CENTRAL WASTE COMPLEX OUTDOOR STORAGE AREA-A
ADDENDUM H
CLOSURE PLAN

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
01/16/2026	8C.2025.2F

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ADDENDUM H
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TERMS

CH	Contact-handled
CLARC	Cleanup Levels and Risk Calculation
CPCCo	Central Plateau Cleanup Company
CWC	Central Waste Complex
DOE	U.S. Department of Energy
DWMU	Dangerous Waste Management Unit
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HHE	Human health and the environment
MLLW	Mixed low-level waste
MTCA	*Model Toxics Control Act Cleanup Regulations* (Washington Administrative Code 173-340)
OSA	Outdoor Storage Area
OUG	Operating Unit Group
PQL	Practical quantitation limit
QA	Quality assurance
RCRA	*Resource Conservation and Recovery Act of 1976*
RH	Remote-handled
SAP	Sampling and Analysis Plan
TPA	Tri-Party Agreement
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TRUM	Transuranic mixed
TSD	Treatment, storage, and disposal
VSP	Visual Sample Plan
WRAP	Waste Receiving and Processing Facility

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H.1 INTRODUCTION

This addendum discusses closure activities for the Central Waste Complex (CWC) Closure Unit Group (CUG) 34, Outdoor Storage Area (OSA)-A dangerous waste management unit (DWMU), hereinafter referred to as OSA-A (Figure H-1). These activities are performed under WA7890008967, Hanford Facility *Resource Conservation and Recovery Act of 1976 (*RCRA) Permit (hereinafter referred to as the Hanford Facility RCRA Permit). The U.S. Department of Energy (DOE) has agreed through a Consent Agreement and Final Order (United States Environmental Protection Agency [EPA], 2013, *Consent Agreement and Final Order in the Matter of the U.S. Department of Energy, Richland, Washington*) with the EPA and Washington State Department of Ecology (Ecology) to close this DWMU. OSA-A will no longer be utilized for future receipts of dangerous or mixed waste. DOE and Central Plateau Cleanup Company (CPCCo) hereinafter referred to as Permittees, will close this unit.

This closure plan complies with Dangerous Waste Regulations in Washington Administrative Code (WAC) 173-303-610, Dangerous Waste Regulations, *Closure and post-closure*, Sections 2 through 6, and WAC 173-303-630, *Use and management of containers*, Section 10. Amendments to this closure plan will be submitted as a permit modification in accordance with WAC 173-303-610(3)(b), and WAC 173-303-830(4), *Permit changes*. Closure requirements also follow Ecology guidance (Ecology Publication #94-111, *Guidance for Clean Closure of Dangerous Waste Units and Facilities*).

Minor deviations from this closure plan must be addressed as in Permit Condition II.K.6 and Unit-Specific Permit Condition V.34.B.2.

This closure plan describes in detail the closure activities necessary to meet closure performance standards for OSA-A. Such closure activities include removal of all waste; records review (i.e., container storage, operating, and inspection records) for documented spills or releases of waste; visual inspection after waste removal to evaluate the potential contamination of the gravel/soil; and sampling and analysis of soil to ensure closure performance standards have been met. Closure will be performed in accordance with the schedule provided in Section H.4.8.

H.1.1 Unit Description

OSA-A is located west of the 2403-series buildings in the 200 West Area. This storage area was activated in 2008 with the primary purpose of storing large transuranic mixed (TRUM) waste boxes that were removed from storage as part of the Waste Retrieval Project. OSA-A is a gravel-covered, rectangular-shaped area 252 m (828 ft) long and 140 m (460 ft) wide, with a total area of 35,385 m^2 (380,872 ft^2), see Attachment HC for actual measurements. OSA-A is an uncovered area that does not have a constructed secondary containment for management of containers with liquids. Figure H-1 shows an overhead view and Figure H-2 shows a view of waste storage containers from ground level. Appendix A of Attachment HA shows aerial imagery of waste storage over time.

Transfer of additional dangerous or mixed waste into OSA-A is not authorized.

Figure H-1 Outdoor Storage Area-A Site Diagram (July 2020)

Figure H-2 Photo of Outdoor Storage Area-A (January 2017)

H.1.2 Unit Components, Parts, and Ancillary Equipment

OSA-A does not have any components, parts, or ancillary equipment.

H.1.3 Maximum Waste Inventory

The OSA-A total cumulative maximum inventory consists of 448 waste containers that are RCRA regulated with a total volume of 7,246 m^3 (9,477 yd^3). Dangerous waste container data can be found in Table HA-1 in *Outdoor Storage Area-A Data Quality Objectives and Sampling and Analysis Plan* (SAP), which is included as Attachment HA in this closure plan.

H.2 DANGEROUS WASTE MANAGEMENT UNIT OPERATIONS ACTIVITIES

H.2.1 Personnel Safety and Training Requirements

Closure will be performed to ensure the safety of human health and the environment (HHE). Health and safety requirements are addressed in Section H.2.1.1, and training for operations and closure personnel are described in Section H.2.1.2.

H.2.1.1 Health and Safety Requirements

Qualified personnel are trained in applicable safety and environmental procedures. Personnel perform all field operations and any necessary closure activities in compliance with established health, safety, and environmental procedures and requirements. Personnel are equipped with appropriate personal protective equipment.

Pre-job briefings are performed to evaluate activities and associated hazards by considering many factors, including the following:

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

H.2.1.2 Training Requirements

The Permittees have instituted training and qualification programs to meet training requirements imposed by regulations, DOE orders, and national standards such as those published by the American National Standards Institute/American Society of Mechanical Engineers. For example, the environmental, safety, and health training program provides workers with the knowledge and skills necessary to execute assigned duties safely. The Hanford Facility RCRA Permit, Attachment 5, describes specific requirements for the *Hanford Facility Personnel Training Program.* The Permittees will comply with the training matrix shown in Table H-1, which provides training requirements for Hanford Facility personnel associated with OSA-A.

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Table H-1 Basic Personnel Training

Course Number	Course Title	Frequency	Training Type[a]	Area Where Training Applies	Job Title/Position									
					Non-CWC Personnel or Visitors	DOS/SDO	Operations Supervisor	SPOC	Waste Service Provider[b]	Maintenance Crafts	RCT	NCO	ECO	BED
General														
000001	Hanford General Employee Training (CBT)	Annual	GHFT, CPT	CWC	X[b]	X	X	X	X	X	X	X	X	X
100090	Hanford Site Visitor Orientation (CBT)	Monthly	GHFT	CWC	X[b]									
100099	Hanford Site Orientation (CBT)	Annual	GHFT	CWC	X[b]									
Facility Health & Safety														
300536	CWC, LLBG, and WRAP Facility Emergency and Hazard Identification Checklist (FEHIC) (CBT)	Annual	GHFT, CPT	CWC	X[c]	X	X	X[c]	X[c]	X	X	X	X	
300701	CWC Orientation	Initial	GHFT, CPT	CWC	X[c]	X	X	X[c]	X[c]	X	X	X	X	
Waste Management														
035100	Container Waste Management (Classroom)	Initial	GHFT, OT	CWC		X	X		X[d]	X[e]	X[e]	X		
035110	Container Waste Management Refresher (CBT)	Annual	GHFT, OT	CWC		X	X		X[d]			X		
02006G	Waste Management Awareness (Classroom)	Initial	GHFT	CWC						X[e]	X[e]			
Building Emergency														
02028B	Building Emergency Director Initial Training (Classroom)	Initial	ECT	CWC										X

Table H-1 Basic Personnel Training

Course Number	Course Title	Frequency	Training Type[a]	Area Where Training Applies	Job Title/Position									
					Non-CWC Personnel or Visitors	DOS/SDO	Operations Supervisor	SPOC	Waste Service Provider[b]	Maintenance Crafts	RCT	NCO	ECO	BED
037515	Building Emergency Director Refresher Training (CBT)	Annual	ECT	CWC										X
304466	SWOC Building Emergency Director Qualification Card Checklist (OJT)	Initial	ECT	CWC										X
Environmental														
600100	Environmental Compliance Officer – Core (OJT)	Initial	OT	CWC									X	
600304	Waste Disposition – ECO[f] (OJT)	Initial	OT	CWC									X	
324097	Waste Disposition – ECO[f] (OJT)	Every 2 years	OT	CWC									X	
Facility Management														
300402	SWSD Waste Management Exam (E/E)	Every 2 years	CPT, OT	CWC		X	X							
300222	Central Waste Complex Surveillance Qualification Exam	Every 2 years	OT	CWC		X	X							
300988	Solid Waste Storage and Disposal – Storage (E/E)	Every 2 years	OT	CWC		X	X							
301130	CWC/LLBG Operations Supervisor Qualification Card (OJT)	Initial	CPT, OT	CWC		X	X							
301135	CWC/LLBG Shift Duty Officer Qualification Card (OJT)	Initial	CPT, OT	CWC		X								
300226	Core Fundamentals for Shift Managers in Training Qualification Training (OJT)	Initial	CPT, OT	CWC		X								

Table H-1 Basic Personnel Training

Course Number	Course Title	Frequency	Training Type[a]	Area Where Training Applies	Job Title/Position									
					Non-CWC Personnel or Visitors	DOS/SDO	Operations Supervisor	SPOC	Waste Service Provider[b]	Maintenance Crafts	RCT	NCO	ECO	BED
604241	CPCCo Field Work Supervisor Qualification Card (OJT)	Initial	OT	CWC		X	X							

[a]Training Types in Attachment 5 of WA7890008967, Hanford Facility Resource Conservation and Recovery Act of 1976 (RCRA) Permit, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste.

[b]Non-CWC personnel or visitors may take course number 000001, 100090, or 100099.

[c]Personnel that do not have this training will be escorted.

[d]Course not required for Waste Service Providers – Waste Shipper.

[e]Maintenance crafts and RCTs may take either course 02006G or 035100. Course 02006G is an awareness level class that satisfies the requirements of the job duties. Course 035100 is an operational level class that satisfies and exceeds the requirements identified in course 02006G.

[f]Required training only for permanently assigned ECO.

BED = Building Emergency Director
CBT = Computer Based Training
CPT = Contingency Plan Training
CWC = Central Waste Complex
DOS = Duty Operations Supervisor
ECO = Environmental Compliance Officer
ECT = Emergency Coordinator Training
E/E = Evaluation/Exam
GHFT = General Hanford Facility Training
LLBG = Low Level Burial Grounds
NCO = Nuclear Chemical Operator
OJT = On-the-Job Training
OT = Operations Training
RCT = Radiological Control Technician
SDO = Shift Duty Officer
SPOC = Single Point of Contact
SWSD = Solid Waste Storage and Disposal
SWOC = Solid Waste Operations Complex
WRAP = Waste Receiving and Processing

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Project-specific safety training will provide the knowledge and skills that personnel need to perform work safely and in accordance with quality assurance (QA) requirements. For soil and groundwater samplers, refer to Attachment 8, *Inspection and Training Plan for Groundwater Monitoring Wells*. Training records are maintained for each employee in an electronic training record database. The Permittee's training organization maintains the training records system.

H.2.2 Inspections and Security

Due to the nature of the waste and extended period requested for closing OSA-A, as required in WAC 173-303-610(4)(a), the Permittees must ensure that the waste containers stored in OSA-A do not pose a risk to HHE. These RCRA compliance requirements include DWMU inspections and emergency preparedness.

H.2.2.1 Remedial Schedule

Problems and substandard conditions identified during inspections are categorized into three general types and addressed accordingly. The types of problems are:

- Problems that require immediate action.
- Easily corrected problems.
- Problems on a prioritized schedule.

Inspections are completed using inspection logs. Problems identified by the inspector are documented on the inspection log and reported to facility management for prioritization and scheduling of remedial actions to minimize environmental or human health incidents. The DOS/SDO evaluates the issue and assigns corrective actions to one or more actionees to correct the issue.

The CWC corrective actions tracking process consists of using a combination of inspection logs, tracking lists, and a job control database. Problems identified during an inspection are noted on the inspection log and either corrected during the time of the inspection or tracked on each subsequent inspection log until the problem is corrected. Problems identified during an inspection that warrant additional evaluation, resources, or interface to remedy are tracked using a RCRA tracking list. If maintenance instructions are necessary to correct the problem, then a job control database is used to plan for corrective action by developing maintenance instructions and using schedule prioritization.

Information from the inspection log sheet will be maintained in the Hanford Facility Operating Record (CWC portion) in accordance with Permit Condition II.I.

H.2.2.1.1 Problems that Require Immediate Action

When an identified problem poses an imminent risk to human health or the environment, actions are taken immediately to mitigate the hazard and may include activation of the Building Emergency Plan for CWC and the Hanford Emergency Management Plan (located in Permit Attachment 4, *Hanford Emergency Management Plan*), when contingency plan action levels are exceeded. Examples of problems that warrant immediate action include fires, explosions, and releases of mixed waste to the environment. The problem will be identified on the inspection log along with corrective actions taken to mitigate or correct the problem.

If a leak or spill to secondary containment is discovered during an inspection, then the inspector will initiate immediate response actions and the DOS/SDO will be contacted. In container storage areas, leaked or spilled waste will be removed from secondary containment as soon as possible. The incident and response actions will be described on the inspection log.

Problems observed for systems that are critical to detecting, preventing, or responding to a fire, spill or release, such as inoperable fire suppression systems and damaged secondary containment in container storage areas, will be corrected as quickly as possible. Remedies may require a prioritized schedule to implement. In these situations, compensatory measures will be implemented until corrective actions are completed. Compensatory measures include actions such as suspension of waste management activities, establishing a fire watch, or moving containers out of the affected area. Once compensatory measures have been implemented, subsequent remedy actions will be completed on a prioritized schedule. Problems identified are noted on the inspection log and either corrected during the time of the inspection or tracked on each subsequent inspection log until corrected.

H.2.2.1.2 Easily Corrected Problems

Problems identified during inspections that are easily remedied, with no work planning required and all required parts or supplies are immediately available, will be corrected within 24 hours of the time of discovery. If additional time is needed, problems are added to a RCRA tracking list, assigned a tracking number, and tracked on each subsequent inspection log until the problem is corrected. Examples of easily-corrected problems include inadequate labeling, insufficient aisle space, incompatible wastes that are not separated, and containers not located in the correct storage area. The inspector will document the problem and completion of the corrective actions on the inspection log.

H.2.2.1.3 Prioritized Schedule

Problems that do not pose an imminent hazard, but cannot be easily corrected, are addressed on a prioritized schedule based on the level of severity of the problem and work planning constraints. The schedule to remedy this type of problem is dependent upon the time required to develop work planning instructions in conjunction with any schedule constraints such as parts availability, fabrication, environmental, and facility access limitations. The time to develop a work planning instruction depends on a number of factors, including nuclear, radiological, and industrial safety hazards associated with the task, complexity of the task; human factors and performance considerations; skill of worker(s); and risk to the worker(s), public, or the environment.

Problems are identified on the inspection log, added to a RCRA tracking list, and assigned a tracking number. Problems will continue to be noted on subsequent inspection logs until remedy actions have been completed. If work planning instructions are necessary to correct the problem, then a job control database is used to plan for corrective action by developing maintenance instructions and using schedule prioritization. In accordance with Permit Condition II.O.2 [WAC 173-303-320(3)], the CWC operating organization will remedy any problems or discrepancies revealed by the inspection on a schedule that prevents hazards to human health and the environment. Where a hazard is imminent or has already occurred, immediate action will be taken, including activation of the Building Emergency Plan for CWC measures, when required, as defined in Permit Condition II.A.

For problems identified during inspections performed by organizations other than CWC, records of the problem and any resulting corrective actions taken as a result of the inspection, are maintained by that organization. The Hanford Fire Department performs inspections of fire suppressant and notification systems (e.g., sprinkler systems and fire alarm pull boxes). Problems identified during these inspections are noted at the time of the inspection and a job control database is used to plan for corrective action by developing maintenance instructions and using schedule prioritization. If problems identified during inspections impact the normal operations of CWC, then compensatory measures (e.g., fire watch, limits on work activity) are established until corrective actions are completed on a prioritized schedule.

H.2.2.2 Inspections

CWC weekly inspections of dangerous or mixed waste containers will continue in accordance with Table H-2 until all waste containers have been removed from OSA-A. Upon completion of closure activities, annual inspections will be performed until such a time as the closure certification is accepted by Ecology.

No reactive or ignitable wastes are being stored in OSA-A. Compliance with regulations on labeling and container integrity is addressed in Table H-2. No additional waste will be received at OSA-A.

Inspections will be conducted to meet the following objectives:

- Conduct inspections in accordance with requirements of WAC 173-303-320, *General Inspection*, and -630(6), *Use and management of containers*, to prevent hazards to HHE.
- Take prompt actions to ensure corrective actions occur and documentation of remedial actions is maintained in the operating record. Corrective action documentation will include tracking the issue and notations of remedial actions (including dates).
- Corrective actions will be addressed based on a graded schedule commensurate to the risk of the problem or hazard associated with a discharge.

Table H-2 Outdoor Storage Area-A Inspection Schedule

Requirement Description	Frequency	Inspection
Container Storage Prior to Closure Activities		
Containers/Container Storage Areas	Weekly*	Container integrity is not compromised by punctures, dents, penetrating scratches, loose lids, bulging, excessive corrosion, damage, or deterioration. Containers are closed and stored in a manner that will not rupture the containers or cause them to leak. Protective covers (tarps) placed over retrievably-stored waste containers or other containers to protect them from the elements are in good condition.
		Storage area is free of transient combustible material. Barricades (chains, ropes, fences, etc.) are accurate, intact, visible, legible, and in good condition. Area is generally dry and free of accumulated precipitation. There is no standing and/or unexpected water or snow accumulation in or around the area.
Container Labels	Weekly*	Dangerous Waste/Hazardous Waste marking/labeling on container or protective cover is intact, unobscured, legible, and in good condition. Labels are visible and legible, and hazards are adequately identified.
Dangerous Waste Management Unit Condition Upon Completion of Closure Activities		
Signage	Annual	Danger signs are present and clearly legible.
Site Condition	Annual	There is no evidence that unusual conditions exist at the closing DWMU site.

Table H-2 Outdoor Storage Area-A Inspection Schedule

Requirement Description	Frequency	Inspection

*Weekly inspection logs will be prepared to meet WAC 173-303-630(6), *Use and management of containers*, and will be completed when waste is being managed within the CWC storage areas. If the storage area is empty, "no waste in storage" or equivalent words will be entered on the inspection log.

Weekly means once per calendar week.

Annual means at least once per 12 month period ± 30 days.

CWC = Central Waste Complex

DWMU = Dangerous waste management unit

OSA = Outdoor Storage Area

H.2.2.3 Central Waste Complex Security

The following sections document security measures in effect at the CWC OSA-A.

H.2.2.3.1 Security Provisions

CWC, located within the 200 West Area of the Hanford Facility, complies with access control and "Danger" sign requirements pursuant to WAC 173-303-310(1) and (2), *Security*.

Security measures are used to control access to the active portions of the Hanford Facility in accordance with Permit Condition II.L, Security. The entire Hanford Facility is a controlled access area as described in Permit Attachment 3, *Security*. The security measures in Permit Attachment 3 and the unit-specific security measures in this addendum prevent the unknowing entry, and minimize the possibility for the unauthorized entry, of persons or livestock. [WAC 173-303-310(1)]

H.2.2.3.2 Outdoor Storage Area-A Access Control

Unknowing entry and the possibility for unauthorized entry of persons or livestock onto the active portions of CWC and WRAP are minimized through implementation and maintenance of the following security measures:

- Access to CWC Low Flashpoint Storage Modules, 2402-W and WB through WL Waste Storage Buildings, 2403-WA through WD Waste Storage Buildings, and the CWC Shipping and Receiving Area is controlled by an approximate 2.1 m (7 ft.) high chain link fence encircling the CWC perimeter. The CWC main entry gate is under surveillance by CWC personnel during operating hours. Alternate vehicle entry gates at points in the CWC perimeter fence are either locked or, when open for operations, subject to surveillance by CWC personnel. Visitors are required to sign in with CWC personnel. Authorization clearance for all entrants to the CWC is required. Clearance to enter is ultimately confirmed by dispatch personnel. During non-operations hours, the main gate is locked. Gate keys are controlled and accessible by authorized personnel only. [WAC 173-303-310(2)(c)]
- WRAP 2336-W Building Process Area and 2336-W Building Nondestructive Assay/Nondestructive Examination Area are located within the 2336-W Building structure. Located adjacent to the 2336-W Shipping and Receiving Area loading dock, 2336-W Building Room 152 is accessible by an external door. Sign-in by personnel to these DWMUs is required. During operating hours, door access is controlled by WRAP personnel. External building doors will remain locked when not in use. During non-operation hours and periods of non-activity or lay-up, all doors accessing the 2336-W Building will remain locked. The keys are controlled by Operations and may only be accessed by authorized personnel.

- The 2336-W Shipping and Receiving Area is under WRAP personnel surveillance when operations are in effect. Shipments of dangerous waste and mixed waste to and from the 2336-W Building are conducted on the south side of the building within the CWC perimeter fence.
- The 2404-WA through WC Waste Storage Buildings and the High-Energy Real-Time Radiography and Super High-Efficiency Neutron Counter Waste Outside Storage Area are enclosed by an approximate 2.1 m (7 ft) high chain link fence. Access is controlled through the main CWC gate or through one of several alternate vehicle access gates in the fenced perimeter. Alternate vehicle access gates remain locked during periods of non-use. Only authorized personnel may access the controlled gate keys. [WAC 173-303-310(2)(c)]

Visitors to CWC and WRAP must adhere to all personal protection requirements and are subject to escorting protocols. Personnel training requirements for CWC operators and workers are found in Section H.2.1.2.

H.2.2.3.3 Danger Signs

Signs stating, "Danger-Unauthorized Personnel Keep Out" or "Danger Do Not Enter-Authorized Personnel Only," are posted at each gate entrance to the CWC and on each access door to the 2336-W Building DWMUs. Signs identical to those affixed at CWC gate entrances are posted along the fence lines at distances not to exceed 7.6 m (25 ft) between signs to ensure that when one sign is no longer visible another sign can be seen. Permittees must maintain danger signs and ensure that signs are written in English, legible from a distance of approximately 7.6 m (25 ft) or more, and visible from all angles of approach. [WAC 173-303-310(2)(a)]

H.2.3 Preparedness, Prevention, Emergency Procedures

CWC preparedness, prevention, and emergency procedures are described as follows. Contingency information for CWC is contained in the CWC Building Emergency Plan, and DOE/RL-94-02, *Hanford Emergency Management Plan*. The CWC is within the Hanford Facility. The CWC Building Emergency Plan describes facility-specific hazards and emergency planning and response. This site-specific plan is intended to be used in conjunction with DOE/RL-94-02. A copy of the CWC Building Emergency Plan is kept in the RCRA operating record and at the CWC unit. DOE/RL-94-02 addresses site emergency management and contingency plan requirements. Together with location- and activity-specific documentation established to meet contingency plan requirements, the plan meets the WAC 173-303 requirements for the Hanford Facility. This document is part of the Hanford Facility RCRA Permit.

H.3 CLOSURE PERFORMANCE STANDARDS

OSA-A will be closed in a manner that complies with the performance standard in WAC 173-303-610(2)(a) and, therefore, achieves clean closure. The objectives of closure activities are as follows:

- Minimizes the need for further maintenance.
- Controls, minimizes, or eliminates, to the extent necessary to protect HHE, post-closure escape of dangerous waste, dangerous constituents, leachate, contaminated runoff, or dangerous waste decomposition products to the ground, surface water, groundwater, or the atmosphere.
- Returns the land to the appearance and use of surrounding land areas to the degree possible, given the nature of the previous dangerous waste activity.

Clean closure requires removal or decontamination of all dangerous waste, dangerous waste residues, and equipment, bases, liners, soils/subsoils, and other materials containing or contaminated with dangerous waste or dangerous waste residue in accordance with WAC 173-303-610(2)(b).

For OSA-A, clean closure will be demonstrated through sampling of soil in grid and focused sample locations. Specific closure sampling standards are addressed below for the environmental media (soil) that makes up the OSA-A.

H.3.1 Standards for Soil Sampling

The presumed exposure pathways that are considered for all CWC OSAs are as follows:

- WAC 173-340-740(3), Model Toxics Control Act Cleanup Regulations (MTCA), *Unrestricted land use soil cleanup standards* Method B (cancer and noncancer), that considers human health based on direct soil contact.
- WAC 173-340-740, Table 740-1, MTCA Method A, which includes closure performance standards for human health based on unrestricted land use. MTCA Method A is only used if MTCA Method B is not available in the Cleanup Levels and Risk Calculation (CLARC) tables.
- WAC 173-340-747, *Deriving soil concentrations for groundwater protection* that notes soil concentrations protective of groundwater.
- WAC 173-340-7493, *Site-specific terrestrial ecological evaluation procedures* that considers ecological indicators (plants, biota, wildlife) found in Table 749-3.
- WAC 173-340-750, *Cleanup standards to protect air quality* that describes human health risks due to wind-borne fugitive vapors and dusts.

Of the exposure pathways listed above, MTCA Method B, or Method A as applicable, is always considered a complete and viable exposure pathway for all soil samples. The exposure pathway for soil protective of groundwater assumes that water or rainwater on a surface has an avenue to percolate through the surface and underlying soil to groundwater. The scenario for ecological indicators requires vegetation, biota and wildlife be present in order for the pathway to be complete. The exposure scenario for inhalation of fugitive vapors and dust describes risk of exposure to wind-borne soil.

Of the viable exposure pathways, the most conservative closure performance standard is selected. Per WAC 173-340-740(5)(c), the closure performance standard value cannot be below the following:

- Hanford Site background.
- Laboratory practical quantitation limit (PQL) found in the CPCCo laboratory contracts.

If a closure performance standard is below both values, the higher of these two values is selected. All the exposure pathways listed above are considered complete and viable pathways for OSA-A.

Target analytes considered for evaluation during closure sampling and analysis were derived from a list of all waste codes identified during review of records for the TRUM and Mixed Low-Level Waste (MLLW) waste containers stored in OSA-A. Table HA-9 of the SAP (Attachment HA of this closure plan) provides the closure performance standards for soil for each individual target analyte associated with the dangerous waste codes identified. Values in Table HA-9 are derived from Washington State regulations, EPA guidance, and Ecology's CLARC values issued in 2021.

The sampling design for focused samples is discussed in SAP Section HA.2.3.1.1. Soil sampling and analysis will be conducted in accordance with the approved closure plan SAP. Analytical results of the focused soil samples will be individually compared to closure performance standards.

H.4 CLOSURE ACTIVITIES

OSA-A currently stores TRUM and MLLW. Disposition of waste stored in OSA-A has been addressed in the Hanford Federal Facility Agreement and Consent Order (HFFACO), also known as the Tri-Party Agreement (TPA). An extended period is needed to remove waste in OSA-A as described in section H.4.8. After waste is removed, closure activities can begin as described in Section H.4.2.

H.4.1 Pre-Closure Activities

Pre-closure activities will consist of a preliminary visual inspection of OSA-A, and waste container removal.

H.4.1.1 Preliminary Operating Records Review and Visual Inspection

To support the development of this closure plan and the associated SAP, a review of the OSA-A RCRA historical documents was performed (Table H-3). The records review included the following RCRA operating record documents: facility operating logbooks (which contain the facility spill log), waste management records, and weekly inspections from 2006 through 2013. The RCRA operating record documents that were reviewed focused on the period during active RCRA-regulated and TRUM waste storage. RCRA operating records for the OSA-A DWMU, including the facility operating logbooks and weekly inspection sheets, indicate that there was one item of concern. On February 6, 2012, the item of concern noted was the 231ZDR-11 box. OSA-A continues to be inspected for spills on a weekly basis and no other releases have been identified. In the event a new release is identified, revision to the OSA-A Closure Plan and SAP will be submitted as a permit modification request. [WAC 173-303-610(3)(b)]

Table H-3 Outdoor Storage Area-A Operating Records Review Summary

Document Title	Document Type	Start Date	End Date	Items of Concern Noted
Weekly RCRA Inspection Checklist for CWC	Weekly Inspection	01/05/2006	06/26/2013	Yes*
Weekly CWC RCRA/ Non-RCRA Inspection Checklist	Weekly Inspection	01/03/2012	12/27/2012	Yes*
Daily Operating Logbook	Logbook	12/06/2006	08/12/2013	Yes*

Reference: *Resource Conservation and Recovery Act of 1976.*

*Item of concern was the 231ZDR-11 box on 02/06/2012.

CWC = Central Waste Complex

OSA = Outdoor Storage Area

Waste management records for the RCRA-regulated and TRUM waste containers stored in OSA-A were reviewed to determine the target analytes to be included in the closure plan SAP Table HA-1 (Attachment HA of this closure plan). No new waste has been added to OSA-A since this review was completed.

A visual inspection was performed of the visible ground surface in OSA-A on September 3, 2013, to identify any RCRA-regulated or TRUM waste-related staining in visible portions of OSA-A. Discoloration that is not related to a waste spill may be paint flakes or rust accumulating from the exterior of a waste container. No waste-related staining was identified during the visual inspection; however, once all waste is removed a final visual inspection will be conducted by the Permittees to identify any additional locations for focused sampling. Ecology may concurrently perform a final visual inspection to identify any additional locations for focused sampling.

Supporting documentation for the RCRA operating records review and visual inspection are documented in Attachment HB of this closure plan. These include OSA-A Daily Operating Logbook Review sheet, the OSA-A Weekly Dangerous Waste Inspection Checklist Review, and OSA-A visual inspection sheet, and any additional supporting information.

H.4.1.2 Waste Removal

Removal of waste from OSA-A will be completed by September 30, 2026, or as amended, in accordance with HFFACO, TPA Milestone M-091-59. According to Milestone M-091-59, removal entails shipment of containers to a Treatment Storage and Disposal facility for repack or disposal; or relocating the containers to a storage area authorized by the Hanford Facility RCRA Permit, or a Temporary Authorization issued pursuant to WAC 173-303-830. The loading occurs within OSA-A, near the location of the container being moved. Containers are loaded with a forklift and spotter, or crane with spotters and riggers. The MLLW is moved from OSA-A to either the compliant East Outside Storage Area, into indoor storage buildings at CWC, or sent to an approved offsite facility for characterization, and/or treatment, and repackaging.

An initial evaluation occurs to determine if waste containers can be received by the approved off-site receiving facility. If the waste meets standards for off-site treatment of Transuranic/TRUM waste, it is shipped offsite. Prior to shipping, every shipment gets a Commercial Vehicle Safety Alliance Level 6 inspection by Washington State Patrol, in addition to the shipper checking the driver's credentials, the vehicle, and other safety equipment necessary for transport. An evaluation of the container condition is included to ensure it is fit for transport. After off-site treatment, the waste is shipped back to CWC in standard waste boxes. It is then placed in compliant indoor storage buildings at CWC. Waste containers must be removed prior to initiating closure activities discussed in the next section.

During the pre-closure period, the following activities will be performed to protect HHE:

- Continue weekly inspections in accordance with Section H.2.2.2, and apply any necessary corrective actions described in section H.2.2.1.

H.4.2 Closure Activities

Once all waste has been removed, closure activities can be initiated in OSA-A. Closure activities include:

- Final review of inspection records and operating logbooks.
- Final visual inspection of gravel and visible surface soil.
- Update the SAP through the permit modification process to incorporate any issues identified during the visual inspections and updated records review, if necessary.
- Perform soil sampling and analysis to confirm closure performance standards are met.
    - If contamination is detected above closure performance standards, soil remediation will be performed.
    - For grid samples, re-grid and resample to confirm whether MTCA (WAC 173-340) Method B closure performance standards have been met. For focused samples, resample to confirm whether MTCA (WAC 173-340) Method B closure performance standards have been met.
    - Perform data validation and verification activities on laboratory results.
- Transmit closure certification to Ecology.

H.4.3 Removal of Wastes and Waste Residues

Removal of waste from OSA-A is part of the closure process and is governed by Ecology et al., 1989a, HFFACO, Milestone M-091-59 (TPA as amended).

The schedule for these waste removal activities is described in Section H.4.1.2.

H.4.3.1 Decontamination

After removal of waste containers from OSA-A, there will be no remaining items that would require decontamination. Contaminated soil above closure performance standards will be removed as identified in Section H.4.6 and levels will be evaluated against closure performance standards as in SAP Section HA.2.4.1.

If necessary, equipment such as earth-moving and or rubblizing machinery used to remove potentially contaminated soil will be decontaminated to the appropriate treatment standard using the technology provided in 40 Code of Federal Regulations (CFR) 268.45, Land Disposal Restrictions, *Treatment standards for hazardous debris*, Table 1, "Alternative Treatment Standards for Hazardous Debris." When such methods are used, a temporary decontamination area will be constructed of Visqueen™ or an equivalent material and established within or near the closure area for the purpose of collecting any newly generated waste.

After any necessary decontamination, a determination of whether the appropriate performance and/or design and operating standard identified in 40 CFR 268.45, Table 1 was met will be documented for the subject equipment. Contaminated equipment that will not be re-used will be discarded and managed as dangerous waste in accordance with Section H.4.6 Identifying and Managing Waste Generated During Closure Activities.

When decontamination of equipment is completed, the Visqueen™ or equivalent materials, rinsate, and solid waste debris generated by equipment decontamination (e.g., rags and personal protective equipment) will be removed and managed as newly generated waste in accordance with Section H.4.6.

Equipment used during sampling will be decontaminated in accordance with Attachment 8 or disposed of and managed as newly generated waste in accordance with Section H.4.6 Identifying and Managing Waste Generated During Closure Activities.

H.4.4 Sampling Activities

Sampling and Analysis of the soil at OSA-A will be conducted to confirm whether closure performance standards established in the OSA-A SAP pursuant to WAC 173-303-610(2)(b)(i) have been met, demonstrating clean closure. Soil will be collected after removing the overlying gravel at focused and grid sample locations. See Attachment HA *Outdoor Storage Area-A Data Quality Objectives and Sampling and Analysis Plan*, Section HA.3.4 Sampling Methods, for additional detail. There are seven sampling zones within OSA-A, which are further described in Section HA.2.3.1 of Attachment HA. Grid sample locations were generated using Visual Sample Plan (VSP) software. VSP supporting information can be found in Attachment HC of this closure plan. Areas of concern relating to focused sampling are identified by visual inspections of the DWMU. OSA-A has been subject to weekly inspections in accordance with WAC 173-303-320, and a pre-closure visual inspection. Currently, there is one area of concern identified.

H.4.5 Identifying and Managing Contaminated Environmental Media

Visual inspections indicated potential contamination in the soil where container 231ZDR-11 was stored. If contaminated environmental media (soil containing constituents of concern above closure performance standards) is identified as a result of closure verification sampling, the nature and extent of contamination will be further investigated. Factors such as constituent levels observed in sample results, visual staining, and odors will be considered in determining next steps to remove contamination. Following further investigation, contaminated soil will be removed using larger equipment (e.g., excavators, backhoes, bulldozers) for larger areas and smaller equipment (e.g., mini excavators, skid-steer loaders, shovels) for smaller areas capable of removing the quantity of material required to complete removal and close the DWMU. Soil surrounding the focused sample location or grid sampling node will be removed up to 4.6 m (15 ft) below the surface and, in the case of grid samples, up to the adjacent sampling node. Following removal of contaminated soil, re-sampling will occur in accordance with section HA.2.3.4 of Attachment HA.

Contaminated soil will be managed as a newly generated waste stream in accordance with WAC 173-303-610(5). Contaminated soil will be handled in accordance with all applicable requirements of WAC 173-303-170, *Requirements for generators of dangerous waste*, through WAC 173-303-230, *Special conditions*. The contaminated soil will be containerized, labeled, and characterized in accordance with WAC 173-303-070. Soil accumulations will be placed in U.S. Department of Transportation compliant containers and sent to an approved disposal facility or staged at central accumulation areas in accordance with WAC 173-303-200 standards. Dangerous and mixed waste subject to the land disposal restriction (LDR) requirements of WAC 173-303-140, *Land disposal restrictions* which includes by reference 40 CFR 268, *Land Disposal Restrictions*) will be characterized, designated, stored, and/or treated, as applicable, prior to disposal in an approved disposal facility.

Management and disposal of the contaminated environmental media will be documented and included with the closure documentation identified in SAP Section HA.3.

H.4.6 Identifying and Managing Waste Generated During Closure

There are no waste streams expected to be generated during closure activities. However, if the soil is determined to be contaminated, there will be new dangerous waste streams including soil, equipment, and solid waste debris. Contaminated soil will be managed as a newly generated waste stream in accordance with WAC 173-303-610(5). See section H.4.6, Identifying and Managing Contaminated Environmental Media, for further details. Any equipment used to remove contaminated soil will be decontaminated in accordance with WAC 173-303-610. See section H.4.3.1, Decontamination, for further details on equipment decontamination as well as solid waste debris generated by decontamination of equipment.

Management and disposal of waste generated during closure will be documented and included with the closure certification documentation included in SAP Section HA.3.3.

H.4.7 Inspection of Units After Closure Activities

To prevent threats to HHE after closure activities are completed, OSA-A will be inspected in accordance with WAC 173-303-320(2). Inspections of OSA-A will be performed annually, until the site closure certification is accepted by Ecology, and will verify the following:

- Posted danger signs at each entrance to CWC are present, legible, and visible at 7.6 m (25 ft).
- No evidence of unusual conditions exists at the closing DWMU site (i.e., improper storage of waste containers, or any condition that presents a potential threat to HHE).

H.4.8 Closure Activities Schedule

The timeline for closure activities is described in Table H-4 and shown in Figure H-3. Pre-closure activities consist of waste removal in accordance with Section H.4.1.2. Closure activities consist of confirmation closure sampling and analysis further described in Section H.4.4 and Attachment HA.

Table H-4 Outdoor Storage Area-A Closure Activities Schedule

Activity	Activity Description	Duration
Pre-Closure Activities		
Perform Initial Visual Inspection	Inspect site for dangerous or mixed waste-related staining. Identify areas of concern for focused sampling locations.	Complete
Remove OSA-A mixed waste containers	TPA Milestone M-091-53 provides annual requirements for removing mixed waste.* All mixed waste containers shall be removed as defined in M-091-59.	See M-091-59
Closure Activities		
Perform final visual inspection of OSA-A	Once all waste is removed, inspect for dangerous- or mixed- waste-related staining. Identify focused sampling locations (as applicable).	5 days

Table H-4 Outdoor Storage Area-A Closure Activities Schedule

Activity	Activity Description	Duration
Perform final records review	Final review of inspection records and operating logbooks.	15 days
Sample soil underlying gravel	Perform grid sampling, focused sampling (as applicable), and analysis.	145 days
	Perform data verification, data validation, confirmation of VSP input parameters, and data quality assessment, as applicable.	
	If soil samples contain constituents of concern above closure performance standards, contaminated soil will be removed. Re-griding (if not a focused sample) and resampling will occur to confirm if closure performance standards have been met.	
Certify closure activities adhere to closure plan	In accordance with WAC 173-303-610(6), within 60 days of completion of closure activities, provide certification to Ecology that the DWMU has been closed.	60 days

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

WAC 173-303-610, Dangerous Waste Regulations, *Closure and post-closure*.

*Annual TRUM waste removal requirements in TPA Milestone M-091-47 are updated in a change control process outlined in TPA Action Plan, Section 12.0.

DWMU = dangerous waste management unit

MLLW = mixed low-level waste

OSA = Outdoor Storage Area

TPA = Tri-Party Agreement (abbreviation used only with mention of milestone)

TRUM = transuranic mixed

VSP = Visual Sample Plan

WAC = Washington Administrative Code

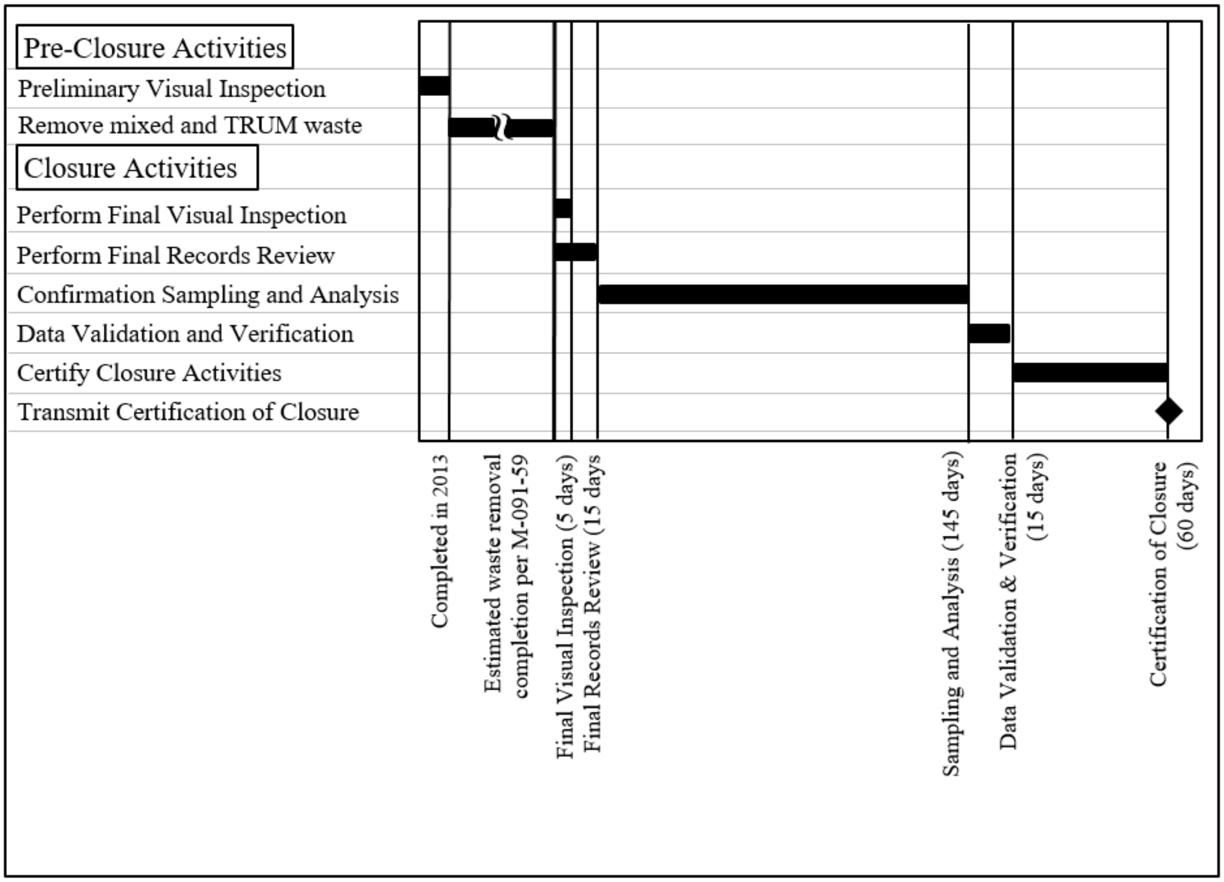

Figure H-3 Outdoor Storage Area-A Closure Activities

H.5 CONDITIONS THAT WILL BE ACHIEVED WHEN CLOSURE IS COMPLETE

Upon confirmation that closure performance standards are met, OSA-A will no longer be an active DWMU and will be left in an “as-is” state, with the gravel remaining in place. The buildings surrounding OSA-A are active DWMUs that will continue to be used. Restoration to its pre-operational appearance is not necessary. The storage area markings will be removed after the closure activities are completed and Ecology has accepted the certification report.

H.6 FACILITY RECORDKEEPING

Facility records are maintained that describe the waste being stored at OSA-A. These records describe the source of the waste, the waste type, container type and quantity, hazards associated with the waste, and storage location within OSA-A. All shipping, storage, and inspection documents are retained in the RCRA operating record, which ensures proper availability and retention periods.

Records will be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure the accuracy and retrievability of stored records. Records required by the TPA (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

H.7 CLOSURE COSTS

An annual report outlining updated projections of anticipated closure costs for the Hanford Facility TSD units having final status is not required per Permit Condition II.H. The Hanford Facility is owned by DOE and operated by DOE and its contractors; therefore, in accordance with WAC 173-303-620(1)(c), *Financial requirements*, provisions of WAC 173-303-620 are not applicable to the Hanford Facility.

H.8 REFERENCES

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173-303-230, *Special conditions*.

173-303-310, *Security*.

173-303-320, *General inspection*.

173-303-610, *Closure and post-closure*.

173-303-620, *Financial requirements*.

173-303-630, *Use and management of containers*.

173-303-830, *Permit changes*.

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173-340-750, *Cleanup standards to protect air quality*."

CENTRAL WASTE COMPLEX OUTDOOR STORAGE AREA-A
ATTACHMENT HA
OUTDOOR STORAGE AREA-A DATA QUALITY OBJECTIVES AND SAMPLING AND ANALYSIS PLAN

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ATTACHMENT HA
OUTDOOR STORAGE AREA-A DATA QUALITY OBJECTIVES AND SAMPLING AND ANALYSIS PLAN

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TERMS

bgs	Below ground surface
COC	Chain-of-custody
DOE	U.S. Department of Energy
DQO	Data quality objective
DWMU	Dangerous Waste Management Unit
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HASQARD	Hanford Analytical Services Quality Assurance Requirements Document
HEIS	Hanford Environmental Information System
IQRPE	Independent, qualified, registered professional engineer
MTCA	Model Toxics Control Act
OS	Operations Supervisor
OSA	Outdoor Storage Area
PSQ	Principal study question
PQL	Practical quantitation limit
QA	Quality assurance
QC	Quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
SAP	Sampling and Analysis Plan
VOA	Volatile organic analysis
VSP	Visual Sample Plan (software)

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HA.1 INTRODUCTION

This document describes the data quality objective (DQO) process used to define steps necessary to achieve clean closure of the CWC facility OSA-A DWMU. This report contains the outcome of the planning effort.

HA.1.1 Project Scope and Objective

The objective of the OSA-A soil sampling effort is to demonstrate that target analytes are at or below established closure performance standards. To demonstrate clean closure, soil samples will be collected from predetermined locations in OSA-A, analyzed for target analytes, and compared to closure performance standards. The analytical results will be evaluated to determine if OSA-A meets clean closure standards. Documentation of the records review will be retained to identify potential releases of waste (Section HA.1.3), field sampling activities (Section HA.2.3.1), laboratory analysis results (Section HA 2.4), and outcome of the comparison to closure performance standards (Section HA 2.3.5). Ecology will receive a report of activities, including certification by an independent, qualified, registered professional engineer (IQRPE) (Section HA.3.2).

HA.1.2 Background

OSA-A became operational in 2008 with the primary purpose of storing TRUM waste boxes removed from storage during the Waste Retrieval Project. The waste packages stored at OSA-A are primarily large metal containers of various size, up to 20.5’ wide, and up to 18.8’ long. Per the Agreed Order and Stipulated Penalty No. DE 10156, all containers have covers to ensure precipitation does not get into the waste packages. These covers are heavy duty plastic or metal weather enclosures. OSA-A is divided into seven zones. Zones one through six are waste storage areas, while zone 7 includes no waste storage. See Section HA.2.3.1 for a description of each zone. This DWMU reaches up to 4.6 m (15 ft) below ground surface (bgs). For the purpose of this document, ground surface is defined as the exposed soil layer once loose gravel has been moved aside. The OSA-A total cumulative maximum inventory consists of 451 waste containers that are RCRA regulated with a total volume of 7,247 m^3 (9,479 yd^3). Dangerous waste container data can be found in Table HA-1. A review of OSA-A historical RCRA documents identified one possibly contaminated location associated with container 231ZDR-11 (Figures HA-1 and HA-2). This area of concern includes the soil in the container’s immediate vicinity.

Table HA-1 Outdoor Storage Area-A Dangerous Waste Container Data

Container Quantity	Waste Package Type	Package Volume (m^3)	Waste Type	Earliest Moved In Date	Latest Moved Out Date	Assigned Waste Code
317	Various sizes: Metal containers up to 20.5’ wide; up to 18.8’ long 55 gallon drums	6,277	TRUM	2008	Ongoing	D001, D002, D004, D005, D006, D007, D008, D009, D010, D011, D018, D019, D022, D027, D028, D029, D030, D032, D033, D034, D035, D037, D038, D043, F001, F002, F003, F004, F005, WSC2, WT02

Table HA-1 Outdoor Storage Area-A Dangerous Waste Container Data

Container Quantity	Waste Package Type	Package Volume (m^3)	Waste Type	Earliest Moved In Date	Latest Moved Out Date	Assigned Waste Code
131	Various sizes: Metal containers up to 20.5' wide; up to 18.8' long 55 gallon drums	970	MLLW	2008	Ongoing	D001, D002, D004, D005, D006, D007, D008, D009, D010, D011, D012, D013, D014, D015, D018, D019, D020, D022, D023, D025, D027, D028, D029, D030, D031, D032, D033, D034, D035, D036, D037, D038, D039, D040, D041, D042, D043, F001, F002, F003, F004, F005, F039, U080, U122, U123, U133, U169, U188, U220, U228, WP01, WP02, WT01, WT02

References: *Resource Conservation and Recovery Act of 1976.*

TRUM = Transuranic mixed

MLLW = Mixed low-level waste

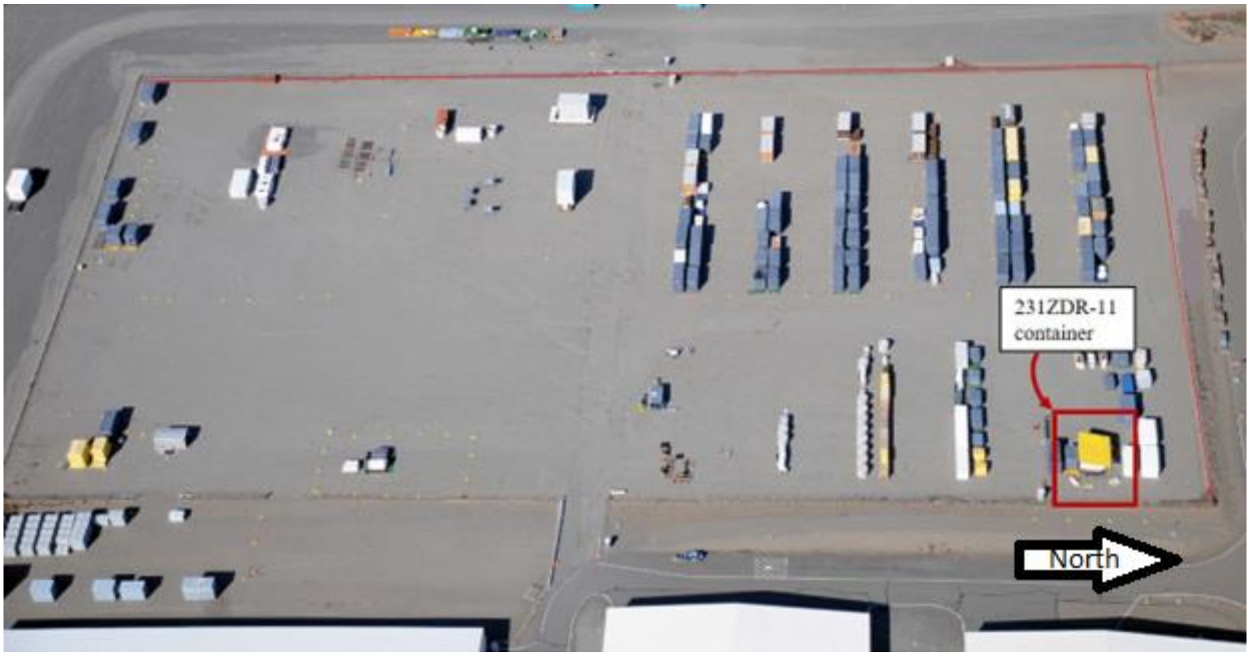


Figure HA-1 Location of 231ZDR-11 (2012)

Figure HA-2 Container 231ZDR-11 (2012)

HA.1.3 Data Quality Objective Summary

The EPA provides guidance on planning to collect environmental data in EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*. The DQO process is a series of logical steps that allows users to collect data in a manner that supports decision-making.

The initial goal of the study was to address each step of the DQO process: identifying the principal study questions (PSQs), defining possible outcomes that may occur for each PSQ, and making decisions statements to address each PSQ that encompass all possible study outcomes. The next goal was to identify the type of data needed to answer these questions.

PSQs for OSA-A were intended to address the two types of sampling that will occur: grid and focused sampling. There are seven zones identified for sampling activities. See section HA.2.3.1 for zone descriptions. Grid samples are randomly selected locations that are determined using the VSP software.[1] The established number of grid samples collected will allow statistical evaluation to estimate target analyte concentrations within the OSA-A boundary. Focused samples are single soil samples collected in response to a possible contamination in a specific location. Focused sample locations are identified through visual inspection or records review (container storage, operating, and inspection records). PSQs for OSA-A are defined in Table HA-2.

Table HA-2 Principal Study Questions for Outdoor Storage Area-A Closure

PSQ	Principal Study Question Statement
1	Are OSA-A grid sampling target analyte concentrations at or below approved closure performance standards for soil?
2	Are OSA-A focused sampling target analyte concentrations at or below approved closure performance standards for soil?

OSA-A = Outdoor Storage Area-A
PSQ = Principal study question

For each PSQ in Table HA-2, there are two possible outcomes (alternate outcomes). For each type of sample, the results will or will not meet closure performance standards. Table HA-3 lists the alternate outcomes.

Table HA-3 Alternate Outcomes to Principal Study Questions

PSQ	Alternate Outcome Number	Alternate Outcome
1	1A	For grid samples, clean closure performance standards are met; the DWMU is declared clean closed.
	1B	For grid samples, clean closure performance standards are not met. Soil will be remediated at grid node locations that indicate contamination.
2	2A	Focused sample results are below closure performance standards. Further investigation is not required.
	2B	Focused sample results are above closure performance standards. Soil will be remediated at focused sample location.

[1] Visual Sample Plan is a product of Pacific Northwest National Laboratory (PNNL), Richland, Washington.

Table HA-3 Alternate Outcomes to Principal Study Questions

PSQ	Alternate Outcome Number	Alternate Outcome

DWMU = Dangerous waste management unit

PSQ = Principal study question

To answer the PSQs (Table HA-2) and determine the outcome (Table HA-3), decision statements associated with the PSQs identify the type of information or data needed (Table HA-4).

A preliminary records review and visual inspection identified one area of potential contamination in the proximity of the 231ZDR-11 container. Focused samples will be taken from this area (see section HA.1.7.3.2 for further details). Additionally, zones three and four will have focused samples taken instead of grid samples as described in Section HA.2.3.1. Once waste containers are no longer stored within OSA-A, a final records review and visual inspection will indicate any possible waste leaks or spills. Similarly, soil sampling will occur once all waste is removed from the OSA-A.

Table HA-4 Data Quality Objective Decision Statements

PSQ	Decision Statement
1	Records review is needed to identify the stored waste type, location, and releases.
2	Soil sample data are needed for target analyte to compare against clean closure performance standards.

DQO = data quality objective

PSQ = principal study question

HA.1.4 Identify Information Inputs

The information inputs are those necessary to obtain the data used to determine if clean closure standards are met. Information inputs were identified during the DQO process and are summarized as the data needs. These inputs answer the PSQs.

Based on the decision statements, the data needs identified for OSA-A are summarized in Table HA-5. Section HA.2.3.3 provides further details about sample collection.

Table HA-5 Data Needs Summary for Outdoor Storage Area-A Soil Samples

PSQ	Data Need	Location	Sampling Method	Action Level	Frequency	Analytical Method	Potential Source of Data
1	Target analyte concentrations	Zones 1, 2, 5, 6, & 7	Surface grab samples	Closure performance standards	Once	Analyte specific	Laboratory analytical results
2	Target analyte concentrations	Affected area of 231ZDR-11 container; Zones 3 and 4	Surface grab samples	Closure performance standards	Once	Analyte specific	Laboratory analytical results

OSA-A = Outdoor Storage Area-A

PSQ = Principal study question

HA.1.5 Boundaries of Study

The boundaries of a study can be defined spatially and temporally. Within OSA-A, there are seven zones identified for sampling activities. See Section HA.2, Sampling and Analysis Plan, for further detail. Sampling within each zone will occur during a single sampling event, and all zones will be sampled as reasonably close together as possible. Additional sampling events may be needed to verify soil remediation efforts are successful.

HA.1.6 Visual Sample Plan Parameter Inputs

When establishing the location and number of grid samples necessary to make decisions about clean closure, the VSP input parameters in Table HA-6 were used.

Acceptable risk of making an incorrect decision is considered during the DQO process. A Type I error is the risk of declaring that a contaminated site is clean, or rejecting the null hypothesis when the null hypothesis is true. For the OSA-A, the acceptable risk of a Type I error is 5 percent (alpha is 5 percent in Table HA-6). A Type II error is the risk of declaring that a clean site is contaminated, or failing to reject the null hypothesis when the null hypothesis is false. For the OSA-A, the acceptable risk of a Type II error is 20 percent (beta is 20 percent in Table HA-6).

The quantity and location of soil sample nodes in OSA-A were determined using the VSP software. VSP is a tool used throughout Washington State and approved for use by the Environmental Protection Agency statistically determines the quantity of samples required to accept or reject the null hypothesis based on input parameters specific to the unit or area. A null hypothesis is generally assumed true until evidence indicates otherwise. As defined in WAC 173-340-200, *Definitions*, the null hypothesis for OSA-A is that the soil is assumed to be above closure performance standards; therefore, the soil is presumed to be contaminated. Rejection of the null hypothesis means results of field sampling and laboratory analysis indicate that soil meets closure performance standards.

Should sampling and analysis provide a basis that the null hypothesis is accepted, such an event will be considered an unanticipated event during closure, and the soil would then be identified as contaminated environmental media and managed in accordance with WAC 173-303-170, *Requirements for generators of dangerous waste*, through 173-303-230, *Special conditions*.

For grid sampling determination in VSP, both parametric and nonparametric equations rely on assumptions about the data population. However, nonparametric equations require fewer assumptions and allow for more uncertainty about the distribution of data. Alternatively, if parametric assumptions are valid, the required number of samples is usually less than if a nonparametric equation was used.

Table HA-6 Visual Sample Plan Input Parameters

Variable/ Input Parameter	Regulatory Requirement or Guidance Document	Proposed Values	Comment
False rejection rate (α)	OSWER Directive 9355.4-23 – 5%	5%	Represents the upper limit of acceptable risk of declaring a dirty site to be clean, otherwise known as a Type I error.
False acceptance rate (β)	OSWER Directive 9355.4-23 – 20%	20%	Represents the upper limit of acceptable risk of declaring a clean site to be dirty, otherwise known as a Type II error.

Table HA-6 Visual Sample Plan Input Parameters

Variable/ Input Parameter	Regulatory Requirement or Guidance Document	Proposed Values	Comment
Upper confidence limit (UCL)	MTCA Method B (WAC 173-340; 95% of the UCL of the CPS)	95% of the UCL	This criterion is part of the three-part rule. A range of 90–99% of the UCL of the closure performance standard can be used depending on the model and accepted risk.
Standard deviation (σ)	None recommended. Assumption based on previously collected data.	40% (Zones 5, 6)/ 66% (Zones 1, 2, 7)	If the calculated standard deviation is smaller than the estimated user-input standard deviation, then no additional sampling will be required. If the calculated standard deviation is larger than the estimated standard deviation, then additional sampling may be required. The standard deviation was modified based on the zone (see Section HA.2.3.1 for further details)
Delta (δ or Δ)	None recommended. Assumption based on tolerance for committing a Type II error.	40%	Delta is the gray region in the MARSSIM Sign Test (NUREG-1575). A small delta value will result in more samples and reduced risk of a Type II error. A larger delta will result in fewer samples and increased risk of a Type II error.
Data distribution	EPA guidance on quality systems EPA/240/B-06/002 and EPA/240/B-06/003	Nonparametric	VSP is used to test for normal distribution and calculate mean, median, variance, standard error, standard deviation, inner quartile range, 95% UCL, and the MARSSIM Sign Test (NUREG-1575). If data are not normally distributed, then appropriate statistics will be used.

Table HA-6 Visual Sample Plan Input Parameters

Variable/ Input Parameter	Regulatory Requirement or Guidance Document	Proposed Values	Comment
Null hypothesis (H_o)	Developed during Step 5 of DQO process, and wording from WAC 173-340-200		The soil is presumed to be contaminated. If soil sampling results are below CPSs, then the null hypothesis is rejected, and the site is clean closed. If soil sampling results are above CPSs, then the null hypothesis is accepted, and further remediation and sampling will be necessary.

Note: Complete reference citations are provided in Section HA.4.

CPS = Closure performance standard
DQO = Data quality objective
EPA = U.S. Environmental Protection Agency
MARSSIM = Multi-Agency Radiation Survey and Site Investigation Manual
MTCA = Model Toxics Control Act
OSWER = Office of Solid Waste and Emergency Response
UCL = Upper confidence limit
VSP = Visual Sample Plan
WAC = Washington Administrative Code

HA.1.7 Analytical Approach

The decision rule for demonstrating compliance with WAC 173-340, *Model Toxics Control Act Cleanup Regulations* (MTCA) Method B cleanup levels for soil includes a three-part comparison of sample results to the closure performance standards. The decision rule related to the action levels identified in MTCA Method B (including, by reference, WAC 173-340-740(7), *Unrestricted land use soil cleanup standards*), is as follows:

- The 95 percent UCL on the true data mean must be less than the MTCA (WAC 173-340) Method B closure performance standard.
- No sample concentration can be more than twice the cleanup level.
- Less than 10 percent of the samples can exceed the cleanup level.

HA.1.7.1 Performance or Acceptance Criteria

If the MTCA Method B three-part rule fails, then the permittees will further investigate those target analytes that failed the decision criteria. Section HA.1.7.2 and HA.2.3.4 describe the necessary steps in this situation.

HA.1.7.2 Clean Closure Criteria

If grid samples for all zones and all focused samples are at or below evaluation criteria, then clean closure standards will be met for OSA-A.

It is possible that either grid samples in a particular zone or focused sample(s) will be outside of acceptable limits. Soil remediation will occur for soil results that fall outside of accepted clean closure criteria. After soil remediation, confirmatory sampling will occur. For grid samples, a new grid will be created for that zone and sampled. For focused sampling, that location will be re-sampled. See discussion on soil remediation in Section H.4.5, Identifying and Managing Contaminated Environmental Media, in the OSA-A closure plan. See Section HA.2.3.4, Sampling and Analysis Requirements to Address Contaminated Soil, for confirmatory sampling.

When all required actions are complete and certified by an IQRPE (Section HA.3.2), clean closure documentation will be provided to Ecology (Section HA.3.3).

HA.1.7.3 Plan for Obtaining Data

Samples will be collected per the OSA-ASAP (Section HA.2). Grid samples will be collected as described in Section HA.2.3.1.2 and focused samples will be collected as described in Section HA.2.3.1.1. See Section HA.2.3.3 for sampling methods and handling. Quality control (QC) samples will be collected as in Section HA.2.3.6 and Table HA-7. Sampling methods and handling are discussed in Section HA.2.3.3.

Figure HA-3 231ZDR-11 Container With Liquid Retrieval System

HA.2 SAMPLING AND ANALYSIS PLAN

Soil sampling and analysis activities were designed using EPA guidance document EPA/240/R-02/005, *Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan*, and Ecology Publication #94-111, *Guidance for Clean Closure of Dangerous Waste Units and Facilities*, and will be conducted via this OSA-A SAP.

HA.2.1 Sampling and Analysis Activities

Sampling and analysis of the soil at OSA-A will be conducted to confirm whether closure performance standards established in the OSA-A SAP pursuant to WAC 173-303-610(2)(b)(i), Dangerous Waste Regulations, *Closure and Post-closure*, have been met, demonstrating clean closure. Soil will be collected after removing the overlying gravel at focused and grid sample locations. OSA-A is divided into seven zones for sampling purposes (see section HA.2.3.1 for further detail). For zones 1, 2, 5, 6, and 7, grid samples were randomly selected. Focused samples will be collected from zones 3 and 4, and the area around container 231ZDR-11 in zone 2 that is most likely to be contaminated. All sampling and analysis will be performed in accordance with the sampling and quality standards established in this SAP.

This SAP details sampling and analysis procedures in accordance with SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium*; ASTM International, 2017, *Annual Book of ASTM Standards*; and applicable EPA guidance. Sampling and analysis activities will meet applicable requirements of SW-846, ASTM International standards, EPA-approved methods, and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD), at the time of closure.

HA.2.2 Project Management

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

HA.2.2.1 Project/Task Organization

The Permittee is responsible for planning, coordinating, sampling, preparing, packaging, and shipping samples to the laboratory. The project has several key positions described in the following sections.

HA.2.2.1.1 Regulatory Representative

Ecology will assign an Ecology employee as Program Manager responsible for oversight of OSA-A closure.

HA.2.2.1.2 Project Manager and Technical Lead

The Project Manager provides oversight for activities and coordinates with the DOE, Ecology, and contract management. In addition, support is provided to the project technical lead to ensure that work performed is safely and cost effectively.

The Project Manager (or designee) for OSA-A closure sampling is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The Project Manager is also responsible for ensuring that project personnel are working to the approved OSA-A closure plan in the permit and for providing updates to field personnel. The Project Manager works closely with Quality Assurance (QA), Health and Safety, and the Operation Supervisor to integrate these and other lead disciplines in planning and implementing the work scope. The Project Manager also coordinates with DOE and the primary contractor management on all sampling activities. In addition, the Project Manager supports DOE in coordinating sampling activities with the regulators.

HA.2.2.1.3 Environmental Compliance Officer

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

HA.2.2.1.4 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project as performed through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulation or internal primary contractor work requirements.

HA.2.2.1.5 Sample Management and Reporting

The permittee's sampling organization coordinates field sampling as well as laboratory analytical work, ensuring that laboratories conform to HASQARD (DOE/RL-96-98) or equivalent at the time of closure. The sampling organization receives the analytical data from the laboratories, performs entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. The sampling organization is responsible for informing the Project Manager of any issues reported by the contract analytical laboratory.

HA.2.2.1.6 Contract Laboratories

The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanation of results in support of data validation.

HA.2.2.1.7 Waste Management Lead

The Waste Management Lead communicates policies and protocols, and ensures project compliance for storage, transportation, disposal, and waste tracking.

HA.2.2.1.8 Operations Supervisor

The Operations Supervisor (OS) is responsible for planning and coordinating field sampling resources. The OS ensures that samplers are appropriately trained and available. Additional related responsibilities include ensuring that the sampling design is understood and can be performed as specified.

The OS must document all deviations from procedures or other problems pertaining to sample collection, chain-of-custody (COC) protocols, analytes, sample analysis, sample transport, or noncompliant monitoring. As appropriate, such deviations or problems will be documented in the field logbook or in nonconformance report forms in accordance with internal corrective action procedures. The Field Work Supervisor is responsible for communicating field corrective actions to the Project Manager and for ensuring that immediate corrective actions are applied to field activities.

The roles described above make up the project organization structure (regarding sampling and analysis) and interact in a manner shown graphically in Figure HA-4.

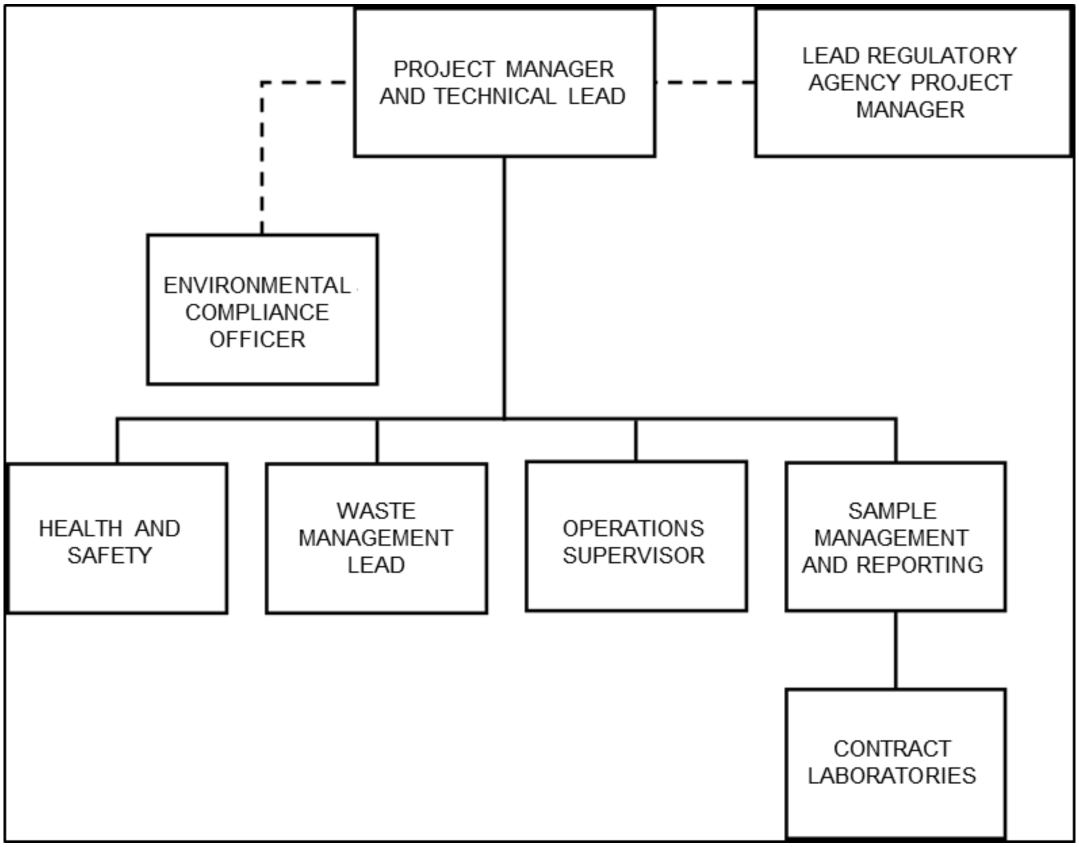


Figure HA-4 Outdoor Storage Area-A Closure Sampling Project Organization

HA.2.2.2 Field Sampler Training/Certification

Training records of field samplers are maintained by the sampling organization, retained in the training database, or archived with operating records. Field samplers will be collecting samples of the soil beneath the gravel layer for analysis to determine if closure performance standards have been met.

HA.2.2.3 Sampling Documents and Records

The Project Manager is responsible for ensuring that the current version of the SAP is being used and providing any updates to field personnel. Version control is maintained by the administrative document control process.

Required for field activities, logbooks must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook, into which only authorized persons may make entries. After review, logbooks will be signed by the field manager, supervisor, cognizant scientist/engineer, or other responsible individual. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

The Project Manager is responsible for ensuring that a project file is properly maintained. The project file will contain the records or references to their storage locations. The following items will be included in the project file, as appropriate:

- Field logbooks or operational records.
- Global positioning system data.

- Sampling authorization forms.
- Data forms.
- COC forms.
- Sample receipt records.
- Inspection or assessment reports and corrective action reports.
- Interim progress reports.
- Final reports.
- Laboratory data packages.
- Data verification and validation reports.

The contract analytical laboratory is responsible for maintaining (and having available on request) the following items:

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

Records may be stored in either electronic or hardcopy format. Regardless of medium or format, documentation and records are controlled in accordance with internal work requirements and processes to ensure the accuracy and retrievability. Records generated during closure will be maintained in the operating record in accordance with Permit Condition II.I.

HA.2.3 Sampling Design and Analysis

The sampling design includes input parameters used to determine the number and location of samples (Section HA.1.6). The primary purpose of sampling the soil underlying the gravel is to determine if analytical data values meet closure performance standards.

HA.2.3.1 Sampling Process Design

This OSA-A SAP used Section 7.0 of Ecology Publication #94-111 to determine the type of sampling design for demonstrating clean closure. When designing the sampling plan, both focused and grid (area-wide) sampling methods were considered and are described in the following sections. VSP was used for grid sample locations. See Section HA.1.6 for further detail.

One limitation of VSP is it does not account for size of an area when determining numbers of samples. Therefore, it is necessary to analyze unit-specific conditions to ensure the VSP inputs produce a sampling strategy that is both statistically valid and spatially representative. To determine if parameters are reasonable for a particular unit or area, many factors are considered, such as the history of the site (i.e., how many containers were stored, how long they were stored, contents of the containers, and where waste was stored within the DWMU); and methods of operations (i.e., inspection frequency, issue tracking, and other regulations governing operations at the DWMU).

Section H.1.1 Unit Description explains that the OSA-A DWMU was activated in 2008, and section H.1.3 Maximum Waste Inventory, identifies a total of 448 RCRA-regulated waste containers were stored at the DWMU. The sizes of containers are summarized on table HA-1 of this document. Section H.4.1.1, Preliminary Operating Records Review and Visual Inspection, explains that there was one potential release identified.

Dangerous Waste regulations require weekly visual inspections as explained in section H.2.2.2 Inspections. Additionally, any time a container is moved to/from/within the DWMU, the container is visually monitored.

Operation of OSA-A includes established setbacks, travel pathways, aisle spacing, and two container width maximums for each row are factors ensuring that the waste is managed in safe configurations. Waste has been and continues to be placed in designated zones only. The stipulated operational zones were used to determine the VSP sampling zones discussed below. The sampling strategy explained in this section provides the highest density of samples where waste containers were stored.

Throughout 2023, Ecology and the Permittees conducted multiple workshops to reach agreement on the VSP inputs shown above in Table HA-6 (which ensure the sampling strategy is statistically valid) and the justification explained below (which supports the total number of samples in each zone as sensible).

Based on historical aerial imagery (Appendix A) and operating records, seven zones are identified for OSA-A. Zones one through six are the areas where waste was stored. Zone seven includes the remaining area within the DWMU such as equipment storage and travel pathways, where waste was not stored. The following provides a description of each zone and explanation of why the number of samples selected is considered spatially representative. Table HA-6 summarizes the parameters and inputs used to develop the sampling strategy for each zone.

Zone 1 – Northwest Corner: Zone 1 is 81,004 ft^2 and started receiving RCRA waste in 2010. Waste is removed according to Section H.4.1.2, Waste Removal. There are no releases documented in the Operating Records Review for this zone. See section H.4.1.1, Preliminary Operating Records Review and Visual Inspection, for additional detail. See Section HA.2.3.1.2, Grid (Area-Wide) Sampling, for further information on the grid sampling strategy identified, as well as table HA-6 for additional information regarding the square feet per sample and VSP inputs.

Zone 2 – Northeast Corner: Zone 2 is 36,085 ft^2 and started receiving RCRA waste in 2008. Waste is removed according to Section H.4.1.2, Waste Removal. This zone contains one known previous release, as described in Section H.4.1.1, Preliminary Operating Records Review and Visual Inspection, and Attachment HB of this closure plan. Therefore, in addition to grid sampling in this zone, there will also be three focused samples. See table HA-6 for additional information regarding the square feet per sample and VSP inputs.

Zone 3 – West: Zone 3 is 2,907 ft^2 and started receiving RCRA waste in 2010. Waste is removed according to Section H.4.1.2, Waste Removal. There are no releases documented in the Operating Records Review for this zone. See Section H.4.1.1, Preliminary Operating Records Review and Visual Inspection, for additional detail. The small size of this zone compared with other zones at OSA-A limits the number of boxes stored in zone 3. This supports the use of a focused sample design instead of a statistical grid sample design. As seen in aerial imagery (Appendix A), the waste configuration remained consistent throughout the years. Therefore, five focused samples will be taken to determine clean closure of this zone where waste was most concentrated. See Section HA.2.3.1.1, Focused (Judgmental) Sampling, for further information.

Zone 4 – East: Zone 4 is 2,623 ft^2 and started receiving RCRA waste in 2010. Waste is removed according to Section H.4.1.2, Waste Removal. There are no releases documented in the Operating Records Review for this zone. See Section H.4.1.1, Preliminary Operating Records Review and Visual Inspection, for additional detail. The small size of this zone compared with other zones at OSA-A limits the number of boxes stored in Zone 4. This supports the use of focused sample design instead of statistical grid sample design. See Section HA.2.3.1.1, Focused (Judgmental) Sampling, for further information. Three focused sample points will be taken to determine clean closure of the zone.

Zone 5 – Southwest Corner: Zone 5 is 40,058 ft^2 and started receiving RCRA waste in 2008. Waste is removed according to Section H.4.1.2, Waste Removal. There are no releases documented in the Operating Records Review for this zone. See section H.4.1.1, Preliminary Operating Records Review and Visual Inspection, for additional detail. See Section HA.2.3.1.2, Grid (Area-Wide) Sampling, for further information on the grid sampling strategy identified, as well as table HA-6 below for details regarding the square feet per sample and VSP inputs.

Zone 6 – Southeast Corner: Zone 6 is 10,043 ft^2 and started receiving RCRA waste in 2008. Waste is removed according to Section H.4.1.2, Waste Removal. There are no releases documented in the Operating Records Review for this zone. See section H.4.1.1, Preliminary Operating Records Review and Visual Inspection, for additional detail. See Section HA.2.3.1.2, Grid (Area-Wide) Sampling, for further information on the grid sampling strategy identified, as well as table HA-6 for details regarding the square feet per sample and VSP inputs.

Zone 7 – Remainder: Zone 7 is 208,152 ft^2 and is comprised of the areas not included in Zones 1-6, but still within the boundary of the OSA-A DWMU. This zone never stored waste. Boxes in zone 7 as seen in aerial imagery (Appendix A) are either material storage boxes, dunnage, transportation trailers and covers, or lifting hardware for crane and rigging activities. There are no releases documented in the Operating Records Review for this zone. See section H.4.1.1, Preliminary Operating Records Review and Visual Inspection, for additional detail. See Section HA.2.3.1.2, Grid (Area-Wide) Sampling, for further information on the grid sampling strategy identified, as well as table HA-6 for additional information regarding the square feet per sample and VSP inputs.

HA.2.3.1.1 Focused (Judgmental) Sampling

Generally speaking, selection of focused sampling units (i.e., the number and location of samples) is based on knowledge of the feature or condition under investigation and on professional judgment. Focused sampling is distinguished from probability based sampling in that inferences are based on professional judgment and not statistical scientific theory. Therefore, conclusions about the target population are limited and depend entirely on the validity and accuracy of professional judgment.

The use of statistical evaluation for focused sample results is not possible. Any data from focused samples must be reviewed directly against the closure performance standards as to whether they are below or above the standards.

As identified in Section 7.2.2 of Ecology Publication #94-111, focused sampling is selective sampling of areas where contamination is expected or releases have been documented. Focused sampling is appropriate at the affected area of container 231ZDR-11. A rectangular sampling area of 11 by 4 m (35 by 13 ft) has been identified. The dimensions are based on the size of the 231ZDR-11 container (7 by 4 m [23 by 12 ft]) and the size of the possibly affected area (as much as 11 by 8 m [35 by 25 ft]). To maximize the likelihood of collecting soil from the highest contamination area, the sampling area was reduced to the area located on the south side of the affected area where the highest likelihood for contamination exists. Figure HA-3 shows the 231ZDR-11 container with a liquid retrieval system located on the south side, which is the concentrated sampling area. Three focused samples will be taken within the concentrated sampling area. Each focused sample will be taken approximately 3 m (10 ft) apart to ensure full representation of the sampling area.

Focused sampling will also occur in zones 3 and 4 based on professional judgement. These two zones are relatively small compared to the square footage of zones 1, 2, 5, and 6. Because of their size, the waste storage capacity was limited based on the size of the containers stored at OSA-A. For zone 3, five focused samples will be collected. Zone 4 will have three focused samples collected. See Figure HA-5 for sample locations. Also, see Section HA.2.3.1 for further detail of each zone.

After waste is removed and records review and visual inspection are complete, a determination will be made whether additional focused sampling is appropriate. Additional samples may be taken within OSA-A based on analytical results and field observation. The location of additional focused samples, if any, will be identified and recorded in the logbook.

HA.2.3.1.2 Grid (Area-Wide) Sampling

Ecology Publication #94-111 identifies that grid sampling is appropriate when the spatial distribution of contamination at or from the closure unit is uncertain. Section 7.3 of Ecology Publication #94-111 identifies the grid sampling approach as generally appropriate for sampling to confirm that closure performance standards are met.

In grid sampling, grab samples are collected at regularly spaced intervals (called sample node locations) over an area. An initial location or time is chosen at random, and then the remaining sample node locations are defined so that the locations are at regular intervals over an area (grid). Grid sampling is used to search for hot spots and to infer means, percentiles, or other parameters and is useful for estimating spatial patterns or trends over time. This design provides a practical method for designating grab sample node locations and ensures uniform coverage of a site, unit, or process.

OSA-A data quality assumptions were based on a DQO process performed in accordance with EPA/240/R-02/005, and are detailed in this report. VSP parameter inputs that are based on the DQO process are detailed in Section HA.1.6 and Table HA-6.

Zones 1, 2, 5, 6, and 7 each have their own grid sampling pattern as shown in Figure HA-5.

HA.2.3.1.3 Development of Closure Performance Standards

The presumed exposure pathways that are considered for CWC closure sites are:

- WAC 173-340-740(3) Method B (cancer and noncancer), that considers human health based on direct soil contact.
- WAC 173-340-740(2), Table 740-1, “Method A Soil Cleanup for Unrestricted Land Uses,” which includes performance standards for human health based on unrestricted land use. MTCA Method A is only used if MTCA Method B is not available in the CLARC tables.
- WAC 173-340-747, *Deriving soil concentrations for groundwater protection,* that notes soil concentration protective of groundwater.
- WAC 173-340-7493, *Site-specific terrestrial ecological evaluation procedures*, that considers ecological indicators (plants, biota, wildlife) found in Table 749-3, “Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals.”
- WAC 173-340-750, *Cleanup standards to protect air quality,* that describes human health risks due to fugitive vapors and dust.

Of the exposure pathways listed above, MTCA Method B direct soil contact, or Method A as applicable, is always considered a complete and viable exposure pathway for all soil samples. The exposure pathway for soil protective of groundwater assumes that water or rainwater on a surface has an avenue to percolate through the surface and underlying soil to groundwater. The scenario for ecological indicators requires vegetation, biota, and wildlife be present in order for the pathway to be complete. The exposure scenario for inhalation of fugitive vapors and dust assumes a complete pathway which would begin with a source of contaminated media and end with a receptor. All exposure pathways noted above were considered complete at OSA-A.

A list of closure performance standard values for all exposure pathways was provided to Ecology in July 2017 as correspondence from DOE (17-AMRP-0217, "Dangerous Waste Management Unit (DWMU) 277-T Building Closure Plan Comment Disposition and Performance Standards for Future Solid Waste Operations Complex (SWOC) Closure Plans"), which Ecology acknowledged (17-NWP-100, "Dangerous Waste Management Unit (DWMU) 277-T Building Closure Plan Comment Disposition and Performance Standards for Future Solid Waste Operations Complex (SWOC) Closure Plans").

Of all closure performance standard values provided to Ecology (17-AMRP-0217), the most conservative closure performance standard is selected for each analyte per WAC 173-340-740(5)(c), the closure performance standard value cannot be below the following:

- Hanford Site background.
- Laboratory PQL found in the laboratory contracts.

If a closure performance standard is below both values, the higher of these two values is selected. The decision rule for demonstrating compliance with the MTCA (WAC 173-340) Method B closure requirements also includes a three-part test that compares sample results to the closure performance standards in Table HA-9:

- The 95 percent UCL on the true data mean must be less than the MTCA Method B closure performance standard.
- No sample concentration can be more than twice the closure performance standards.
- Less than 10 percent of the samples can exceed the closure performance standards.

Using a nonparametric test and the input parameters identified in Table HA-6, VSP calculated the number of samples that would adequately describe the population for each zone. These sample numbers are shown in Table HA-7 With this level of confidence in the population description, the null hypothesis could be rejected with 95 percent confidence and ensure that a site would not be mistakenly released as clean (uncontaminated). The VSP software compares the site mean to a fixed threshold in order to accept or reject the null hypothesis. Data will further be evaluated to ensure that the three-part test requirements are met (Section HA.2.4).

HA.2.3.2 Sample Location

The sampling design uses a grid sampling approach with focused sampling as identified by visual inspections. Focused samples will be collected at the area with the greatest likelihood of contamination within the affected area of the 231ZDR-11 container. In addition, focused sampling will be performed for zones 3 and 4 as well as any waste-related staining identified during the final visual inspection performed after all waste containers are removed.

Grid samples will be collected at the sample locations identified in Table HA-7 and shown in Figure HA-5.

Table HA-7 Sample Number, Locations, and Methods for Soil Samples at Outdoor Storage Area-A

Sample Locations*	Total Square Feet	Square Feet Per Sample	Number of Samples**	Sampling Method***
Zone 1: NW Corner	81,004	2,250	36	Grid
Zone 2: NE Corner	36,085	947	36	Grid
Zone 3: West	2,907	N/A	5	Focused
Zone 4: East	2,623	N/A	3	Focused
Zone 5: SW Corner	40,058	1,834	23	Grid
Zone 6: SE Corner	10,043	591	20	Grid
Zone 7: Remaining Area	208,152	5,782	36	Grid
Total	**380,872**		**159**	

*Surface samples taken at 0 to 15.2 cm (0 to 6 in.) bgs. See VSP report (Attachment HC) for exact locations.

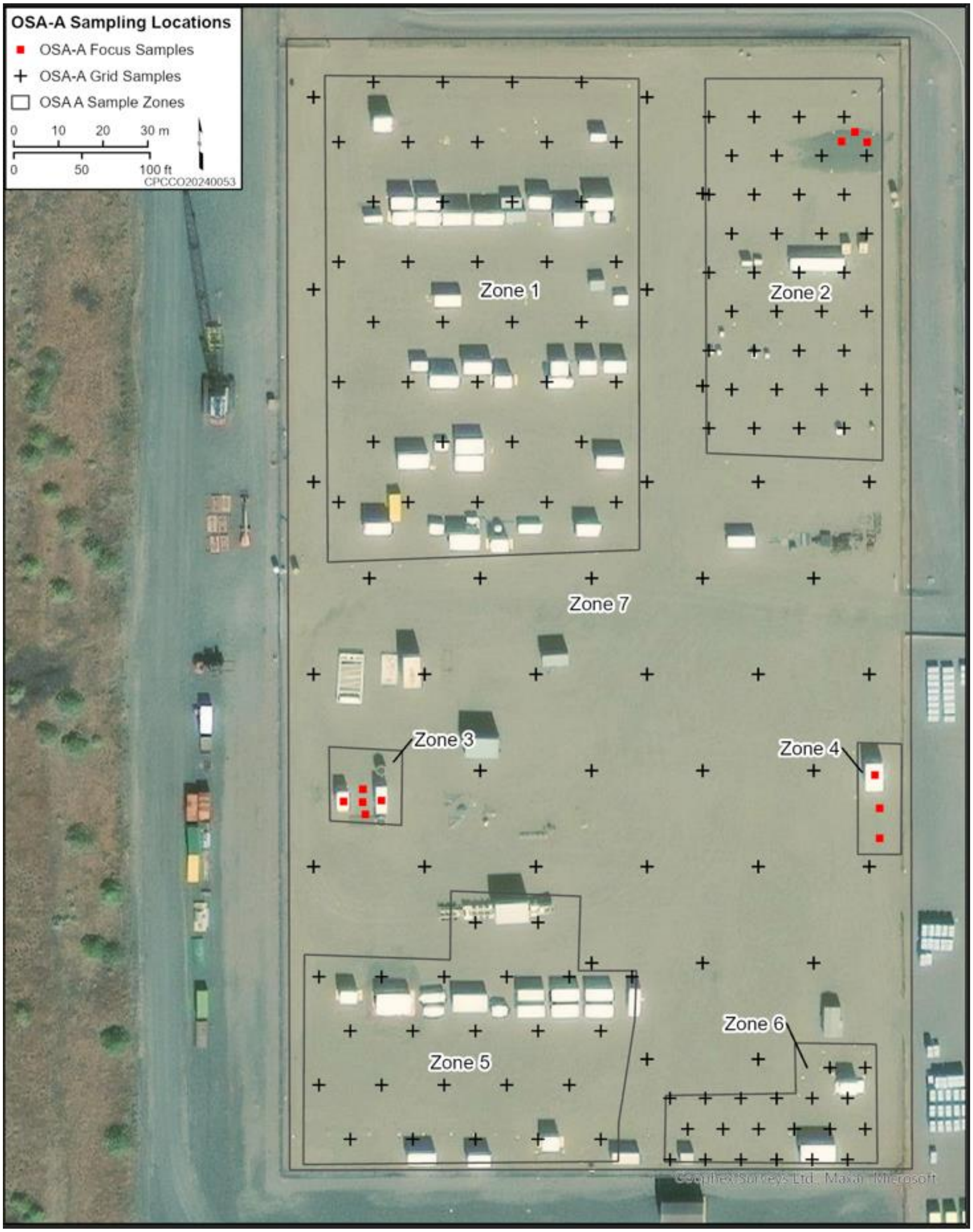
**Number of Quality Assurance Samples: One each of the following samples: trip blank, field blank, equipment rinsate blank, and field duplicate.

***All sampling is done with grab samples.

OSA-A = Outdoor Storage Area-A

VSP = Visual Simple Plan

Statistical analysis of grid sample data is valid if a random starting location is used and no bias is introduced. Grid samples will be collected and placed into containers representing the sample node locations indicated in Figure HA-5.



1 **Figure HA-5 Outdoor Storage Area-A Sampling Locations**

HA.2.3.3 Sampling Methods and Handling

The grab sample matrix will consist of soil collected in clean sample containers taken at a depth of no more than 15.2 cm (6 in.) bgs. To gather the most representative sample, loose gravel will be moved aside to expose the surface soil and compacted gravel. Over time, precipitation would have caused any potential contamination from waste storage to migrate down from the loose surface gravel into the surface soil and compacted gravel below. Subsurface sampling will be evaluated based on results of the records review or visual indicators during sampling. If subsurface sampling is deemed necessary, a permit modification will be submitted in accordance with WAC 173-303-610(3)(b).

Soil will be collected from a sampling node, and the soil will be placed into clean sampling containers as prescribed by the sampling method.

All soil collected from a sampling node will be placed into a clean stainless steel mixing bowl and homogenized with a one-time use plastic or clean stainless steel scoop. Using the same scoop, soil will be placed into the sampling containers as prescribed by the sampling method.

Once the soil is collected, the sampled media will be screened to remove material larger than approximately 2 mm (0.08 in.) in diameter, which allows for a larger surface area to volume ratio and therefore increases the likelihood of identifying any potential contamination in the sample. To ensure sample and data usability, sampling will be performed in accordance with established practices, procedures, and requirements pertaining to sample collection, collection equipment, and sample handling. Sampling includes the following activities:

- Preparation and review of sampling paperwork, such as COCs or labels.
- Sample container and equipment preparation.
- Field walkdown of sample area (includes locating and marking sample nodes).
- Sample collection.
- Sample preservation, packaging, and shipping.

Sample preservation and holding time requirements are specified in Table HA-8. These requirements are in accordance with the analytical method specified. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. The final container type and volumes will be identified on the sample authorization form and COC form. To prevent potential contamination of samples, clean equipment will be used for each sampling location.

Table HA-8 Preservation and Holding Time Requirements for Soil Samples

EPA Method	Analysis/Analytes	Preservation	Holding Time	Bottle Type
6010	ICP-AES (Metals)	None	180 days	G/P
6020	ICP-MS (Metals)	Cool ≤6°C	180 days	G/P
7196	Colorimetric (Hexavalent Chromium)	Cool ≤6°C	30 days prior to extraction, 7 days after extraction	G/P
7471	Cold Vapor Atomic Absorption (Mercury)	Cool ≤6°C	28 days	G/P
8015	GC/Flame Ionization Detector (Nonhalogenated Organics [Methanol])	Cool ≤ 6°C	14 days	G

Table HA-8 Preservation and Holding Time Requirements for Soil Samples

EPA Method	Analysis/Analytes	Preservation	Holding Time	Bottle Type
8260	GC/MS (Volatile Organic Compounds)	Cool ≤6°C	14 days	G
8270	GC/MS (Semivolatile Organic Compounds)	Cool ≤6°C	14 days prior to extraction, 40 days after extraction	Amber Glass

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

AES = Atomic emission spectrometry

EPA = U.S. Environmental Protection Agency

GC = Gas chromatography

G/P = Glass/Plastic

ICP = Inductively coupled plasma

MS = Matrix spike

A sampling and data tracking database (e.g., HEIS) is used to track the samples from the point of collection through the laboratory analysis process. Laboratory analytical results are entered and maintained in the HEIS database. HEIS sample numbers are issued to the sampling organization for the project. Each sample is identified and labeled with a unique HEIS sample number.

To prevent potential contamination of the samples, clean equipment will be used for each sampling activity. Disposable equipment used during sampling will be managed as newly generated waste in accordance with all applicable requirements of WAC 173-303-170 through WAC 173-303-230. Level I EPA precleaned sample containers will be used for samples collected for chemical analysis. Container sizes may vary, depending on laboratory-specific volumes/requirements for meeting the PQL.

The date and time of sample collection and the sample locations, depths, and corresponding HEIS numbers will be documented in the sampler's field logbook. A custody seal (i.e., evidence tape) will be affixed to the lid of each sample container (except for volatile organic analysis [VOA] sample containers) and or sample collection package in such a way as to indicate potential tampering. The custody seal will be inscribed with the sampler's initials and date. Custody tape is not applied directly to VOA sample containers based on the potential for affecting analyte results and/or fouling of laboratory equipment. Alternatively, VOA vials are placed in a sealable plastic bag affixed with custody seals and any other required labels/documentation.

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

- Sample authorization form number.
- HEIS number.
- Sample collection date and time.
- Sampler identification (e.g., initials).
- Analysis required.
- Preservation method (if applicable).
- COC identification number.

In addition to the above information, sample records must include the sample location and matrix (water, soil, etc.).

Sample custody will be maintained in accordance with existing Hanford Facility protocols to ensure the maintenance of sample integrity throughout the analytical process. These protocols are found in Volumes 2 and 4 in HASQARD (DOE/RL-96-68). COC protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A COC record is initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory. At a minimum, the following information must be identified on a completed COC record:

- Collector(s) names.
- Project designation.
- Unique sample numbers.
- Date, time, and location (or traceable reference thereto) of sample collection.
- Chain of possession information (i.e., signatures/printed names of all individuals involved in the transfer of sample custody and storage locations, dates of receipt and relinquishment).

Additional information regarding the sample and specific analytical instructions may also be documented.

Discrepancies with the sample material (unusual color, texture, or odor), collection techniques, containers, or transfer packages are noted in the field logbook and communicated with the Project Manager, along with the initiation of corrective actions. For example, where a custody seal is damaged or missing, each case is individually reviewed for sample usability. The damaged or missing seal and action taken will be documented in the final data package. Data verification and validation will also note any issues with sample collection and analysis.

Contaminated environmental media and newly generated waste resulting from sampling activities must be handled in accordance with all applicable requirements of WAC 173-303-170 through WAC 173-303-230.

HA.2.3.4 Sampling and Analysis Requirements to Address Contaminated Soil

Remediation of confirmed contaminated soil above closure performance standards must be performed to remove contaminated soil. Once contaminated soil is removed, re-sampling will occur. If the remediation is at a focused sample point, then that sample needs to be re-sampled. If the location is part of grid sampling, then VSP will be used to generate a new grid sampling design for that zone that will provide a new random start point and new grid-node sampling locations in accordance with the same model parameters established in Section HA.2.3.1. Grab samples collected from the new grid-node locations will be analyzed to confirm clean closure as described in Section HA.2.3.1. If the new sample results meet the closure performance standards, then the zone will be considered clean closed. All zones must be clean closed for OSA-A to be determined clean closed. If the new sample results do not meet the closure performance standards, then the Permittees will meet with Ecology to determine a path forward for closure.

HA.2.3.5 Analytical Methods

All analyses and testing will be performed consistent with this OSA-A SAP, laboratory contracts, laboratory analytical procedures, and HASQARD (DOE/RL-96-68) at the time of closure. The contracted analytical laboratory must achieve the lowest PQLs consistent with the selected analytical method (identified in Table HA-9) to confirm that the closure performance standards are met.

Table HA-9 Analytical and Performance Requirements

CAS Number	Waste Code(s)	Analyte	Closure Performance Standard		PQL[a] (mg/kg)
			Value (mg/kg)	Basis	
SW-846 Method 6010			**Accuracy Requirement ±20% Recovery[b] Precision Requirement ≤35 RPD[c]**		
7440-38-2	D004	Arsenic[d]	2.00E+01	Ecology, 2013	1.00E+01
7440-39-3	D005	Barium	1.32E+02	Background	5.00E+00
7440-43-9	D006	Cadmium	6.90E-01	Groundwater protection	5.00E-01
7439-92-1	D008	Lead	5.00E+01	Ecological – Plants	5.00E+00
7782-49-2	D010	Selenium	1.00E+01	PQL	1.00E+01
7440-22-4	D011	Silver	2.00E+00	Ecological – Plants	1.00E+00
SW-846 Method 6020			**Accuracy Requirement ±20% Recovery[b] Precision Requirement ≤35 RPD[c]**		
7440-38-2	D004	Arsenic[d]	2.00E+01	Ecology, 2013	1.00E+01
SW-846 Method 7196			**Accuracy Requirement ±20% Recovery[b] Precision Requirement ≤35 RPD[c]**		
18540-29-9	D007	Chromium (hexavalent)	5.00E-01	PQL	5.00E-01
SW-846 Method 7471			**Accuracy Requirement ±20% Recovery[b] Precision Requirement ≤35 RPD[c]**		
7439-97-6	D009	Mercury[e]	2.00E-01	PQL	2.00E-01
SW-846 Method 8260			**Accuracy Requirement ±30% Recovery[b] Precision Requirement ≤20 RPD[c]**		
67-64-1	F003	Acetone	2.90E+01	Groundwater protection	2.00E-02
71-43-2	D018, F005	Benzene	3.00E-02	Groundwater protection	5.00E-03
71-36-3	F003	n-Butyl alcohol (I-Butanol)	3.30E+00	Groundwater protection	2.50E-01
75-15-0	F005, (P022)	Carbon disulfide	4.10E+00	Groundwater protection	5.00E-03
56-23-5	D019, F001, F002, (U211)	Carbon tetrachloride	4.10E-02	Groundwater protection	5.00E-03
67-66-3	D022	Chloroform	7.40E-02	Groundwater protection	5.00E-03
108-90-7	F002	Chlorobenzene	8.60E-01	Groundwater protection	5.00E-03
108-94-1	F003, (U057)	Cyclohexanone	1.70E+02	Groundwater protection	1.00E-01

Table HA-9 Analytical and Performance Requirements

CAS Number	Waste Code(s)	Analyte	Closure Performance Standard		PQL[a] (mg/kg)
			Value (mg/kg)	Basis	
123-91-1	(U108)	1,4-Dioxane	3.33E-01	PQL	3.33E-01
106-46-7	D027	1,4-Dichlorobenzene	1.20E+00	Groundwater protection	3.33E-01
107-06-2	D028	1,2-Dichloroethane	2.30E-02	Groundwater protection	5.00E-03
75-35-4	D029	1,1-Dichloroethylene (1,1-Dichloroethene)	4.60E-02	Groundwater protection	1.00E-02
60-29-7	F003, (U117)	Diethyl ether (ethyl ether, ethoxyethane, or 1,1'-oxybis-ethane)	6.80E+00	Groundwater protection	1.00E-02
141-78-6	F003	Ethyl acetate	3.00E+01	Groundwater protection	5.00E+00
100-41-4	F003	Ethyl benzene	2.28E+00	Inhalation (cancer)	5.00E-03
78-83-1	F005	Isobutanol (isobutyl alcohol or 2-Methyl-1-propanol)	9.70E+00	Groundwater protection	5.00E-01
78-93-3	D035, F005	Methyl ethyl ketone (2-butanone)	2.00E+01	Groundwater protection	2.00E-02
108-10-1	F003, (U161)	Methyl isobutyl ketone (4-Methyl-2-pentanone)	2.70E+00	Groundwater protection	2.00E-02
75-09-2	F001, F002, U080	Methylene chloride	2.20E-02	Groundwater protection	5.00E-03
127-18-4	D039, F001, F002	Tetrachloroethylene	5.00E-02	Groundwater protection	5.00E-03
109-99-9	(U213)	Tetrahydrofuran	3.00E+01	Groundwater protection	5.00E-2
108-88-3	F005, U220	Toluene	4.50E+00	Groundwater protection	5.00E-03
75-69-4	F001, WP01, (U121)	Trichloromonofluoromet hane	2.30E+01	Groundwater protection	1.00E-02
76-13-1	F001, F002	1,1,2-Trichloro-1,2,2-trifluoroethane	7.60E+03	Groundwater protection	1.00E-02
71-55-6	F001, F002, (U226)	1,1,1-Trichloroethane	1.50E+00	Groundwater protection	5.00E-03
79-00-5	F002	1,1,2-Trichloroethane	1.70E-02	Groundwater protection	5.00E-03
79-01-6	D040, F001, F002	Trichloroethylene (TCE or trichloroethene)	2.50E-02	Groundwater protection	5.00E-03
75-01-4--	D034	Vinyl chloride	1.00E-02	PQL	1.00E-02

Table HA-9 Analytical and Performance Requirements

CAS Number	Waste Code(s)	Analyte	Closure Performance Standard		PQL[a] (mg/kg)
			Value (mg/kg)	Basis	
108-38-3	F003	*m*-Xylene[f]	1.30E+01	Groundwater Protection	5.00E-03
95-47-6	F003	*o*-Xylene	1.40E+01	Groundwater protection	5.00E-03
106-42-3	F003	*p*-Xylene[f]	1.70E+01	Groundwater Protection	5.00E-03
1330-20-7	F003	Xylene (total)	1.40E+01	Groundwater protection	1.00E-02
SW-846 Method 8270			**Accuracy Requirement ±30% Recovery[b] Precision Requirement ≤30 RPD[c]**		
108-39-4	F004	*m*-cresol[g]	8.00E+00	Groundwater protection	6.66E-01
95-48-7	F004	*o*-cresol	8.10E+00	Groundwater protection	3.33E-01
106-44-5	F004	*p*-cresol[g]	1.60E+01	Groundwater protection	6.66E-01
1319-77-3	F004	Total Cresols (cresylic acid)	1.62E+01	Groundwater protection	6.66E-01
95-50-1	F002	1,2-Dichlorobenzene (Ortho-dichlorobenzene)	7.00E+00	Groundwater protection	3.33E-01
111-44-4	(U025)	Bis (bis (2-chloroethyl) ether (dichloroethyl ether)	3.33E-01	PQL	3.33E-01
121-14-2	D030	2,4-Dinitrotoluene	3.33E-01	PQL	3.33E-01
118-74-1	D032	Hexachlorobenzene	3.67E-01	Inhalation	3.33E-01
87-68-3	D033	Hexachlorobutadiene	1.20E-02	Groundwater protection	3.33E-01
67-72-1	D034	Hexachloroethane	3.33E-01	PQL	3.33E-01
98-95-3	F004, U169, D036	Nitrobenzene	3.33E-01	PQL	3.33E-01
87-86-5	D037	Pentachlorophenol	6.60E-01	PQL	6.60E-01
108-95-2	U188	Phenol	1.10E+01	Groundwater protection	3.33E-01
110-86-1	D038, F005	Pyridine	6.60E-01	PQL	6.60E-01
95-95-4	D041	2,4,5-Trichlorophenol	4.00E+00	Ecological - plants	3.33E-01
88-06-2	D042	2,4,6-Trichlorophenol	3.33E-01	PQL	3.33E-01

Table HA-9 Analytical and Performance Requirements

CAS Number	Waste Code(s)	Analyte	Closure Performance Standard		PQL[a] (mg/kg)
			Value (mg/kg)	Basis	
SW-846 Method 8015			**Accuracy Requirement ±30% Recovery[b] Precision Requirement ≤30 RPD[c] (8015)**		
67-56-1	F003	Methanol	6.40E+01	Groundwater protection	5.00E+01
SW-846 Method 8081			**Accuracy Requirement ±30% Recovery[b] Precision Requirement ≤30 RPD[c]**		
72-20-8	D012	Endrin	2.00E-01	Ecological - Wildlife	1.70E-03
58-89-9	D013	Lindane (gamma-hexachlorocyclohexane)	6.20E-03	Groundwater protection	1.70E-03
72-43-5	D014	Methoxychlor	6.40E+01	Groundwater protection	1.00E-02
8001-35-2	D015	Toxaphene	9.10E-01	Human Health – Direct Contact	8.50E-02
57-74-9	D020	Chlordane	2.10E+00	Groundwater protection	1.65E-02
76-44-8	D031	Heptachlor	3.80E-02	Groundwater protection	2.00E-03
SW-846 Method 9012 or 9014			**Accuracy Requirement ±30% Recovery[b] Precision Requirement ≤30 RPD[c]**		
57-12-5	P030	Cyanides (total)	1.00E+00	Groundwater protection	1.00E+00
SW-846 Method 9056			**Accuracy Requirement ±20% Recovery[b] Precision Requirement ≤35 RPD[c]**		
64-18-6	U123	Formate (measured as Formic Acid)	7.20E+04	Human Health – Direct Contact (noncancer)	1.00E+01
Not Analyzed					
110-80-5	F005	2-Ethoxyethanol[h]			
50-00-0	U122	Formaldehyde[i]			
302-01-2	U133	Hydrazine[j]			
79-46-9	F005	2-Nitropropane[k]			

Notes: Complete reference citations are provided in Section HA.4.

Screening levels considered when developing closure performance standards were drawn from the following:

- MTCA (WAC 173-340-740); Ecology, 2019 (May 2019) data tables are most recent). MTCA Method B values represent both carcinogen and noncarcinogen human health risk values from direct soil contact. The most conservative value of the two Method B published values will be used. Method A values are substituted when MTCA Method B values are not provided in the CLARC tables.
- MTCA (WAC 173-340-750) Method B. Values are listed for carcinogen and noncarcinogen levels that represent human health risk due to inhalation of vapors and dust.

Table HA-9 Analytical and Performance Requirements

CAS Number	Waste Code(s)	Analyte	Closure Performance Standard		PQL[a] (mg/kg)
			Value (mg/kg)	Basis	

- MTCA (WAC 173-340-747). Section 4 describes the fixed parameter three-phase partitioning model. Where applicable, these values were used. Values selected were from the 25°C vadose zone. If values were not listed for 25°C, values from the 13°C vadose zone were used.
- MTCA (WAC 173-340-7493). Values were taken from Table 749-3, including plants, biota, and wildlife.
- Background levels as published in ECF-HANFORD-11-0038 and DOE/RL-92-24. Background values were used at the 90th percentile of calculated Hanford Facility background values.
- Values taken from the above resources that fell below background levels were not considered.

[a]Highest allowable PQL will be defined in the individual laboratory contract with the CPCCo. In practice, the laboratory PQL values have the potential to be lower.

[b]Accuracy criteria for associated batch matrix spike percent recoveries. Evaluation based on statistical control of laboratory control samples is also performed. Precision criteria for batch laboratory replicate matrix spike analyses or replicate sample analyses.

[c]Precision is determined by the laboratory based on historical data or statistically derived control limits. Limits are reported with the data. Where specific acceptance criteria are listed, those may be used in place of statistically derived acceptance criteria.

[d]Arsenic – The Hanford Facility closure performance standard is 20 mg/kg based on a letter (Ecology, 2013) indicating that the Method A soil closure performance standard of 20 mg/kg can be used to define natural background levels when developing Method B soil closure performance standards for the Hanford Facility. One of the two methods (SW-846 6010 or 6020) may be used.

[e]Mercury – Equations 740-1 and 740-2 from WAC 173-340-740(3)(b) are used to calculate the MTCA Direct Contact Human Health soil closure performance standards. The MTCA human health direct contact soil closure performance standard for mercury is calculated to be 24 mg/kg.

[f]Xylenes – m-xylene and p-xylene elute from the analytical instrument at times too close to discern the individual analytical peaks for the two constituents and are reported as a combined value - m+p-xylene. The combined m+p-xylene analytical result will be compared against the individual closure performance standard for both m-xylene and p-xylene.

[g]Cresols – m-Cresol and p-Cresol elute from the analytical instrument at the same time and must be reported as a combined value - m+p-Cresol. The combined m+p-Cresol analytical result will be compared against the individual closure performance standard for both m-Cresol and p-Cresol.

[h]2-Ethoxyethanol – Due to the extremely short half-life of 2-ethoxyethanol (between 168 and 672 hr), its presence in soil samples is highly unlikely; therefore, samples will not be analyzed for this constituent. Degradation rates from Howard et al., 1991, *Handbook of Environmental Degradation Rates*, p.420.

[i]Formaldehyde - The short half-life of formaldehyde (between 1.6 and 9 hours in air/sunlight) means its presence in soil samples is highly unlikely. Therefore samples will not be analyzed for this constituent. Department of Health and Human Services, 1999, *Toxicological Profile for Formaldehyde*, Table 3-2.

[j]Hydrazine has an atmospheric half-life of less than 2 hr, and degradation in soil of 1.5 hr to 8 day, depending on concentration. Its presence in soil is highly unlikely, therefore, samples will not be analyzed for this constituent. Department of Health and Human Services, 1997, *Toxicological Profile for Hydrazine,* p. 130.

[k]2-nitropropane is not listed in the CLARC tables and will not be analyzed.

CAS = Chemical Abstracts Service
CLARC = Cleanup Levels and Risk Calculation
MTCA = Model Toxics Control Act
PQL = practical quantitation limit
RPD = relative percent difference
WAC = Washington Administrative Code

HA.2.3.6 Quality Control

QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability. Field QC includes collection of the following samples:

- Trip blanks.
- Field blanks.

- Equipment rinsate blanks.
- Field duplicates.

Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC includes the following samples:

- Method blanks.
- Laboratory duplicates.
- Matrix spikes.
- Matrix spike duplicates.
- Surrogates.
- Laboratory control samples.

Field and laboratory QC samples are summarized in Table HA-10.

Table HA-10 Project Quality Control Sampling Summary

QC Sample Type	Frequency	Characteristics Evaluated
Field Quality Control		
Field trip blanks	One per 20 samples per media sampled, minimum one per decision unit	Field trip blanks are used to assess contamination from sample containers or during transportation and storage procedures.
Field transfer blanks	One per day that volatile organic compounds are sampled	Field transfer blanks are used to assess contamination from surrounding sources during sample collection.
Equipment rinsate blanks	One per 20 samples per analytical method per media sampled	Equipment rinsate blanks are used to measure the cleanliness of sampling equipment and effectiveness of equipment decontamination procedures. Equipment blanks are not required if only disposable equipment is used, or if rinsing between samples is not practical (e.g., drilling equipment).
Field duplicates	One per 20 samples with a minimum one per decision unit	Field duplicates are used to assess precision of the entire data collection activity, including sampling, analysis, and site heterogeneity.
Laboratory Quality Control*		
Method blanks	One per batch	Method blanks measure contamination associated with laboratory sample preparation and analysis.

Table HA-10 Project Quality Control Sampling Summary

QC Sample Type	Frequency	Characteristics Evaluated
Laboratory duplicates	One per laboratory analytical batch	Laboratory duplicates measure laboratory reproducibility and precision.
Matrix spikes	One per laboratory analytical batch	The spike recover measures the effects of interferences in the sample matrix and reflects the accuracy of the determination.
Matrix spike duplicates	One per laboratory analytical batch	The relative percent difference between matrix spike and matrix spike duplicate measures the precision of a given analysis.
Surrogates	Added to each sample and QC (laboratory and field) sample	Surrogate standards are added prior to extraction of a sample to evaluate accuracy, method performance and extraction efficiency.
Laboratory control samples	One per laboratory analytical batch	The laboratory control sample measures the accuracy of the analytical methods.

*Batching across projects is allowed for similar matrices.

QC = Quality control

HA.2.4 Data Review, Verification, Validation, and Usability Requirements

Analytical results will be received from the contract analytical laboratory, loaded into a database (e.g., HEIS), and verified in accordance with Section HA.2.4.1. A total of 5 percent of the data will be validated as described in Section HA.2.4.2. Grid sample results will be evaluated to ensure VSP model assumptions were correct (Section HA.2.4.3) and a data quality assessment (DQA) will be conducted to ensure the output of the DQO process provided appropriate values (Section HA.2.4.4).

HA.2.4.1 Data Verification

Analytical results will be received from the laboratory, loaded into a database (e.g., HEIS), and verified. The steps outlined below will consider both the primary and QC samples. Verification activities will include, but are not limited to, the following:

- Amount of data requested matches the amount of data received (number of samples for requested methods, all analytes of concern included).
- Correct procedures and methods are used.
- Documentation and deliverables are complete.
- Hard copy and electronic versions of the data are identical.

HA.2.4.2 Data Validation

The contract analytical laboratory supplies contract laboratory program-equivalent analytical data packages intended to support data validation by the third party. These data packages are supported by QC test results and raw data. Data validation considers both primary and QC samples, and considers issues with sample collection and analysis.

Controls are in place to preserve the data sent to the validators, such as allowing only additions to be made, not changes to the raw data. The format and requirements for data validation activities are based upon the most current version of OSWER Directive 9240.1-48, *National Functional Guidelines for Superfund Organic Methods Data Review*, and OSWER Directive 9240.1-51, *National Functional Guidelines for Inorganic Superfund Data Review*. As defined by the validation guidelines, 5 percent of the analytical results will undergo Level C validation.

HA.2.4.3 Verification of Visual Sample Plan Input Parameters

Analytical data from grid sampling will be entered back into the VSP data analysis function, including laboratory and data validation qualifiers, in order to generate the Data Analysis Report. If all analytical data for a particular analyte are nondetectable at levels below the closure performance standard, then verification of VSP input parameters is not required for that analyte. Primary samples are entered, but QC samples are not. VSP software uses the analytical data to determine if the user input parameters were estimated appropriately for the given model.

Once analytical data are entered into VSP, the software will calculate the true standard deviation and determine if the null hypothesis can be rejected (Section HA.2.3.1). If the calculated standard deviation is smaller than the estimated user-input standard deviation, then no additional sampling will be required. If the calculated standard deviation is larger than the estimated standard deviation, then additional sampling may be required. However, additional statistical analyses can be performed as needed to calculate the estimated standard deviation as allowed by the following guidance documents:

- *Visual Sample Plan, Version 7.0 Users Guide*.
- Ecology's *Guidance for Clean Closure of Dangerous Waste Units and Facilities*, Publication #94-111.
- Ecology Toxics Cleanup Program, *Statistical Guidance for Ecology Site Managers*, Publication #92-54.
- WAC 173-340-740(7)(f)(i) and WAC 173-340-740(7)(f)(ii).

Per the above-mentioned guidance documents, these statistical analyses can include the following as needed:

- Estimated Sampling Standard Deviation – This is an estimate of the standard deviation expected between the multiple samples. This estimate could be obtained from previous studies, previous experience with similar sites and contaminants, or expert opinion. Note that this is the square root of the variance. In one form or another, all the designs require some type of user-input as to the variability of contamination expected in the study area.
- When a background comparison is used to determine cleanup levels, the *Statistical Guidance for Ecology Site Managers* or an equivalent method must be used to confirm that clean closure levels have been achieved.
- Environmental data sets commonly contain data that are reported as "less than" the detection limit, or "not detected." This is particularly common for contaminants such as volatile organics, which are not normally present in the environment. In addition, due to conditions such as matrix interference, a laboratory measurement may be above the method detection, but below the PQL, and these measurements will commonly be report as "less than" the PQL. Data sets that contain below-detection-limit (BDL) or below-PQL data are known as censored data sets. Censored data sets present difficulties for many standard estimation procedures and statistical tests. For example, the mean cannot be estimated by the method described in Section 2.2.2 of Ecology Publication #92-54 unless numerical values are assigned to the BDL or below-PQL data. Thus, the values assigned to BDL and below-PQL data could have a significant impact on the

calculated mean for the data set. Censored data are less influential, however, when we are interested in upper—percentile estimates (e.g., defining background concentrations).

- The method described in MTCA for handling censored data sets is the same as that used for estimating background concentrations, and for demonstrating compliance with groundwater, surface water, and soil cleanup levels. The regulation requires that all concentrations below the detection limit be assigned a value equal to one-half the detection limit of the method being used. Measurements above the method detection limit, but below the PQL shall be assigned a value equal to the detection limit. However, "alternate statistical procedures" for handling censored data may be approved by the department.
- Robust methods for estimating the mean and standard deviation: These methods use the observed data above the detection limit to assume a distribution, and then extrapolate the distribution below the detection limit to calculate summary statistics. If the data above the detection limit fit a normal or a lognormal distribution this can be done with a probability plot. Robust methods are recommended when data do not appear to fit the assumed distribution well. The median average deviation (MAD) can be calculated when the data set does not give a normal or lognormal distribution. The MAD is particularly useful because it is less affected by outliers than the standard deviation. Unlike the standard deviation, which squares the deviations and gives more weight to large deviations, the MAD treats all deviations equally. This robustness makes it valuable in situations where extreme values might distort the analysis.
- When using statistical methods to demonstrate compliance with soil cleanup levels, the following procedures shall be used for measurements below the practical quantitation limit:
  - Measurements below the method detection limit shall be assigned a value equal to one-half the method detection limit when not more than 15 percent of the measurements are below the practical quantitation limit.
  - Measurements above the method detection limit but below the practical quantitation limit shall be assigned a value equal to the method detection limit when not more than 15 percent of the measurements are below the practical quantitation limit.
- Outlier analysis is a process of identifying and examining data points that significantly differ from the rest of the dataset. Outlier analysis, also known as outlier detection, is an important step in data analysis, as it removes erroneous or inaccurate observations which might otherwise skew conclusions. The outlier analysis can be done by calculating the Inter-Quartile Range (IQR) (subtracting the first quartile by the third quartile). The upper bound limit is calculated by multiplying the IQR by 1.5 and adding it to the third quartile value and the lower bound limit is calculated by multiplying the IQR by 1.5 and subtracting it from the first quartile. Rosner's Outlier Test may also be used if it can be assumed that the data without outliers follows a normal (Gaussian) distributed. A Rosner's Outlier Test can be performed using ProUCL Version 5.1 or greater.
- Verification of the null hypothesis through VSP, and the three-part test, will determine if the mean value of the site analytical data supports rejection of the null hypothesis (Section HA.2.3.1).

  If additional statistical tools are identified, such as EPA's ProUCL (Version 5.1 or later),[2] then they will be used as appropriate to augment evaluation of the data set.

HA.2.4.4 Data Quality Assessment

A data quality assessment will be performed using the guidance in EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide*, and EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners*, and implementing the specific requirements in Section HA.2.4.

[2]ProUCL Software is a comprehensive statistical software package developed and maintained by EPA.

HA.2.5 Revisions to the Sampling and Analysis Plan and Constituents to be Analyzed

Changes to this OSA-A SAP may be necessary due to unexpected events during closure. An unexpected event would be one outside of the scope of the SAP or a condition that inhibits implementation of the SAP as written. Revision to this OSA-A SAP will be submitted no later than 30 days after an unexpected event as a permit modification request. [WAC 173-303-610(3)(b)]

HA.3 CONFIRMATION AND CERTIFICATION OF CLOSURE ACTIVITIES

Confirmation of closure will be performed using methods defined in Section HA.3.1. Closure certification is performed by an IQRPE (Section HA.3.2). Certification is submitted to Ecology as described in Section HA.3.3.

HA.3.1 Confirmation of Clean Closure

The OSA-A will be confirmed clean closed through sampling of soil. Soil sample results from the contract analytical laboratory will be reviewed to confirm that target analytes meet closure performance standards (Section HA.1.7.2). Once it has been determined that the soil sample results have met closure performance standards, the OSA-A will be considered clean.

Once clean closure has been confirmed for OSA-A, a closure certification will be prepared in accordance with Section HA.3.3.

HA.3.2 Role of the Independent Qualified Registered Professional Engineer

An IQRPE will be retained to provide certification of the closure as required by WAC 173-303-610(6). The IQRPE will be responsible for observing field activities and reviewing documents associated with clean closure of OSA-A. At a minimum, the following field activities would be completed:

- Review OSA-A visual inspection documentation.
- Observe and/or review soil sampling activities.
- Verify that locations of soil samples are as specified in the SAP.
- Review sampling procedures and results.
- Observe and/or review contaminated environmental debris removal (as applicable).
- Observe and/or review newly generated waste management and disposition records.
- Verify that closure activities were performed in accordance with this closure plan.

The IQRPE will record observations and reviews in a written report that will be retained in the operating record. The result report will be used to develop the clean closure certification, which will then be submitted to Ecology.

HA.3.3 Closure Certification

Within 60 days of completion of closure activities for OSA-A, a certification that the DWMU has been closed in accordance with the specifications in this closure plan will be submitted to Ecology by registered mail. The certification will be signed by the Permittees and by the IQRPE.

Upon request by Ecology, information will be submitted to support closure certification in accordance with WAC 173-303-610(6). This information may include, but is not limited to, the following:

- All field notes and photographs related to closure activities.
- A description of any minor deviations from this closure plan and justification for these deviations.
- Documentation of the removal and final disposition of any unanticipated contaminated environmental media.
- Documentation of the removal and final disposition of any newly generated waste.

- All laboratory or field data, including sampling procedures, sampling locations, QA/QC samples, and COC procedures for all samples and measurements, including samples and measurements taken to determine background conditions and determine or confirm clean closure.
- A summary report that identifies and described the data reviewed by the IQRPE and tabulation of the analytical results of samples taken to determine and confirm clean closure performance standards were met.
- Description of the OSA-A appearance at completion of closure.

HA.4 REFERENCES

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CENTRAL WASTE COMPLEX OUTDOOR STORAGE AREA-A
ATTACHMENT HB
RESOURCE CONSERVATION AND RECOVERY ACT RECORDS REVIEW AND DANGEROUS WASTE MANAGEMENT UNIT VISUAL INSPECTION SUPPORTING DOCUMENTATION

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CWC, Outdoor Container Storage Area "A"

Purpose:

A visual inspection walkdown of the CWC outdoor container storage area "A" was performed to determine if there is any evidence of spills and/or leaks from waste packages containing dangerous waste that were and are stored at this location. The inspection was to identify and document by photographing any waste related staining of the storage area surface (i.e., gravel and soil), and to denote any remaining waste related items.

The inspection was performed on August 14, 2013, by Brett M. Barnes (CHPRC) Environmental Compliance Officer.

Results:

Staining (excluding herbicides) was observed at the northeast corner of the outdoor storage area "A" (see attached photos). Stains appear to be rust. No other stains were observed.

Some debris materials were observed:

- Metal pallets
- Wood pallets
- Composite roofing material
- Metal ladders
- Wooden boxes
- Buckets
- Metal banding strips
- Cinder blocks
- Tie-downs
- Rubber chocks
- Fiberglass rods with orange flags
- Tables
- Metal posts
- Railroad ties
- Pressure treated lumber
- Other types of lumber
- Rubber mats
- Tool boxes
- Metal railings
- Concrete barriers
- Change trailer

- Portable electrical lighting
- Tumbleweeds
- Extension cords
- Nylon rope
- Cylinders for applying fixative
- Plastic chain
- Metal chain
- Concrete personnel protection barriers
- Wagons
- Metal pipes
- Brooms
- Plastic traffic markers

Housekeeping will be performed on the area prior to closure and the debris material will be removed.

Signature/Date:

Brett M. Barnes: Brett M Barnes 9/3/13

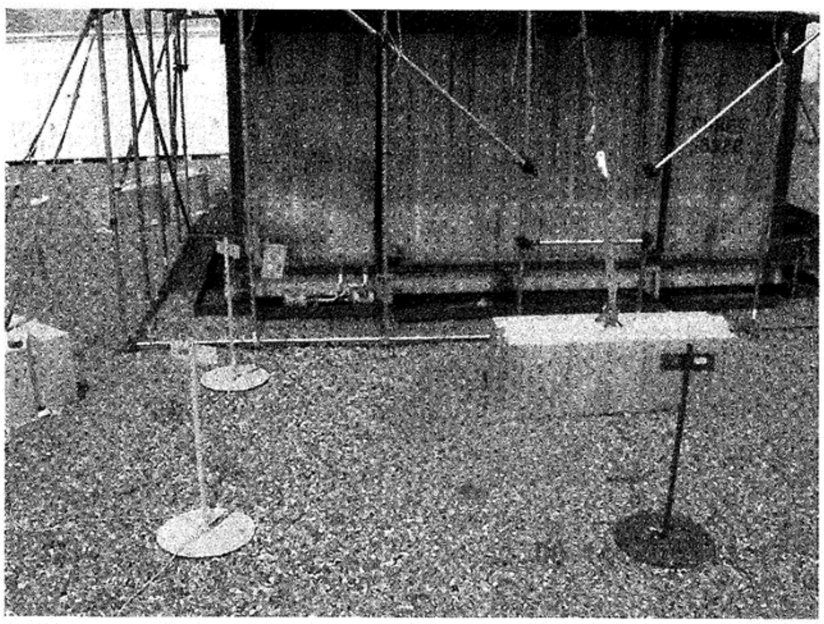
Strickling, Lana R

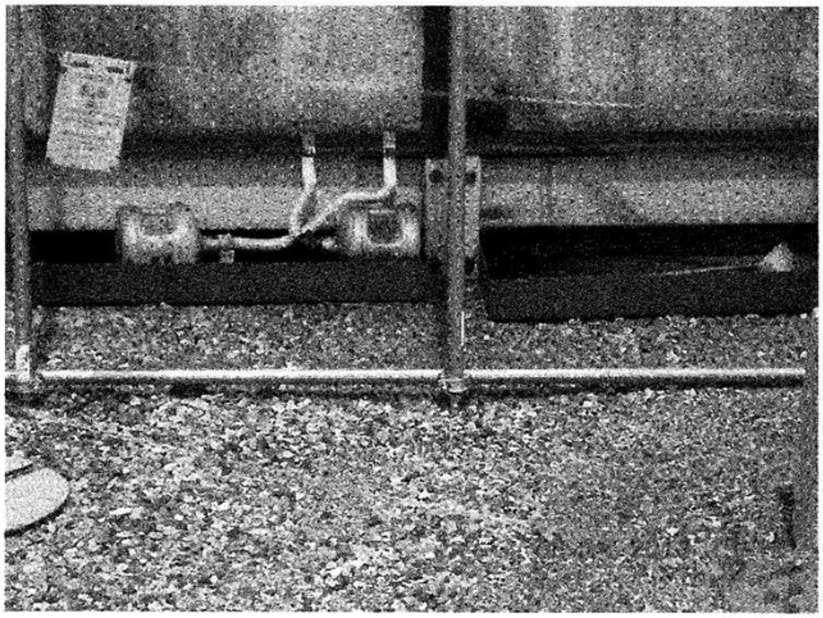
From:	Barnes, Brett M
Sent:	Tuesday, September 03, 2013 1:24 PM
To:	Horn, Sarah R; Strickling, Lana R
Cc:	Engelmann, Richard H; Dixon, Brian J; Ruck, Fred A III; Seaver, Jennie R
Subject:	REVISED CWC OUTDOOR CONTAINER STORAGE AREA "A" CLOSURE INSPECTION REPORT
Attachments:	SPDQ0638013090313010.pdf

All, please ignore my previous closure inspection reports...I had to correct some editorial comments.

Attached is the closure inspection report for the CWC Outdoor Container Storage Area "A." The photographs that are attached to this report are directly below, in descending order. Should you have any questions, please call me on my cell phone, 521-3053.

Brett M. Barnes
Environmental Compliance Officer





CWC Outdoor Waste Container Storage Area A
Weekly Dangerous Waste Inspection Checklist Review

Title of Weekly Waste Inspection Form: Weekly RCRA Inspection Checklist for CWC

Date of Weekly Waste Inspection Review: Finalized 9/5/13

Reviewer's Name: Lana Strickling

A review of the summary sheets completed by Linda Carr, which covered both CWC Outdoor Storage Areas A and B, was performed. Weekly RCRA Inspection checklists could not be located for the following time period: Mid September 2008 – Mid December 2008.

Waste Management Units: CWC Outdoor Waste Container Storage Area A

Time Frame of Weekly Inspections: 1/5/06 – 6/26/13

Items of Concern Noted: YES _ X__ NO _ __
If "YES", complete entire checklist.
If "NO", skip to Reviewer's signature and date.

Items of Concern: One item of concern was noted for CWC Outside Waste Container Storage Area A. On 2/6/12, dangerous waste box 231ZDR-11 was identified as "leaking" during the weekly RCRA inspection. Subsequent review determined this was a radiological contamination event. Mitigative actions were performed via work package 2X-12-01430, *Apply Fixative and Absorbent to Contamination Area.*

Reviewer's Signature and Date: Lana Strickling 9/6/13

Instructions:

Review Weekly Waste Inspection checklists for any references to unplanned spills, releases or discharges associated with dangerous waste containers. Anomalies that would not affect closure of the unit such as missing labels, open containers, or dented containers, do not need to be documented.

If items of concern are noted, check "YES" and complete the entire checklist. If no items of concern are noted, check "NO" and skip to the signature and date field. Note that if no items of concern are noted for an extended period of time, the "Time Frame of Weekly Inspections" can be January 1, 20xx to December 31, 20xx or even several years if no items of concern are noted.

CWC Outdoor Waste Container Storage Area A
Weekly Dangerous Waste Inspection Checklist Review

If unplanned spills, releases or discharges are referenced on the inspection checklist, document the item of concern as "spill", "stain", "ruptured container", etc. Also note the date of the corrective action.

Attach copies of weekly waste inspection checklists noting the items of concern and corrective actions.

Complete all review fields as applicable.

Sign and date form and deliver to Stephanie Johansen.

CWC Weekly Dangerous Waste Inspection Checklist Review

Title of Weekly Waste Inspection Form:	Weekly CWC RCRA/Non-RCRA Inspection Checklist
Date of Review:	8/8/2013
Reviewer's Name:	Linda Carr
Waste Management Units:	Outside Staging Areas
Time Frame of Weekly Inspections:	2012-January 3 - December 27
Items of Concern Noted (Circle) If "YES", complete entire checklist. If "NO", skip to Reviewer's signature and date.	YES☒ NO☐
Items of Concerns:	leak (week 2/8/12)

Attach copies of Weekly Inspection sheets noting concern.

Dates of Corrective Actions:	"Plan now in Progress 2/8/12"

Attach copies of Weekly Inspection sheets noting concern.

Reviewer's Signature and Date: Linda Carr 9/4/13

Instructions:

Review Weekly Waste Inspection checklists for any references to unplanned spills, releases or discharges associated with dangerous waste containers. Anomalies that would not affect closure of the unit such as missing labels, open containers, or dented containers, do not need to be documented.

If items of concern are noted, check "YES" and complete the entire checklist. If no items of concern are noted, check "NO" and skip to the signature and date field. Note that if no items of concern are noted for an extended period of time, the "Time Frame of Daily Inspections" can be January 1, 20xx to December 31, 20xx or even several years if no items of concern are noted.
If unplanned spills, releases or discharges are referenced on the inspection checklist, document the item of concern as "spill", "stain", "ruptured container", etc. Also note the date of the corrective action. Attach copies of daily waste inspection checklists noting the items of concern and corrective actions.

Complete all review fields as applicable.

Sign and date form and deliver to Stephanie Johansen.

Page **1** of **1**

SW-040-043
Inspect CWC & Miscellaneous Buildings

Published Date: 01/27/12 **Effective Date: 01/27/12**

Appendix A - Weekly CWC RCRA/Non-RCRA Inspection Checklists

Location/Facility/Module: OUTSIDE STORAGE AREAS Date/Time: 02/08/12 13:45

#	Yes	No	N/A	Weekly CWC RCRA Checklist — Area Inspection
1	✓			Marker-barricades (chain barricades, chain-link fences, marker posts, etc.) around area are intact and in good condition. Area ground postings are intact, unobscured, legible and in good condition?
2			① ✓	Containment curbing and flooring is free of scratches that penetrate to the concrete, cracks, or gaps and is sufficiently impervious to contain leaks, spills, and accumulated rainfall?
3	✓			Area is generally dry and free of accumulated water. There is no standing and/or unexpected water or snow accumulation in or around area?
4	✓			Areas where dangerous waste may be accumulated have "Danger – Unauthorized Personnel Keep Out" (or an equivalent legend) and "No Smoking" signs posted?
5	✓			Postings are accurate, intact, visible, legible and in good condition?
6			② ✓	Secondary containment system is free of liquid? If "No", notify FWS and go to SW-080-003.
#	**Yes**	**No**	**N/A**	**Container Inspection**
7		* ✓ (circled)		Container integrity is not compromised by punctures, dents, penetrating scratches, loose lids, bulging, excessive corrosion or other physical damage/deterioration. [TSR 5.6.4.b]
8		* ✓ (circled)		Containers are closed, are stored in a manner which will not rupture the containers or cause them to leak, and show no evidence of spillage or leakage, such as moisture on the sides or underneath?
9	✓			Container top does not have excessive buildup of dirt/debris that would possibly interfere with the proper operation of the drum's ventilation system (such as, clogging of NucFils).
10	✓			Container marking/labeling is intact, unobscured, legible and in good condition?
11	✓			Dangerous/hazardous waste containers are marked as "hazardous" or "dangerous" and have major risk label, as applicable?
12	✓			Aisle space between rows of containers appears to be at least 36 inches? [FHA SWOC Key 1.3.1.13][FHA Key #10]
13	✓			Containers are stored in rows no more than 2 wide?
14	✓			Containers are elevated (palletized)?
				Weekly CWC Non-RCRA Checklist
#	**Yes**	**No**	**N/A**	**Area Inspected/Description of Non-RCRA Items**
15	✓			Lighting is adequate to complete inspection (where applicable)?
16	✓			Areas in and around waste stored in the facilities/modules are free of combustibles such as tumbleweeds, paper, rags, trash, empty wood pallets, etc.? [TSR 5.7.1.b&c][TSR 5.6.4.h]
17	✓			Roadways are clear and unobstructed. Fire fighting vehicles have free and easy access to the area. Exits are clear and unobstructed?
18	✓			PCB label at facilities/modules entrances are intact, unobscured, legible and in good condition (where applicable)?
19	✓			Pallet condition is adequate to ensure module stability.
20	✓			Aisle space between rows of containers appears to be at least 36 inches? [FHA SWOC Key 1.3.1.13][FHA Key #10]
21	✓			Waste containers staged or stored outside are no higher than 2 tiers. [TSR 5.6.4.a]
22	✓			Space between inside waste array zones is > 12 ft and free of combustibles. [TSR 5.6.4.g]
23			③ ✓	Third-tier drums are banded horizontally with metal band (single drum banded to pallet) [TSR 5.6.4.a]

Comments: SEE open item # 11-015

① Container are sitting on dirt/gravel ② No secondary containment.
③ No third tier drums.
(*) Container # 231-ZDR-11 was found to be leaking. Work plan & recovery now in progress.

Operator (print/sign/date/time): Christine Kiehn Christine Kiehn 02/08/12 13:45

FWS (print/sign/date/time): Dwayne Bierman [signature] 2/8/12 1803

Before each use, ensure this copy is the most current version.

CWC Outdoor Waste Container Storage Area A
Daily Operating Log Book Review

Date of Log Book Review: 8/12/13

Reviewer's Name: Joel Williams

Daily Operating Log Book Document No./Log Book Timeframe (Month/Year to Month/Year):

LOGBOOK NUMBER	DATES
HNF-N-450-84	12-06-2006 through 07-09-2007
HNF-N-450-85	07-10-2007 through 02-06-2008
HNF-N-450-91	02-07-2008 through 08-26-2008
HNF-N-450-94	08-27-2008 through 04-16-2009
HNF-N-450-95	04-20-2009 through 11-17-2009
HNF-N-450-100	11-02-2009 through 06-23-2010
HNF-N-450-103	06-24-2010 through 01-16-2011
HNF-N-450-107	01-19-2011 through 08-11-2011
HNF-N-450-109	08-15-2011 through 03-06-2012
HNF-N-450-110	03-07-2012 through 07-16-2012
HNF-N-450-113	07-07-2012 through 12-01-2012
HNF-N-450-111	12-02-2012 through 05-01-3013
HNF-N-450-112	05-02-2013 through 08-12-2013

Items of Concern Noted (Circle) YES__X__ NO____
If "YES", complete entire checklist.
If "NO", skip to Reviewer's signature and date.

Items of Concern (Attach copies of log book pages noting concern)

On 2/6/12, box 231ZDR-11 was identified as having contamination area levels around the box. See attached logbook pages.

Dates of Corrective Actions:

Mitigative actions were performed via work package 2X-12-01430, *Apply Fixative and Absorbent to Contamination Area.*

Reviewer's Signature and Date: Lana Strickling for Joel Williams per telecon 9/5/13

Page **1** of **1**

Page 118 HNF-N-450-109 2-6-12 Days Cont. ②

1501	millwrites have completed work for packages 2X-12-002 and 2X-12-00215 for today. will work again at a later
1612	Turned Logbook duties over to Patty Carter. Janelle: Janelle Funker. Took over Logbook Patricia Carter
1613	Patricia Carter.
2048	Reentry team reentering zone 14 to perform rad s ph testing Box 231 ZDR-11
2209	Exiting team Expansion Area after surveys Expan area posted CA. last entry Patricia Carter Patricia
	Security checks all buildings locked.
2308	Late Entry 1440 Rad Con found CA Level contamination around Was Box 231 ZDR-11 in Zone 14, Rad Con notified Operation manager
	Dwayne Bierman [signature]
2311	SDO completed logbook review Dwayne Bierman [signature]

No further entries DB 2/6/12

pg. 123 HNF-N-450-109 02-11-2012 Days (3)

0900 Richard A. Monlux is The Logbook Custodian, Dave Gilles is The B
Richard A Monlux Richard A Monlux

0906 Notified Dave Gilles on The status of Box 2312DR-11 catch Con
in CWC's Expansion Area Z14. The Following Results were Repor
To Dave Gilles. The North 2 catch Containers are empty, The
catch Container is Approximant ½ inch from overflow, The SouthWe
corner catch Container is Full, The South catch Container is Em
(center), The SouthEast catch Container is Full, and the East
Container is Approximant ¼ inch from overflow. The 3 gallon ca
bottles are as fallows from East To West #1 Empty, #2 Empty, #3 Empt
is Approximant ¾ To The Full line.

1334 Checked on status of Box 2312DR-11 catch Containers No change fr
Previous entery.

2010 SDO Reviewed Logbook [signature]

No further entries this date
2-11-12

HNF-N-450-111   1-30-13 DAY   page 61   (1)

0625 Reviewed log and assumed duties as SDO. DAGiles [signature]

0700 BED/SDO Dave Gilles Logbook custodian Dave Cleavenger Dave Cleavenger
Minimum shift compliment verified. CWC/LLBG is in stand-by mode

0725 Patrol has been notified for access to 3A, 3AE, 4B + 4C

0804 Management safety drive through of CWC complex completed with no issu

0900 Perform Ultrasonic Testing on fire piping in 2402WG

1310 The 3 gallon container has liquid in it. Catch pans have moisture in them. Straps are tight and in good condition. No change to tear and punctures. The Box is not dripping.

1520 End of shift sweep complete

1523 Last Entry Dave Cleavenger Dave Cleavenger

1750 LATE ENTRY 1900 NCO NOTIFIED FWS THAT PRIOR TO STARTING A PLANNED ACTIVITY TO APPLY INVISABLUE TO THE 2312DR-11 BOX (2X-12-8493) HE OBSERVED THE LOWER SOUTH RAIL (ANGLE IRON) OF THE BOX DRIPPING IN 2 SPOTS. THE DRIPS WERE IN THE AREA ADJACENT TO THE CATCH CONTAINER IN THE WESTERN MOST SOUTH CATCH PAN. DRIP RATE WAS REPORTED TO BE 1 DRIP EVERY 5-6 SECONDS. LIQUID WAS NOTED IN THE CATCH CONTAINER AND THE CATCH PAN. RADCON PERFORMED BOUNDARY SURVEYS AND FOUND NO SPREAD OF CONTAMIN THE NCO AND TEAM CONTINUED WITH THE ACTIVITY AND APPLIED A HEAVY COAT OF INVISABLUE TO THE ENTIRE PERIMETER OF THE BOX. THE FWS NOTIFIED THE SDO/OPS MANAGER WHO NOTIFIED THE FACILITY MANAGER AND DIRECTOR. FACILITY MANAGER AND OPS MANAGER OBSERVED THE BOX. WEATHER CONDITIONS DURING THE PAST 2 DAYS HAD HIGH TEMPERATURES IN THE MID 40'S AND MID 50'S AS OPPOSED TO THE BELOW FREEZING TEMPERATURES OF THE PAST FEW WEEKS. AN ENTRY TO REPLACE THE CATCH CONTAINER AND REMOVE LIQUID FROM THE CATCH PAN IS PLANNED FOR TOMORROW. APPROPRIATE NOTIFICATIONS HAVE BEEN MADE

1810 SDO LOG REVIEW COMPLETE [signature] DA GILES

NO FURTHER ENTRIES [signature]

CENTRAL WASTE COMPLEX OUTDOOR STORAGE AREA-A
ATTACHMENT HC
VISUAL SAMPLE PLAN SOFTWARE SUPPORTING DOCUMENTATION

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Systematic sampling locations for comparing a median with a fixed threshold (nonparametric - MARSSIM)

Summary

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) in the Field	Systematic with a random start location
Working (Null) Hypothesis	The median (mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test - MARSSIM version
Calculated number of samples	30
Number of samples adjusted for EMC	30
Number of samples with MARSSIM Overage	36
Number of samples on map[a]	36
Number of selected sample areas[b]	1
Specified sampling area[c]	7525.54 m^2
Size of grid / Area of grid cell[d]	15.5365 meters / 209.043 m^2
Grid pattern	Triangular

[a]This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

[b]The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

[c]The sampling area is the total surface area of the selected colored sample areas on the map of the site.

[d]Size of grid / Area of grid gives the linear and square dimensions of the grid used to systematically place samples. If there was more than one sample area, this represents the largest dimensions used.

Area: Zone 1						
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**	**Sample Area**
565649.5169	136166.2461			Systematic		
565665.0533	136166.2461			Systematic		
565680.5898	136166.2461			Systematic		
565696.1263	136166.2461			Systematic		
565711.6627	136166.2461			Systematic		
565657.2851	136179.7011			Systematic		
565672.8216	136179.7011			Systematic		
565688.3580	136179.7011			Systematic		
565703.8945	136179.7011			Systematic		
565649.5169	136193.1561			Systematic		
565665.0533	136193.1561			Systematic		
565680.5898	136193.1561			Systematic		
565696.1263	136193.1561			Systematic		
565711.6627	136193.1561			Systematic		
565657.2851	136206.6111			Systematic		
565672.8216	136206.6111			Systematic		
565688.3580	136206.6111			Systematic		
565703.8945	136206.6111			Systematic		
565649.5169	136220.0660			Systematic		
565665.0533	136220.0660			Systematic		
565680.5898	136220.0660			Systematic		

Area: Zone 1						
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**	**Sample Area**
565696.1263	136220.0660			Systematic		
565711.6627	136220.0660			Systematic		
565657.2851	136233.5210			Systematic		
565672.8216	136233.5210			Systematic		
565688.3580	136233.5210			Systematic		
565703.8945	136233.5210			Systematic		
565649.5169	136246.9760			Systematic		
565665.0533	136246.9760			Systematic		
565680.5898	136246.9760			Systematic		
565696.1263	136246.9760			Systematic		
565711.6627	136246.9760			Systematic		
565657.2851	136260.4310			Systematic		
565672.8216	136260.4310			Systematic		
565688.3580	136260.4310			Systematic		
565703.8945	136260.4310			Systematic		

Primary Sampling Objective

The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach

A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

VSP offers many options to determine the locations at which measurements are made or samples are collected and subsequently measured. For this design, systematic grid point sampling was chosen. Locating the sample points systematically provides data that are all equidistant apart. This approach does not provide as much information about the spatial structure of the potential contamination as simple random sampling does. Knowledge of the spatial structure is useful for geostatistical analysis. However, it ensures that all portions of the site are equally represented. Statistical analyses of systematically collected data are valid if a random start to the grid is used.

Number of Total Samples: Calculation Equation and Inputs

The equation used to calculate the number of samples is based on a Sign test (see PNNL 13450 for discussion). For this site, the null hypothesis is rejected in favor of the alternative one if the median(mean) is sufficiently smaller than the threshold. The number of samples to collect is calculated so that if the inputs to the equation are true, the calculated number of samples will cause the null hypothesis to be rejected.

The formula used to calculate the number of samples is:

$$n = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4(SignP - 0.5)^2}$$

where

$$SignP = \Phi\left(\frac{\Delta}{S_{total}}\right)$$

$\Phi(z)$ is the cumulative standard normal distribution on $(-\infty,z)$ (see PNNL-13450 for details),

n is the number of samples,

S_{total} is the estimated standard deviation of the measured values including analytical error,

Δ is the width of the gray region,

α is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold,

β is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold,

$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,

$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n. VSP allows a user-supplied percent overage as discussed in MARSSIM (EPA 2000, p. 5-33).

For each nuclide in the table, the values of these inputs that result in the calculated number of sampling locations are:

Nuclide	n[a]	n[b]	n[c]	Parameter					
				S_{total}	Δ	α	β	$Z_{1-\alpha}$ [d]	$Z_{1-\beta}$ [e]
Analyte 1	30	30	36	0.66	0.4	0.05	0.2	1.64485	0.841621

[a]The number of samples calculated by the formula.

[b]The number of samples increased by EMC calculations.

[c]The final number of samples increased by the MARSSIM Overage of 20%.

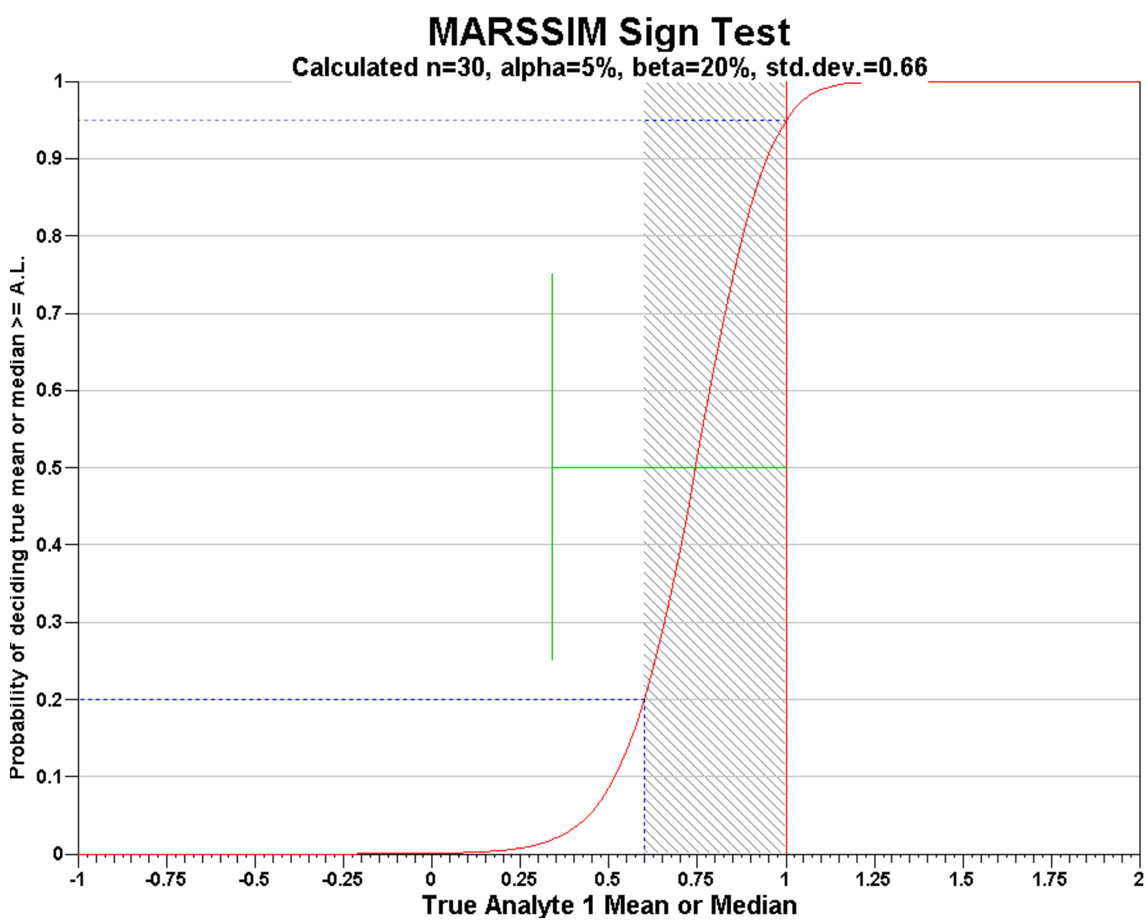
[d]This value is automatically calculated by VSP based upon the user defined value of α.

[e]This value is automatically calculated by VSP based upon the user defined value of β.

Performance

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the computed sign test statistic is normally distributed,
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=1		**α=5**		**α=10**		**α=15**	
		s=1.32	**s=0.66**	**s=1.32**	**s=0.66**	**s=1.32**	**s=0.66**
LBGR=90	**β=15**	2367	596	1769	446	1415	357
	β=20	2036	513	1485	374	1162	293
	β=25	1772	446	1260	317	964	243
LBGR=80	**β=15**	596	153	446	114	357	92
	β=20	513	132	374	96	293	76
	β=25	446	114	317	82	243	63
LBGR=70	**β=15**	268	71	201	53	160	42
	β=20	231	62	168	45	132	35
	β=25	201	53	143	39	110	29

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Note: Values in table are not adjusted for EMC.

Total Dose Calculation

The total dose from all sources was calculated based on the user-entered values below.

Total Dose From All Sources		
Area	**Average**	**DCGL**
Survey Unit	0	10
Total Dose Sum of Fractions:		0
Total dose from all sources is below release criteria. 0 < 1		

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Systematic sampling locations for comparing a median with a fixed threshold (nonparametric - MARSSIM)

Summary

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) in the Field	Systematic with a random start location
Working (Null) Hypothesis	The median(mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test - MARSSIM version
Calculated number of samples	30
Number of samples adjusted for EMC	30
Number of samples with MARSSIM Overage	36
Number of samples on map[a]	36
Number of selected sample areas[b]	1
Specified sampling area[c]	3352.38 m^2
Size of grid / Area of grid cell[d]	10.0815 meters / 88.0201 m^2
Grid pattern	Triangular

[a]This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

[b]The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

[c]The sampling area is the total surface area of the selected colored sample areas on the map of the site.

[d]Size of grid / Area of grid gives the linear and square dimensions of the grid used to systematically place samples. If there was more than one sample area, this represents the largest dimensions used.

Area: Zone 2						
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**	**Sample Area**
565732.4796	136182.7656			Systematic		
565742.5611	136182.7656			Systematic		
565752.6426	136182.7656			Systematic		
565762.7241	136182.7656			Systematic		
565737.5203	136191.4965			Systematic		
565747.6018	136191.4965			Systematic		
565757.6833	136191.4965			Systematic		
565767.7648	136191.4965			Systematic		
565732.4796	136200.2273			Systematic		
565742.5611	136200.2273			Systematic		
565752.6426	136200.2273			Systematic		
565762.7241	136200.2273			Systematic		
565737.5203	136208.9582			Systematic		
565747.6018	136208.9582			Systematic		
565757.6833	136208.9582			Systematic		
565767.7648	136208.9582			Systematic		
565732.4796	136217.6890			Systematic		
565742.5611	136217.6890			Systematic		
565752.6426	136217.6890			Systematic		
565762.7241	136217.6890			Systematic		
565737.5203	136226.4199			Systematic		
565747.6018	136226.4199			Systematic		

Area: Zone 2						
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**	**Sample Area**
565757.6833	136226.4199			Systematic		
565767.7648	136226.4199			Systematic		
565732.4796	136235.1507			Systematic		
565742.5611	136235.1507			Systematic		
565752.6426	136235.1507			Systematic		
565762.7241	136235.1507			Systematic		
565737.5203	136243.8815			Systematic		
565747.6018	136243.8815			Systematic		
565757.6833	136243.8815			Systematic		
565767.7648	136243.8815			Systematic		
565732.4796	136252.6124			Systematic		
565742.5611	136252.6124			Systematic		
565752.6426	136252.6124			Systematic		
565762.7241	136252.6124			Systematic		

Primary Sampling Objective

The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach

A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

VSP offers many options to determine the locations at which measurements are made or samples are collected and subsequently measured. For this design, systematic grid point sampling was chosen. Locating the sample points systematically provides data that are all equidistant apart. This approach does not provide as much information about the spatial structure of the potential contamination as simple random sampling does. Knowledge of the spatial structure is useful for geostatistical analysis. However, it ensures that all portions of the site are equally represented. Statistical analyses of systematically collected data are valid if a random start to the grid is used.

Number of Total Samples: Calculation Equation and Inputs

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The formula used to calculate the number of samples is:

$$n = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4(SignP - 0.5)^2}$$

where

$$SignP = \Phi\left(\frac{\Delta}{S_{total}}\right)$$

$\Phi(z)$	is the cumulative standard normal distribution on $(-\infty, z)$ (see PNNL-13450 for details),
n	is the number of samples,
S_{total}	is the estimated standard deviation of the measured values including analytical error,
Δ	is the width of the gray region,
α	is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold,
β	is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold,
$Z_{1-\alpha}$	is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$	is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n. VSP allows a user-supplied percent overage as discussed in MARSSIM (EPA 2000, p. 5-33).

For each nuclide in the table, the values of these inputs that result in the calculated number of sampling locations are:

Nuclide	**n**[a]	**n**[b]	**n**[c]	**Parameter**					
				S_{total}	Δ	α	β	$Z_{1-\alpha}$ [d]	$Z_{1-\beta}$ [e]
Analyte 1	30	30	36	0.66	0.4	0.05	0.2	1.64485	0.841621

[a]The number of samples calculated by the formula.

[b]The number of samples increased by EMC calculations.

[c]The final number of samples increased by the MARSSIM Overage of 20%.

[d]This value is automatically calculated by VSP based upon the user defined value of α.

[e]This value is automatically calculated by VSP based upon the user defined value of β.

Performance

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.

Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the computed sign test statistic is normally distributed,
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,

3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=1		**α=5**		**α=10**		**α=15**	
		s=1.32	**s=0.66**	**s=1.32**	**s=0.66**	**s=1.32**	**s=0.66**
LBGR=90	**β=15**	2367	596	1769	446	1415	357
	β=20	2036	513	1485	374	1162	293
	β=25	1772	446	1260	317	964	243
LBGR=80	**β=15**	596	153	446	114	357	92
	β=20	513	132	374	96	293	76
	β=25	446	114	317	82	243	63
LBGR=70	**β=15**	268	71	201	53	160	42
	β=20	231	62	168	45	132	35
	β=25	201	53	143	39	110	29

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Note: Values in table are not adjusted for EMC.

Total Dose Calculation

The total dose from all sources was calculated based on the user-entered values below.

Total Dose From All Sources		
Area	**Average**	**DCGL**
Survey Unit	0	10
Total Dose Sum of Fractions:		0
Total dose from all sources is below release criteria. 0 < 1		

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Software and documentation available at https://www.pnnl.gov/projects/visual-sample-plan

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Systematic sampling locations for comparing a median with a fixed threshold (nonparametric - MARSSIM)

Summary

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) in the Field	Systematic with a random start location
Working (Null) Hypothesis	The median(mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test - MARSSIM version
Calculated number of samples	14
Number of samples adjusted for EMC	14
Number of samples with MARSSIM Overage	17
Number of samples on map[a]	23
Number of selected sample areas[b]	1
Specified sampling area[c]	3721.46 m^2
Size of grid / Area of grid cell[d]	14.0284 meters / 170.431 m^2
Grid pattern	Triangular

[a]This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

[b]The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

[c]The sampling area is the total surface area of the selected colored sample areas on the map of the site.

[d]Size of grid / Area of grid gives the linear and square dimensions of the grid used to systematically place samples. If there was more than one sample area, this represents the largest dimensions used.

1 

2

Area: Zone 5						
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**	**Sample Area**
565652.1082	136023.3488			Systematic		
565666.1367	136023.3488			Systematic		
565680.1651	136023.3488			Systematic		
565694.1936	136023.3488			Systematic		
565708.2220	136023.3488			Systematic		
565645.0940	136035.4977			Systematic		
565659.1225	136035.4977			Systematic		
565673.1509	136035.4977			Systematic		
565687.1793	136035.4977			Systematic		
565701.2078	136035.4977			Systematic		
565652.1082	136047.6467			Systematic		
565666.1367	136047.6467			Systematic		
565680.1651	136047.6467			Systematic		
565694.1936	136047.6467			Systematic		
565708.2220	136047.6467			Systematic		
565645.0940	136059.7957			Systematic		
565659.1225	136059.7957			Systematic		
565673.1509	136059.7957			Systematic		
565687.1793	136059.7957			Systematic		
565701.2078	136059.7957			Systematic		
565715.2362	136059.7957			Systematic		

Area: Zone 5						
X Coord	Y Coord	Label	Value	Type	Historical	Sample Area
565680.1651	136071.9447			Systematic		
565694.1936	136071.9447			Systematic		

Primary Sampling Objective

The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach

A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

VSP offers many options to determine the locations at which measurements are made or samples are collected and subsequently measured. For this design, systematic grid point sampling was chosen. Locating the sample points systematically provides data that are all equidistant apart. This approach does not provide as much information about the spatial structure of the potential contamination as simple random sampling does. Knowledge of the spatial structure is useful for geostatistical analysis. However, it ensures that all portions of the site are equally represented. Statistical analyses of systematically collected data are valid if a random start to the grid is used.

Number of Total Samples: Calculation Equation and Inputs

The equation used to calculate the number of samples is based on a Sign test (see PNNL 13450 for discussion). For this site, the null hypothesis is rejected in favor of the alternative one if the median(mean) is sufficiently smaller than the threshold. The number of samples to collect is calculated so that if the inputs to the equation are true, the calculated number of samples will cause the null hypothesis to be rejected.

The formula used to calculate the number of samples is:

$$n = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4(SignP - 0.5)^2}$$

where

$$SignP = \Phi\left(\frac{\Delta}{S_{total}}\right)$$

$\Phi(z)$ is the cumulative standard normal distribution on $(-\infty,z)$ (see PNNL-13450 for details),

n is the number of samples,

S_{total} is the estimated standard deviation of the measured values including analytical error,

Δ is the width of the gray region,

α is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold,

β is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold,

$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,

$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n. VSP allows a user-supplied percent overage as discussed in MARSSIM (EPA 2000, p. 5-33).

For each nuclide in the table, the values of these inputs that result in the calculated number of sampling locations are:

Nuclide	n[a]	n[b]	n[c]	Parameter					
				S_{total}	Δ	α	β	$Z_{1-\alpha}$ [d]	$Z_{1-\beta}$ [e]
Analyte 1	14	14	17	0.4	0.4	0.05	0.2	1.64485	0.841621

[a]The number of samples calculated by the formula.

[b]The number of samples increased by EMC calculations.

[c]The final number of samples increased by the MARSSIM Overage of 20%.

[d]This value is automatically calculated by VSP based upon the user defined value of α.

[e]This value is automatically calculated by VSP based upon the user defined value of β.

Performance

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.

Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the computed sign test statistic is normally distributed,
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that $\mu >$ action level and alpha (%), probability of mistakenly concluding that $\mu <$ action level. The following table shows the results of this analysis.

Number of Samples							
AL=1		α=5		α=10		α=15	
		s=0.8	s=0.4	s=0.8	s=0.4	s=0.8	s=0.4
LBGR=90	β=15	873	222	652	166	522	134
	β=20	750	191	548	140	429	110
	β=25	653	167	465	119	356	92
LBGR=80	β=15	222	60	166	45	134	36
	β=20	191	52	140	38	110	30
	β=25	167	45	119	33	92	24
LBGR=70	β=15	102	30	76	22	62	18
	β=20	88	26	64	20	51	15
	β=25	76	22	54	16	42	12

s = Standard Deviation

LBGR = Lower Bound of Gray Region (% of Action Level)

β = Beta (%), Probability of mistakenly concluding that μ > action level

α = Alpha (%), Probability of mistakenly concluding that μ < action level

AL = Action Level (Threshold)

Note: Values in table are not adjusted for EMC.

Total Dose Calculation

The total dose from all sources was calculated based on the user-entered values below.

Total Dose From All Sources		
Area	Average	DCGL
Survey Unit	0	10
Total Dose Sum of Fractions:		0
Total dose from all sources is below release criteria. 0 < 1		

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Systematic sampling locations for comparing a median with a fixed threshold (nonparametric - MARSSIM)

Summary

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) in the Field	Systematic with a random start location
Working (Null) Hypothesis	The median(mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test - MARSSIM version
Calculated number of samples	14
Number of samples adjusted for EMC	14
Number of samples with MARSSIM Overage	17
Number of samples on map[a]	20
Number of selected sample areas[b]	1
Specified sampling area[c]	933.05 m^2
Size of grid / Area of grid cell[d]	7.96091 meters / 54.8853 m^2
Grid pattern	Triangular

[a]This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

[b]The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

[c]The sampling area is the total surface area of the selected colored sample areas on the map of the site.

[d]Size of grid / Area of grid gives the linear and square dimensions of the grid used to systematically place samples. If there was more than one sample area, this represents the largest dimensions used.

Area: Zone 6						
X Coord	Y Coord	Label	Value	Type	Historical	Sample Area
565723.7108	136018.7677			Systematic		
565731.6717	136018.7677			Systematic		
565739.6326	136018.7677			Systematic		
565747.5935	136018.7677			Systematic		
565755.5544	136018.7677			Systematic		
565763.5154	136018.7677			Systematic		
565727.6913	136025.6620			Systematic		
565735.6522	136025.6620			Systematic		
565743.6131	136025.6620			Systematic		
565751.5740	136025.6620			Systematic		
565759.5349	136025.6620			Systematic		
565767.4958	136025.6620			Systematic		
565723.7108	136032.5564			Systematic		
565731.6717	136032.5564			Systematic		
565739.6326	136032.5564			Systematic		
565747.5935	136032.5564			Systematic		
565755.5544	136032.5564			Systematic		
565763.5154	136032.5564			Systematic		
565759.5349	136039.4507			Systematic		
565767.4958	136039.4507			Systematic		

Primary Sampling Objective

The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach

A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

VSP offers many options to determine the locations at which measurements are made or samples are collected and subsequently measured. For this design, systematic grid point sampling was chosen. Locating the sample points systematically provides data that are all equidistant apart. This approach does not provide as much information about the spatial structure of the potential contamination as simple random sampling does. Knowledge of the spatial structure is useful for geostatistical analysis. However, it ensures that all portions of the site are equally represented. Statistical analyses of systematically collected data are valid if a random start to the grid is used.

Number of Total Samples: Calculation Equation and Inputs

The equation used to calculate the number of samples is based on a Sign test (see PNNL 13450 for discussion). For this site, the null hypothesis is rejected in favor of the alternative one if the median(mean) is sufficiently smaller than the threshold. The number of samples to collect is calculated so that if the inputs to the equation are true, the calculated number of samples will cause the null hypothesis to be rejected.

The formula used to calculate the number of samples is:

$$n = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4(SignP - 0.5)^2}$$

where

$$SignP = \Phi\left(\frac{\Delta}{S_{total}}\right)$$

$\Phi(z)$ is the cumulative standard normal distribution on $(-\infty,z)$ (see PNNL-13450 for details),

n is the number of samples,

S_{total} is the estimated standard deviation of the measured values including analytical error,

Δ is the width of the gray region,

α is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold, β is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold,

$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is 1-α,

$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is 1-β.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n. VSP allows a user-supplied percent overage as discussed in MARSSIM (EPA 2000, p. 5-33).

For each nuclide in the table, the values of these inputs that result in the calculated number of sampling locations are:

Nuclide	n^a	n^b	n^c	Parameter					
				S_{total}	Δ	α	β	$Z_{1-\alpha}$ [d]	$Z_{1-\beta}$ [e]
Analyte 1	14	14	17	0.4	0.4	0.05	0.2	1.64485	0.841621

[a]The number of samples calculated by the formula.

[b]The number of samples increased by EMC calculations.

[c]The final number of samples increased by the MARSSIM Overage of 20%.

[d]This value is automatically calculated by VSP based upon the user defined value of α.

[e]This value is automatically calculated by VSP based upon the user defined value of β.

Performance

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.

Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the computed sign test statistic is normally distributed,
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that $\mu >$ action level and alpha (%), probability of mistakenly concluding that $\mu <$ action level. The following table shows the results of this analysis.

Number of Samples							
AL=1		**α=5**		**α=10**		**α=15**	
		s=0.8	**s=0.4**	**s=0.8**	**s=0.4**	**s=0.8**	**s=0.4**
LBGR=90	**β=15**	873	222	652	166	522	134
	β=20	750	191	548	140	429	110
	β=25	653	167	465	119	356	92
LBGR=80	**β=15**	222	60	166	45	134	36
	β=20	191	52	140	38	110	30
	β=25	167	45	119	33	92	24
LBGR=70	**β=15**	102	30	76	22	62	18
	β=20	88	26	64	20	51	15
	β=25	76	22	54	16	42	12

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Note: Values in table are not adjusted for EMC.

Total Dose Calculation

The total dose from all sources was calculated based on the user-entered values below.

Total Dose From All Sources		
Area	**Average**	**DCGL**
Survey Unit	0	10
Total Dose Sum of Fractions:		0
Total dose from all sources is below release criteria. 0 < 1		

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Systematic sampling locations for comparing a median with a fixed threshold (nonparametric - MARSSIM)

Summary

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

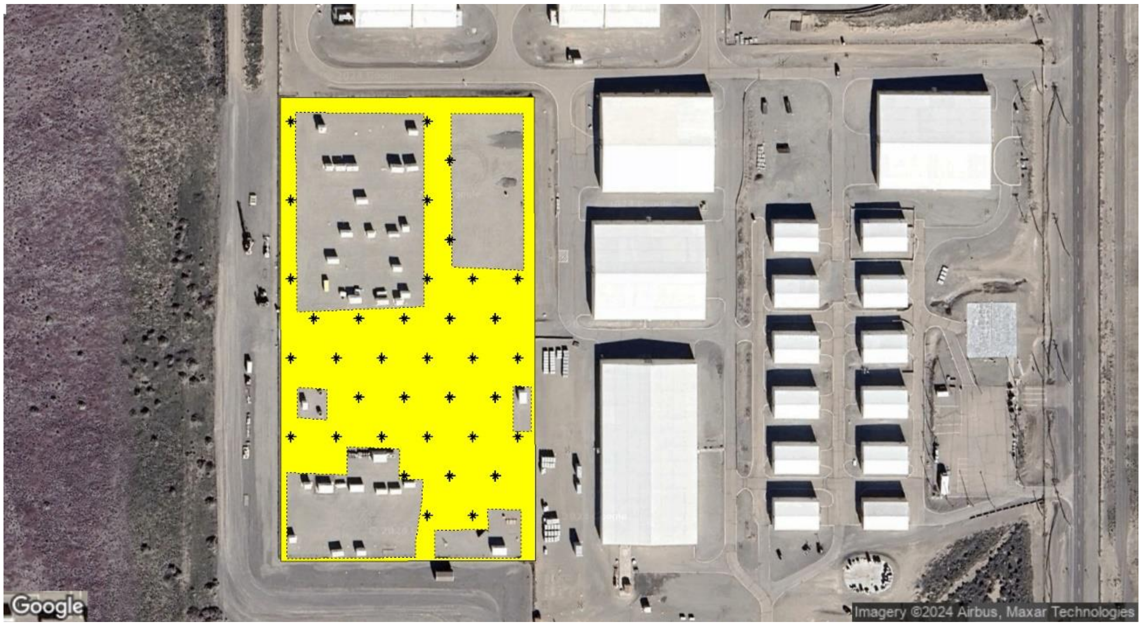
SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) in the Field	Systematic with a random start location
Working (Null) Hypothesis	The median(mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test - MARSSIM version
Calculated number of samples	30
Number of samples adjusted for EMC	30
Number of samples with MARSSIM Overage	36
Number of samples on map[a]	36
Number of selected sample areas[b]	1
Specified sampling area[c]	19337.96 m^2
Size of grid / Area of grid cell[d]	24.9051 meters / 537.166 m^2
Grid pattern	Triangular

[a]This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

[b]The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

[c]The sampling area is the total surface area of the selected colored sample areas on the map of the site.

[d]Size of grid / Area of grid gives the linear and square dimensions of the grid used to systematically place samples. If there was more than one sample area, this represents the largest dimensions used.

1 

2

Area: Zone 7						
X Coord	Y Coord	Label	Value	Type	Historical	Sample Area
565718.5952	136041.3175			Systematic		
565743.5003	136041.3175			Systematic		
565706.1426	136062.8860			Systematic		
565731.0477	136062.8860			Systematic		
565755.9529	136062.8860			Systematic		
565643.8798	136084.4545			Systematic		
565668.7849	136084.4545			Systematic		
565693.6901	136084.4545			Systematic		
565718.5952	136084.4545			Systematic		
565743.5003	136084.4545			Systematic		
565768.4054	136084.4545			Systematic		
565681.2375	136106.0230			Systematic		
565706.1426	136106.0230			Systematic		
565731.0477	136106.0230			Systematic		
565755.9529	136106.0230			Systematic		
565643.8798	136127.5914			Systematic		
565668.7849	136127.5914			Systematic		
565693.6901	136127.5914			Systematic		
565718.5952	136127.5914			Systematic		
565743.5003	136127.5914			Systematic		
565768.4054	136127.5914			Systematic		
565656.3324	136149.1599			Systematic		

Area: Zone 7						
X Coord	Y Coord	Label	Value	Type	Historical	Sample Area
565681.2375	136149.1599			Systematic		
565706.1426	136149.1599			Systematic		
565731.0477	136149.1599			Systematic		
565755.9529	136149.1599			Systematic		
565643.8798	136170.7284			Systematic		
565718.5952	136170.7284			Systematic		
565743.5003	136170.7284			Systematic		
565768.4054	136170.7284			Systematic		
565731.0477	136192.2969			Systematic		
565643.8798	136213.8653			Systematic		
565718.5952	136213.8653			Systematic		
565731.0477	136235.4338			Systematic		
565643.8798	136257.0023			Systematic		
565718.5952	136257.0023			Systematic		

Primary Sampling Objective

The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach

A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

VSP offers many options to determine the locations at which measurements are made or samples are collected and subsequently measured. For this design, systematic grid point sampling was chosen. Locating the sample points systematically provides data that are all equidistant apart. This approach does not provide as much information about the spatial structure of the potential contamination as simple random sampling does. Knowledge of the spatial structure is useful for geostatistical analysis. However, it ensures that all portions of the site are equally represented. Statistical analyses of systematically collected data are valid if a random start to the grid is used.

Number of Total Samples: Calculation Equation and Inputs

The equation used to calculate the number of samples is based on a Sign test (see PNNL 13450 for discussion). For this site, the null hypothesis is rejected in favor of the alternative one if the median(mean) is sufficiently smaller than the threshold. The number of samples to collect is calculated so that if the inputs to the equation are true, the calculated number of samples will cause the null hypothesis to be rejected.

The formula used to calculate the number of samples is:

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(SignP - 0.5)^2}$$

where

$$SignP = \Phi\left(\frac{\Delta}{S_{total}}\right)$$

$\Phi(z)$ is the cumulative standard normal distribution on $(-\infty,z)$ (see PNNL-13450 for details),

n is the number of samples,

S_{total} is the estimated standard deviation of the measured values including analytical error,

Δ is the width of the gray region,

α is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold,

β is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold,

$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,

$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n. VSP allows a user-supplied percent overage as discussed in MARSSIM (EPA 2000, p. 5-33).

For each nuclide in the table, the values of these inputs that result in the calculated number of sampling locations are:

Nuclide	n[a]	n[b]	n[c]	Parameter					
				S_{total}	Δ	α	β	$Z_{1-\alpha}$ [d]	$Z_{1-\beta}$ [e]
Analyte 1	30	30	36	0.66	0.4	0.05	0.2	1.64485	0.841621

[a]The number of samples calculated by the formula.

[b]The number of samples increased by EMC calculations.

[c]The final number of samples increased by the MARSSIM Overage of 20%.

[d]This value is automatically calculated by VSP based upon the user defined value of α.

[e]This value is automatically calculated by VSP based upon the user defined value of β.

Performance

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.

Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the computed sign test statistic is normally distributed,
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that $\mu >$ action level and alpha (%), probability of mistakenly concluding that $\mu <$ action level. The following table shows the results of this analysis.

Number of Samples							
AL=1		**α=5**		**α=10**		**α=15**	
		s=1.32	**s=0.66**	**s=1.32**	**s=0.66**	**s=1.32**	**s=0.66**
LBGR=90	**β=15**	2367	596	1769	446	1415	357
	β=20	2036	513	1485	374	1162	293
	β=25	1772	446	1260	317	964	243
LBGR=80	**β=15**	596	153	446	114	357	92
	β=20	513	132	374	96	293	76
	β=25	446	114	317	82	243	63
LBGR=70	**β=15**	268	71	201	53	160	42
	β=20	231	62	168	45	132	35
	β=25	201	53	143	39	110	29

s = Standard Deviation

LBGR = Lower Bound of Gray Region (% of Action Level)

β = Beta (%), Probability of mistakenly concluding that $\mu >$ action level

α = Alpha (%), Probability of mistakenly concluding that $\mu <$ action level

AL = Action Level (Threshold)

Note: Values in table are not adjusted for EMC.

Total Dose Calculation

The total dose from all sources was calculated based on the user-entered values below.

Total Dose From All Sources		
Area	**Average**	**DCGL**
Survey Unit	0	10
Total Dose Sum of Fractions:		0
Total dose from all sources is below release criteria. 0 < 1		

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