Appendix B

Waste Site Supporting Information

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B1 Introduction

This appendix contains an overview of supporting waste site information consisting of historical waste streams from operating facilities, indications of historical groundwater effects, and a preliminary screening of remedial technologies (see Tables B-1 to B-7).

Table B-1. T Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total) [a]	Receiving Waste Site	Comment
Coating Removal Waste (221-T)	NaOH $NaNO_3$ $NaAlO_2$ Na_2SiO_3 $NaNO_2$	4,700 gal per 1.5 metric tons of fuel	Tank Farm	This was an alkaline waste stream.
Metal Dissolution (221-T)	NO_x Xe I_2		To Stack	Released to atmosphere.
Metal Waste (221-T)	UNH Fission products HNO_3 H_2SO_4 H_3PO_4 $NaNO_3$ NaOH Na_2CO_3	5,700 gal per 1.5 metric tons of fuel	Tank Farm	This waste stream contained most of the residual uranium from the irradiated fuel. This was an acidic waste stream that was made alkaline before transfer to the tank farm.
First Cycle Waste (221-T)	$CaPO_4$ $Zr_3(PO_4)_2$ H_3PO_4 HNO_3 $BiPO_4$ $Fe_2(SO_4)_3$ $Cr(NO_3)_3$ $(NH_4)_2SO_4$ $(NH_4)_2SiF_6$ $NaNO_3$ NH_4NO_3 $Pu(NO_3)_4$ Fission products NaOH	4,700 gal per 1.5 metric tons of fuel	Tank Farm	This acidic waste stream was made alkaline before transfer to the tank farm.

Table B-1. T Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total) [a]	Receiving Waste Site	Comment
Second Cycle Waste (221-T)	H_3PO_4 HNO_3 $BiPO_4$ $Fe_2(SO_4)_3$ $Cr(NO_3)_3$ $(NH_4)_2SO_4$ $(NH_4)_2SiF_6$ $NaNO_3$ NH_4NO_3 Fission products NaOH	3,600 gal per 1.5 metric tons of fuel	Tank Farm[b]	This acidic waste stream was made alkaline before transfer to the tank farm. As tank farms became full, and tank space for waste was limited, this waste stream was discharged to selected cribs and trenches.
Plutonium Concentration Waste (224-T)	H_3PO_4 HNO_3 LaF_3 $BiPO_4$ KOH $Cr(NO_3)_3$ $NaNO_3$ KNO_3 HF KF $H_2C_2O_4.2H_2O$ $Mn(NO_3)_2$ NH_4NO_3 $Pu(NO_3)_4$ Fission products NaOH	24,000 to 31,000 L/day (6,340 to 8,200 gal/day)	From 1945 to 1946, to 216-T-3 Reverse Well[c] via 241-T-361 Settling Tank After 1946, to 216-T-6 Crib[c] via 241-T-361 Settling Tank	This acidic waste stream was made alkaline before transfer to the settling tank and 216-T-6 Crib.
Cell Drainage (221-T and 224-T)	Any of the materials in the waste streams listed previously in this table	Not a routine release	Tank Farm or, from 1945 to 1946, to 216-T-3 Reverse Well[c] via 241-T-361 Settling Tank After 1946, to 216-T-6 Crib[c] via 241-T-361 Settling Tank	A high-suspended solid waste stream.

Table B-1. T Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total) [a]	Receiving Waste Site	Comment
Cooling Water and Steam Condensate	Water	About 26.8 million L (7.1 million gal/day)	216-T-4-1 Pond/Swamp via 207-T Retention Basin, then to 216-T-4-1D Ditch; later to 216-T-4-2 Ditch[d]	This waste stream could become radiologically contaminated during system upset/equipment failure episodes. The waste stream could be held up in retention basis, but there was no diversion capability.
Chemical Sewer Waste (221-T and 224-T)	Any of the nonradioactive materials listed previously in this table	Not a routine release	216-T-4-1 Pond/Swamp via 207-T Retention Basin, then to 216-T-4-1D Ditch; later to 216-T-4-2 Ditch[d]	
222-T Process Control Laboratory Waste	Liquid waste containing any of the materials listed previously in this table	About 1,000 to 3,000 L/day (260 to 800 gal/day)	To 216-T-2 Reverse Well (1945 to 1950) and later to 216-T-8 Crib (1950 to 1951)	Reverse well estimated to have received 2.6 Ci of fission products and 600 mg of plutonium per month for approximately 60 months; expect similar discharge to crib for approximately 12 months.

a. Additional information on release history for each 200-WA-1 and 200-BC-1 OU waste site can be found in Appendix D.

b. The waste tank farms (e.g., 241-T, 241-TX, and 241-TY) received high-level waste from T Plant; however, they are assigned to RCRA waste management areas and are not further assessed in this 200-WA-1 and 200-BC-1 OU RI/FS.

c. Waste sites 216-T-3 Reverse Well and 216-T-6 Crib are assigned to the 200-DV-1 OU and are not further assessed in this 200-WA-1 and 200-BC-1 OU RI/FS.

d. Waste site 216-T-4-2 Ditch is assigned to the 200-SW-2 OU and is not further assessed in this 200-WA-1 and 200-BC-1 OU RI/FS.

OU = operable unit

RCRA = *Resource Conversation and Recovery Act of 1976*

RI/FS = remedial investigation/feasibility study

UNH = uranyl nitrate hexahydrate

Table B-2. Z Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total) [a]	Receiving Waste Site	Comment
Plutonium Isolation Process Wastes from 231-Z Building	$La(NO_3)_2$ KNO_3 $(NH_4)_2SO_4$ $(NH_4)_2SO_3$ HNO_3 H_2SO_4 H_2O_2 $NaNO_3$ $KMnO_4$ Fission products $Pu(NO_3)_4$	Variable flow, ranging from 400 to 43,000 L/day (106 to 11,300 gal/day)	Transferred to 231-W-151 Tank for pH adjustment prior to discharge to cribs: • 216-Z-10[b] (1945) • 216-Z-4 (1945) • 216-Z-5[b] (1945 to 1947) • 216-Z-6 (1945) • 216-Z-7 (1947 to 1967)	This waste stream was primarily composed of water jet effluent from the process cell vacuum system and evaporator/condenser overhead condensate streams. The waste stream was acidic and was made alkaline before discharge to cribs. Some of the waste was recycled back to plutonium concentration operations at 224-T and 224-B.
Emergency Blower Condensate	Water (steam condensate)	Discharge only when steam-powered blowers were used	216-Z-13 and 216-Z-14 French drains	
Ventilation Evaporative Cooler Condensate	Water	Discharge when evaporative cooler is in service	216-Z-15 French drain	
234-5-Z Complex Steam Condensate and Cooling Water	Water		Transferred to 207-Z Retention Basin	This waste stream could become contaminated during upset conditions or equipment failure.
Metallurgy Laboratory Waste Water (231-Z Building)	Water Plutonium		216-Z-16 Crib 216-Z-17 Crib	The 216-Z-16 and 216-Z-17 Cribs received discharge of cooling water that had passed through the gloveboxes and hoods within 231-Z Building.

a. Additional information on release history for each 200-WA-1 and 200-BC-1 OU waste site can be found in Appendix D.

b. Waste sites 216-Z-5 Crib and 216-Z-10 Reverse Well are assigned to the 200-PW-6 OU and are not assessed further in this 200-WA-1 and 200-BC-1 OU RI/FS.

OU = operable unit

RI/FS = remedial investigation/feasibility study

Table B-3. U Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total)[a]	Receiving Waste Site	Comment
Cooling Water and Steam Condensate	Water		216-U-10 Pond via 207-U Retention Basin[b] and 216-U-14 Ditch Later, 216-U-16 Crib via 207-U Retention Basin	This stream could become contaminated during periods of system upset or equipment failure. The 207-U Retention Basin offered hold-up capacity, but no diversion capability.
271-U and 224-U Chemical Sewer	Any of the nonradioactive chemicals used in the TBP process, including the following: • HNO_3 • NaOH • Na_2SO_4 • $CaCO_3$ • H_2NSO_3H • $Fe(SO_4)(NH_4)_2SO_4.6H_2O$ • TBP • NPH (kerosene-range hydrocarbons)	Not a routine discharge	216-U-10 Pond via 207-U Retention Basin and 216-U-14 Ditch	
Process Condensate from 221-U, 224-U, and 224-UA	Water HNO_3 $CaCO_3$ F^- NO_3^- PO_4^{-3} Na^+ K^+ TBP NPH (kerosene-range hydrocarbons) Fission products Uranium	Variable, ranged from 1,000 to 132,000 L/day (260 to 35,000 gal/day)	216-U-8 Crib via 270-W Neutralization Tank (1952 to 1960) 216-B-12 Crib[c] via 270-E Neutralization Tank[c] (1952 to 1960) 216-U-12 Crib (1960 to 1988) 216-U-17 Crib via 224-U-CNT (1988 to 1994)	This acidic waste stream was initially pH-adjusted to near neutral by passing through a limestone bed prior to discharge to the 216-U-8 and 216-B-12 Cribs. Later, it was discharged in its original acidic condition to the 216-U-12 Crib. During final years of operation, the stream was again adjusted to near neutral pH before discharge to the 216-U-17 Crib.

Table B-3. U Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total)[a]	Receiving Waste Site	Comment
Solvent Cleanup Waste from 276-U	Water HNO_3 $CaCO_3$ F^- NO_3^- PO_4^{-3} Na^+ K^+ TBP NPH (kerosene-range hydrocarbons) Fission products Uranium	Average discharge 8,000 L/day (2,100 gal/day)	216-U-1 and 216-U-2 Cribs via 241-U-361 Settling Tank 216-U-15 Trench	A single release of unrecoverable solvent was made to the 216-U-15 Trench.
Laboratory Waste from 222-U	The laboratory streams likely contained all process constituents	Totals of 3.0E+05 L (7.9E+05 gal), 5.45E+05 L (1.44+05 gal), and 3.3+04E+04 L (8.7E+03 gal)	216-U-4 Reverse Well (1947 to 1955) 216-U-4A French drain (1955 to 1970) 216-U-4B (1960 to 1970)	Relatively low volumes.
Cold Startup Waste from 221-U	Uranium recovery process chemicals with unirradiated uranium and no fission products		216-U-5 and 216-U-6 Trenches	
221-U High-Level Uranium Recovery Waste	Uranium recovery process chemicals, bismuth phosphate process chemicals, and fission products		Returned to tank farms via the 241-WR Vault through underground pipelines	The volume of waste returned to the tank farms was approximately equal to the volume of uranium recovery process feedstock initially removed from the tanks.
221-U Thorium Recovery Waste	Thorium recovery process chemicals and fission products		Returned to tank farms via the 241-WR Vault through underground pipelines	
Ventilation System Exhaust from 221-U	Ventilation air from 221-U Building		200-W-44 Sand filter and 291-U-1 Stack	

Table B-3. U Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total)[a]	Receiving Waste Site	Comment

a. Additional information on release history for each 200-WA-1 and 200-BC-1 OU waste site can be found in Appendix D.

b. The 207-U Retention Basin was demolished in 2010 and is not considered further in this 200-WA-1 and 200-BC-1 OU RI/FS.

c. 216-B-12 Crib and 207-E Neutralization Tank are assigned to the 200-EA-1 OU and are not further evaluated in this 200-WA-1 and 200-BC-1 OU RI/FS.

OU = operable unit

RI/FS = remedial investigation/feasibility study

TBP = tributyl phosphate

Table B-4. S Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total)*	Receiving Waste Site	Comment
Cooling Water and Steam Condensate	Water	About 1.9E+06 to 1.1E+07 L/day (5E+05 to 2.9E+06 gal/day)	Initially, 216-S-17 Pond via 207-S Retention Basin Later, 216-S-5 Crib and 216-S-6 Crib via 207-S Retention Basin Then to 216-S-16 Ditch and Pond with diversion of off-normal flows to 216-S-6 Crib	This stream became grossly contaminated during equipment failure on numerous occasions, resulting in contamination of the 207-S Retention Basin and 216-S-17 Pond. The 207-S Retention Basin offered hold-up capacity, but no diversion capability. When the 216-S-5 and -S-6 Cribs were found to be unable to handle the stream flow, the 216-S-5 Crib was abandoned. The stream was sent to the new 216-S-16 Ditch and Pond with the 216-S-6 Crib maintained for diversion of contaminated water.
202-S Chemical Sewer	Any of the nonradioactive chemicals used in the REDOX process, including the following: • HNO_3 • NaOH • Mn • $NaNO_2$ • $NaNO_3$ • ANN • Hexone (MIBK) • $NaAlO_2$ • $Na_2Cr_20_7$	Not a routine discharge	216-S-17 Pond via 207-S Retention Basin Later, 216-S-10 Ditch	

Table B-4. S Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total)*	Receiving Waste Site	Comment
Process Condensate from 202-S	Water HNO_3 NaOH Mn $NaNO_2$ $NaNO_3$ ANN Hexone (MIBK) $NaAlO_2$ Fission products Uranium	About 61,000 L/day (16,000 gal/day)	216-S-1 and -2 Cribs (1952 to 1956) 216-S-7 Crib (1956 to 1965) 216-S-9 Crib (1965 to 1969) 216-S-23 Crib (1969 to 1972)	These cribs were used sequentially to receive process condensate from the 202-S Building.
Solvent Cleanup Waste from 276-S	Water HNO_3 NaOH Mn $NaNO_2$ $NaNO_3$ ANN Hexone (MIBK) $NaAlO_2$ Fission products Uranium	About 700 L/day (180 gal/day)	216-S-13 Crib	Waste was generated in batch process from cleanup of solvent phase; about 3,600 gal of waste per 10,000 gal of solvent was processed.
Combined High-Level Waste	Water HNO_3 NaOH Mn $NaNO_2$ $NaNO_3$ ANN Hexone (MIBK) $NaAlO_2$ Fission products Uranium	39,700 L/day (10,500 gal/day)	241-S Tank Farm Later to 241-SX and 241-SY Tank Farms	This waste stream included cladding removal waste, fuel dissolution waste, and separation waste. The waste stream contained an average of 23.6 Ci/gal of combined beta and gamma emitters and 17 g/gal of plutonium.

Table B-4. S Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total)*	Receiving Waste Site	Comment
Laboratory Waste from 222-S and 300 Area	The laboratory streams likely contained all process constituents.	18,750 L/day (5,000 gal/day)	216-S-20 Crib via 207-SL Retention Basin	This waste stream is suspected to be the source of 1,4-dioxane detected in groundwater downgradient of the 216-S-20 Crib.
Acid Recovery Waste from 293-S	Acid recovery waste was likely primarily nitric acid in water with some fission products.	About 27 L/day (7 gal/day)	216-S-22 Crib	
Steam Condensate from 242-T Waste Evaporator	Steam condensate occasionally contaminated by tank waste constituents and fission products.		216-S-25 Crib	The 216-S-25 Crib also received groundwater remediation wastewater from initial response to uranium contamination near the 216-U-1 and 216-U-2 Cribs.
Condensate Waste Water from Tank Riser Condensers at 241-S-101 and 241-S-104 Tanks	This stream likely contained water, tritium, some entrained fission products, and other waste constituents.		216-S-3 and 216-S-4 Cribs	
Cold Startup Waste from 222-S	All of the nonradioactive REDOX process chemicals, with unirradiated uranium and no fission products		216-S-8 Trench (aqueous inorganic startup waste) 216-S-14 Trench (contaminated organic startup waste)	
291-S Stack Flush Wastewater	Fission products, water		216-S-12 Trench	This site received a single discharge of wastewater used to flush the REDOX main stack in 1954.

Table B-4. S Plant Waste Streams and Disposition to Waste Sites in the Inner Area

Waste Stream	Composition	Volume (Rate or Total)*	Receiving Waste Site	Comment
Equipment Decontamination Wastewater	Steam condensate, water, fission products, and REDOX process chemicals		218-S-18 Pit	The pit was exhumed in 1972 and subsequently used to bury contaminated surface soil from near the 241-S Tank Farm.

Note: The waste tank farms (e.g., 241-S, 241-SX, and 241-SY) received high-level waste from S Plant; however, they are assigned to RCRA waste management areas and are not further assessed in this 200-WA-1 and 200-BC-1 OU RI/FS.

* Additional information on release history for each 200-WA-1 and 200-BC-1 OU waste site can be found in Appendix D.

ANN = aluminum nitrate nonahydrate

OU = operable unit

MIBK = methyl isobutyl ketone

RCRA = *Resource Conservation and Recovery Act of 1976*

REDOX = Reduction-Oxidation (Plant)

RI/FS = remedial investigation/feasibility study

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
200-E-14	200-E-14, 216-BC-201 Siphon Tank, 216-B-201, IMUST	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Underground Storage Tank	Scavenged Tank Waste Supernatant	Liquid Process Waste
200-W-1	200-W-1, REDOX Mud Pit West	S Plant Operations	S Plant Vicinity	Surface Contamination Site	Drilling Mud	Solid Waste
200-W-106	200-W-106, Soil Contamination Area Adjacent to 200-W-55	Not defined	T Plant Vicinity	Surface Contamination Site	Shallow Contaminated Soil	Solid Waste
200-W-11	200-W-11, Concrete Foundation South of 241-S, S-Farm Foundation and Dump Site	S Plant Operations	S Plant Vicinity	Surface Contamination Site	Debris	Solid Waste
200-W-12	200-W-12, 201-W Soil Mound and Plastic Pipe	Not defined	U Plant Vicinity	Surface Contamination Site	Debris	Solid Waste
200-W-127	200-W-127, Surface Stabilized Area East of UPR-200-W-29/ UPR-200-W-97 (UN-216-W-5)	T Plant Operations	T Plant Vicinity	Surface Contamination Site	Possible Leak from Underground Transfer Line	Liquid Process Waste
200-W-128	200-W-128, Underground Radioactive Material Area East of 218-W-4A	Burial Ground Operations	T Plant Vicinity	Surface Contamination Site	Contaminated Specks	Airborne Particulate Deposition
200-W-13	200-W-13, 2713-WB Green Hut Complex	Not defined	T Plant Vicinity	Surface Contamination Site	Radiological- and Petroleum-Contaminated Soil	Solid Waste
200-W-14	200-W-14, 200 West Heavy Equipment Storage Area	Not defined	T Plant Vicinity	Surface Contamination Site	Petroleum-Contaminated Soil	Solid Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
200-W-15	200-W-15, S Plant Project W-087 Hexone Discovery	S Plant Operations	S Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Hexone Solvent	Liquid Process Waste
200-W-2	200-W-2, REDOX Berms West	S Plant Operations	S Plant Vicinity	Surface Contamination Site	Disturbed Soil	Solid Waste
200-W-21	200-W-21, 204-T Unloading Station, T Plant Waste Railcar Unloading Facility, Unloading Station 1, and Unloading Station 2	300 Area Operations	T Plant Vicinity	Surface Contamination Site	Consolidated Liquid Waste from 340 Building	Liquid Process Waste
200-W-22	200-W-22, 203-S/204-S/205-S Stabilized Area	S Plant UNH Cleanup	S Plant Vicinity	Structures and Foundations	UNH Solutions, Ion-Exchange Regeneration Solutions	Liquid Process Waste
200-W-231	200-W-231, Temporary Facilities Construction Trailer Septic Tank and Tile Field	241-TY Tank Farm Construction	T Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste and Possible X-ray Film Development Chemicals	Sanitary Wastewater
200-W-244-PL	200-W-244-PL; Encased Pipelines from 221-U Canyon Building to 241-WR Vault; Line Numbers 4705, 4707, 4709, 4711, 4861, 4871	U Plant Operations	U Plant Vicinity	Pipeline	Uranium and Thorium Slurry Solutions from the Single-Shell Tanks and Neutralized Waste from the 221-U Extraction Process	Liquid Process Waste
200-W-248-PL	200-W-248-PL; Direct Buried lines from 241-UX-154 to 200-W-244-PL and 241-WR Vault; Line Numbers 4866, 4976, and 4977	U Plant Operations	U Plant Vicinity	Pipeline	Not specified	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
200-W-42	200-W-42, U Plant Radioactive Process Sewer from 221-U to 216-U-8 and 216-U-12 Cribs, 200-W-42-PL	U Plant Operations	U Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Process Condensate from 224-U and 221-U	Liquid Process Waste
200-W-44	200-W-44; 200-W-234, 291-U Stack Sand Filter and French Drain	U Plant Operations	U Plant Vicinity	Structures and Foundations	Ventilation System Exhaust from 221-U	Ventilation System Exhaust
200-W-51	200-W-51, Septic Tank (abandoned)	Unknown	S Plant Vicinity	Septic Tank	Sanitary Waste	Sanitary Wastewater
200-W-53	200-W-53, UPR-200-W-166, UN-216-W-31	241-T Tank Farm Operations	T Plant Vicinity	Surface Contamination Site	Contaminated Specks	Airborne Particulate Deposition
200-W-54	200-W-54, Contamination Migration from 241-SX Tank Farm	241-SX Tank Farm	S Plant Vicinity	Surface Contamination Site	Animal Feces, Contaminated Specks, and Contaminated Plants	Airborne Particulate Deposition
200-W-6	200-W-6, 200-W Painter Shop Paint Solvent Disposal Area	200 West Operations	T Plant Vicinity	Surface Contamination Site	Paint Solvent Contaminated Soil	Liquid Process Waste
200-W-63	200-W-63, Contaminated Concrete Pad	Not defined	T Plant Vicinity	Structures and Foundations	Contaminated Concrete Slab	Solid Waste
200-W-67	200-W-67, Contaminated Soil at the Corner of Cooper and 16th Street	241-U Tank Farm Operations	U Plant Vicinity	Surface Contamination Site	Contaminated Specks	Airborne Particulate Deposition
200-W-71	200-W-71, Undocumented Trench, Undocumented Burn Pit	Not defined	U Plant Vicinity	Surface Contamination Site	Burned Debris	Solid Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
200-W-75	200-W-75, Radiological Logging System (RLS) Calibration Silos	S Plant Operations	S Plant Vicinity	Underground Storage Tank	Sealed Radioactive Sources in Soil-Filled Tank	Solid Waste
200-W-77	200-W-77, Posted Contamination Area East of 216-U-14 Ditch	Not defined	U Plant Vicinity	Surface Contamination Site	Contaminated Specks and Tumbleweeds	Airborne Particulate Deposition
200-W-80	200-W-80, Stabilized Contaminated Soil Area Southwest of T Plant, Mound of Contaminated Soil Southwest of T Plant	Not defined	T Plant Vicinity	Surface Contamination Site	Debris	Solid Waste
200-W-81	200-W-81, Contaminated Tumbleweed Fragments along Railroad Track East of 218-W-3AE	Burial Ground Operations	T Plant Vicinity	Surface Contamination Site	Contaminated Soil and Tumbleweeds	Airborne Particulate Deposition
200-W-82	200-W-82; Risers East of 216-TY-201 and 216-T-26, 216-T-27, and 216-T-28 Cribs; Crib Unloading Station	300 Area Operations	T Plant Vicinity	Structures and Foundations	Concrete and Pipe Risers Contaminated with Liquid Waste from 340 Building	Liquid Process Waste
200-W-83	200-W-83, Contamination Area North of 2727W	Not defined	U Plant Vicinity	Surface Contamination Site	Contaminated Specks	Airborne Particulate Deposition
200-W-85	200-W-85, Soil Contamination Area East of 2727 W	Not defined	U Plant Vicinity	Surface Contamination Site	Contaminated Specks	Airborne Particulate Deposition
200-W-86	200-W-86, Contamination Area Around Light Pole	Not defined	U Plant Vicinity	Surface Contamination Site	Contaminated Soil	Airborne Particulate Deposition

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
200-W-87	200-W-87, Unplanned Release on Chemical Spur Railroad Track Northwest of 221-U Plant	Not defined	U Plant Vicinity	Surface Contamination Site	No Documented Release, Site is Erroneous	Solid Waste
200-W-89	200-W-89, 252-U, U Plant Electrical Substation, C8S17 Substation, U-Cat Substation	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Contaminated Specks on Equipment that No Longer Exists	Airborne Particulate Deposition
200-W-9	200-W-9, Project W291 Excavation VCP Contamination	T Plant Operations	T Plant Vicinity	Cribs, Trenches and Pipe Leaks	Leaking Process Sewer Contaminated Soil	Liquid Process Waste
200-W-90	200-W-90, Underground Radioactive Material Areas Posted Along 23rd Street in 200 West Area	241-U Tank Farm Operations	T Plant Vicinity	Surface Contamination Site	High-Level Tank Waste	Liquid Process Waste
200-W-92	200-W-92, Contaminated Mound of Soil and Debris, Soil Mound West of 241-TY Tank Farm	Not defined	T Plant Vicinity	Surface Contamination Site	Debris and Contaminated Soil	Solid Waste
207-S	207-S, REDOX Retention Basin, 207-S Retention Basin	S Plant Operations	S Plant Vicinity	Retention Basin	Cooling Water/Steam Condensate	Process Waste Water

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
207-T	207-T, T Plant Retention Basin, 207-T Retention Basin	T Plant Operations	T Plant Vicinity	Retention Basin	Cooling Water/Steam Condensate/Chemical Sewer	Process Waste Water
207-U	207-U, 207-U Retention Basin	U Plant Operations	U Plant Vicinity	Retention Basin	Cooling Water/Steam Condensate/Chemical Sewer	Process Waste Water
207-Z	207-Z, 207-Z Retention Basin, 241-Z Retention Basin, 241-ZRB, 241-Z-RB	Plutonium Finishing Plant Operations	Z Plant Vicinity	Retention Basin	Cooling Water/Steam Condensate	Process Waste Water
216-B-14	216-B-14, 216-BC-1 Crib	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Process Waste Crib	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-15	216-B-15, 216-BC-2 Crib	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Process Waste Crib	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-16	216-B-16, 216-BC-3 Crib	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Process Waste Crib	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-17	216-B-17, 216-BC-4 Crib	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Process Waste Crib	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-18	216-B-18, 216-BC-5 Crib	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Process Waste Crib	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-19	216-B-19, 216-BC-6 Crib	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Process Waste Crib	Scavenged Tank Waste Supernatant	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-B-20	216-B-20, 216-BC-7 Trench, 216-B-20 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-21	216-B-21, 216-BC-8 Trench, 216-B-21 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-22	216-B-22, 216-BC-9 Trench, 216-B-22 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-23	216-B-23, 216-BC-10 Trench, 216-B-23 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-24	216-B-24, 216-BC-11 Trench, 216-B-24 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-25	216-B-25, 216-BC-12 Trench, 216-B-25 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-26	216-B-26, 216-BC-13 Trench, 216-B-26 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-27	216-B-27, 216-BC-14 Trench, 216-B-27 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-28	216-B-28, 216-BC-15 Trench, 216-B-28 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-B-29	216-B-29, 216-BC-16 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-30	216-B-30, 216-BC-17 Trench, 216-B-30 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-31	216-B-31, 216-BC-18 Trench, 216-B-31 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-32	216-B-32, 216-BC-19 Trench, 216-B-32 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-33	216-B-33, 216-BC-20 Trench, 216-B-33 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-34	216-B-34, 216-BC-21 Trench	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-52	216-B-52, 216-B-52 Trench, 216-BC-22	High-Level Tank Waste Scavenging	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Scavenged Tank Waste Supernatant	Liquid Process Waste
216-B-53A	216-B-53A, 216-B-53A Trench, PRTR Trench	300 Area Laboratory, R&D	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Accumulated Waste from 304 Building	Liquid Process Waste
216-B-53B	216-B-53B, 216-B-53 Trench, 216-B-53B Trench	300 Area Reactor Operations	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	PRTR Decontamination Solution	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-B-54	216-B-54, 216-B-54 Trench	300 Area Laboratory, R&D	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Accumulated Waste from 304 Building	Liquid Process Waste
216-B-58	216-B-58, 216-B-58 Trench, 216-B-59 Crib	300 Area Laboratory, R&D	BC Cribs and Trenches	Cribs, Trenches, and Pipe Leaks	Accumulated Waste from 304 Building	Liquid Process Waste
216-S-1&2	216-S-1&2, 216-S-5 Crib, 216-S-1&2	S Plant Operations	S Plant Vicinity	Process Waste Crib	Process Condensate and Cell Drainage	Liquid Process Waste
216-S-12	216-S-12, UPR-200-W-30, 291-S Stack Wash Sump, REDOX Stack Flush Trench	S Plant Operations	S Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Exhaust Stack Flush Water	Process Waste Water
216-S-14	216-S-14, Buried Contaminated Hexone, Cold Organic Trench or Grave, 216-S-4 Burial Contaminated Hexone	S Plant Operations	S Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Spent Hexone Solvent	Liquid Process Waste
216-S-18	216-S-18, 241-SX Steam Cleaning Pit, 216-S-14 Steam Cleaning Pit	S Plant Operations	S Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Vehicle Decontamination Water	Process Waste Water
216-S-20	216-S-20, 216-SL-1&2 Crib, 216-SL-2	222-S Laboratory Operation and 300 Area	S Plant Vicinity	Process Waste Crib	Liquid Waste from Analytical Laboratory	Liquid Process Waste
216-S-22	216-S-22, 216-S-22 Crib	293-S Building Acid Recovery	S Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Liquid Waste from Recovered Nitric Acid and Sodium Hydroxide	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-S-23	216-S-23 Crib	S Plant Operations	S Plant Vicinity	Process Waste Crib	Process Condensate and Cell Drainage	Liquid Process Waste
216-S-25	216-S-25 Crib	S Plant Operations	S Plant Vicinity	Process Waste Crib	Process Condensate and Effluent	Liquid Process Waste
216-S-4	216-S-4, 216-S-7, 216-S-4 Sump or Crib, UN-216-W-1	241-S Tank Farm Tank Vapor Condensation	S Plant Vicinity	Injection Wells and French Drains	Tank Farm Vapor Condensate	Liquid Process Waste
216-S-5	216-S-5, 216-S-5 Cavern 1, 216-S-6 Crib, 216-S-9 (see subsites)	S Plant Operations	S Plant Vicinity	Cooling Water/Steam Condensate/Chemical Sewer, Cribs, and Ditches	Contaminated Cooling Water and Steam Condensate	Process Waste Water
216-S-6	216-S-6, 216-S-6 Cavern 2, 216-S-5 Crib, 216-S-13 Crib	S Plant Operations	S Plant Vicinity	Cooling Water/Steam Condensate/Chemical Sewer, Cribs, and Ditches	Contaminated Cooling Water and Steam Condensate	Process Waste Water
216-S-7	216-S-7, 216-S-7 Crib, 216-S-15	S Plant Operations	S Plant Vicinity	Process Waste Crib	Process Condensate and Cell Drainage	Liquid Process Waste
216-S-8	216-S-8, Cold Aqueous Trench, Cold Aqueous Crib, 216-S-3, Unirradiated Uranium Waste Trench, Cold Aqueous Grave	S Plant Operations	S Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Startup Waste and Unirradiated Uranium	Liquid Process Waste
216-SX-2	216-SX-2, 216-SX-2 Crib	241-SX Tank Farm Operations	S Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Air Compressor Condensate/Blow Down	Process Waste Water

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-T-10	216-T-10, Decontamination Trenches, Equipment Decontamination Area	Equipment Decontamination	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Vehicle Decontamination Water	Process Waste Water
216-T-11	216-T-11, Decontamination Trenches, Equipment Decontamination Area	Equipment Decontamination	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Vehicle Decontamination Water	Process Waste Water
216-T-12	216-T-12, 207-T Sludge Grave, 207-T Sludge Pit, 216-T-11	T Plant Operations	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Sludge from Bottom of 207-T Retention Basin	Solid Waste
216-T-13	216-T-13, 269-W Regulated Garage, 269-W Decontamination Pit or Trench, 216-T-12, 269-W Regulated Garage Decontamination Pit	Equipment Decontamination	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Vehicle Decontamination Water	Process Waste Water
216-T-2	216-T-2, 222-T-110 Dry Well, 222-T Reverse Well	222-T Process Control Laboratory	T Plant Vicinity	Injection Wells and French Drains	Analytical Laboratory Waste	Liquid Process Waste
216-T-20	216-T-20, 216-TX-2, 216-T-20 Crib, 241-TX-155 Contaminated Acid Grave	Uranium Recovery Operations	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Contaminated 60% Nitric Acid	Liquid Process Waste
216-T-27	216-T-27, 216-TY-2 Cavern, 216-TY-2 Crib, 216-TX-2 Cavern, 216-TX-2 Crib	300 Area Operations	T Plant Vicinity	Process Waste Crib	Consolidated Liquid Waste from 340 Building	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-T-28	216-T-28, 216-TY-3 Cavern, 216-TY-3 Crib, 216-TX-3 Cavern, 216-TX-3 Crib	300 Area Operations	T Plant Vicinity	Process Waste Crib	Consolidated Liquid Waste from 340 Building	Liquid Process Waste
216-T-29	216-T-29, 291-T Sand Filter Sewer, 216-T-29 French Drain	T Plant Operations	T Plant Vicinity	Injection Wells and French drains	221-T Ventilation System Condensate	Liquid Process Waste
216-T-31	216-T-31, 216-T-31 French Drain	241-TX Tank Farm Operations	T Plant Vicinity	Injection Wells and French Drains	Contaminated Steam Condensate	Process Waste Water
216-T-33	216-T-33, 216-T-33 Crib	2706-T Equipment Decontamination	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Equipment Decontamination Water	Process Waste Water
216-T-34	216-T-34, 216-T-34 Crib	300 Area Operations	T Plant Vicinity	Process Waste Crib	Consolidated Liquid Waste from 340 Building	Liquid Process Waste
216-T-35	216-T-35, 216-T-35 Crib	300 Area Operations	T Plant Vicinity	Process Waste Crib	Consolidated Liquid Waste from 340 Building	Liquid Process Waste
216-T-36	216-T-36 Crib	T Plant/U Plant/ 2706-T Operations	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Decontamination Solutions from T Plant/ U Plant/2706-T	Liquid Process Waste
216-T-4-1D	216-T-4-1D, 216-T-4 Ditch, 216-T-4 Swamp	T Plant Operations/242-T Evaporator	T Plant Vicinity	Cooling Water/Steam Condensate/Chemical Sewer, Cribs, and Ditches	Cooling Water/Steam Condensate/Chemical Sewer	Process Waste Water

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-T-8	216-T-8, 222-T-1&2 Cribs	222-T Process Control Laboratory	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Analytical Laboratory Waste	Liquid Process Waste
216-T-9	216-T-9, Decontamination Trenches, Equipment Decontamination Area	Equipment Decontamination	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Vehicle Decontamination Water	Process Waste Water
216-U-1&2	216-U-1&2, 361-WR (Crib 2), 216-U-3, 216-UR 1&2 Cribs, 216-U-1&2, 216-U-1, 216-U-2	U Plant Operations	U Plant Vicinity	Process Waste Crib	Solvent Cleanup Waste from 221-U	Liquid Process Waste
216-U-12	216-U-12, 216-U-12 Crib	U Plant Operations	U Plant Vicinity	Process Waste Crib	Acidic Process Condensate from 224-U	Liquid Process Waste
216-U-13	216-U-13, 216-U-13 Cribs, 216-U-13, Vehicle Steam Cleaning Pit	U Plant Operations	U Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Vehicle Decontamination Water	Process Waste Water
216-U-14	216-U-14, 216-U-14 Ditch, Laundry Ditch	U Plant Operations	U Plant Vicinity	Cooling Water/Steam Condensate/Chemical Sewer, Cribs, and Ditches	Cooling Water/Steam Condensate/Chemical Sewer	Process Waste Water
216-U-15	216-U-15, UN-216-W-10, 388-U Tank Dumping, UPR-200-W-125, UN-200-W-158, U-152 Interface Crud Burial	U Plant Operations	U Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Contaminated Off-Spec TBP/Kerosene Solvent	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-U-16	216-U-16, UO3 Crib	U Plant Operations	U Plant Vicinity	Cooling Water/Steam Condensate/Chemical Sewer, Cribs, and Ditches	Cooling Water/Steam Condensate/Chemical Sewer	Process Waste Water
216-U-17	216-U-17, 216-U-17 Crib	U Plant Operations	U Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Neutralized Process Condensate from 224-U	Liquid Process Waste
216-U-3	216-U-3, 216-U-11, 216-U-3 French Drain	241-U Tank Farm Operations	U Plant Vicinity	Injection Wells and French Drains	Tank Farm Vapor Condensate	Liquid Process Waste
216-U-4	216-U-4, 222-U Dry Well, 222-U-110 Dry Well, 216-U-2, 216-U-4 Dry Well	222-U Process Control Laboratory	U Plant Vicinity	Injection Wells and French Drains	Analytical Laboratory Waste	Liquid Process Waste
216-U-4A	216-U-4A, 216-U-4 Reverse Well Replacement French Drain, 216-U-4 Dry Well	222-U Process Control Laboratory	U Plant Vicinity	Injection Wells and French Drains	Analytical Laboratory Waste	Liquid Process Waste
216-U-4B	216-U-4B, 216-U-4B Dry Well, 216-U-4B French Drain	222-U Process Control Laboratory	U Plant Vicinity	Injection Wells and French Drains	Analytical Laboratory Waste	Liquid Process Waste
216-U-5	216-U-5, 216-U-4, 221-U Cold U Trench #2	U Plant Startup	U Plant Vicinity	Process Waste Crib	TBP Process Cold Startup with Unirradiated Uranium	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-U-6	216-U-6, U Facility Unirradiated Uranium Waste Trench, 221-U Cold U Trench, 216-U Cold U Trench 1, 216-U-5, 221-U Cold U Grave 1	U Plant Startup	U Plant Vicinity	Process Waste Crib	TBP Process Cold Startup with Unirradiated Uranium	Liquid Process Waste
216-U-7	216-U-7, 221-U Counting Box French Drain, 221-U Vessel Vent Blower Pit French Drain	U Plant Operations	U Plant Vicinity	Injection Wells and French Drains	Acidic Process Condensate	Liquid Process Waste
216-U-8	216-U-8, 216-WR-1,2,3 Cribs, 216-U-9	U Plant Operations	U Plant Vicinity	Process Waste Crib	Neutralized Process Condensate from 224-U and 221-U	Liquid Process Waste
216-Z-13	216-Z-13, 234-5 Dry Well #1, 216-Z-13 Dry Well, Miscellaneous Stream #261, 216-Z-13 A and B	Z Plant Operations	Z Plant Vicinity	French Drain	Cooling water and steam condensate from 291-Z ET-8 exhaust fan turbine and S-13 and S-14 coolers	Liquid Process Waste
216-Z-14	216-Z-14, 234-5 Dry Well #2, 216-Z-14 Dry Well, Miscellaneous Stream #262, 216-Z-14 A and B	Z Plant Operations	Z Plant Vicinity	French Drain	Cooling water and steam condensate from 291-Z ET-9 exhaust fan turbine and floor drains	Liquid Process Waste
216-Z-15	216-Z-15, 234-5 Dry Well #3, 216-Z-15 Dry Well, Miscellaneous Stream #263	Z Plant Operations	Z Plant Vicinity	French Drain	Condensate drainage from 291-Z building S-12 Evaporator Cooler	Liquid Process Waste
216-Z-16	216-Z-16 Crib	231-Z Metallurgical Lab Operations	Z Plant Vicinity	Process Waste Crib	Plutonium-Contaminated Wastewater	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
216-Z-17	216-Z-17, 216-Z-17 Ditch	231-Z Metallurgical Lab Operations	Z Plant Vicinity	Process Waste Crib	Plutonium-Contaminated Wastewater	Liquid Process Waste
216-Z-4	216-Z-4, 231-W-3 Pit, 231-W-3 Sump, 231-W-3 Crib, 216-Z-3, 216-Z-4 Crib	231-Z Plutonium Isolation Operations	Z Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Neutralized Evaporator Condensate and Vacuum Jet Water	Liquid Process Waste
216-Z-6	216-Z-6, 231-W-4 Crib, 231-Z-6, 216-W-4, 231-W Crib, 216-Z-4, 216-Z-6 & 6A Crib	231-Z Plutonium Isolation Operations	Z Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Neutralized Evaporator Condensate and Vacuum Jet Water	Liquid Process Waste
216-Z-7	216-Z-7, 231-W Crib, 231-W Trench, 216-Z-6	231-Z Plutonium Isolation Operations	Z Plant Vicinity	Process Waste Crib	Neutralized Evaporator Condensate and Vacuum Jet Water	Liquid Process Waste
218-W-8	218-W-8, 222-T Vault	222-T Process Control Laboratory	T Plant Vicinity	Underground Storage Tank	Radioactive Solid and Containerized Liquid Wastes	Solid Waste
218-W-9	218-W-9, Dry Waste Burial Ground No. 9, Non-TRU Dry Waste No. 009	S Plant Operations	S Plant Vicinity	Surface Contamination Site	Shallow Debris and Process Condensate from Crib Pipeline Leak	Solid Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
231-W-151	231-W-151, 231-W-151 Vault, 231-W-151-001 (Tank), 231-W-151-002 (Tank), 231-W-151 Sump, 231-Z-151 Sump, IMUST, Inactive Miscellaneous Underground Storage Tank (see subsites)	231-Z Plutonium Isolation Operations	Z Plant Vicinity	Underground Storage Tank	Acidic Evaporator Condensate and Vacuum Jet Water	Liquid Process Waste
241-T-361	241-T-361, 241-T-361 Settling Tank, 361-T-Tank, IMUST,	T Plant Operations	T Plant Vicinity	Underground Storage Tank	Precipitated Radioactive Process Waste Solids	Solid Waste
241-U-361	241-U-361, 241-U-361 Settling Tank, 361-U-TANK, IMUST, Inactive Miscellaneous Underground Storage Tank	U Plant Operations	U Plant Vicinity	Underground Storage Tank	Precipitated Radioactive Process Waste Solids	Solid Waste
241-WR Vault	241-WR VAULT; 241-WR Vault (Tanks -001 Through -009); 241-WR-01 Thru 09; 244-WR Vault; 296-U-6 Stack; IMUST; Inactive Miscellaneous Underground Storage Tank; 241WR 241-WR Diversion Station Vault	U Plant Operations	U Plant Vicinity	Structures and Foundations	Uranium and Thorium Slurry Solutions from the Single-Shell Tanks and Neutralized Waste from the 221-U Extraction Process	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
2607-W3	2607-W3	221-T, 222-T, 224-T and 271-T Buildings	T Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste	
2607-W4	2607-W4, T Plant Septic Tank and Drain Field	221-T Head End Addition	T Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste	
2607-W5	2607-W5, Septic Tank and Drain Field	U Plant facilities	U Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste	
2607-W7	2607-W7, Septic Tank	221-U Canyon Building	U Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste	Sanitary Wastewater
2607-W8	2607-W8	231-Z Building Operations	Z Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste	Sanitary Wastewater
2607-WC	2607-WC	242-S and 272-S Buildings	S Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste	
2607-WZ	2607-WZ	241-SX Tank Farm	S Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste	Sanitary Wastewater
2607-Z	2607-Z	234-5Z, 2704-Z, 270-Z, 236-Z, 292-Z, 2701-Z, 2701-ZA, and the 2701-ZB Buildings	Z Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste	Sanitary Wastewater
2607-Z1	2607-Z1, Septic Tank and Drain Field	234-5Z Building Annex and 2736-ZB	Z Plant Vicinity	Septic Tank and Drain Field	Sanitary Waste	Sanitary Wastewater
270-W	270-W, 270-W Tank, 270-W Neutralization Tank, IMUST	U Plant Operations	U Plant Vicinity	Underground Storage Tank	Acidic Process Condensate from 224-U	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
600-70	600-70, SWMU 2—Miscellaneous Solid Waste	S Plant Construction	S Plant Vicinity	Surface Contamination Site	Shallow Debris	Solid Waste
UPR-200-W-101	UPR-200-W-101, UN-216-W-9, 221-U Acid Spill R-1 through R-9, UN-200-W-101	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Recovered Nitric Acid	Liquid Process Waste
UPR-200-W-103	UPR-200-W-103, 216-Z-18 Line Break, UN-216-W-13, UN-200-W-103, Pipe Line Leak	236-Z Building Operations	Z Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Process Waste Bound for 216-Z-18 Crib	Liquid Process Waste
UPR-200-W-111	UPR-200-W-111, Sludge Trench at 207-U, UN-216-W-21	U Plant Operations	U Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Sludge from Bottom of 207-U Retention Basin	Solid Waste
UPR-200-W-112	UPR-200-W-112, Sludge Trench at 207-U, UN-216-W-22	U Plant Operations	U Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Sludge from Bottom of 207-U Retention Basin	Solid Waste
UPR-200-W-116	UPR-200-W-116, UN-216-W-26, Ground Contamination North of 202-S, UN-200-W-116	203-S UNH Operations	S Plant Vicinity	Surface Contamination Site	Contaminated Specks	Airborne Particulate Deposition
UPR-200-W-117	UPR-200-W-117, Railroad Track Contamination, 221-U Railroad Cut Contamination, UN-216-W-27, UN-200-W-117	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Process Chemicals/Fission Products	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
UPR-200-W-118	UPR-200-W-118, Contamination at 211-U, UN-216-W-28, UN-200-W-118	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Recovered Nitric Acid	Liquid Process Waste
UPR-200-W-138	UPR-200-W-138, 221-U Vessel Vent Blower Pit French Drain, UN-216-W-11, UN-200-W-138, UN-200-W-22, UPR-200-W-22	U Plant Operations	U Plant Vicinity	Surface Contamination Site	No Release to the Environment	Liquid Process Waste
UPR-200-W-14	UPR-200-W-14, Waste Line Leak at 242-T Evaporator, UN-200-W-14	242-T Evaporator Operations	T Plant Vicinity	Cribs, Trenches, and Pipe Leaks	Contaminated Steam Condensate	Process Wastewater
UPR-200-W-162	UPR-200-W-162, Contaminated Area on East Side of 221-U, UN-216-W-37	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Contaminated Specks	Airborne Particulate Deposition
UPR-200-W-165	UPR-200-W-165, Contamination area East of 241-S, UN-216-W-30	241-S Tank Farm Operations	S Plant Vicinity	Surface Contamination Site	Contaminated Specks	Airborne Particulate Deposition
UPR-200-W-166	UPR-200-W-166, Contamination Migration from 241-T Tank Farm, UN-216-W-31	241-T Tank Farm Operations	T Plant Vicinity	Surface Contamination Site	Contaminated Soil and Tumbleweeds	Airborne Particulate Deposition
UPR-200-W-19	UPR-200-W-19, 241-U-361 Overflow, UN-200-W-19	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Solvent Cleanup Waste from 221-U	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
UPR-200-W-23	UPR-200-W-23 Waste Box Fire at 234-5Z, UN-200-W-23	Z Plant Operations	Z Plant Vicinity	Surface Contamination Site	Contaminated Soil	Airborne Particulate Deposition
UPR-200-W-3	UPR-200-W-3, Railroad Contamination, UN-200-W-3	T Plant Operations	T Plant Vicinity	Surface Contamination Site	Nonspecified Waste	Liquid Process Waste
UPR-200-W-33	UPR-200-W-33, Ground Contamination at 224-U, UN-200-W-33	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Acidic Process Condensate from 224-U	Liquid Process Waste
UPR-200-W-36	UPR-200-W-36, Groundwater Contamination at 216-S-1&2	S Plant Operations	S Plant Vicinity	Effluent from 216-S-1&2 Cribs Discharged to Groundwater through Failed Well Casing	Process Condensate and Cell Drainage	Liquid Process Waste
UPR-200-W-39	UPR-200-W-39, UN-200-W-39, 224-U Buried Contamination Trench	U Plant Operations	U Plant Vicinity	Surface Contamination Site	UNH Solution from 224-U	Liquid Process Waste
UPR-200-W-4	UPR-200-W-4, Railroad Contamination, UN-200-W-4	T Plant Operations	T Plant Vicinity	Surface Contamination Site	Nonspecified Waste—Speck Contamination along Railroad Track	Liquid Process Waste
UPR-200-W-41	UPR-200-W-41, Railroad Contamination, UN-200-W-41, REDOX Railroad Cut Contamination	S Plant Operations	S Plant Vicinity	Surface Contamination Site	Drips and Leaks from Containers on Train Cars	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
UPR-200-W-46	UPR-200-W-46, Contaminated Railroad Track, H-2 Centrifuge Burial, UN-200-W-46	S Plant Operations	S Plant Vicinity	Surface Contamination Site	Drips and Leaks from Containers on Train Cars	Liquid Process Waste
UPR-200-W-48	UPR-200-W-48, Contaminated Railroad Track Near 221-U, UN-200-W-48	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Leaks from jumper transferred to train cars	Liquid Process Waste
UPR-200-W-51	UPR-200-W-51, Release from 241-S Diversion Box, UN-200-W-51, UPR-200-W-52	S Plant Operations	S Plant Vicinity	Surface Contamination Site	Contaminated Specks	Airborne Particulate Deposition
UPR-200-W-55	UPR-200-W-55, Uranium Powder Spill at 224-U, UN-200-W-55	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Uranium Powder Spilled onto Asphalt Loading Ramp	Solid Process Material
UPR-200-W-60	UPR-200-W-60, Railroad Contamination, UN-200-W-60	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Contaminated Shielding Water	Liquid Process Waste
UPR-200-W-63	UPR-200-W-63, Road Contamination along the South Shoulder of 23rd Street, UN-200-W-63	241-TX Tank Farm Operations	T Plant Vicinity	Surface Contamination Site	Waste Dripped from Diversion Box Jumper	Liquid Process Waste
UPR-200-W-65	UPR-200-W-65, Contamination in the T Plant Railroad Cut, UN-200-W-65	T Plant Operations	T Plant Vicinity	Surface Contamination Site	Nonspecified Waste—Speck Contamination along Railroad Track	Liquid Process Waste

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types
UPR-200-W-67	UPR-200-W-67, Contamination Near 2706-T, UN-200-W-67	2706 T Operations	T Plant Vicinity	Surface Contamination Site	Nonspecified Waste Dripped from Equipment	Liquid Process Waste
UPR-200-W-73	UPR-200-W-73, Contaminated Railroad Track at 221-T, UN-200-W-73	T Plant Operations	T Plant Vicinity	Surface Contamination Site	Nonspecified Waste—Speck Contamination along Railroad Track	Liquid Process Waste
UPR-200-W-76	UPR-200-W-76, UN-200-W-76, Contamination Found at 241-TX-155	TX Tank Farm Operations	T Plant Vicinity	Surface Contamination Site	Tank Waste—Contaminated Soil and Rabbit Droppings	Liquid Process Waste
UPR-200-W-78	UPR-200-W-78, UO3 Powder Spill at 224-U, UN-200-W-78	U Plant Operations	U Plant Vicinity	Surface Contamination Site	Uranium Trioxide Powder	Liquid Process Waste
UPR-200-W-82	UPR-200-W-82, UN-200-W-82, Contamination Spread at 240-S-151	240-S-151 Diversion Box	S Plant Vicinity	Surface Contamination Site	Unspecified Waste Dripped from Equipment	Liquid Process Waste
UPR-200-W-99	UPR-200-W-99, UN-216-W-7, 241-153-TX Diversion Box Contamination Spread, UN-200-W-99	241-TX Tank Farm Operations	T Plant Vicinity	Surface Contamination Site	Contaminated Soil	Airborne Particulate Deposition

Table B-5. 200-WA-1 and 200-BC-1 OU RI Work Plan Waste Sites

Site Code	Site Name	Associated Plant Operations	Geographic/ Operational Unit	Waste Site Type	Waste	Primary Source Types

IMUST = inactive miscellaneous underground storage tank
OU = operable unit
PRTR = Plutonium Recycle Test Reactor
R&D = research and development
REDOX = Reduction-Oxidation (Plant)
RI = remedial investigation
SWMU = Solid Waste Management Unit
TBP = tributyl phosphate
TRU = transuranic
UNH = uranyl nitrate hexahydrate
UPR = unplanned release

Table B-6. Summary of Waste Sites with Apparent Historical Groundwater Impacts

Waste Site	Selected Target Analytes Detected in Historical Groundwater Samples	
	Cesiums-137	Strontium-90
216-T-33*		X
226-T-34	X	X
216-T-35	X	X
216-T-28	X	X
216-Z-7	X	X
216-Z-16	X	X
216-U-1&2	X	X
216-U-14		X
216-U-16	X	X
216-U-8		X
216-U-12	X	X
216-S-1&2	X	X
216-S-7	X	X
216-S-6	X	X
216-S-5	X	X
216-S-20	X	X
216-S-22	X	X
216-S-23	X	X
216-S-25	X	X
216-B-14		X
216-B-15		X
215-B-16		X
216-B-17		X
216-B-18	X	X
216-B-19		X
216-B-20*	X	X
216-B-21*	X	X
216-B-22*		X

Note: Based on historical groundwater monitoring data in HEIS.

* Available data indicate, but are not conclusive, that observed groundwater contamination originated from this waste site.

HEIS = Hanford Environmental Information System

X = Apparent historical groundwater impact noted for the respective constituent.

Table B-7. Preliminary Screening of Remedial Technologies for Vadose Zone Remediation of Radionuclides, Hexavalent Chromium, Other Metals, and Organic Compounds—Hanford Site Inner Area

General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
No Action	No Action	No Action	All	Shallow/ Deep	No further actions to address contamination. Source areas and residual contaminants in the vadose zone are left untreated.	Low No remedial actions are taken, but effectiveness could be high if risk was previously mitigated.	High No administrative or technical implementability challenges are associated with this option because no actions are required.	Low No associated cost	Low No associated cost	Moderate/High Continued impact to soil resources	Retained	Retained per the NCP
MNA	MNA	MNA	Radionuclides with reasonable half-lives. Select organic compounds, select metals.	Shallow/ Deep	Contaminants in the vadose zone are allowed to attenuate over time from natural biological processes, chemical processes, radioactive decay, and/or flushing from surface water infiltration. Rates of flushing must be low enough that groundwater standards are not exceeded. Involves ongoing monitoring to verify attenuation processes are occurring. If site is well characterized, the graded approach to modeling could be applied. Contingency measures are developed if attenuation is not adequate to control the risks. Typically combined with other technologies that manage the source areas and mitigate exposure.	Low/Moderate Effectiveness of MNA is driven by the state of the existing site-specific intrinsic processes, given that under MNA, natural processes are not enhanced. Effectiveness is evaluated and documented through long-term monitoring and evaluation of geochemical conditions. Contaminant leaching into groundwater may be an acceptable component of the vadose zone remedy if the resultant dissolved contaminant concentrations still meet the groundwater cleanup criteria.	High No administrative or technical implementability challenges are associated with this option.	Low/Moderate	Low	Moderate/High Continued impact to soil resources	Retained	Retained as a possible component of alternatives
Removal	Excavation	Standard Excavation	All	Shallow	Shallow soil in identified source areas is removed using conventional construction equipment. Excavation is limited to a maximum depth of approximately 6 m (20 ft) bgs. Excavated soil is segregated (automated or laboratory based) to determine disposal or treatment requirements.	High Shallow sources removed	High Shallow excavation is typically straightforward. A permit is required for excavation in the 100, 200, and 300Areas and the Hanford Reach National Monument.	Moderate/High	Low to none No associated cost	Moderate/High Waste generation if excavated soil is disposed of; GHG and energy for excavation equipment	Retained	Retained as potential component of remedy

Table B-7. Preliminary Screening of Remedial Technologies for Vadose Zone Remediation of Radionuclides, Hexavalent Chromium, Other Metals, and Organic Compounds—Hanford Site Inner Area

General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
		Deep Excavation	All	Shallow/ Deep	Soil is removed from a depth greater than approximately 6 m (20 ft) bgs. Deep excavation would require implementation of more complex technologies such as large layback for open-pit type excavation. Alternatively, use of shoring. Excavated soil is segregated (automated or laboratory based) to determine disposal or treatment requirements.	High	Low/Moderate	High	Low to none	Moderate/High	Retained	Retained as potential component of remedy
						Locations of the deep sources will be difficult to identify, meaning large areas would have to be excavated to depth to ensure that the deep sources were removed.	Shoring may be difficult with cobbles and boulders. Significant safety issues with very deep excavations. A permit is required for excavation in the 100, 200, and 300Areas and the Hanford Reach National Monument.		No associated cost	Waste generation if excavated soil is disposed of; GHG and energy for excavation equipment		
Ex Situ Treatment and Processing, and Onsite Backfilling	Ex Situ Treatment and Processing[d]	Solidification/ Stabilization	Mobile to semimobile contaminants (technetium-99, hexavalent chromium, strontium-90, and uranium)	Depends on excavation method	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Agents include soluble phosphates, pozzolan/ portland cement, and polyethylene extrusion. The stabilized mass is returned to its original location and capped to shed water and prevent weathering, and the locale is engineered to withstand seismic activity.	Moderate	High	High	Low	Low	Not Retained*	Screened out in favor of disposal in ERDF. Additional handling of the excavated soil will significantly increase costs and increase the potential for industrial accidents and contaminant exposure, which could pose considerable risk to workers.
						Effective at immobilizing contaminants in excavated material. However, the stabilized mass must be protected from weathering and seismic activity for long-term durability.	Well-established technology. Site-specific studies need to be completed to evaluate equipment required and appropriate cement agents. Significant health and safety concerns.		Integrated into Inner Area institutional management costs	GHG and energy used for production and delivery of reagent, and for transport and mixing		

Table B-7. Preliminary Screening of Remedial Technologies for Vadose Zone Remediation of Radionuclides, Hexavalent Chromium, Other Metals, and Organic Compounds—Hanford Site Inner Area

General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
		Soil Washing	Hexavalent chromium, technetium-99, nitrate and, possibly, uranium	Depends on excavation method	Consists of size separation of highly contaminated soil fractions (fines) from minimally contaminated soil fractions (coarse), followed by mechanical abrasion or washing to remove surface contamination	Low/Moderate Effectiveness is driven by the binding processes that exist between the contaminants and the soil particles (adsorbed or precipitated). Effectiveness is variable based on the nature of the COPC. Pilot testing at the Hanford Site suggests many contaminants strongly sorb to all soil types. Pilot test is necessary for hexavalent chromium.	Moderate/High Conventional aggregate washing and screening technology are used to separate soil particles by size fraction. Contaminated soils and water are disposed of or further treated. Soils that meet cleanup criteria (remediated coarse soil) can be returned to the site. Mechanically intense.	Moderate	Low Integrated into Inner Area institutional management costs	Moderate Additional resource impact (water used in process); GHG and energy for process and additional treatment required (of contaminated fines and water)	Not Retained	Not proven for Hanford soils; mechanically intense
		Vitrification	All	Depends on excavation method	Thermal treatment process that converts excavated soil and other materials into stable crystalline substances.	High Heavy metals and radionuclides are incorporated into the crystalline structure, which is generally resistant to leaching.	Low High complexity of equipment required. Ex situ joule heating vitrification uses furnaces that have evolved from the glass industry. Implementability is higher than for in situ application given use of proven technology (furnaces).	High	Low Integrated into Inner Area institutional management costs	Low GHG and energy for heat generation. High energy requirements to sustain required heat.	Not Retained*	Very complex technology, safety concerns with implementation
		Thermal Desorption	Organics	Depends on excavation method	Direct application of heat to soil piles to increase the temperature of soil and destroy or volatilize organic compounds. A vapor cover and vacuum system is needed to transport volatilized water and organics to the gas treatment system. Also completed using mechanical systems (e.g., rotary drum).	High Technology can achieve rapid removal/destruction of a mix of volatile and semivolatile organics at low residual levels.	Low Equipment is readily available and commonly used but can be mechanically complex.	High	Low No associated cost	Low GHG and energy for production of heat vapor treatment	Not Retained*	Very complex and challenging to implement

Table B-7. Preliminary Screening of Remedial Technologies for Vadose Zone Remediation of Radionuclides, Hexavalent Chromium, Other Metals, and Organic Compounds—Hanford Site Inner Area

General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
Disposal	Disposal	Backfill Treated Soil	All	Shallow/ Deep	Excavation and ex situ treatment followed by onsite disposal (backfill)	High	High	Low/Moderate	Low	Moderate	Retained	
						Contaminated material has been treated by ex situ technologies.	Excavated and treated soil will need to be compared to cleanup criteria to verify backfill is appropriate.		No associated cost	GHG and energy for backfill		
		Onsite Landfill	All	Shallow/ Deep	Disposal of excavated soil at ERDF. Treatment performed at the facility as required to meet land disposal restrictions.	High	High	Low/Moderate	Low	Low/Moderate	Retained	
							Implementability is limited by COPC concentrations and onsite landfill requirements.		Integrated into Inner Area institutional management costs.	GHG and energy for transport.		
		Offsite Landfill	All	Shallow/ Deep	Disposal of excavated soil at offsite landfill.	High	High	Moderate	Low	Low	Retained	Liability concerns over offsite landfills
						Contaminated material has been treated by ex situ technologies.	Implementability is limited by COPC concentrations and offsite landfill requirements.		No associated cost	GHG and energy for transport		
		Offsite Repository (WIPP)	TRU waste	Shallow/ Deep	TRU waste is soil and debris containing alpha-emitting TRU radionuclides having half-lives greater than 20 years at concentrations greater than or equal to 100 nCi/g at the time of assay. TRU radionuclides include elements with atomic numbers greater than 92 such as neptunium, plutonium, americium, and curium. TRU waste must be packaged and shipped to the WIPP in Carlsbad, New Mexico.	High	High	High	Low	High	Retained	May not be applicable to this geographic area but retained as a contingent remedial technology
							Implementable, but it is an offsite activity, so substantial administrative requirements apply. Work must be coordinated through the Hanford Transuranic Waste Certification Program.		No associated cost	GHG and energy for transport		

Table B-7. Preliminary Screening of Remedial Technologies for Vadose Zone Remediation of Radionuclides, Hexavalent Chromium, Other Metals, and Organic Compounds—Hanford Site Inner Area

General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
In Situ Treatment												
In Situ Treatment via Reagent—Reagent Approach												
Physical/Chemical/Biological—Solidification/Stabilization			Mobile COCs to semimobile radionuclides, other metals, and organics	Shallow	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Agents include soluble phosphates, pozzolan/ portland cement, and polyethylene extrusion. Typically, only used for organics when the COPC exists as a free-phase hydrocarbon to reduce mobility.	Low/Moderate There is debate about the long-term durability of the monolith and whether it is, in fact, permanent. Potential for exposure still exists.	Moderate Depends on delivery method	Moderate	Low Assuming monolith is permanent	Low/Moderate GHG and energy for production and delivery of substrate/reagent	Retained	Straightforward and proven option Retained for strontium-90 and other PCOCs if applicable
Physical/Chemical/Biological—Chemical Treatment			Hexavalent chromium, technetium-99, uranium, and strontium-90	Shallow/ Deep	Chemical reductant (e.g., calcium polysulfide, hydrogen sulfide gas, ferrous sulfate, ZV iron, etc.) and/or sequestration agent (e.g., phosphate, calcite, etc.) is applied to the subsurface to treat contaminants within the vadose zone. Chemical can be combined with solidification/stabilization or other treatment mechanisms.	Moderate Chemical reductants are instantly reactive, which requires overloading to maintain reactive strength at depth. Reduction of technetium-99 and uranium is potentially reversible.	Low/High Depends on delivery method. Localized temporary generation of secondary byproducts may occur. May temporarily mobilize COPCs (in first pore volume) toward groundwater. Handling chemical reductants is a health and safety concern.	Low/Moderate	Moderate	Moderate GHG and energy for production and delivery of chemical agent	Retained	

Table B-7. Preliminary Screening of Remedial Technologies for Vadose Zone Remediation of Radionuclides, Hexavalent Chromium, Other Metals, and Organic Compounds—Hanford Site Inner Area

General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
Physical/Chemical/Biological—In Situ Chemical Oxidation			Organics	Shallow/ Deep	Subsurface delivery of chemical oxidant (e.g., hydrogen peroxide, ozone, permanganate, persulfate, or percarbonate) to degrade organic COPCs. Oxidants cause chemical destruction of toxic organic chemicals. Petroleum hydrocarbons and PAHs can be treated with a variety of oxidants (including peroxide, percarbonate, persulfate, and ozone); however, limited case studies demonstrate the successful treatment of PCBs with in situ chemical oxidation. Ozone is the most likely oxidant.	Moderate Effectiveness is a function of oxidant distribution and contact. Injection of ozone a possible alternative but more complex than bioventing alone. Multiple applications may be required to achieve complete treatment.	Low/Moderate Chemical oxidants can be delivered using soil mixing, horizontal injections wells, or vertical injection wells.	Moderate	Low/High O&M costs would be low assuming complete treatment could be achieved with a single application; high O&M costs if multiple applications are required to achieve treatment.	Moderate GHG and energy for production and delivery of substrate/reagent; waste generation from soil cuttings	Not Retained*	More challenging to implement compared to bioventing
			Organics	Shallow	Surface bioremediation involves tilling the soil and adding moisture and an amendment to stimulate natural degradation at shallow depths of 0 to 1.2 m (0 to 4 ft) bgs. Organic compounds are degraded by indigenous or inoculated microorganisms. May also be supplemented by additions of fertilizer.	Low/Moderate Surface bioremediation is effective for remediating low-level residual petroleum hydrocarbons in conjunction with source removal. PAHs and PCBs are more difficult to degrade. Effectiveness can be hindered by non-uniform amendment distribution, lack of appropriate microorganisms, or non-optimal moisture and temperature.	Low Tilling equipment limits achievable treatment depth. Implementation is challenging in gravelly/ cobbly lithologies. Maintaining appropriate temperature and moisture conditions is more challenging for surface treatment.	Low/Moderate	Low	Moderate GHG and energy for production and delivery of substrate/reagent.	Retained	Potentially applicable to small volumes of petroleum-contaminated soil
Physical/Chemical/Biological—Biological Treatment			Hexavalent chromium, technetium-99, uranium, and nitrate	Shallow/ Deep	Biological carbon source (e.g., molasses, sodium lactate, emulsified oil, etc.) is applied to the subsurface to treat contaminants within the vadose zone.	Moderate/High Carbon source follows source release pathways. Biological reductants are activated by microbial activity, so reactive strength is maintained over relatively longer distances. Reduction of technetium-99 and uranium is potentially reversible.	Low/High Depends on delivery method. Localized temporary generation of secondary byproducts may occur. May temporarily mobilize COPCs (in first pore volume) toward groundwater.	Low/Moderate	Moderate	Moderate GHG and energy for production and delivery of substrate. Depends on which substrate is used.	Retained	

Table B-7. Preliminary Screening of Remedial Technologies for Vadose Zone Remediation of Radionuclides, Hexavalent Chromium, Other Metals, and Organic Compounds—Hanford Site Inner Area

General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
Physical/Chemical/Biological—Combined Chemical/Biological Treatment			Hexavalent chromium, technetium-99, uranium, and nitrate	Shallow/ Deep	Chemical reductant (e.g., calcium polysulfide, hydrogen sulfide gas, ferrous sulfate, ZV iron, etc.) and biological carbon source (e.g., molasses, sodium lactate, emulsified oil, etc.) are combined and applied to the subsurface to treat contaminants within vadose zone.	Moderate/High Amendments follow source release pathways. Combined chemical and biological treatment might improve performance. Reduction of technetium-99 and uranium is potentially reversible.	Low/High Depends on delivery method. Localized temporary generation of secondary byproducts may occur. May temporarily mobilize COPCs (in first pore volume) toward groundwater. Handling chemical reductants is a health and safety concern.	Low/Moderate	Moderate	Moderate GHG and energy for production and delivery of substrate/reagent. Depends on which substrate is used.	Retained	
Physical/Chemical/Biological—Gaseous Ammonia Injection			Mobile COPCs	Shallow/ Deep	One of a number of possible gaseous reagents that are being investigated, along with ISGR. It involves the injection of ammonia gas to increase pH to dissolve silica. The pH naturally decreases to ambient conditions over time, and aluminosilicate minerals precipitate and possibly coat and immobilize various contaminants.	Unknown Effectiveness is being studied as part of a laboratory-scale investigation.	Unknown Implementation is unknown at a full-scale level.	Unknown Technology evaluation has been limited to laboratory tests.	Unknown Technology evaluation has been limited to laboratory tests.	Unknown GHG emissions from injection activities	Retained	Evaluation of results from the ongoing treatability study is needed prior to making a decision regarding its full-scale use at the Hanford Site. This technology could be evaluated as a remedial alternative later.
Physical/Chemical/Biological—Bioventing			Organics	Shallow/ Deep	Process that stimulates the natural biodegradation of aerobically degradable compounds in soil by providing oxygen to existing soil microorganisms. Bioventing uses low airflow rates to provide only enough oxygen to sustain microbial activity.	Low/Moderate Technology is proven for remediating soils contaminated by petroleum hydrocarbons but is less effective for PAHs and not effective for PCBs. Effectiveness can be limited by extremely low soil moisture content, which would limit biodegradation.	High Applied using horizontal or vertical wells	Moderate	Low	Moderate GHG and energy for installation of delivery mechanism and delivery of air; waste generation from soil cuttings	Retained	Retained for petroleum hydrocarbons and PAHs

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General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
Physical/Chemical/Biological—Reductive Dechlorination Using ZV Metals and Bioremediation			PCBs	Shallow/ Deep	ZV metals have the potential to reductively dechlorinate PCBs. Metals include iron, palladium, and other combinations. The contaminated soil and the metals are mixed in some fashion to allow the reactions to occur. Bioremediation, via the addition of an organic substrate, is a very similar process and can be combined with ZV metal addition.	Unknown Very few published testing results are available.	Moderate Could be implemented by soil mixing with conventional excavation equipment if the contamination is shallow.	High	Low Integrated into Inner Area institutional management costs	Unknown	Not Retained*	Several laboratory and field-scale demonstrations have been conducted to evaluate the performance of using nano-scale ZV iron for PCB dechlorination. The effectiveness of this treatment technology is considered to be poorly known, given the limited availability of published testing results and/or conflicting technology demonstration data. Reductive dechlorination using ZV metals and bioremediation is not a proven technology and was not retained for further consideration. More field studies must be conducted to test methods of bioaugmentation and biostimulation for PCB dechlorinators.
In Situ Treatment (cont.)												
In Situ Treatment via Reagent—Delivery Method												
ISGR with Chemical Reductant or Biological Substrate			Hexavalent chromium, technetium-99, uranium, and nitrate	Shallow/ Deep	A gaseous mixture of chemical reductants (e.g., hydrogen sulfide) or biological substrate (e.g., butane) is injected into and drawn through the vadose zone to reduce hexavalent chromium, technetium-99, and uranium. Research is underway to evaluate other reagents to immobilize contaminants.	Unknown Soil heterogeneity will result in preferential flow and limit treatment effectiveness of lower-permeability soil.	Unknown Vapor extraction wells are installed around injection well at a radial spacing of approximately 4.6 m (15 ft)—large numbers of wells are required. Because of health and safety risks, monitoring and emergency response plans are required for transporting, storing, and handling.	High	Unknown	Unknown GHG emissions from injection activities	Not Retained*	Evaluation of results from the ongoing treatability study is needed prior to making a decision regarding its full-scale use at the Hanford Site. This technology could be evaluated as a remedial alternative later.

Table B-7. Preliminary Screening of Remedial Technologies for Vadose Zone Remediation of Radionuclides, Hexavalent Chromium, Other Metals, and Organic Compounds—Hanford Site Inner Area

General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
Mixing with Conventional Excavation Equipment			N/A[d]	Shallow	Use of conventional excavation equipment (backhoes, excavators, front-end loaders, etc.) to mix amendments into the soil	High Agents are uniformly mixed with soil column, providing good contact and reaction between COPC and chemical.	High Simple technology. Dust-mitigation techniques will need to be implemented to control/prevent mechanical dispersion of contaminants.	Low/Moderate	Low No associated cost	Low/Moderate GHG emissions from diesel- or gasoline-burning engines	Not Retained*	Not retained in favor of surface infiltration. Could be retained if shallow mobile contaminants are identified in the future.
Deep Soil Mixing (Vertical/Horizontal)			N/A[d]	Shallow/ Deep	Large mixing augers (1.5 to 3 m [5 to 10 ft] in diameter) or horizontally rotating heads are used to blend and homogenize reactants with soil. The reactants may be chemical reductants, biological substrate, or solidification/stabilization agents.	High Chemical agents are uniformly mixed with soil column, providing good contact and reaction between COPC and chemical. Cement or clay can also be mixed with the chemical slurry to reduce the hydraulic conductivity and leachability of the soil.	Low Implementation will be more challenging in gravelly/ cobbly lithologies. Although deep soil mixing has been performed to depths of 30 m (100 ft) bgs, most field applications have been limited to approximately 15 m (50 ft) bgs.	High	Low No associated cost	Low/Moderate GHG emissions from diesel- or gasoline-burning engines	Not Retained*	Deep soil mixing implementability will be limited by site conditions and required depth of treatment.
Foam Delivery of Reagents			N/A[d]	Shallow/ Deep	Injection of a foam into the vadose zone. The foam is a mixture of a surfactant solution to create the foam, and a reagent, such as calcium polysulfide. The foam increases the horizontal migration of the reagent away from the injection well.	Unknown Technology evaluation has been limited to laboratory column tests. The stability of the foam, which will dictate the well spacing, is unknown, as is the ability of the foam to permeate a large volume of the vadose zone.	Unknown Technology evaluation has been limited to laboratory column tests.	Unknown Technology evaluation has been limited to laboratory column tests.	Unknown Technology evaluation has been limited to laboratory column tests.	Unknown	Not Retained*	Evaluation of results from the ongoing treatability study is needed prior to making a decision regarding its full-scale use at the Hanford Site. This technology could be evaluated as a remedial alternative later.
Gas Delivery of Reagents			N/A[d]	Shallow/ Deep	A gaseous mixture of chemical reagent is injected into and drawn through the vadose zone to reduce mobile COPCs.	Unknown Soil heterogeneity will result in preferential flow and limit treatment effectiveness of lower-permeability soil.	Unknown Vapor extraction wells are installed around injection well at a radial spacing of approximately 4.6 m (15 ft)—large numbers of wells are required. Because of health and safety risks, monitoring and emergency response plans are required for transporting, storing, and handling.	High	Unknown	Unknown GHG emissions from injection activities	Not Retained*	Evaluation of results from the ongoing treatability study is needed prior to making a decision regarding its full-scale use at the Hanford Site. This technology could be evaluated as a remedial alternative later.

Table B-7. Preliminary Screening of Remedial Technologies for Vadose Zone Remediation of Radionuclides, Hexavalent Chromium, Other Metals, and Organic Compounds—Hanford Site Inner Area

General Response Actions	Remedial Technology	Technology Process Option	COPC Applicability[a]	Depth Range[b]	Description	Effectiveness	Implementability	Relative Capital Cost	Relative O&M Cost	Sustainability[c]	Retained/ Not Retained	Screening Comment
Injection Wells (Horizontal)			N/A[d]	Shallow/ Deep	Delivery of amendments using horizontal wells. Wells are installed using horizontal drilling techniques.	Moderate Effectiveness can be hindered by non-uniform amendment distribution. Soil heterogeneity will result in preferential flow and limit treatment effectiveness of lower-permeability soil. Multiple injections could be required.	Low Implementation is challenging in gravelly/ cobbly lithologies. Lithology would also pose issues with maintaining target depth and alignment with horizontal drilling. A pilot test of this technology encountered significant implementation challenges.	Moderate/High	Low	Moderate GHG emissions from well installation, development, and injection activities; waste generation from soil cuttings	Not Retained*	Testing at the Hanford Site has not been successful.
Injection Wells (Vertical)			N/A[d]	Shallow/ Deep	Delivery of amendments using conventional vertical wells	Low Effectiveness can be hindered by non-uniform amendment distribution. Distribution of liquid amendments is highly ineffective because of gravelly/cobbly lithology. Better distribution would likely be obtained with gaseous amendment. Radius of influence could be low.	Moderate Radius of influence likely to be low with conventional liquid reagents requiring large number of injection wells, because of gravelly/cobbly lithology.	Moderate/High	Low	Moderate GHG emissions from well installation, development, and injection activities; waste generation from soil cuttings	Retained for saturated zone	Not retained for vadose zone soils. Not adequate for distribution of liquid substrate. Retained for bioventing.
Jet Grouting			N/A[d]	Shallow/ Deep	High-pressure injection of reactive slurry into soil to hydraulically mix the soil with the slurry. Fluidization of the soil is preferred. Jet grouting can also be completed using super-permeating molten wax by heating the soil and injecting the wax, resulting in an impermeable material.	Low While jet grouting is capable of reaching the required treatment depth, jet grouting is not likely to achieve effective distribution in this formation because of gravel/cobbles. Currently being pilot tested at 100-N for shallower and more limited application.	Low/Moderate Implementation will be more challenging in gravelly/ cobbly lithologies. Jet grouting has been performed to as deep as 91 m (300 ft) bgs.	High Limited radius of influence would make jet grouting cost-prohibitive over a large area.	Low	Moderate GHG emissions from injection activities.-	Not Retained*	Not retained. Could be considered in the future if technology develops. Currently, jet grouting has potentially limited effectiveness.
Surface Infiltration			N/A[d]	Shallow/ Deep	Reagent is applied to the ground surface to treat contaminants within the vadose zone. Surface infiltration can be done through drip irrigation and shallow basin systems. Systems are generally designed to be 30.48 cm (12 in.) below the surface and covered to be protected.	Moderate/High Amendments follow source release pathways. Distribution is not likely to be uniform.	High Surface infiltration systems are simple to install and accessible for O&M.	Low/Moderate	Low	Low Limited infrastructure. GHG emissions from production and delivery of substrate	Retained	Retained for liquid substrates

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Void Filling/Grouting			N/A[d]	N/A (Pipelines)	Grouting for solidification of buried wastes. Void grouting is considered for filling large voids, specifically pipelines.	High Established and commonly used technology for removing voids in pipelines and old landfills/buried waste	High Established and commonly used technology for removing voids in pipelines and old landfills/buried wastes. Pipe branch lines/breaks need to be identified. Landfills require geophysics to identify void space in waste.	Low	Low No associated cost	Moderate GHG and energy for production and delivery of grout used	Retained	Retained for pipelines and waste sites (e.g., cribs with timbers) where an engineered barrier is selected and future subsidence can occur
Physical/Chemical/Biological Desiccation			All	Shallow/ Deep	Remediation by injecting hot dry air and withdrawing moist air from soil, immobilizing contaminants by preventing their aqueous-phase transport.	Unknown A treatability test for this technology is being conducted for waste sites in the Central Plateau contaminated with technetium-99. Theoretically, desiccation would reduce moisture content in the vadose zone. Reduction of COPC migration would be effective until the soil is rewetted. The technology is not effective in the long term without concurrent infiltration control (e.g., construction of an engineered surface barrier).	Unknown Implementation requires installation of injection and extraction wells, which are proven technologies. However, there is uncertainty related with the number of wells, well spacing, and well configuration details required for optimal field/full-scale implementation. Would also require implementation of infiltration control.	High	Unknown	Moderate GHG and energy for air injection	Not Retained*	Evaluation of results from the ongoing treatability study is needed prior to making a decision regarding its full-scale use at the Hanford Site. This technology could be evaluated as a remedial alternative later.
Physical/Chemical/Biological In Situ Thermal Desorption			Organics	Shallow/ Deep	Direct application of heat (e.g., using electrical heater elements, injection of hot air, steam, or hot water, radio frequency, etc.) to increase the temperature of soil and destroy or volatilize organic compounds. VOC capture required.	High Technology can achieve rapid removal/destruction of a mix of volatile and semivolatile organics, and achieve low residual concentrations.	Low Technology is applied using vertical drilling methods and requires a spacing of 1.5 to 3.0 m (5 to 10 ft). Recovery of COPC vapors will require soil vapor extraction network and vapor barrier over entire treatment area.	High	Low No associated cost	Low GHG and energy for production of heat and vapor recovery; waste generation from soil cuttings	Not Retained*	Mechanically complex; challenging to implement

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Physical/Chemical/Biological			All	Shallow/ Deep	Thermal treatment process that converts soil and other materials into stable crystalline substances. Contaminants are incorporated into the glass structure, which is generally strong, durable, and resistant to leaching.	High	Low	High	Low	Low	Not Retained*	Very complex and challenging to implement
In Situ Vitrification						Heavy metals and radionuclides are retained within the treated soil, which is generally resistant to leaching.	High complexity of equipment required. Process uses an electric current to melt soil or other earthen materials at extremely high temperatures (1,600 to 2,000 °C [2,900 to 3,650 °F]). It is important to also account for safety considerations from exposure to high heat.		Integrated into Inner Area institutional management costs	GHG and energy for heat generation. High energy requirements to sustain required heat.		
Physical/Chemical/Biological			Anionic contaminants (hexavalent chromium, technetium-99, iodine-129, fluoride, uranium and, possibly, cyanide)	Shallow/ Deep	Current is applied using electrodes to encourage desorption of contaminants from media.	Low	Low	High	Low	Low	Not Retained*	Not retained because sufficient soil moisture is required to allow ions to flow.
Electrokinetics						Effectiveness is limited by the solubility of the COPCs, soil moisture content, and areas of poor electrical conductivity. Not likely to be effective for coarse soil conditions relevant in the vadose zone.	Extraction of concentrated contaminant could pose risk to workers. Equipment is complex, which might present implementability challenges in finding contractors.		No associated cost	GHG and energy for heat generation. High energy requirements to sustain required heat.		
Physical/Chemical/Biological			Contaminants with high to moderate solubility in water (hexavalent chromium, technetium-99, and nitrate)	Shallow/ Deep	Clean or treated water is applied to the ground surface or in infiltration trenches to flush contaminants out of the vadose zone to the water table, where it would be captured/treated.	Moderate	High	Low/Moderate	Low	Low	Retained	
In Situ Flushing						Water follows source release pathways, but contaminants that remain in adsorbed phase will not be treated. May create a larger groundwater problem if the groundwater capture is not effective.	Drip irrigation system or trenches are simple to install and accessible for O&M.			GHG and energy for installation		

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Physical/Chemical/Biological Phytoremediation			Bioavailable metals and organics	Shallow	Phytoremediation uses plants and their associated rhizospheric microorganisms to remove, degrade, or contain contaminants.	Low Phytoremediation is only effective when plants are active; thus, the technology is not effective during the winter. Phytoremediation only treats soils to the approximate depth of the plant roots and is only appropriate for low concentrations of contaminants. It is a slow process that is applied over long periods of years or decades. Many metals and radionuclides are only taken up by the plants and not transformed to innocuous forms.	Moderate Involves large land requirements, and considerable work would be required to make a plot of land at the Hanford Site suitable for plant growth. If used to treat contaminants that are merely taken up and not transformed to innocuous forms, plants would need to be disposed of elsewhere to avoid ultimately returning the contaminants back to the soils they came from. Concerns about contaminants in the plants entering the food chain may need to be addressed.	Low	Low	High GHG and energy for installation. Implementation of phytoremediation could lead to a GHG reduction credit.	Not Retained*	Phytoremediation would only be effective for low concentrations of contaminants in shallow soils over long periods, and many metals and radionuclides would accumulate in the plants and would not actually be treated, posing risks to ecological receptors.
Containment												
Surface Barriers												
Maintain Existing Soil Cover with MNA			All	Shallow/ Deep	The existing soil cover on a waste site is maintained and/or augmented as needed to provide protection from intrusion by biological receptors. Existing soil covers include soil stabilization covers and clean overburden.	Moderate Does not reduce contamination. Effective in supporting mitigation of potential for direct contact with residual contaminants if consistently well implemented for duration of elevated risk. Relies on natural attenuation to decrease contaminant concentrations to levels protective of human health and the environment.	High Applicable only on sites with existing soil covers. Simple to implement but requires maintenance and periodic monitoring throughout the attenuation period. Restrictions on future land use would be necessary.	Low No associated cost; system in place	Low	Moderate Continued impact to soil resources	Retained	Retained if used in conjunction with MNA
Hanford Barrier			All	Shallow/ Deep	A nine-layer barrier with a total thickness of 4.5 m (11.8 ft). Designed to be impermeable to prevent surface water infiltration through the vadose zone and limit contaminant leaching to groundwater. Will also prevent direct contact with contaminants.	Moderate/High Leaching of near-surface source COPCs will be controlled, but residual COPCs in capillary fringe and deeper vadose zone pore water will continue to affect groundwater because of water table fluctuation.	High Most ET barriers are simple to construct, however the nine-layered Hanford Barrier construction is complex. Biointrusion will need to be considered as part of the barrier/cap design and is in the Hanford Barrier.	High	Low	Moderate GHG and energy for installation. Continued impact to soil resources.	Not Retained*	Installation of large number of layers makes this technology difficult to implement. It has very few advantages over the ET barrier in comparison to cost.

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Modified RCRA Subtitle C and/or D Barrier			All	Shallow/ Deep	Modified RCRA Subtitle C barriers are designed for hazardous waste, Category 3 and Category 1 (mixed) low-level waste. Modified RCRA Subtitle D barriers are designed for nonradiological and nonhazardous solid waste, or Category 1 low-level waste where hazardous constituents are not present. Various modifications to a RCRA C barrier designed to be site-specific. Number of layers can vary from four to seven. Modified RCRA Subtitle D is composed of approximately four layers with a relative thickness of 0.9 m (2.9 ft). Barriers are generally designed to be impermeable to prevent surface water infiltration through the vadose zone and limit contaminant leaching to groundwater. May also prevent direct contact with contaminants.	Moderate/High Leaching of near-surface source COPCs will be controlled, but residual COPCs in capillary fringe and deeper vadose zone pore water will continue to affect groundwater because of water table fluctuation. Prevention of direct contact will depend on specific design.	Low Most ET surface barriers are simple to construct; however the nine-layered Hanford Barrier construction is complex. Biointrusion will need to be considered as part of the barrier/cap design and is in the Hanford Barrier.	High	Low	Moderate GHG and energy for installation. Continued impact to soil resources.	Not Retained	Modified RCRA barriers have been demonstrated to fail in arid and semiarid environments, as well as some humid climates. The smectitic clays will shrink and crack when dry and can allow significant quantities of precipitation to infiltrate through the cracks down into the underlying waste. In addition, man-made materials in RCRA barriers can have a limited life prior to failure.
Asphalt/Concrete Cap			All	Shallow/ Deep	Barriers used around structures to remain in place (e.g., reactors) in the short-term (75 years) to promote drainage, prevent infiltration into possible sources below the reactors, and prevent exposure to contaminated soil.	High For increased effectiveness, barrier needs to be properly sealed, given that asphalt and concrete are permeable. High effectiveness in the short term.	High No technical or administrative challenges. Simple to construct.	Low	Low	Moderate GHG and energy for installation. Continued impact to soil resources.	Retained	Potential component of alternatives. May be applicable for small areas requiring short-term effectiveness.

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Vegetative Cap (ET Cap)			All	Shallow/ Deep	There are two types of ET barriers: monofill and capillary. Both barriers function on the premise of minimizing (<2mm) or stopping water from percolating through the engineered barrier through the processes of evaporation and transpiration. Barrier thickness and associated soil moisture storage capacity must take into account the local current and future climatic conditions. The barrier functions as a giant sponge soaking up the water and minimizing or preventing percolation. The monofill ET layer consists of a single layer, whereas the capillary layers consist of a fine-grained soil layer overlying a relatively coarse-grained soil layer. The distinct textural interface in capillary ET barriers between the fine and coarse soil layers creates a capillary break, which functionally increases the water-holding capacity of the fine-grained soil layer. To mitigate erosion, pea gravel should be blended into the surface approximately 100 cm of the ET barrier. See EPA 542-F-11-001 for additional information on ET barriers.	Low/Moderate Leaching of near-surface source COPCs will decrease once grasses have become established, but residual COPCs in capillary fringe and deeper vadose zone pore water may continue to affect groundwater because of water table fluctuation. Prevention of direct contact will depend on specific design. See SGW-34059 for further details.	High Vegetative cap readily installed. Biointrusion will need to be considered as part of the barrier/cap design. If the depth of waste is less than 4.6 m (15 ft), a biobarrier will be needed (biobarriers in arid/semiarid zones often consist of a cobble layer).	Low	Low	High GHG and energy for installation	Retained	In arid and semiarid environments, ET barriers are preferred over modified RCRA barriers due to superior performance, limited maintenance, costs, and barrier life expectancy. Capillary barriers should not be used in areas susceptible to subsidence.

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Horizontal Subsurface Barriers												
Jet Grouting, Soil Freezing, or Wire Saw Barriers			All	Shallow/ Deep	Barriers are placed beneath the contaminated zone to limit further migration. Jet grouting is as previously discussed at one specific depth. Soil freezing involves placement of cooling media distribution systems into the subsurface to freeze a soil layer below the contamination. Wire saw barrier involves cutting a thin horizontal trench that is filled with grout using a diamond wire saw. The saw is placed in an excavation around the soil mass to be contained.	Low Significant uncertainty on the completeness of the barrier with all methods.	Low All methods would be difficult or impossible to implement at the Hanford Site because of the gravels and cobbles and the depths required.	High	Low	Low Large amount of waste would be generated during installation, and GHG and energy for installation.	Not Retained*	Not implementable
Compaction												
Dynamic Compaction			All	Shallow/ Deep	Dynamic compaction is used for consolidation of soils and buried wastes, and can be used to minimize the potential subsidence for a subsequent barrier. The process involves dropping a weight from a predetermined height onto the area to be compacted or the use of heavy equipment.	Moderate/High Effective at removing void spaces and compacting surface soil, where voids exist around buried waste. Not effective for native soils. Not effective for treatment of hazardous wastes.	High Simple and widely used technology	Low	Low No associated cost	Low/Moderate GHG and energy for installation. Continued impact to soil resources.	Retained	Retained for waste sites that may require construction of an engineered barrier that could be prone to future subsidence (e.g., cribs)

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Sources: DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*.

EPA 542-F-11-001, *Fact Sheet on Evapotranspiration Cover Systems for Waste Containment.*

SGW-34059, *Effect of Waste Depth on Barrier Effectiveness.*

a. Indicates the contaminants that can be addressed by a technology based on geochemical properties. A COPC Applicability of "All" indicates implementation of a technology is not dependent on the nature of a chemical.

b. Depth range is based on practical limitations of implementing the given technology.

c. Sustainability rating based on E = energy use, GHG = air pollution and greenhouse gas emissions reduction, Water = water use and resource impacts, Waste = Reduce, reuse, and recycle waste, Eco = protect land and ecosystems.

d. Dependent on reagent approach.

e. Ex situ treatment does not include treatment done for ultimate disposal at ERDF. Treatment performed at ERDF or the site as required to meet disposal restrictions is assumed part of the disposal to onsite landfill process option.

* Additional details on technologies not retained will be provided in an appendix to the RI/FS report.

bgs = below ground surface
COC = contaminant of concern
COPC = contaminant of potential concern
ERDF = Environmental Restoration Disposal Facility
ET = evapotranspiration
GHG = greenhouse gas
ISGR = in situ gaseous reduction
MNA = monitored natural attenuation
NCP = National Contingency Plan (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan")
N/A = not available
O&M = operations and maintenance
PAH = polynuclear aromatic hydrocarbon
PCB = polychlorinated biphenyl
RCRA = *Resource Conservation and Recovery Act of 1976*
RI/FS = remedial investigation/feasibility study
TRU = transuranic
VOC = volatile organic compound
WIPP = Waste Isolation Pilot Plant
ZV = zero valent

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B2 References

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