

**221-T RAILROAD CUT  
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

<b>Modification Date</b>	<b>Modification Number</b>
02/03/2026	PCN-221TRC-2025-02 (8C.2026.Q1)
03/10/2025	PCN-221TRC-2025-01 (8C.2025.Q1)
03/13/2024	PCN-221TRC-2024-01 (8C.2024.Q1)
08/17/2023	8C.2023.3F
12/06/2021	8C.2021.1F

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**221-T RAILROAD CUT  
ADDENDUM H  
CLOSURE PLAN**

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**ADDENDUM H  
CLOSURE PLAN**

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**TERMS**

ASTM	American Society for Testing and Materials
CAA	Central Accumulation Area
CFR	Code of Federal Regulations
COC	Chain-of-Custody
CPCCo	Central Plateau Cleanup Company, LLC
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQA	Data Quality Assessment
DQO	Data Quality Objectives
DWMU	Dangerous Waste Management Unit
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FWS	Field Work Supervisor
HEIS	Hanford Environmental Information System
HHE	Human Health and the Environment
HWMA	Hazardous Waste Management Act (Revised Code of Washington [RCW] 70A.300, Washington Administrative Code [WAC] 173-303)
IQRPE	Independent Qualified Registered Professional Engineer
MTCA	Model Toxics Control Act—Cleanup (RCW 70A.305, WAC 173-340)
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RCW	Revised Code of Washington
SAA	Satellite Accumulation Area
SAP	Sampling and Analysis Plan
SWOC	Solid Waste Operations Complex
VOA	Volatile Organic Analysis
VSP	Visual Sample Plan
WAC	Washington Administrative Code

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1 **H.1 Introduction**

2 The purpose of this plan is to describe the *Resource Conservation and Recovery Act of 1976*  
3 (RCRA)/Hazardous Waste Management Act (HWMA), Chapter 70A.300 Revised Code of Washington  
4 (RCW) closure process for the 221-T Railroad Cut Dangerous Waste Management Unit (DWMU),  
5 hereinafter called the 221-T Railroad Cut. The 221-T Railroad Cut is located in the northwest portion of  
6 the T Plant Complex in the 200 West Area of the Hanford Site (Figure H-1). The U.S. Department of  
7 Energy (DOE) and Central Plateau Cleanup Company, LLC (CPCCo), hereinafter called the Permittees,  
8 along with the Washington State Department of Ecology (Ecology), have agreed to close this DWMU.  
9 The 221-T Railroad Cut is no longer used for storage of dangerous or mixed waste and will be  
10 clean closed.

11 This closure plan complies with closure requirements in Washington Administrative Code  
12 (WAC) 173-303-610(2) through WAC 173-303-610(6), *Closure and post-closure*, and WAC 173-303-  
13 630(10), *Use and management of containers*.

14 Amendments to this closure plan must be submitted as a permit modification request in accordance with  
15 Permit Condition I.C.3.

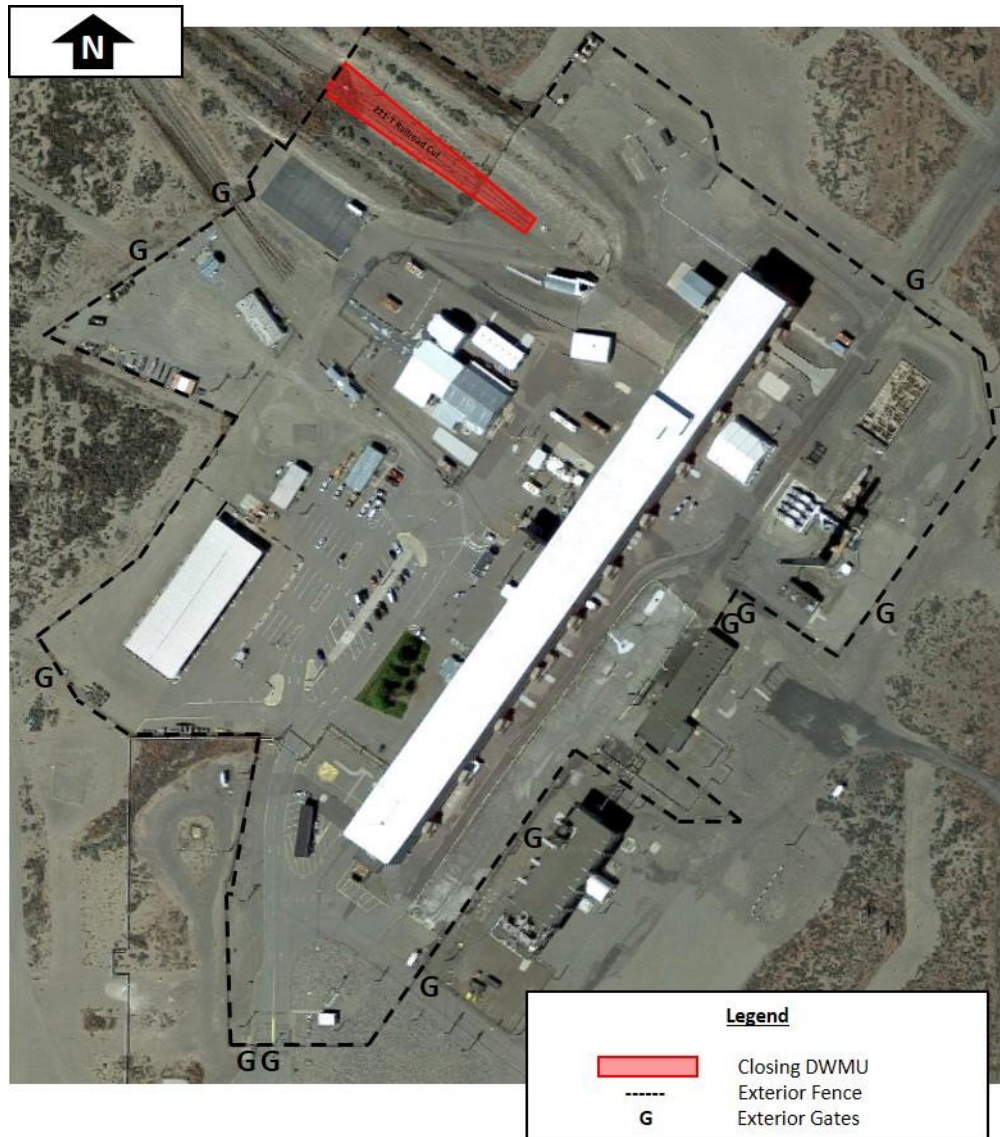
16 Minor deviations from this closure plan must be addressed in accordance with Permit Condition II.K.6.

17 Closure requirements are based on RCW 70A.300, WAC 173-303, and Ecology guidance  
18 (Ecology Publication #94-111, *Guidance for Clean Closure of Dangerous Waste Units and Facilities*).  
19 This closure plan is also designed to fulfill the elements of the Data Quality Objectives (DQO) Process, as  
20 defined in U.S. Environmental Protection Agency (EPA) Publication EPA/240/B-06/001, *Guidance on*  
21 *Systematic Planning Using the Data Quality Objectives Process* (EPA QA/G-4). A site-specific DQO has  
22 been incorporated into this closure plan.

23 This closure plan describes in detail the closure activities necessary to achieve closure performance  
24 standards for the 221-T Railroad Cut. Closure activities include:

- 25 • Removal of all dangerous and mixed waste.
- 26 • Records review (i.e., container storage, operating, and inspection records) for documented spills  
27 or releases of dangerous or mixed waste and subsequent cleanup activities.
- 28 • Visual inspection to evaluate the likelihood of potential contamination of the soil.
- 29 • Sampling of soil to evaluate whether closure performance standards are met.
- 30 • Transmit closure certification to Ecology.

31 Closure will be performed in accordance with the schedule provided in Section H.6.



1 **Figure H-1 T Plant Complex Overview, 221-T Railroad Cut**  
2 **Dangerous Waste Management Unit (Month Unknown, 2017)**

3  
4 **H.1.1 Unit Description**

5 The 221-T Railroad Cut is an uncovered gravel area with railroad tracks located west of the north end of  
6 the 221-T Canyon Building outside of the 221-T Railroad Tunnel.

7 The 221-T Railroad Cut is approximately 94 m (309 ft) long by 15 m (50 ft) wide at the fence and 10 m  
8 (33 ft) wide at the 221-T Railroad Tunnel end for a total approximate area of 1,357 m<sup>2</sup>(14,603 ft<sup>2</sup>).

9 Figure H-2 shows the 221-T Railroad Cut from Northeast 221-T Railroad Tunnel end to the fence.

10 Figure H-3 shows an overhead view of the 221-T Railroad Cut.

11 The 221-T Railroad Cut was used to store mixed waste in a Central Accumulation Area (CAA) or  
12 Satellite Accumulation Area (SAA) while being transferred into or out of the 221-T Railroad Tunnel. The  
13 221-T Railroad Cut does not currently store dangerous or mixed waste. Future dangerous waste container  
14 storage and treatment of dangerous or mixed waste within the 221-T Railroad Cut is not authorized.



1 **Figure H-2 221-T Railroad Cut Outdoor Container Storage Area (February 2018)**



2 **Figure H-3 Overhead View of 221-T Railroad Cut from Southwest (October 2017)**

3  
4 **H.1.2 Maximum Waste Inventory**

5 No dangerous waste permitted storage was identified during at the 221-T Railroad Cut during the T Plant  
6 operating records review; therefore, no maximum waste inventory is presented. Weekly inspection  
7 records of CAAs and SAAs identified that the 221-T Railroad Cut may have managed nondangerous,  
8 dangerous, and mixed waste.

1 **H.1.3 Personnel Safety and Training Requirements**

2 Closure will be performed in a manner to ensure the safety of Human Health and the Environment (HHE).  
3 Health and safety requirements are addressed in Section H.1.3.1 and training for facility and closure  
4 personnel is described in Section H.1.3.2.

5 **H.1.3.1 Health and Safety Requirements**

6 Personnel will be trained in the applicable safety and environmental procedures described in Table H-1.  
7 Personnel will be equipped with personal protective equipment. Personnel will perform all field  
8 operations and any necessary closure activities in compliance with applicable health, safety, and  
9 environmental procedures and requirements.

10 Pre-job briefings will be performed to evaluate activities and associated hazards by considering the  
11 following factors:

- 12 • Objective of the activities.
- 13 • Individual tasks to be performed.
- 14 • Hazards associated with the planned tasks.
- 15 • Environment in which the job will be performed.
- 16 • Facility where the job will be performed.
- 17 • Equipment and material required.
- 18 • Safety protocols applicable to the job.
- 19 • Training requirements for individuals assigned to perform the work.
- 20 • Level of management control.
- 21 • Proximity of emergency contacts.

22 **H.1.3.2 Training Requirements**

23 The Permittees have instituted training and qualification programs to meet training requirements imposed  
24 by regulations, DOE orders, and national standards such as those published by the American National  
25 Standards Institute/American Society of Mechanical Engineers. For example, the environmental, safety,  
26 and health training program provides workers with the knowledge and skills necessary to execute  
27 assigned duties safely. Permit Attachment 5, *Hanford Facility Personnel Training Program*, describes  
28 specific requirements for the Hanford Facility Personnel Training Program. The Permittees will comply  
29 with the training matrix shown in Table H-1, which provides training requirements for Hanford Facility  
30 personnel associated with the 221-T Railroad Cut.

31 Project-specific safety training will provide the knowledge and skills that personnel need to perform work  
32 safely and in accordance with Quality Assurance (QA) requirements. Training records are maintained for  
33 each employee in an electronic training record database. The Permittee's training organization maintains  
34 the training records system.

**Table H-1 Training Matrix for the 221-T Railroad Cut Dangerous Waste Mangement Units**

Training Category Course Description <sup>a</sup>	Frequency of Training	Training Type <sup>b</sup>	Job Title/Position					
			Non-T Plant Personnel or Visitor	FWS	SPOC	ECO	BED	FS
General Training	Annual	GHFT, CPT	X	X	X	X	X	X
Building Emergency	Annual	ECT					X	
ECO Training	Initial	OT				X		
Facility Health and Safety	Annual	GHFT, CPT	X <sup>c</sup>	X	X <sup>c</sup>	X	X	X <sup>c</sup>
Sampler	Annual	GHFT, CPT						X

<sup>a</sup>The T Plant Complex Dangerous Waste Training Plan provides a complete description of coursework in each training category.

<sup>b</sup>Training types defined in Permit Attachment 5.

<sup>c</sup>This training is required only if workers are unescorted in the facility.

BED = Building Emergency Director

FWS = Field Work Supervisor

CPT = Contingency Plan Training

GHFT = General Hanford Facility Training

ECO = Environmental Compliance Officer

OT = Operations Training

ECT = Emergency Coordinator Training

SPOC = Single Point of Contact

FS = Field Sampler

1

2 **H.1.4 Maintenance and Security During Closure**

3 To maintain the 221-T Railroad Cut in a compliant manner during closure, measures are taken to ensure  
4 inspections are performed and security and emergency preparedness activities are in place.

5 **H.1.4.1 Inspections**

6 The 221-T Railroad Cut will be closed in a manner that demonstrates that all steps to prevent threats to  
7 HHE have been met and will continue to be taken. After closure activities have been completed, the  
8 221-T Railroad Cut will be inspected annually until Ecology approves the unit closure certification.

9 Table H-2 shows annual inspection requirements that will be performed.

10

**Table H-2 221-T Railroad Cut Inspection Schedule**

Requirement Description	Frequency	DWMU Condition*
Signage	Annual	Warning signs are present and clearly legible.
Site – General	Annual	There is no evidence that unusual conditions exist at the closing DWMU site.

\*The storage area is empty of dangerous and mixed waste. “No waste in storage” or equivalent words will be entered on the inspection log.

11

12 **H.1.4.2 Facility Security**

13 The following sections document security measures in effect at the T Plant Complex.

14 **H.1.4.2.1 Security Provisions**

15 Located within the 200 West Area of the Hanford Facility, the T Plant Complex complies with access  
16 control and warning sign requirements pursuant to WAC 173-303-310(1) and (2), *Security*.

1 Security measures are used to control access to the active portions of the Hanford Facility in accordance  
2 with Permit Condition II.M, Security.

3 The entire Hanford Facility is a controlled access area as described in Permit Attachment 3, *Security*. The  
4 security measures in Permit Attachment 3 and the unit-specific security measures prevent the unknowing  
5 entry, and minimize the possibility for the unauthorized entry, of persons or livestock.

6 [WAC 173-303-310(1)]

#### 7 **H.1.4.2.2 T Plant Complex Access Control**

8 Unknowing entry and the possibility for unauthorized entry of persons or livestock onto the active  
9 portions of the T Plant Complex are minimized through implementation and maintenance of the following  
10 security measures.

11 Access to T Plant DWMUs is controlled by an approximate 2.4 m (8 ft) high chain-link fence encircling  
12 the operating boundary (Figure H-1). A two-part swinging chain link gate at the T Plant main entrance is  
13 open during operational hours to allow vehicle and personnel ingress to the parking lot and outdoor areas.  
14 Signs are posted at the main entrance instructing all visitors to check in at 271-T Building. This gate is  
15 closed and locked when personnel are away from T Plant. Alternate vehicle access gates, found about the  
16 fenced perimeter, are closed and locked except when in use. Keys to gates are controlled and accessible  
17 only by authorized personnel. [WAC 173-303-310(2)(c)]

18 Upon arrival at T Plant, visitors are required to sign in at the 271-T Building administration office, and  
19 must adhere to all personal protection requirements, and are subject to escorting protocols.

20 Section H.1.3.2 provides the personnel training requirements for T Plant Complex operators, workers, and  
21 visitors.

22 Access to the 221-T Railroad Cut is restricted by the T Plant Complex access controls described above.

#### 23 **H.1.4.2.3 Warning Signs**

24 Warning signs stating “Danger-Unauthorized Personnel Keep Out” are posted near the entrance gate of  
25 the T Plant Complex. Identical signs are posted along the perimeter fence lines at distances not to exceed  
26 250 ft (76.2 m) between signs. Permittees must maintain warning signs at points described in this closure  
27 plan and ensure that signs are written in English, legible from a distance of 25 feet (approximately 7.6 m)  
28 or more, and visible from all angles of approach. [WAC 173-303-310(2)(a)]

#### 29 **H.1.4.3 Preparedness, Prevention, Emergency Procedures**

30 T Plant preparedness, prevention, and emergency procedures are described in the following subsections.  
31 Contingency information is contained in the Building Emergency Plan for the T Plant Complex, as well  
32 as Permit Attachment 4, *Hanford Emergency Management Plan*.

##### 33 **H.1.4.3.1 T Plant Building Emergency Plan**

34 The T Plant Complex is within the Hanford Facility. The Building Emergency Plan for the T Plant  
35 Complex describes facility-specific hazards and emergency planning and response. This site-specific plan  
36 is intended to be used in conjunction with Permit Attachment 4, *Hanford Emergency Management Plan*.  
37 If an emergency occurs, the on-call Building Emergency Director will be notified, and the requirements  
38 associated with Permit Attachment 4, *Hanford Emergency Management Plan*, and the T Plant Complex  
39 Building Emergency Plan will be implemented. A copy of the T Plant Complex Building Emergency Plan  
40 is kept in the operating record.

##### 41 **H.1.4.3.2 Hanford Emergency Management Plan**

42 Permit Attachment 4, *Hanford Emergency Management Plan*, addresses site emergency management and  
43 contingency plan requirements for the Hanford Facility.

#### 1 **H.1.4.4 Facility Recordkeeping**

2 Historical records that describe dangerous and mixed waste management activities within the  
3 221-T Railroad Cut are retained in the operating record, which ensures proper availability and retention  
4 periods. These records describe the source of the chemicals, quantity, and hazards associated with the  
5 chemicals.

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

### 10 **H.2 Closure Performance Standards**

11 The 221-T Railroad Cut will be closed in a manner that complies with the closure performance standards  
12 in WAC 173-303-610(2)(a) and (b) and, therefore, achieves clean closure. The objectives of closure  
13 activities for the 221-T Railroad Cut are as follows:

- 14 • Minimize the need for further maintenance.
- 15 • Control, minimize, or eliminate to the extent necessary to protect HHE, post-closure escape of  
16 dangerous waste, dangerous constituents, leachate, contaminated runoff, or dangerous waste  
17 decomposition products to the ground, surface water, groundwater, or atmosphere.
- 18 • Remove all waste and waste residues.
- 19 • Perform soil sampling and analysis to ensure soils in the 221-T Railroad Cut meet standard  
20 Model Toxics Control Act (MTCA) Method A or B cleanup levels, and remove any soils  
21 contaminated above these levels.
- 22 • Return the land to the appearance and use of surrounding land areas to the degree possible given  
23 the nature of the previous dangerous waste activity.

### 24 **H.3 Closure Activities**

25 The 221-T Railroad Cut will be clean closed.

26 The following closure activities are required to achieve and certify clean closure:

- 27 • Remove all dangerous and mixed waste inventory (completed; Section H.3.1).
- 28 • Review dangerous and mixed waste container storage, operating, and inspection records for  
29 documented spills or releases of dangerous or mixed waste during periods of waste storage and  
30 subsequent cleanup (completed; Section H.3.2).
- 31 • Perform a visual inspection of the soil and gravel surface to identify dangerous or mixed waste  
32 related staining to identify potential for focused sample locations (completed; Section H.3.2).
- 33 • Perform soil sampling (Section H.4.4).
- 34 • Confirm analytical results from soil samples meet closure performance standards (Section H.3.8).
- 35 • Identify and manage contaminated environmental media (Section H.3.5).
- 36 • Identify and manage waste generated during closure (Section H.3.6).
- 37 • Transmit closure certification to Ecology (Section H.5.3).

#### 38 **H.3.1 Removal of Wastes and Waste Residues**

39 No dangerous or mixed waste is currently stored at the 221-T Railroad Cut. The 221-T Railroad Cut will  
40 not be used for storage of dangerous or mixed waste in the future.

1 It is unknown if dangerous or mixed waste residues are present at this DWMU. There are no containers in  
2 the 221-T Railroad Cut where dangerous or mixed waste could be present. There are rails running though  
3 the DWMU. If dangerous or mixed waste residues are found during clean closure activities, then the  
4 residues will be removed and managed as newly generated waste in accordance with Section H.3.6.

### 5 **H.3.2 Operating Records Review and Visual Inspection**

6 To support the development of this closure plan and the Sampling and Analysis Plan (SAP), a review of  
7 the T Plant Complex container storage, operating, and inspection records was completed and submitted to  
8 the operating record. The records review included the following operating record documents: facility  
9 operating logbooks (including spill reports), and waste management inspection and surveillance records.  
10 The operating records that were reviewed focused on the period during active waste storage for the  
11 T Plant Complex (i.e., January 1985 through June 2013) including:

- 12 • 271-T Cage.
- 13 • 211-T Pad.
- 14 • 221-T Sand Filter Pad.
- 15 • 277-T Outdoor Storage Area.
- 16 • 277-T Building.
- 17 • 221-T Railroad Cut.
- 18 • 2706-TB Tank System.
- 19 • 221-T Pipe Gallery Storage.
- 20 • 221-T R5 Waste Storage Area.
- 21 • 221-T Tank System.

22 The records review extended past the active waste storage period to June 2013. The records review  
23 indicated no releases of dangerous or mixed waste in the 221-T Railroad Cut. Table H-3 provides a  
24 summary of the records review.

25 Waste management records reviewed in Table H-3 included both the closing 221-T Railroad Cut and the  
26 loading and unloading area of the operating 221-T Railroad Tunnel as one combined area. Those records  
27 indicated that there was dangerous or mixed waste present within the combined area. However, historical  
28 facility operations indicate only equipment was stored within the 221-T Railroad Cut prior to being  
29 moved into the 221-T Railroad Tunnel. Dangerous or mixed waste was only stored outside of the  
30 operating 221-T Railroad Tunnel DWMU.

31 Since the 221-T Railroad Cut was not permitted for dangerous or mixed waste storage, this area lacks  
32 sufficient documentation to clearly identify the target analytes for confirmation sampling. Therefore, as a  
33 conservative measure, the target analytes for the 221-T Railroad Cut (shown in Table H-4) were derived  
34 from the collective list of all dangerous waste codes identified during the records review of the T Plant  
35 Complex DWMUs.

**Table H-3 Operating Records Review Summary**

Document Title	Document Type	Timeframe of Records Reviewed		Items of Concern Noted
		Start Date	End Date	
T Plant Daily Operating Logbook	Logbook	01/02/1985	06/22/2010	No
T Plant Operation Logbook	Logbook	07/27/2010	04/07/2011	No
Waste Management Area Daily Inspection Data Sheet	Data sheet	08/29/2005	12/01/2005	No
Waste Management Area Daily Inspection Data Sheet	Data sheet	10/01/2007	04/22/2013	No
Weekly Surveillance Log, <90-day Storage Areas and Satellite Accumulation Areas	Log sheet	06/07/1991	12/20/1999	No
Treatment Facility Waste Management Weekly Inspection Log Sheet Treatment Facility Waste Management Area Daily Inspection Log Sheet Treatment Facility Waste Management Area Weekly Inspection Data Sheet Treatment Facility Waste Management Area Daily Inspection Data Sheet Weekly Waste Area Surveillance T-Plant Daily Waste Management Area Inspection Data Sheet	Inspection, data and log sheets	01/2000 01/2005	12/2002 12/2007	No
Waste Management Area Daily Inspection Report Weekly Waste Area Surveillance	Inspection sheets	01/2003	12/2004	Yes*
T-Plant Weekly Waste Management Area Inspection Data Sheet	Data sheet	10/18/2007	06/12/2013	No

\*Item of concern was a container of Insulkote® leaking in 271-T Cage. Product was determined to be nonregulated material. Insulkote® is a registered trademark of Industrial Insulation Group, LLC, Brunswick, Georgia.

- 1
- 2 For the purposes of focused sampling, a visual inspection was performed on September 18, 2013, to
- 3 identify whether any staining was present that could be related to dangerous or mixed waste storage.
- 4 No unusual or suspect staining was identified during the visual inspection; therefore, only confirmation
- 5 sampling and analysis to verify clean closure will be performed.
- 6 Supporting documentation for the Permittees' visual inspection is included in Attachment A, *T Plant*
- 7 *221-T Railroad Cut Visual Inspection Supporting Documentation*.
- 8 **H.3.3 Unit Components, Parts, and Ancillary Equipment**
- 9 The 221-T Railroad Cut consists of fencing, railroad tracks and gravel surfaces and does not have any unit
- 10 components, parts, or ancillary equipment identified for removal as part of closure.

1 **H.3.4 Decontamination**

2 Based on the records review and visual inspection described in Section H.3.2, soil decontamination  
3 activities are not planned for the 221-T Railroad Cut. Equipment that becomes contaminated during  
4 sampling activities will be decontaminated for re-use or managed and disposed of as newly generated  
5 waste in accordance with Section H.3.6. A temporary decontamination area may be established near the  
6 221-T Railroad Cut. This area will be constructed of Visqueen™ or an equivalent material, and may be  
7 used for decontamination of sampling equipment, personal protective equipment, and other miscellaneous  
8 small equipment used during sampling activities. When decontamination of equipment is completed, the  
9 Visqueen™ or equivalent materials, rinsate, and solid waste debris generated by equipment  
10 decontamination (e.g., rags and personal protective equipment) will be removed and managed as newly  
11 generated waste in accordance with Section H.3.6.

12 **H.3.5 Identifying and Managing Contaminated Environmental Media**

13 The records review and visual inspection outlined in Section H.3.2 did not identify any releases of  
14 dangerous or mixed waste or the presence of staining that could be related to dangerous or mixed waste.  
15 Contaminated environmental media (soil) removal is not anticipated. However, contaminated soil will be  
16 remediated at grid sampling location(s) where analytical results indicate contamination.

17 If contamination above closure performance standards is identified, then the nature and extent of  
18 contamination will be evaluated. Soil surrounding the grid sampling node that identified soil  
19 contamination, will be removed up to 4.6 m (15 ft) below the surface and up to the adjacent sampling  
20 node location. Contaminated soil will be removed using equipment capable of removing the quantity of  
21 material required to complete removal and clean close the DWMU. If contamination exists in the soil  
22 deeper than 4.6 m (15 ft), the Permittees shall collaborate with Ecology for a path forward on closure.  
23 Resulting changes to this closure plan will be submitted to Ecology as a permit modification request in  
24 accordance with Permit Condition I.C.3.

25 Contaminated soil will be removed and managed as a newly generated waste stream. Contaminated soil  
26 will be managed in accordance with all applicable requirements of WAC 173-303-170, *Requirements for*  
27 *generators of dangerous waste*, through 173-303-230, *Special conditions*. [WAC 173-303-610(5)]

28 The contaminated soil will be containerized, labeled, and sampled as needed to designate for disposal of  
29 the entire volume of contaminated soil. Contaminated soil will be placed in U.S. Department of  
30 Transportation-compliant containers and sent to an appropriate land disposal unit, possibly with central  
31 accumulation as an intermediary step in accordance with all applicable requirements of WAC 173-303-  
32 200, *Conditions for exemption for a large quantity generator that accumulates dangerous waste*.  
33 Contaminated soil subject to the requirements of WAC 173-303-140, *Land disposal restrictions*  
34 (which includes by reference 40 Code of Federal Regulations [CFR] 268 *Land Disposal Restrictions*) will  
35 be characterized, designated, and treated, as applicable, prior to disposal in an appropriate land disposal  
36 unit.

37 **H.3.6 Identifying and Managing Waste Generated During Closure**

38 There are no newly generated waste streams anticipated for the 221-T Railroad Cut. However, in the  
39 unlikely event that waste is generated, newly generated waste will be managed in accordance with all  
40 applicable requirements of WAC 173-303-170 through WAC 173-303-230. Once waste characterization  
41 results are received, all waste will be designated. The waste will be managed as a newly generated waste  
42 stream and either disposed of or decontaminated in accordance with WAC 173-303-610(5). Dangerous  
43 and mixed waste will be treated, if necessary, to meet land disposal restrictions in WAC 173-303-140  
44 (which incorporates by reference 40 CFR 268), then ultimately disposed of in an appropriate land disposal  
45 unit.

1 Management and disposal of waste generated during closure will be documented and included as part of  
2 the clean closure certification documentation (Section H.5.3).

### 3 **H.3.7 Closure Performance Standards for Soil**

4 The presumed exposure pathways that are considered for the 221-T Railroad Cut are:

- 5 • WAC 173-340-740(3), MTCA—Cleanup, *Unrestricted land use soil cleanup standards*,  
6 Method B (cancer and noncancer), which considers human health based on direct soil contact.
- 7 • WAC 173-340-740(2), Table 740-1, “Method A Soil Cleanup Levels for Unrestricted Land Uses”  
8 (WAC 173-340-900, *Tables*), which includes closure performance standards for human health  
9 based on unrestricted land use. MTCA Method A is only used if MTCA Method B is not  
10 available for a particular contaminant in the Cleanup Levels and Risk Calculation tables.
- 11 • WAC 173-340-747, *Deriving soil concentrations for groundwater protection*, which notes soil  
12 concentrations protective of groundwater.
- 13 • WAC 173-340-7493, *Site-specific terrestrial ecological evaluation procedures*, which considers  
14 ecological indicators (plants, biota, wildlife) in Table 749-3, “Ecological Indicator Soil  
15 Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals” (WAC 173-340-900).
- 16 • WAC 173-340-750, *Cleanup standards to protect air quality*, that describes human health risks  
17 due to fugitive vapors and dust.

18 Of the exposure pathways listed above, direct soil contact is always considered a complete and viable  
19 exposure pathway for all soil samples. The exposure pathway for soil protective of groundwater assumes  
20 that water or precipitation on a surface has an avenue to percolate through the surface of underlying soil  
21 to groundwater. The scenario for ecological indicators requires that vegetation, biota, and wildlife be  
22 present in order for the pathway to be complete. The exposure scenario for inhalation of fugitive vapors  
23 and dust assumes a complete pathway, which would begin with a source of contaminated media and end  
24 with a receptor.

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

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

29 If a closure performance standard is below both values, the higher of these two values is selected.

30 Four exposure pathways were considered complete pathways at 221-T Railroad Cut—direct soil contact,  
31 soil levels protective of groundwater, ecological indicator soil concentrations for protection of terrestrial  
32 plants and animals, and human health risks due to fugitive vapors and dust.

33 Soil grab samples will be collected following the grid sampling design described in Section H.4.4.1. Soil  
34 sampling and analysis will be conducted in accordance with the closure plan SAP located in Section H.4.

35 Analytical results of grid samples will be evaluated in the Visual Sample Plan (VSP<sup>1</sup>) data analysis  
36 function to generate the Data Analysis Report and follow the MTCA three-part test (also described in  
37 Section H.4.4.1) to determine if closure performance standards (Table H-4) have been met. The VSP Data  
38 Analysis Report is to be provided to Ecology within 30 days after all data verification activities are  
39 complete.

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<sup>1</sup>Visual Sample Plan is a product of Pacific Northwest National Laboratory (PNNL), Richland, Washington.

1 If target analytes do not meet closure performance standards, then the contaminated soil will be  
2 remediated and confirmatory grid sampling will be conducted in accordance with Section H.4.4.3 to  
3 ensure the closure performance standards are achieved for the remaining soil. If failed constituents of  
4 concern do not meet closure performance standards after soil remediation, then the Permittees will meet  
5 with Ecology to determine a path forward for closure. Resulting changes to this closure plan will be  
6 submitted to Ecology as a permit modification request in accordance with Permit Condition I.C.3. The  
7 sample design for grid soil samples is discussed in Section H.4.4.1.

### 8 **H.3.8 Development of Closure Performance Standards**

9 The target analytes considered for evaluation during closure sampling and analysis were derived from a  
10 list of all waste codes identified at other T Plant closure DWMUs. Table H-4 provides the closure  
11 performance standards for soil for each individual target analyte associated with the dangerous waste  
12 codes identified. A list of closure performance standard values for all exposure pathways was provided to  
13 Ecology in July 2017 as correspondence from DOE (17-AMRP-0217, “Dangerous Waste Management  
14 Unit [DWMU] 277-T Building Closure Plan Comment Disposition, and Performance Standards for  
15 Future Solid Waste Operations Complex [SWOC] Closure Plans”) and which Ecology acknowledged  
16 (17-NWP-100, “Dangerous Waste Management Unit [DWMU] 277-T Building Closure Plan Comment  
17 Disposition and Performance Standards for Future Solid Waste Operations Complex [SWOC] Closure  
18 Plans”).

**Table H-4 Closure Performance Standards for Soil and Analytical Performance Requirements**

CAS Number	Waste Code(s) <sup>a</sup>	Analyte	Closure Performance Standards		PQL <sup>b</sup> (mg/kg)
			Value (mg/kg)	Basis	
<b>SW-846 Method 6010</b>			<b>Accuracy Requirement ±20% Recovery<sup>c</sup> Precision Requirement ≤35 RPD<sup>d</sup></b>		
7440-38-2	D004	Arsenic <sup>c</sup>	2.00E+01	Background	1.00E+00
7440-39-3	D005	Barium	1.65E+03	Groundwater Protection	5.00E+00
7440-43-9	D006	Cadmium	6.90E-01	Groundwater Protection	5.00E-01
7439-92-1	D008	Lead	2.50E+02	Unrestricted L and Use (MTCA Method A)	5.00E+00
7782-49-2	D010	Selenium	1.00E+01	PQL	1.00E+01
7440-22-4	D011	Silver	1.36E+01	Groundwater Protection	1.00E+00
1314-62-1 (7440-62-2)	(P120)	Vanadium pentoxide (analyzed as vanadium)	4.00E+02	Human Health – Direct Contact (noncancer)	5.00E+00
<b>SW-846 Method 6020</b>			<b>Accuracy Requirement ±20% Recovery<sup>c</sup> Precision Requirement ≤35 RPD<sup>d</sup></b>		
7440-38-2	D004	Arsenic <sup>c</sup>	2.00E+01	Background	1.00E+00
<b>SW-846 Method 7196</b>			<b>Accuracy Requirement ±20% Recovery<sup>c</sup> Precision Requirement ≤35 RPD<sup>d</sup></b>		
18540-29-9	D007	Chromium (Hexavalent)	5.00E-01	PQL	5.00E-01
<b>SW-846 Method 7471</b>			<b>Accuracy Requirement ±20% Recovery<sup>c</sup> Precision Requirement ≤35 RPD<sup>d</sup></b>		
7439-97-6	D009	Mercury <sup>f</sup>	2.09E+00	Groundwater Protection	2.00E-01
<b>SW-846 Method 8015</b>			<b>Accuracy Requirement ±30% Recovery<sup>c</sup> Precision Requirement ≤30 RPD<sup>d</sup></b>		
67-56-1	F003	Methanol	6.43E+01	Groundwater Protection	5.00E+01
<b>SW-846 Method 8260</b>			<b>Accuracy Requirement ±30% Recovery<sup>c</sup> Precision Requirement ≤20 RPD<sup>d</sup></b>		
67-64-1	F003	Acetone	2.89E+01	Groundwater Protection	2.00E-02
71-43-2	D018, F005	Benzene	2.82E-02	Groundwater Protection	5.00E-03

**Table H-4 Closure Performance Standards for Soil and Analytical Performance Requirements**

CAS Number	Waste Code(s) <sup>a</sup>	Analyte	Closure Performance Standards		PQL <sup>b</sup> (mg/kg)
			Value (mg/kg)	Basis	
71-36-3	F003	n-Butyl alcohol (1-Butanol)	3.31E+00	Groundwater Protection	2.50E-01
75-15-0	F005, (P022)	Carbon disulfide	5.65E+00	Groundwater Protection	5.00E-03
56-23-5	D019, F001, F002	Carbon tetrachloride	4.60E-02	Groundwater Protection	5.00E-03
67-66-3	D022	Chloroform	7.50E-02	Groundwater Protection	5.00E-03
108-90-7	F002	Chlorobenzene	8.74E-01	Groundwater Protection	5.00E-03
108-94-1	F003	Cyclohexanone	1.74E+02	Groundwater Protection	1.00E-01
123-91-1	(U108)	1,4-Dioxane	1.00E+01	Human Health -Direct Contact (cancer)	5.00E-01
141-78-6	F003	Ethyl acetate	2.97E+01	Groundwater Protection	5.00E+00
100-41-4	F003	Ethylbenzene	3.44E-01	Groundwater Protection	5.00E-03
60-29-7	F003, (U117)	Diethyl ether [ethyl ether, ethoxyethane, or 1,1'-oxybis-ethane]	6.85E+00	Groundwater Protection	1.00E-02
78-83-1	F005	Isobutanol (Isobutyl Alcohol)	9.70E+00	Groundwater Protection	5.00E-01
78-93-3	D035, F005	Methyl ethyl ketone (MEK) (2-Butanone)	1.96E+01	Groundwater Protection	2.00E-02
108-10-1	F003	Methyl isobutyl ketone (4-Methyl-2-Pentanone)	2.73E+00	Groundwater Protection	2.00E-02
75-09-2	F001, F002	Methylene chloride	2.18E-02	Groundwater Protection	5.00E-03
127-18-4	D039, F001, F002	Tetrachloroethylene	5.30E-02	Groundwater Protection	5.00E-03
109-99-9	(U213)	Tetrahydrofuran	3.00E+01	Groundwater Protection	5.00E-02
108-88-3	F005	Toluene	4.65E+00	Groundwater Protection	5.00E-03

**Table H-4 Closure Performance Standards for Soil and Analytical Performance Requirements**

CAS Number	Waste Code(s) <sup>a</sup>	Analyte	Closure Performance Standards		PQL <sup>b</sup> (mg/kg)
			Value (mg/kg)	Basis	
71-55-6	F001, F002, (U226)	1,1,1-Trichloroethane	1.58E+00	Groundwater Protection	5.00E-03
79-00-5	F002	1,1,2-Trichloroethane	2.78E-02	Groundwater Protection	5.00E-03
79-01-6	D040, F001, F002	Trichloroethylene	2.64E-02	Groundwater Protection	5.00E-03
76-13-1	F002	1,1,2-Trichloro-1,2,2-trifluoroethane	1.09E+04	Groundwater Protection	1.00E-02
75-69-4	F002	Trichlorofluoromethane	2.84E+01	Groundwater Protection	1.00E-02
75-01-4	D043	Vinyl chloride	1.00E-02	PQL	1.00E-02
1330-20-7	F003	Xylenes (total)	1.46E+01	Groundwater Protection	1.00E-02
<b>SW-846 Method 8270</b>			<b>Accuracy Requirement ±30% Recovery<sup>c</sup> Precision Requirement ≤30 RPD<sup>d</sup></b>		
111-44-4	(U025)	bis (2-chloroethyl) ether (dichloroethyl ether)	3.33E-01	PQL	3.33E-01
95-48-7	F004	<i>o</i> -Cresol reported as total cresols <sup>g</sup>	2.33E+00	Groundwater Protection	3.33E-01
95-50-1	F002	1,2-Dichlorobenzene (ortho-Dichlorobenzene)	7.03E+00	Groundwater Protection	3.33E-01
121-14-2	D030	2,4-Dinitrotoluene	3.33E-01	PQL	3.33E-01
67-72-1	D034	Hexachloroethane	3.33E-01	PQL	3.33E-01
98-95-3	F004	Nitrobenzene	3.33E-01	PQL	3.33E-01
87-86-5	D037	Pentachlorophenol	6.60E-01	PQL	6.60E-01
110-86-1	F005	Pyridine	6.60E-01	PQL	6.60E-01
<b>SW-846 Method 9012</b>			<b>Accuracy Requirement ±20% Recovery<sup>c</sup> Precision Requirement ≤35 RPD<sup>d</sup></b>		
57-12-5	(P030)	Cyanides, Total <sup>g</sup> (soluble cyanide salts)	1.94E+00	Groundwater Protection	1.00E+00

**Table H-4 Closure Performance Standards for Soil and Analytical Performance Requirements**

CAS Number	Waste Code(s) <sup>a</sup>	Analyte	Closure Performance Standards		PQL <sup>b</sup> (mg/kg)
			Value (mg/kg)	Basis	
<b>SW-846 Method 9056</b>			<b>Accuracy Requirement ±20% Recovery<sup>c</sup> Precision Requirement ≤35 RPD<sup>d</sup></b>		
64-18-6	(U123)	Formic Acid (analyzed as Formate)	7.20E+04	Human Health – Direct Contact (noncancer)	2.00E+00
<b>Not Analyzed</b>			<b>Not Analyzed</b>		
CAS Numbers	Waste Code(s)	Analyte	CAS Numbers	Waste Code(s)	Analyte
75-07-0	(U001)	Acetaldehyde <sup>i</sup>	1338-23-4	(U160)	MEK peroxide <sup>j</sup>
75-36-5	(U006)	Acetyl chloride <sup>j</sup>	79-46-9	F005	2-Nitropropane <sup>i</sup>
107-20-0	(P023)	Chloroacetaldehyde <sup>k</sup>	1314-80-3	(U189)	Phosphorus pentasulfide <sup>j</sup>
110-80-5	F005, (U359)	2-Ethoxyethanol <sup>l</sup>	N/A	F001, F002	Chlorinated fluorocarbons <sup>m</sup>

References: 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.”

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.”

DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*.

<sup>a</sup>Many of the chemicals listed in this table also have P and U waste codes associated with them (WAC 173-303-9903, *Discarded chemical products lists*). (1) These codes are listed in the table because it is unknown whether or not the waste container had a “discarded chemical product” (per WAC 173-303-081) or if it was a chemical contaminant of the waste. (2) The P and U code designations do play a part in the determination of dangerous waste criteria (WAC 173-303-100), as they indicate that chemical as either acutely hazardous (P) or dangerous (U) waste based on toxicity and/or persistence calculations. For these reasons, the P and U codes are listed in parentheses.

<sup>b</sup>Highest allowable PQL will be defined in the individual laboratory contract with CPCCo. In practice, the laboratory PQL values have the potential to be lower.

<sup>c</sup>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 analysis.

<sup>d</sup>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 acceptance criteria may be used in place of statistically derived acceptance criteria.

<sup>e</sup>Arsenic – The Hanford Site closure performance standard for arsenic is 20 mg/kg based on a letter (Ecology, 2013, “Issues Associated with Establishing Soil Cleanup Levels for Arsenic”) 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 Site. One of the two methods (SW-846 6010 or 6020) may be used.

**Table H-4 Closure Performance Standards for Soil and Analytical Performance Requirements**

CAS Number	Waste Code(s) <sup>a</sup>	Analyte	Closure Performance Standards		PQL <sup>b</sup> (mg/kg)
			Value (mg/kg)	Basis	

<sup>f</sup>Mercury – Equation 740-1 and Equation 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.

<sup>g</sup>Cresols – the closure performance standard for o-cresol will be reported as total cresols: a total of the three isomeric forms: o-cresol, m-cresol, and p-cresol.

<sup>h</sup>Cyanides – Copper (P029), potassium (P098), and sodium cyanides (P106), as well as other cyanide salts not specified will be analyzed as total cyanide.

<sup>i</sup>Acetaldehyde and 2-nitropropane are listed with inhalation values in the CLARC Tables. However, because the inhalation pathway is not being addressed as part of this closure plan, they will not be analyzed.

<sup>j</sup>Acetyl chloride, MEK peroxide, and phosphorus pentasulfide are not listed in the CLARC Tables. They would most likely be inhalation hazards if present (based on National Institute for Occupational Safety and Health chemical hazard data), so they are not being calculated as closure performance standards and will not be analyzed.

<sup>k</sup>Chloroacetaldehyde – No previous records of analysis on the Hanford Site. CAS is not listed in the CLARC tables. Chloroacetaldehyde is not listed in the CLARC Tables. It would most likely be an inhalation hazard if present, so it is not being calculated as a closure performance standard and will not be analyzed.

<sup>l</sup>2-Ethoxyethanol – Due to the extremely short half-life of 2-ethoxyethanol (between 168 and 672 hours), 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.

<sup>m</sup>A CFC is an organic compound that contains only carbon, chlorine, and fluorine, produced as a volatile derivative of methane, ethane, and propane. Examples of CFCs include 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-133) and trifluoromethane (CFC-11).

CAS = Chemical Abstract Services

MTCA = Model Toxics Control Act

CFC = Chlorinated fluorocarbon

N/A = Not applicable

CLARC = Cleanup Levels and Risk Calculation

PQL = Practical quantitation limit

CPCCo = Central Plateau Cleanup Company, LLC

RPD = Relative percent difference

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### 1 **H.3.9 Conditions That Will be Achieved When Closure is Complete**

2 Upon completion of the closure activities, the 221-T Railroad Cut will remain in an “as-is” state with the  
3 gravel and railroad tracks remaining in place. Once Ecology accepts the clean closure certification, a  
4 permit modification request will be submitted to remove the 221-T Railroad Cut DWMU closure  
5 requirements from the Permit.

## 6 **H.4 Sampling and Analysis Plan**

7 Sampling and analysis of the 221-T Railroad Cut soil will be conducted to confirm whether closure  
8 performance standards have been met. Sampling includes 24 grid (area-wide) soil samples  
9 (Section H.4.4.1). Analysis will be performed in accordance with the sampling and quality standards  
10 established in this closure SAP.

### 11 **H.4.1 Sampling and Analysis Plan Requirements**

12 Soil sampling and analysis activities were designed using the EPA guidance document EPA/240/R-02/005,  
13 *Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a*  
14 *Quality Assurance Project Plan* (EPA QA/G-5S) and Ecology Publication #94-111, and will be conducted  
15 via this SAP. The objective of the sampling described in this section is to determine if the closure  
16 performance standards (Table H-4) established in this closure plan pursuant to WAC 173-303-610(2)(b)(i)  
17 and WAC 173-303-610(2)(b)(ii) have been satisfied, demonstrating clean closure of the 221-T Railroad  
18 Cut.

19 The closure SAP details sampling and analysis procedures in accordance with SW-846, *Test Methods for*  
20 *Evaluating Solid Waste: Physical/Chemical Methods*, Third Edition; Final Update V; the American  
21 Society for Testing and Materials (ASTM) *Annual Book of ASTM Standards* (ASTM International, 2017);  
22 and applicable EPA guidance. Sampling and analysis activities will meet applicable requirements of  
23 SW-846, ASTM standards, EPA-approved methods at the time of closure. This SAP was also developed  
24 using guidance from Ecology Publication #94-111, Section 7.0, Sampling and Analysis for Clean  
25 Closure, and EPA/240/R-02/005.

### 26 **H.4.2 Sampling and Analysis Schedule**

27 Closure sampling and analysis will be performed in accordance with the closure plan schedule located in  
28 Section H.6.

### 29 **H.4.3 Project Management**

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

#### 34 **H.4.3.1 Project/Task Organization**

35 The Permittees are responsible for planning, coordinating, sampling, preparing, packaging, and shipping  
36 samples to the contract analytical laboratory. The project has the following key positions.

37 **Regulatory Representative.** Ecology will assign an Ecology employee as Project Manager responsible  
38 for oversight of the 221-T Railroad Cut closure.

39 **Project Manager and Technical Lead.** The CPCCo Project Manager provides oversight of closure  
40 activities and coordinates with the U.S. Department of Energy, Richland Operations Office (DOE-RL),  
41 Ecology, and contract management. In addition, support is provided to the project technical lead to ensure  
42 that work is performed safely and cost effectively.

1 The Project Manager (or designee) for the 221-T Railroad Cut closure sampling is responsible for direct  
2 management of sampling documents and requirements, field activities, and subcontracted tasks. The  
3 Project Manager is responsible for ensuring that project personnel are working to the approved version of  
4 the 221-T Railroad Cut Closure Plan in the Permit and for providing updates to field personnel.

5 The Project Manager works closely with QA, Health and Safety and the Field Work Supervisor (FWS) to  
6 integrate these and other lead disciplines in planning and implementing the work scope. The Project  
7 Manager also coordinates with DOE-RL and the primary contractor management on all sampling  
8 activities. The Project Manager supports DOE-RL in coordinating sampling activities with the Regulatory  
9 Representative.

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

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

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

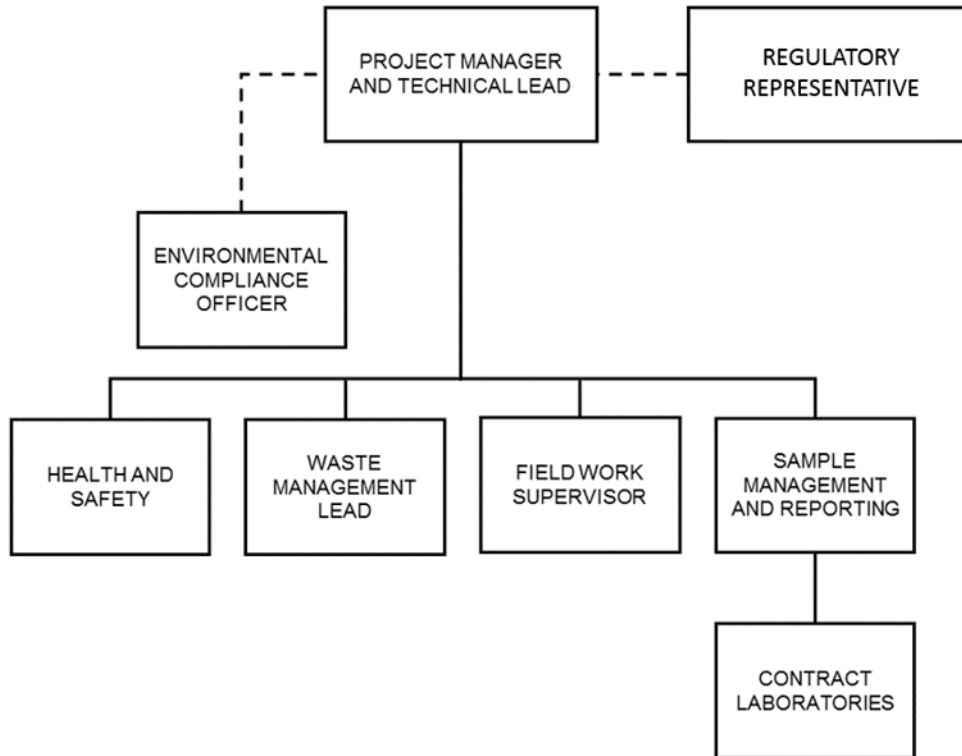
19 **Field Work Supervisor.** The FWS is responsible for planning and coordinating field sampling resources.  
20 The FWS ensures that samplers are appropriately trained and available. Additional related responsibilities  
21 include ensuring that the sampling design is achievable, understood, and can be performed as specified.

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

28 **Sample Management and Reporting.** The Permittee's sampling organization coordinates field sampling  
29 as well as laboratory analytical work, ensuring that laboratories conform to the specifications of SW-846  
30 analytical methodology at the time of closure. The sampling organization receives the analytical data  
31 from the laboratories, performs the data entry into the Hanford Environmental Information System  
32 (HEIS) database, and arranges for data validation. The sampling organization is responsible for informing  
33 the Project Manager of any issues reported by the contract analytical laboratory.

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

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



1 **Figure H-4 Sampling and Analysis Plan Project Organization**

2

3 **H.4.3.2 Field Sampler Training/Certification**

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

7 **H.4.3.3 Sampling Documents and Records**

8 The Project Manager is responsible for ensuring that the current version of the SAP is being used and  
9 providing any updates to field personnel. Version control is maintained by the administrative document  
10 control process. Changes to the SAP affecting the data needs will be submitted as a permit modification  
11 request.

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

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

- 23
- 24
- Field logbooks or operational records.
  - Global positioning system data.

- 1       • Sample authorization forms.
- 2       • Data forms.
- 3       • COC forms.
- 4       • Sample receipt records.
- 5       • Inspection or assessment reports and corrective action reports.
- 6       • Interim progress reports.
- 7       • Final reports.
- 8       • Laboratory data packages.
- 9       • Data verification and validation reports.

10 The contract analytical laboratory is responsible for maintaining, and having available upon request, the  
11 following items:

- 12       • Analytical logbooks.
- 13       • Raw data and Quality Control (QC) sample records.
- 14       • Standard reference material or proficiency test sample data.
- 15       • Instrument calibration information.

16 Records will be stored in accordance with Section H.1.4.4.

#### 17 **H.4.4 Sampling Design and Analysis**

18 The sampling design includes input parameters used to determine the number and location of samples.  
19 The primary purpose of sampling the soil is to determine if analytical results meet closure performance  
20 standards (Table H-4).

##### 21 **H.4.4.1 Sampling Process Design**

22 This SAP is based on guidance from Ecology Publication #94-111, Section 7.0, to determine the type of  
23 sampling design that will be used to demonstrate clean closure. When designing the sampling plan,  
24 area-wide (grid or random) sampling methods were considered. The basis for grid (area-wide) sampling is  
25 described in the following paragraphs.

26 **Grid (Area-Wide) Soil Sampling.** Ecology Publication #94-111, Section 7.2.1, Area Wide Sampling,  
27 identifies that grid sampling is appropriate when the spatial distribution of contamination at or from the  
28 closure unit is uncertain. Ecology Publication #94-111, Section 7.3, Sampling to Determine or Confirm  
29 Clean Closure, identifies the grid sampling approach as generally appropriate for sampling to determine  
30 or confirm whether closure performance standards are met.

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

37 The quantity and location of sample nodes for the soil and gravel areas within the 221-T Railroad Cut  
38 were determined using the VSP software. VSP is a tool used throughout Washington State and nationally  
39 that statistically determines the quantity of samples required to accept or reject the null hypothesis based  
40 on input parameters specific to the unit or area. A null hypothesis is generally assumed true until evidence  
41 indicates otherwise. The null hypothesis, as defined in WAC 173-340-200, *Definitions*, for  
42 221-T Railroad Cut is that soil is assumed to be above closure performance standards as defined in  
43 Sections H.3.7 and H.3.8. Therefore, the soil is presumed to be contaminated. Rejection of the null

1 hypothesis means results of field sampling and laboratory analysis indicated that soil meets closure  
2 performance standards.

3 Should sampling and analysis provide a basis that the null hypothesis can be accepted, such an event will  
4 be considered an unexpected event during closure, and the soil would then be identified as contaminated  
5 environmental media and managed in accordance with Section H.3.5.

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

11 For the 221-T Railroad Cut, data assumptions were based on a DQO process performed in accordance  
12 with EPA/240/R-02/005. VSP parameter inputs, which are based on the DQO process, are detailed in  
13 Table H-5.

14 The decision rule for demonstrating compliance with the closure performance standards, which are based  
15 on MTCA (WAC 173-340) Method B cleanup levels, includes a three-part test comparing sample results  
16 to the closure performance standards:

- 17 • The 95 percent upper confidence limit on the true data mean must be less than the MTCA  
18 Method B cleanup level.
- 19 • No sample concentration can be more than twice the applicable cleanup level.
- 20 • Less than 10 percent of the samples can exceed the applicable cleanup levels.

21 Using a nonparametric test and the input parameters identified in Table H-5, VSP calculated that  
22 24 samples would adequately describe the population. With this level of confidence in the population  
23 description, the null hypotheses could be rejected with 95 percent confidence and ensure that a site would  
24 not be mistakenly released as clean (uncontaminated). The VSP software compares the site mean to a  
25 fixed threshold in order to accept or reject the null hypothesis. Data will be evaluated to ensure that less  
26 than 10 percent of the individual values exceed MTCA (WAC 173-340) Method B cleanup levels and that  
27 no values are more than twice the cleanup level.

28 Grid sample node locations were determined using the grid with a random start sampling method run in  
29 the VSP software. Statistical analysis of systematically collected data is valid if a random start to the grid  
30 is used. The dimensions of the 221-T Railroad Cut were entered into VSP to determine the locations of  
31 the sample nodes. The triangular grid sampling layout was determined to have an even distribution over  
32 the soil and gravel areas within the 221-T Railroad Cut; thus, providing the most representative data set  
33 including coverage of the middle portion of the sampling area. The 24 samples will be taken from the  
34 node locations indicated by the VSP software (shown in Figure H-5) and will be assigned sample location  
35 identifications and sample numbers using the HEIS database.

36 The first node location is chosen at random by the VSP software, and the subsequent 23 sample locations  
37 are assigned by the VSP software using a triangular grid sampling method to achieve an even distribution.

38 Supporting documentation for the VSP software sampling designations is provided in Attachment B,  
39 *T Plant 221-T Railroad Cut Visual Sampling Plan Supporting Documentation*.

**Table H-5 Visual Sample Plan Parameter Inputs for Grid (Area-Wide) Soil Sampling**

<b>Parameter</b>	<b>Value</b>	<b>Basis</b>
Primary Objective of the Sampling Design	Null Hypothesis	Compare a site mean or median to a fixed threshold. The basis is that the null hypothesis is true (site is contaminated). Clean closure requires rejection of the null hypothesis. Rejection of the null hypothesis.
Type of Sampling Design	Nonparametric	Data are not assumed to be normally distributed.
Working Null Hypothesis	The mean value exceeds the threshold	The null hypothesis assumes that the site is dirty requiring the sampling and analysis to demonstrate through statistical analysis that the site is clean (MTCA [WAC 173-340] Method B closure performance standards).
Grid Sampling Pattern	Triangular	A triangular pattern provided an even distribution of sample locations over soil and gravel areas within the 221-T Railroad Cut.
Standard Deviation (S)	45%	This is the assumed standard deviation value relative to a unit action level for the sampling area. The value of 45% is conservative, based on consideration of past verification sampling. (Number of samples calculated increases with higher standard deviation values relative to a unit action level.)
Delta ( $\Delta$ )	40%	This is the width of the grey region. It is a user-defined value relative to a unit action level. The value of 40% balances unnecessary remediation cost with sampling cost. A Type II error with the grey region would result in cleanup of a site that is already clean.
Alpha ( $\alpha$ )	5%	This is the acceptable error of deciding a dirty site is clean when the true mean is equal to the action level. It is a maximum error rate since dirty sites with a true mean above the action level will be easier to detect. A value of 5% was chosen as a practical balance between health risks and sampling cost.
Beta ( $\beta$ )	20%	This is the acceptable error of deciding a clean site is dirty when the true mean is at the lower bound of the gray region. A value of 20% was chosen during the DQO process as a practical balance between unnecessary remediation cost and sampling cost.
MARSSIM sampling overage	20%	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 $n$ .

**Table H-5 Visual Sample Plan Parameter Inputs for Grid (Area-Wide) Soil Sampling**

Parameter	Value	Basis
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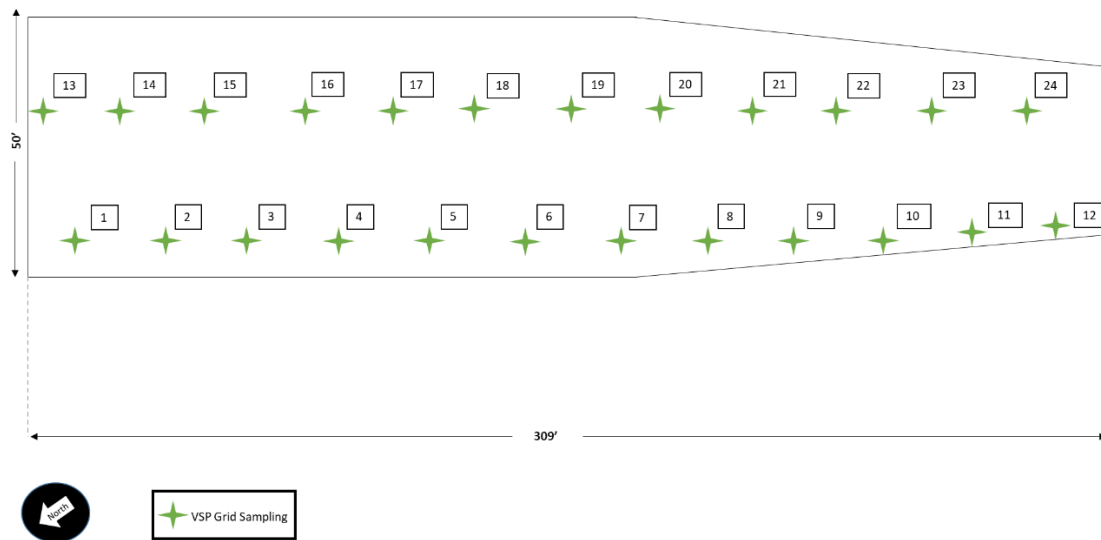
References: EPA 402-R-97-016, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

WAC 173-340, *Model Toxics Control Act Cleanup Regulations*.

DQO = Data quality objective

MTCA = Model Toxics Control Act—Cleanup

1



**Figure H-5 Grid Sampling Locations**

2

3

**H.4.4.2 Sampling Methods and Handling**

5 The grab sample matrix will consist of soil collected in clean sample containers. Soil will be collected at a  
6 depth of no more than 15 cm (6 in.) below ground surface, unless staining or discoloration indicates  
7 contamination is below that depth. For the purpose of this SAP, ground surface is defined as the exposed  
8 surface layer once loose gravel has been removed. Once the soil is collected, the sampled media will be  
9 screened to remove material larger than approximately 2 mm (0.08 in.) in diameter, which allows for a  
10 larger surface area-to-volume ratio. This ratio increases the likelihood of identifying any potential  
11 contamination in the sample.

12 To ensure sample and data usability, sampling will be performed in accordance with established sampling  
13 practices, procedures, and requirements pertaining to sample collection, collection equipment, and sample  
14 handling. Sampling includes the following:

- 15 • Preparation and review of sampling paperwork such as COCs or labels.
- 16 • Sample container and equipment preparation.
- 17 • Field walk down of sample area (includes locating and marking sample locations).
- 18 • Sample collection.
- 19 • Sample packaging and shipping.

20 Sample preservation and holding time requirements are specified in Table H-6. These requirements are in  
21 accordance with the analytical method specified. The final container type and volumes will be identified  
22 on the sampling authorization form and COC form.

**Table H-6 Preservation, Container, 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)	None	180 days	G/P
7196	Colorimetric (Hexavalent Chromium)	Cool $\leq 6^{\circ}\text{C}$	30 days prior to extraction; 7 days after extraction	G/P
7471	Cold Vapor Atomic Absorption (Mercury)	Cool $\leq 6^{\circ}\text{C}$	28 days	G/P
8015	GC/Flame Ionization Detector (Non-halogenated Organics [Methanol])	Cool to $\leq 6^{\circ}\text{C}$	14 days	G
8260	GC/MS (Volatile Organic Compounds)	Frozen*	14 days	G
8270	GC/MS (Semivolatile Organic Compounds)	Cool $\leq 6^{\circ}\text{C}$	14 days prior to extraction; 40 days after extraction	Amber Glass
9012	Colorimetric (Total Cyanide)	Cool $\leq 6^{\circ}\text{C}$	14 days from sampling to extraction; 40 days from extraction to analysis	G/P
9056	Ion Chromatography (Inorganic Anions [Formic Acid as Formate])	Cool $\leq 6^{\circ}\text{C}$	28 days	G/P

Reference: SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, Third Edition; Final Update V.

\*Preservation techniques for soil samples collected include refrigeration immediately following collection (placing on ice) and freezing overnight prior to shipping. Holding times are from sampling to analysis unless specified otherwise.

AES = Atomic emission spectrometry

ICP = Inductively coupled plasma

EPA = U.S. Environmental Protection Agency

MS = Mass spectrometry

GC = Gas chromatography

G/P = Glass/plastic

- 1
- 2 A sampling and data-tracking database (e.g., HEIS) is used to track the samples from the point of
- 3 collection through the laboratory analysis process. HEIS sample numbers are issued to the sampling
- 4 organization for the project. Each sample is identified and labeled with a unique HEIS sample number.
- 5 To prevent potential contamination of the samples, clean equipment will be used for each sampling
- 6 activity. Equipment used during sampling will be decontaminated or disposed of and managed as newly
- 7 generated waste in accordance with Section H.3.6. Level I EPA pre-cleaned sample containers will be
- 8 used for samples collected for chemical analysis. Container sizes may vary, depending on
- 9 laboratory-specific volumes/requirements for meeting the PQL.
- 10 The date and time of sample collection, and the sample location, depth, and corresponding HEIS numbers
- 11 will be documented in the sampler's field logbook. A custody seal (e.g., evidence tape) will be affixed to
- 12 each sample container (except for Volatile Organic Analysis [VOA] sample containers) or the sample
- 13 collection package in such a way as to indicate potential tampering. The custody seal will be inscribed
- 14 with the sampler's initials and date. Custody tape is not applied directly to VOA sample containers based
- 15 on the potential for affecting analyte results or fouling of laboratory equipment. Alternatively, VOA vials
- 16 are placed in a sealable plastic bag affixed with custody seals and any other required
- 17 labels/documentation.

1 Data verification and validation will also note any issues with sample collection and analysis. Each  
2 sample container will be labeled with the following information on firmly affixed, water-resistant labels:

- 3 • Sample authorization form and form number.
- 4 • HEIS number.
- 5 • Sample collection date and time.
- 6 • Sampler identification (e.g., initials).
- 7 • Analysis required.
- 8 • Preservation method (if applicable).
- 9 • COC identification number.

10 In addition to the container label information, sample records must include:

- 11 • Sample location.
- 12 • Matrix (e.g., soil).

13 Sample custody will be maintained in accordance with existing Hanford Facility protocols to ensure  
14 maintenance of sample integrity throughout the analytical process. COC protocols will be followed  
15 throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is  
16 maintained. A COC record is initiated in the field at the time of sampling and will accompany each set of  
17 samples shipped to any laboratory. At a minimum, the following information must be identified on a  
18 completed COC record:

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

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

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

32 Contaminated environmental media and newly generated waste resulting from sampling activities will be  
33 handled in accordance with all applicable requirements of WAC 173-303-170 through WAC 173-303-230  
34 as outlined in Sections H.3.5 and H.3.6.

#### 35 **H.4.4.3 Sampling and Analysis Requirements to Address Removal of Contaminated Soil**

36 In the event that grid sampling results based on the MTCA (WAC 173-340) three-part test  
37 (Section H.4.4.1) indicate contamination above clean closure performance standards, then the  
38 contaminated soil from the node locations(s) that indicated contamination will be removed and managed  
39 in accordance with Section H.3.5.

1 Following remediation of the contaminated soil, VSP will be used to generate a new grid sampling  
2 design. The new grid sampling design will use a new random start point and new grid-node sampling  
3 locations, in accordance with the same model parameters established in Section H.4.4.1. Grab samples  
4 collected from the new grid-node locations will be analyzed for constituents that previously did not meet  
5 closure performance standards. The new sample results will be analyzed to confirm clean closure as  
6 described in Section H.5.1. If the new sample results meet the closure performance standards, the site will  
7 be considered clean. If the new sample results do not meet the closure performance standards, then the  
8 Permittees will meet with Ecology to determine a path forward for closure. Resulting changes to this  
9 closure plan will be submitted to Ecology as a permit modification request in accordance with Permit  
10 Condition I.C.3.

11 The new grid sampling design, analytical results, and corresponding VSP report documentation will be  
12 provided as supporting information with the closure certification as described in Section H.5.3.

#### 13 **H.4.4.4 Analytical Methods**

14 All analyses and testing will be performed consistent with this closure plan, laboratory contracts, and  
15 laboratory analytical procedures at the time of closure. The contracted analytical laboratory must achieve  
16 the lowest PQLs consistent with the selected analytical method (identified in Table H-4) in order to  
17 confirm that the closure performance standards are met.

#### 18 **H.4.4.5 Quality Control**

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

- 22 • Field trip blanks.
- 23 • Field transfer blanks.
- 24 • Equipment rinsate blanks.
- 25 • Field duplicates.

26 Laboratory QC samples estimate the precision and bias of the analytical data. Laboratory QC samples  
27 include:

- 28 • Method blanks.
- 29 • Laboratory duplicates.
- 30 • Matrix spikes.
- 31 • Matrix spike duplicates.
- 32 • Surrogates.
- 33 • Laboratory control samples.

34 Field and laboratory QC samples are summarized in Table H-7.

**Table H-7 Project Quality Control Sampling Summary**

QC Sample Type	Frequency	Characteristics Evaluated
<b>Field QC</b>		
Field Trip Blanks	One per 20 samples, minimum of 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	Equipment rinsate blanks are used to measure the cleanliness of sampling equipment and effectiveness of equipment decontamination procedures.  Equipment rinsate blanks are not required if only disposable equipment is used, or if rinsing between samples is not practical (e.g., core drilling equipment).
Field Duplicates	One per 20 samples with a minimum of one per decision unit	Field duplicates are used to assess the precision of the entire data collection activity, including sampling, analysis, and site heterogeneity.
<b>Laboratory QC*</b>		
Method Blanks	One per batch	Method blanks measure contamination associated with laboratory sample preparation and analysis.
Laboratory Duplicates	One per laboratory analytical batch	Laboratory duplicates measure laboratory reproducibility and precision.
Matrix Spikes	One per laboratory analytical batch	The matrix spike recovery 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 spikes and matrix spike duplicates 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 the sample to evaluate accuracy, method performance, and extraction efficiency.
Laboratory Control Samples	One per laboratory analytical batch	The laboratory control samples measure the accuracy of the analytical methods.

\*Batching across projects is allowed for similar matrices.

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#### **H.4.5 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 H.4.5.1. A total of 5 percent of the data will be validated as described in Section H.4.5.2. Grid soil sample results will be evaluated to ensure VSP model assumptions were correct (Section H.4.5.3) and a Data Quality Assessment (DQA) will be conducted to ensure the output of the DQO process provided appropriate values (Section H.4.5.4).

#### 1 **H.4.5.1 Data Verification**

2 Verification activities ensure analytical data in the database were properly uploaded and reflect the  
3 contract laboratory program equivalent data packages. The steps outlined below will consider both the  
4 primary and QC samples. Activities will include, but are not limited to, the following:

- 5 • Amount of data requested matches the amount of data received (number of samples for requested  
6 methods of analytes).
- 7 • Correct procedures/methods are used.
- 8 • Issues with sample collection and analysis are noted.
- 9 • Documentation/deliverables are complete.
- 10 • Hardcopy and electronic versions of the data are identical.
- 11 • Data is reasonable based on analytical methodologies.

#### 12 **H.4.5.2 Data Validation**

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

17 Controls are in place to preserve the data sent to the validators, such as allowing only additions to be  
18 made, not changes to the raw data. The format and requirements for data validation activities are based on  
19 the most current version of EPA-540-R-08-01, *National Functional Guidelines for Superfund Organic*  
20 *Methods Data Review* (OSWER 9240.1-48), and EPA-540-R-10-011, *National Functional Guidelines for*  
21 *Inorganic Superfund Data Review* (OSWER 9240.1-51). As defined by the validation guidelines,  
22 5 percent of the analytical results will undergo Level C validation.

#### 23 **H.4.5.3 Verification of Visual Sample Plan Input Parameters**

24 Analytical data from grid soil sampling will be entered back into the VSP data analysis function to  
25 generate the data Analysis Report. If all analytical data for a particular analyte are nondetectable at levels  
26 below the closure performance standard, then verification of VSP input parameters is not required for that  
27 analyte. VSP software uses the analytical data to determine if the user input parameters were estimated  
28 appropriately.

29 Once analytical data are entered into VSP, the software will calculate the true standard deviation and  
30 determine if the null hypothesis can be rejected (Section H.4.4.1). If the calculated standard deviation is  
31 smaller than the estimated user input standard deviation, then no additional sampling will be required. If  
32 the calculated standard deviation is larger than the estimated standard deviation, then additional sampling  
33 may be required.

34 Verification of the null hypothesis through VSP will determine if the mean value of the site analytical  
35 data supports rejection of the null hypothesis (Section H.4.4.1). If additional statistical tools are identified,  
36 such as EPA's ProUCL,<sup>2</sup> then they will be used, as appropriate, to augment evaluation of the data set.

#### 37 **H.4.5.4 Data Quality Assessment**

38 A DQA will be performed on the final data using the guidance in EPA/240/B-06/002, *Data Quality*  
39 *Assessment: A Reviewer's Guide* (EPA QA/G-9R), and implementing the specific requirements in  
40 Sections H.4.5.1 through H.4.5.3.

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<sup>2</sup>ProUCL Software is a comprehensive statistical software package developed and maintained by EPA.

#### 1 **H.4.6 Revisions to the Sampling and Analysis Plan and Constituents to be Analyzed**

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

#### 6 **H.5 Confirmation and Certification of Closure Activities**

7 Confirmation of closure will be performed using methods defined in Section H.5.1. Closure certification  
8 is performed by an Independent Qualified Registered Professional Engineer (IQRPE) (Section H.5.2).  
9 Certification is submitted to Ecology as described in Section H.5.3, and the conditions of the DWMU  
10 after closure are described in Section H.3.9. The timing of closure is described in Section H.6.

##### 11 **H.5.1 Confirmation of Clean Closure**

12 The 221-T Railroad Cut will be confirmed clean closed through sampling of soil. Soil sample results from  
13 the contract analytical laboratory will be reviewed to confirm that target analytes meet closure  
14 performance standards (Sections H.3.7 and H.3.8). Once it has been determined that the soil sample  
15 results have met closure performance standards, the soils and gravel in the 221-T Railroad Cut will be  
16 considered clean.

17 Once clean closure has been confirmed for the 221-T Railroad Cut DWMU, a closure certification will be  
18 prepared in accordance with Section H.5.3.

##### 19 **H.5.2 Role of the Independent Qualified Registered Professional Engineer**

20 An IQRPE will be retained to provide certification of the closure as required by WAC 173-303-610(6).  
21 The IQRPE will be responsible for observing field activities and reviewing documents associated with  
22 clean closure of the 221-T Railroad Cut DWMU. At a minimum, the following field activities will be  
23 completed:

- 24 • Review 221-T Railroad Cut visual inspection documentation.
- 25 • Verify that the locations of soil samples are as specified in the SAP.
- 26 • Observe and/or review soil sampling activities.
- 27 • Review sampling procedures and results.
- 28 • Observe and/or review contaminated environmental media removal (as applicable).
- 29 • Observe and/or review newly generated waste management and disposition records.
- 30 • Verify that closure activities were performed in accordance with this closure plan.

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

##### 34 **H.5.3 Closure Certification**

35 Within 60 days of completion of closure of the 221-T Railroad Cut DWMU, a certification that the  
36 DWMU has been closed in accordance with the specifications in this closure plan will be submitted to  
37 Ecology by registered mail or other means that establish proof of receipt (including applicable electronic  
38 means). The certification will be signed by the Permittees and by the IQRPE.

39 At the time of the closure certification submittal, the Permittees will submit to Ecology information to  
40 support the closure certification. [WAC 173-303-610(6)]

1 The supporting information will include at least the following:

- 2 • All field notes and photographs related to closure activities.
- 3 • A description of any minor deviations from this closure plan and justification for these deviations.
- 4 • Documentation of the removal and final disposition of any unanticipated contaminated  
5 environmental media.
- 6 • Documentation of the removal and final disposition of any newly generated waste.
- 7 • All laboratory and/or field data, including sampling procedures, sampling locations, QA/QC  
8 samples, and COC procedures for all samples and measurements, including samples and  
9 measurements taken to determine background conditions and determine or confirm clean closure.
- 10 • A summary report that identifies and describes the data reviewed by the IQRPE, and tabulation of  
11 the analytical results of samples taken to determine and confirm clean closure performance  
12 standards were met.
- 13 • Description of the 221-T Railroad Cut DWMU appearance at completion of closure, including  
14 what parts of the former unit, if any, will remain after closure.

## 15 **H.6 Closure Schedule and Time Frame**

16 Closure activities will take longer to complete<sup>3</sup> than 180 days after the effective date of the approved  
17 permit modification incorporating this closure plan. The permit modification request to extend completion  
18 of closure has set the revised date of closure completion by March 14, 2027. This request also had the  
19 required information on steps to be taken to prevent threats to human health and the environment.  
20 [WAC 173-303-610(4)(b)]

21 Should an unexpected event occur and an extension to the revised closure activity expiration date be  
22 deemed necessary, a permit modification request will be submitted to Ecology for approval at least  
23 30 days prior to the March 14, 2027, expiration date. [WAC 173-303-610(4)(c)]

24 The permit modification request will include the statement that, closure activities, will of necessity, take  
25 longer than the March 14, 2027, to complete, and the supporting basis for the statement. The permit  
26 modification request will also include necessary information demonstrating that all steps to prevent  
27 threats to HHE have been and will continue to be taken, including compliance with all applicable permit  
28 requirements. [WAC 173-303-610(4)(b)]

29 The closure certification will be submitted to Ecology within 60 days following completion of closure  
30 activities at the 221-T Railroad Cut DWMU (Table H-8 and Figure H-6).

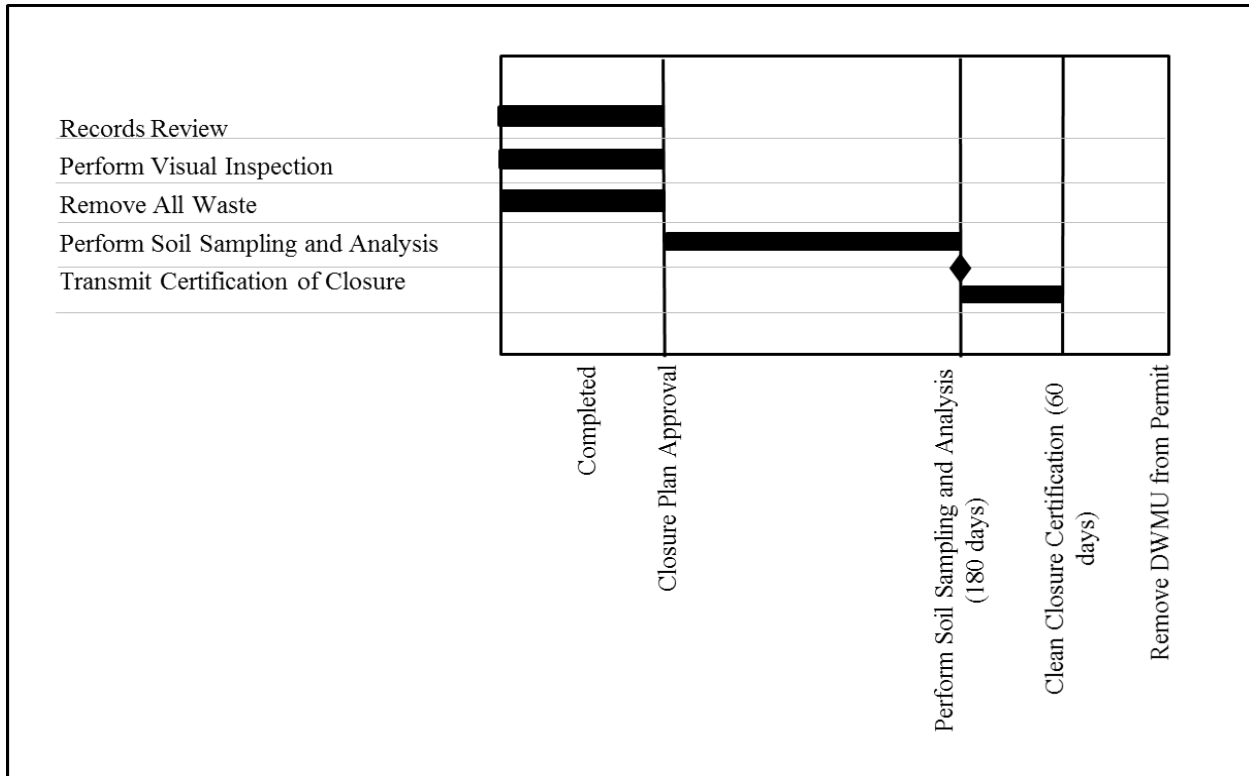
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<sup>3</sup>The closure timeline was extended from March 14, 2024, to March 14, 2025, through approval of Class <sup>1</sup>1 Permit Modification PCN-221TRC-2024-01 and was extended again from March 14, 2025, to March 14, 2026, through approval of Class <sup>1</sup>1 Permit Modification PCN-221TRC-2025-01. The closure timeline is extended from March 14, 2026, to March 14, 2027, through approval of Class <sup>1</sup>1 Permit Modification PCN-221TRC-2025-02. The permit modification incorporating this closure plan was issued on August 17, 2023 (8C.2023.3F). The original date for closure activity completion was March 14, 2024.

**Table H-8 221-T Railroad Cut Dangerous Waste Management Unit Closure Schedule**

<b>Closure Activity Description</b>		
<b>Activity</b>	<b>Description</b>	<b>Duration</b>
<b>Closure Activities</b>		
Remove All Waste	Package and ship dangerous and mixed waste to a RCRA permitted facility for treatment, storage, or disposal.	Completed (Section H.3.1)
Records Review	Perform review of 221-T Railroad Cut container storage, operating, and inspection records.	Completed (Section H.3.2)
Perform Visual Inspection of 221-T Railroad Cut	Inspect for dangerous or mixed waste-related staining. Identify focused sampling locations (as applicable).	Completed (Section H.3.2)
Perform Soil Sampling and Analysis of the 221-T Railroad Cut	Perform grid sampling and analysis in accordance with SAP (Section H.4).	170 Days
	Perform data verification and validation of VSP input parameters, and data quality assessment, as applicable (Section H.4.5).	
	If necessary, remove contaminated environmental media, and resample and analyze (Section H.4.4.3).	
Confirm Clean Closure	Review soil sample results from contract analytical laboratory. Ensure closure performance standards were met (Section H.5.1).	10
<b>Closure Certification</b>		
Permittees and IQRPE Submit Closure Certification	Within 60 days of completion of closure activities; provide certification to Ecology that the DWMU has been closed in accordance with specifications in this closure plan (Section H.5.3).	60 Days

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



**Figure H-6 221-T Railroad Cut Closure Schedule Activities**

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**H.7 Closure Costs**

An annual report outlining updated projections of anticipated closure costs for the Hanford Facility treatment, storage, and disposal units is not required per Permit Condition II.H.

**H.8 References**

17-AMRP-0217, 2017, “Dangerous Waste Management Unit (DWMU) 277-T Building Closure Plan Comment Disposition, and Performance Standards for Future Solid Waste Operations Complex (SWOC) Closure Plans” (letter to Alexandra K. Smith, Nuclear Waste Program, from Joe R. Franco), DOE-RL, Richland Operations Office, Richland, Washington, July 12. Available at: <https://pdw.hanford.gov/document/0069231H?>.

17-NWP-100, 2017, “Dangerous Waste Management Unit (DWMU) 277-T Building Closure Plan Comment Disposition and Performance Standards for Future Solid Waste Operations Complex (SWOC) Closure Plans” (letter to Joe Franco, DOE-RL, from Suzanne Dahl), Nuclear Waste Program, Ecology, Richland, Washington, August 14. Available at: <https://pdw.hanford.gov/document/0069016H?>.

21-NWP-033, 2021, “Approval of Permit Change Notices and Part A Forms to Transfer Co-Operator Responsibilities for the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8c, for the Treatment, Storage, and Disposal of Dangerous Waste* (Site-wide Permit), WA7890008967” (letter to Brian T. Vance, DOE-RL/ORP and Scott Sax, CPCCo, from Stephanie Schleif), Nuclear Waste Program, Ecology, Richland, Washington, March 15. Available at: <https://pdw.hanford.gov/document/AR-10235>.

- 1 40 CFR 268, *Land Disposal Restrictions*, Code of Federal Regulations. Available at:  
2 <http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol26/xml/CFR-2010-title40-vol26->  
3 [part268.xml](http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol26/xml/CFR-2010-title40-vol26-part268.xml).  
4 268.45, *Treatment standards for hazardous debris*.
- 5 ASTM International, 2017, *Annual Book of ASTM Standards*, ASTM International, West Conshohocken,  
6 Pennsylvania.
- 7 DOE/RL-92-24, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*,  
8 Rev. 4, 2 Volumes, DOE-RL, Richland, Washington. Available at:  
9 <https://pdw.hanford.gov/document/0096061?>.
- 10 DOE/RL-94-02, *Hanford Emergency Management Plan*, DOE-RL, Richland, Washington. Available at:  
11 [https://fortress.wa.gov/ecy/nwp/permitting/hdwp/rev/8c/Attachments/Att\\_04\\_Em\\_Mgt.pdf](https://fortress.wa.gov/ecy/nwp/permitting/hdwp/rev/8c/Attachments/Att_04_Em_Mgt.pdf).
- 12 ECF-HANFORD-11-0038, 2012, *Soil Background for Interim Use at the Hanford Site*, Revision 0,  
13 CH2M HILL Plateau Remediation Company, Richland, Washington. Available at:  
14 <https://pdw.hanford.gov/document/0088381?>.
- 15 Ecology, 2013, “Issues Associated with Establishing Soil Cleanup Levels for Arsenic”  
16 (letter to Jane Hedges and John Price, Nuclear Waste Program, from Dave Bradley),  
17 Toxics Cleanup Program, Washington State Department of Ecology, Olympia, Washington,  
18 June 11. Available at: <https://pdw.hanford.gov/document/1309180453?>.
- 19 Ecology, 2019, *Cleanup Levels and Risk Calculation (CLARC) Data Tables*, Toxics Cleanup Program,  
20 Ecology, Olympia, Washington. Available at:  
21 <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
- 22 Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 Volumes,  
23 as amended, Ecology, EPA, and DOE, Olympia, Washington. Available at:  
24 <https://www.hanford.gov/page.cfm/TriParty>.
- 25 Ecology Publication #94-111, 2005, *Guidance for Clean Closure of Dangerous Waste Units and*  
26 *Facilities*, as amended, Ecology, Olympia, Washington. Available at:  
27 <https://fortress.wa.gov/ecy/publications/documents/94111.pdf>.
- 28 EPA/240/B-06/001, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process*,  
29 EPA QA/G-4, Office of Environmental Information, EPA, Washington, D.C. Available at:  
30 [http://www.epa.gov/sites/production/files/documents/guidance\\_systematic\\_planning\\_dqo\\_](http://www.epa.gov/sites/production/files/documents/guidance_systematic_planning_dqo_)  
31 [process.pdf](http://www.epa.gov/sites/production/files/documents/guidance_systematic_planning_dqo_process.pdf).
- 32 EPA/240/B-06/002, 2006, *Data Quality Assessment: A Reviewer’s Guide*, EPA QA/G-9R, Office of  
33 Environmental Information, EPA, Washington, D.C. Available at:  
34 <http://www.epa.gov/sites/production/files/2015-08/documents/g9r-final.pdf>.
- 35 EPA/240/R-02/005, 2002, *Guidance on Choosing a Sampling Design for Environmental Data Collection*  
36 *for Use in Developing a Quality Assurance Project Plan*, EPA QA/G-5S, Office of  
37 Environmental Information, EPA, Washington, D.C. Available at:  
38 <http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=20011HKB.txt>.
- 39 EPA 402-R-97-016, 2000, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*,  
40 Rev. 1, U.S. Environmental Protection Agency, U.S. Department of Energy, U.S. Department of  
41 Defense, and U.S. Nuclear Regulatory Commission, Washington, D.C. Available at:  
42 [https://www.epa.gov/sites/production/files/2017-09/documents/marssim\\_manual\\_rev1.pdf](https://www.epa.gov/sites/production/files/2017-09/documents/marssim_manual_rev1.pdf).

- 1 EPA-540-R-08-01, 2008, *National Functional Guidelines for Superfund Organic Methods Data Review*,  
2 USEPA Contract Laboratory Program, OSWER 9240.1-48, Office of Superfund Remedial  
3 Technology and Innovation, EPA, Washington, D.C. Available at:  
4 [http://www.epa.gov/sites/production/files/2015-03/documents/somnfg\\_0.pdf](http://www.epa.gov/sites/production/files/2015-03/documents/somnfg_0.pdf).
- 5 USEPA-540-R-10-011, 2010, *National Functional Guidelines for Inorganic Superfund Data Review*,  
6 USEPA Contract Laboratory Program, OSWER 9240.1-51, Office of Superfund Remedial  
7 Technology and Innovation, EPA, Washington, D.C. Available at:  
8 <http://www.epa.gov/sites/production/files/2015-03/documents/ism1nfg.pdf>.
- 9 Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meyland, and E.M. Michalenko, 1991, *Handbook of*  
10 *Environmental Degradation Rates*, Lewis Publishers, Chelsea, Michigan.
- 11 NIOSH, 2010, *NIOSH Pocket Guide to Chemical Hazards*, Department of Health and Human Services  
12 (Centers for Disease Prevention and Control and National Institute for Occupational Safety and  
13 Health), Washington, D.C. Available at: <https://www.cdc.gov/niosh/npg/default.html>.
- 14 PNNL-23211, 2014, *Visual Sample Plan Version 7.0 User's Guide*, Pacific Northwest National  
15 Laboratory Richland, Washington. Available at: <https://vsp.pnnl.gov/docs/PNNL-23211.pdf>.
- 16 RCW 70A.300, *Hazardous Waste Management*, Olympia, Washington. Available at:  
17 <https://app.leg.wa.gov/RCW/default.aspx?cite=70A.300>.
- 18 *Resource Conservation and Recovery Act of 1976*, 42 U.S.C. 6901, et seq. Available at:  
19 <https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act>.
- 20 SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, Third Edition,  
21 Final Update V, Office of Solid Waste and Emergency Response, EPA, Washington, D.C.  
22 Available at: <https://www.epa.gov/hw-sw846>.
- 23 WAC 173-303, *Dangerous Waste Regulations*, Washington Administrative Code, Olympia, Washington.  
24 Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303>.  
25 173-303-140, *Land disposal restrictions*.  
26 173-303-170, *Requirements for generators of dangerous waste*.  
27 173-303-200, *Conditions for exemption for a large quantity generator that accumulates*  
28 *dangerous waste*.  
29 173-303-230, *Special conditions*.  
30 173-303-310, *Security*.  
31 173-303-350, *Contingency plan and emergency procedures*.  
32 173-303-610, *Closure and post-closure*.  
33 173-303-620, *Financial requirements*.  
34 173-303-630, *Use and management of containers*.  
35 173-303-830, *Permit changes*.
- 36 WAC 173-340, *Model Toxics Control Act Cleanup Regulations*, Washington Administrative Code,  
37 Olympia, Washington. Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340>.  
38 173-340-740, *Unrestricted land use soil cleanup standards*.  
39 173-340-747, *Deriving soil concentrations for groundwater protection*.  
40 173-340-7493, *Site-specific terrestrial ecological evaluation procedures*.  
41 173-340-750, *Cleanup standards to protect air quality*.  
42 173-340-900, *Tables*.

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**221-T RAILROAD CUT  
ATTACHMENT A  
T PLANT 221-T RAILROAD CUT VISUAL INSPECTION SUPPORTING DOCUMENTATION**

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T Plant Complex 221-T Railroad Cut Storage Area

**Purpose:**

A visual inspection of the T Plant Complex 221-T Railroad Cut Storage Area was performed to determine if there is any evidence of spills and/or leaks from waste packages containing dangerous waste that was stored at this location from past operations. The inspection was to identify and document by photographing any waste related staining of the storage area surface, and to denote any remaining waste related items.

The inspection was performed on September 18, 2013 by David Richards, Manager, T Plant (CHPRC).

**Results:**

No evidence of spills or staining was noted.

No waste is being stored in this area. Area consists of abandoned rail road tracks, gravel, tumbleweeds, and an inner and outer chain link fence and gates. Some debris was noted at the Western end of the Cut. Debris consists of steel plate, steel pipe, railroad ties, and a metal storage box (see photographs).

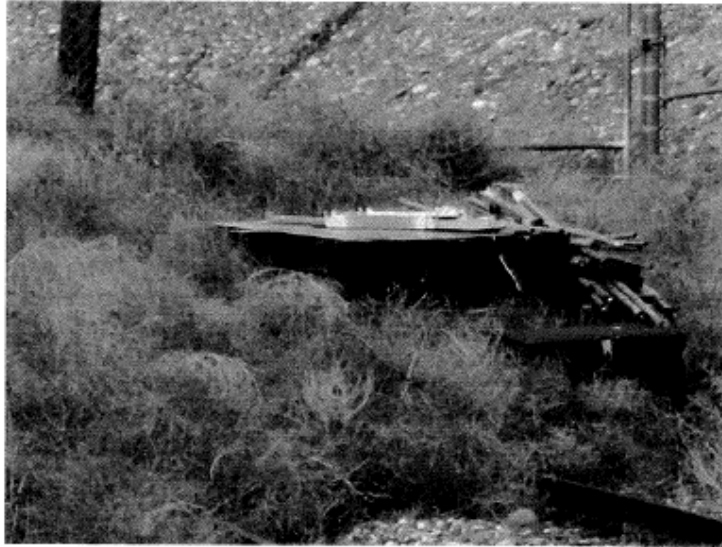
Area was photographed.



T Plant Complex 221-T Railroad Cut Storage Area



T Plant Complex 221-T Railroad Cut Storage Area



Signature/date:

David E. Richards

*David E. Richards* 9-26-13

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**221-T RAILROAD CUT  
ATTACHMENT B  
T PLANT 221-T RAILROAD CUT VISUAL SAMPLE PLAN 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	16
Number of samples adjusted for EMC	16
Number of samples with MARSSIM Overage	20
Number of samples on map <sup>a</sup>	24
Number of selected sample areas <sup>b</sup>	1
Specified sampling area <sup>c</sup>	14285.50 ft <sup>2</sup>
Size of grid / Area of grid cell <sup>d</sup>	25.847 feet / 578.563 ft <sup>2</sup>
Grid pattern	Triangular

<sup>a</sup> 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.

<sup>b</sup> 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.

<sup>c</sup> The sampling area is the total surface area of the selected colored sample areas on the map of the site.

<sup>d</sup> Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.



(0,0) Northwest Corner  
(-119.62002, 46.66279)

Area: Area 1						
X Coord	Y Coord	Label	Value	Type	Historical	Sample Area
16.5258	8.7292	1		Systematic		
42.3728	8.7292	2		Systematic		
68.2198	8.7292	3		Systematic		
94.0667	8.7292	4		Systematic		
119.9137	8.7292	5		Systematic		
145.7607	8.7292	6		Systematic		
171.6077	8.7292	7		Systematic		
197.4547	8.7292	8		Systematic		
223.3017	8.7292	9		Systematic		
249.1487	8.7292	10		Systematic		
274.9957	8.7292	11		Systematic		
300.8426	8.7292	12		Systematic		
3.6023	31.1133	13		Systematic		
29.4493	31.1133	14		Systematic		
55.2963	31.1133	15		Systematic		
81.1433	31.1133	16		Systematic		
106.9902	31.1133	17		Systematic		
132.8372	31.1133	18		Systematic		
158.6842	31.1133	19		Systematic		
184.5312	31.1133	20		Systematic		
210.3782	31.1133	21		Systematic		
236.2252	31.1133	22		Systematic		
262.0722	31.1133	23		Systematic		
287.9191	31.1133	24		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.

**Nuclides**

The following table summarizes the analyzed nuclides.

Nuclides Analyzed by Study		
Nuclide	DCGL <sub>w</sub>	DCGL <sub>EMC</sub>
Analyte 1	1	

**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:

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

where

$$\text{Sign}P = \Phi\left(\frac{\Delta}{s_{total}}\right)$$

- Φ(z) is the cumulative standard normal distribution on (-∞, z) (see PNNL-13450 for details),
- n is the number of samples,
- S<sub>total</sub> 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,

- $\beta$  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 **Nuclides Analyzed by Study** table, the values of these inputs that result in the calculated number of sampling locations are:

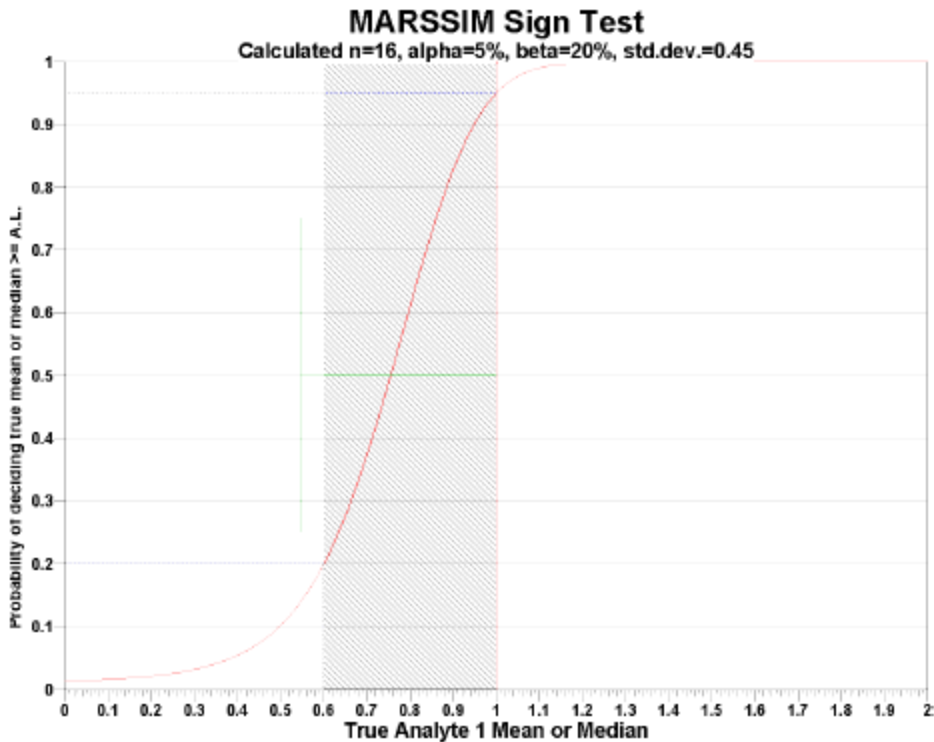
Nuclide	n <sup>a</sup>	n <sup>b</sup>	n <sup>c</sup>	Parameter					
				S	$\Delta$	$\alpha$	$\beta$	$Z_{1-\alpha}$ <sup>d</sup>	$Z_{1-\beta}$ <sup>e</sup>
Analyte 1	16	16	20	0.45	0.4	0.05	0.2	1.64485	0.841621

- <sup>a</sup> The number of samples calculated by the formula.
- <sup>b</sup> The number of samples increased by EMC calculations.
- <sup>c</sup> The final number of samples increased by the MARSSIM Overage of 20%.
- <sup>d</sup> This value is automatically calculated by VSP based upon the user defined value of  $\alpha$ .
- <sup>e</sup> This value is automatically calculated by VSP based upon the user defined value of  $\beta$ .

#### 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  $\Delta$ ; the upper horizontal dashed blue line is positioned at  $1-\alpha$  on the vertical axis; the lower horizontal dashed blue line is positioned at  $\beta$  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  $\Delta$  at  $\beta$  and the upper bound of  $\Delta$  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		$\alpha=5$		$\alpha=10$		$\alpha=15$	
		s=0.9	s=0.45	s=0.9	s=0.45	s=0.9	s=0.45
LBGR=90	$\beta=15$	1103	280	825	209	659	167
	$\beta=20$	948	240	692	176	542	138
	$\beta=25$	826	209	587	149	449	114
LBGR=80	$\beta=15$	280	75	209	56	167	45
	$\beta=20$	240	64	176	47	138	36
	$\beta=25$	209	56	149	40	114	30
LBGR=70	$\beta=15$	128	36	95	27	77	22
	$\beta=20$	110	32	81	23	63	18
	$\beta=25$	95	27	69	20	52	15

s = Standard Deviation

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

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

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

AL = Action Level (Threshold)

Note: values in table are note adjusted for EMC

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