid			
Radionuclides	Soil/Sludge/ Sediment/Scale	G/P	Teflon®-lined cap	None	None	6 months
IC anions	Soil/Sludge/ Sediment/Scale	G/P	Teflon®-lined cap	None	Cool 4 °C	48 hours
ICP metals	Soil/Sludge/ Sediment/Scale	G/P	Teflon®-lined cap	None	None	6 months
Mercury	Soil/Sludge/ Sediment/Scale	G	Teflon®-lined cap	None	None	28 days
Total cyanide	Soil/Sludge/ Sediment/Scale	G	Teflon®-lined cap	None	Cool 4 °C	14 days
pH (soil)	Soil/Sludge/ Sediment/Scale	G/P	Teflon®-lined cap	None	None	As soon as possible after receiving sample
SVOA, pesticides, and diesel-range organics	Soil/Sludge/ Sediment/Scale	AG	Teflon®-lined cap	None	Cool 4 °C	14/40 days
VOA and gasoline range organics	Soil/Sludge/ Sediment/Scale	AG	Teflon®-septum cap	Sodium bisulfate	Cool 4 °C	14 days
PCBs	Soil/Sludge/ Sediment/Scale	G	Teflon®-lined cap	None	Cool 4 °C	None

AG = amber glass
CVAA = cold vapor atomic absorption
EPA = U.S. Environmental Protection Agency
G = glass
GC = gas chromatography
IC = ion chromatography
ICP = inductively coupled plasma
P = plastic
PCB = polychlorinated biphenyl
SVOA = semivolatile organic analysis
VOA = volatile organic analysis

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A-2.5.3 Sample Collection Requirements

See Section 3.0.

A-2.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

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

minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment per manufacturer or other applicable guidelines. Maintenance requirements (such as parts lists and documentation of routine maintenance) will be included in the individual laboratory and the onsite organization quality assurance plan or operating procedures (as appropriate). Calibration of laboratory instruments will be performed in a manner consistent with SW-846 as implemented by DOE/RL-96-68.

Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use. Note that contamination is monitored by the QC samples discussed in Section 5.0 of the SAP.

A-2.7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

See Sections 5.2 and A-2.6.

A-2.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

See Section A-2.6.

A-2.9 NON-DIRECT MEASUREMENTS

See Section 3.0 for a discussion of field survey techniques.

A-2.10 DATA MANAGEMENT

See Section 6.0 for data reporting requirements.

A-3.0 ASSESSMENT AND OVERSIGHT

A-3.1 ASSESSMENT AND RESPONSE ACTIONS

Project management and Quality Assurance may conduct random surveillance and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the project quality management plan, procedures, and regulatory requirements. Deficiencies identified by these assessments shall be reported in accordance with existing programmatic requirements. Corrective actions will be implemented as required by the Tank Operation Contractor policy and procedures.

A-3.2 REPORTS TO MANAGEMENT

Management will be made aware of deficiencies identified by assessments and surveillances and subsequent corrective actions.

A-4.0 DATA VALIDATION AND USABILITY

A-4.1 DATA REVIEW, VERIFICATION, AND VALIDATION

Sample analysis data will be reviewed by laboratory QA and chemists prior to issuance. The characterization task lead will be responsible for checking completeness of the data report(s), reviewing results against any existing knowledge, and assessing the data to determine if they are adequate for the intended use. Third-party data validation is not required for SST tank waste sample results (see RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*). Both tank waste and soil sample data will be used for WMA C closure. Third-party data validation will be performed on at least 5% of WMA C soil sample results.

A-4.2 VERIFICATION AND VALIDATION METHOD

See above section (Section A-4.1).

A-4.3 RECONCILIATION WITH USER REQUIREMENTS

The data quality assessment 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 if quantitative data are of the correct type and are of adequate quality and quantity to meet the project DQOs. Data quality assessment will be performed according to guidelines in EPA/600/R-96/084.

A-5.0 QUALITY ASSURANCE PROJECT PLAN REFERENCES

ASME NQA-1, 2004, *2004 Quality Assurance Requirements for Nuclear Facility Applications (QA)*, ASME International, New York, New York.

DOE/RL-96-68, 2008, *Hanford Analytical Services Quality Assurance Requirements Documents*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5*, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

EPA/600/R-96/084, 2000, *Guidance for Data Quality Assessment, Practical Methods for Data Analysis, EPA QA/G-9, QA00 Update*, U.S. Environmental Protection Agency, Washington, D.C.

RPP-23403, 2006, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

SW-846, 1986, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Third Edition as amended, U.S. Environmental Protection Agency, Washington, D.C.

TFC-PLN-02, Rev. F-2, "Quality Assurance Program Description," Washington River Protection Solutions, LLC, Richland, Washington.

WAC 173-303, "Dangerous Waste Regulations", *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.