DOE/RL-2011-15
Revision 1

Remedial Design/Remedial Action Work Plan for K Basins Interim Remedial Action: Treatment and Packaging of K Basins Sludge

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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Title: *Remedial Design/Remedial Action Work Plan for the K Basins Interim Remedial Action: Treatment and Packaging of K Basins Sludge*

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Executive Summary

This remedial design/remedial action work plan (RD/RAWP) provides plans and implementation details to treat and package K Basins sludge for disposal at a national repository. It also provides details for storage of untreated sludge in T Plant cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L prior to treatment and packaging for disposal. This RD/RAWP satisfies two of the elements identified in the *Hanford Federal Facility Agreement and Consent Order* [1] also known as the Tri-Party Agreement (TPA) Milestone M-016-140 for the submittal of RD/RAWPs for 100-K Area Records of Decision. Table ES-1 presents a summary of TPA Milestone M-016-140.

[1] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Table ES-1. Milestone M-016-140 (RD/RAWP Requirements)
Submit Revised RD/RA Work Plans for 100-K Area RODs as Primary Document(s) per HFFACO 11.6 with New Proposed Milestones Including for the Following

Current Milestone Deliverable	Required Milestone Elements	Document Number
☐ ☐	*Complete removal of the K West Basin*	DOE/RL-2010-52 (deactivation) DOE/RL-2010-53 (demolition)
☐	*Complete removal of all sludge (includes container, settler tank sludge) from K West Basin except knock out pot contents*	DOE/RL-2010-63
☐	*Complete removal of knock out pot contents*	DOE/RL-2010-63
☑	*Complete treatment and packaging of first container of TRU sludge waste certifiable for disposal at WIPP*	DOE/RL-2011-15
☑	*Complete treatment and packaging of sludge for disposal at WIPP*	DOE/RL-2011-15
☐	*Begin 105-KW reactor interim safe storage*	DOE/RL-2005-26, including TPA-CN-432
☐	*Complete 105-KW reactor interim safe storage*	DOE/RL-2005-26, including TPA-CN-432
☐	*Initiate soil remediation under K West Basin*	DOE/RL-96-17, including TPA-CN-320 and TPA-CN-433
☐	*Complete all interim response actions at the 100-K Area*	DOE/RL-96-17, including TPA-CN-320 and TPA-CN-433

Notes: Complete reference citations are provided in Chapter 8.

HFFACO is referring to the Tri-Party Agreement (Ecology et al., 1989a, Hanford Federal Facility Agreement and Consent Order) TRU = transuranic

WIPP = Waste Isolation Pilot

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Terms

105-KE	105-K East
105-KW	105-K West
ALARA	as low as reasonably achievable
ALARACT	as low as reasonably achievable control technology
ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant differences
ETF	effluent treatment facility
GFM	glass-forming minerals
HASP	health and safety plan
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document* (DOE/RL-96-68)
HEPA	high-efficiency particulate air
ICV	in-container vitrification
MEI	maximally exposed individual
PCB	polychlorinated biphenyl
ppm	parts per million
RACM	regulated asbestos-containing material
RACT	reasonably achievable control technology
RAO	remedial action objective
RD/RAWP	remedial action work plan
RDR	remedial design report
RH	remote handled
ROD	record of decision
RQ	reportable quantity

RWP	radiological work permit
SAP	sampling and analysis plan
SNF	spent nuclear fuel
STS	sludge transport system
STSC	sludge transport and storage container
T-BACT	Best Available Control Technology for Toxics
TBC	to be considered
TPA	Tri-Party Agreement *(Hanford Federal Facility Agreement and Consent Order)*
TRU	transuranic
WIPP	Waste Isolation Pilot Plant

1 Introduction

This remedial design/remedial action work plan (RD/RAWP) provides details for the design and implementation of work to treat and package K Basins engineered container (EC) sludge for disposal at the Waste Isolation Pilot Plant (WIPP), and for transport of the treated and packaged sludge to interim storage at the Hanford Site pending shipment to WIPP. This RD/RAWP also provides details for the storage of untreated sludge[1] in T Plant cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L while awaiting treatment and packaging for disposal.

This RD/RAWP does not address sludge collected in the knock-out pots during the fuel washing activities. Such sludge will be managed separately as described in DOE/RL-2010-63, *Remedial Design/Remedial Action Work Plan for the K Basins Interim Remedial Action: Removal of K Basins Sludge from the River Corridor to the Central Plateau.*

1.1 Purpose

This RD/RAWP describes the design and implementation of systems for treatment and packaging of sludge to meet the relevant remedial action objectives (RAOs) identified in the K Basins Interim Action Record of Decision (ROD) (EPA/ROD/R10-99/059, *Interim Remedial Action Record of Decision for the 100-KR-2 Operable Unit K Basins, Hanford Site, Benton County, Washington*) and the storage of untreated sludge identified in 16-AMRP-0173, *Explanation of Significant Differences for the Hanford Site 100 K Area K Basins Interim Remedial Action Record of Decision*, (hereafter referred to as the explanation of significant differences [ESD]).

This RD/RAWP satisfies two of the elements identified in *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989), also known as the Tri-Party Agreement (TPA), Milestone M-016-140 for the submittal of RD/RAWPs for 100-K Area RODs. Table 1 presents a summary of RD/RAWP requirements under TPA Milestone M-016-140.

1.2 Scope

This RD/RAWP addresses design and work activities for the following:

- Retrieval of sludge transport and storage containers (STSCs) from T Plant and transport to the Sludge, Treatment and Packaging Facility[2]
- Retrieval of sludge from STSCs for treatment and packaging
- Uranium metal oxidation treatment of sludge
- Solidification and packaging of treated sludge
- Transport of treated sludge to interim storage

[1] While this RD/RAWP addresses storage of untreated sludge at specific locations in T Plant, DOE/RL-2010-63 addresses sludge retrieval from KW Basin and transport to T Plant.

[2] The specific treatment process to be used and the location where treatment and packaging will be performed have not yet been established. These will be determined through completion of TPA Milestone M-016-173. This work plan will be updated accordingly. The current revision presents pre-conceptual design information contained in PRC-STP-00465, *K-Basin Sludge Treatment Project – Phase 2 Technology Evaluation and Alternative Analysis*.

In addition to the above design and work activities, this RD/RAWP also addresses requirements for storage of untreated sludge[3] prior to treatment and packaging for disposal. Figure 1 presents the activities addressed by this RD/RAWP, along with their relationship to the overall remedial action.

Table 1. Milestone M-016-140 (RD/RAWP Requirements)
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☐	*Initiate soil remediation under K West Basin*	DOE/RL-96-17, including TPA-CN-320 and TPA-CN-433
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Notes: Complete reference citations are provided in Chapter 8.

HFFACO is referring to the Tri-Party Agreement (Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*).

TRU = transuranic

WIPP = Waste Isolation Pilot Plant

[3] Untreated sludge includes sludge retrieved from the K Basins floor, pit, and settler tanks and sludge collected on sand and garnet filter media.

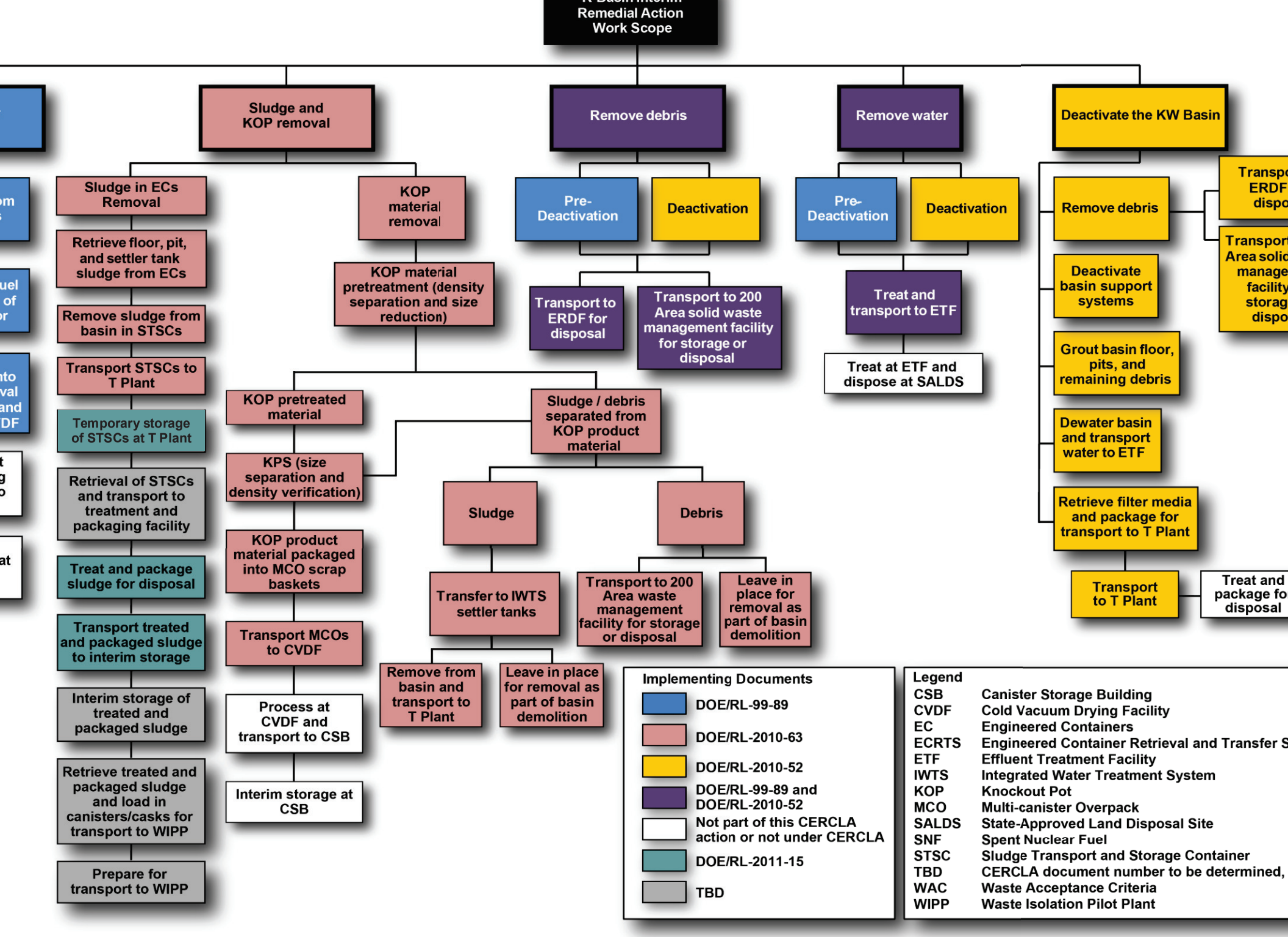

Figure 1. 105-KW Basin Interim Remedial Action Scope

1.3 Design-Phased Approach

The remedial design for the treatment and packaging of sludge from the 105-K West (105-KW) Basin will be developed using a design-phased approach based on the duration and complexity of this remedial action. Remedial Design Reports (RDRs) will be prepared as addenda to this RD/RAWP and submitted to the U.S. Environmental Protection Agency (EPA) for review and approval as the design levels advance toward 90 percent. More detailed discussion about the approach for remedial design development is provided in Section 3.2.

1.4 Site Description and Background

Sludge from the 105-KW Basin will be transported to T Plant for interim storage and treated and packaged at a Hanford Site 200 Area location that has not yet been selected. Selection will be based on considerations such as: soil conditions for foundation design, proximity of utilities, ecological and cultural considerations, and proximity of other Hanford Site solid waste management facilities that would be used for the interim storage of the treated and packaged sludge pending shipment to a national repository for disposal.

Actions that have been or will be taken in support of the K Basins Interim Action ROD include:

- Removal of spent nuclear fuel (SNF) from the K Basins
- Grouting of the 105-K East (105-KE) and 105-KW discharge chutes
- Containerization of the 105-KW Basin floor and pit sludge
- Containerization and transfer of sludge from the 105-KE Basin to the 105-KW Basin
- Partial removal of debris from the basins
- Retrieval and containerization of sludge from the 105-KW Basin settler tanks
- Sampling and analysis of sludge in ECs
- In-pool inspection of knock-out pot material in the 105-KW Basin
- Vacuuming and containerization of floor and pit sludge
- Deactivation and dewatering of the 105-KE Basin
- Removal of sludge from the 105-KW Basin in STSCs and transport to T Plant for interim storage

1.4.1 Physical Setting

The Hanford Site lies in a sediment-filled basin on the Columbia Plateau in southeastern Washington (Figure 2). The 200 Area is located in the center portion of the Hanford Site.

The 200 Area is situated on relatively flat and level terrain. Elevations across the central portion of the basin and the Hanford Site range from about 119 m (390 ft) above mean sea level at the Columbia River to 1,060 m (3,480 ft) above mean sea level at Rattlesnake Mountain, which forms the southwestern boundary of the site. The area has been extensively disturbed and graded during processing operations from the 1940s through present-day operations and waste site remedial activities.

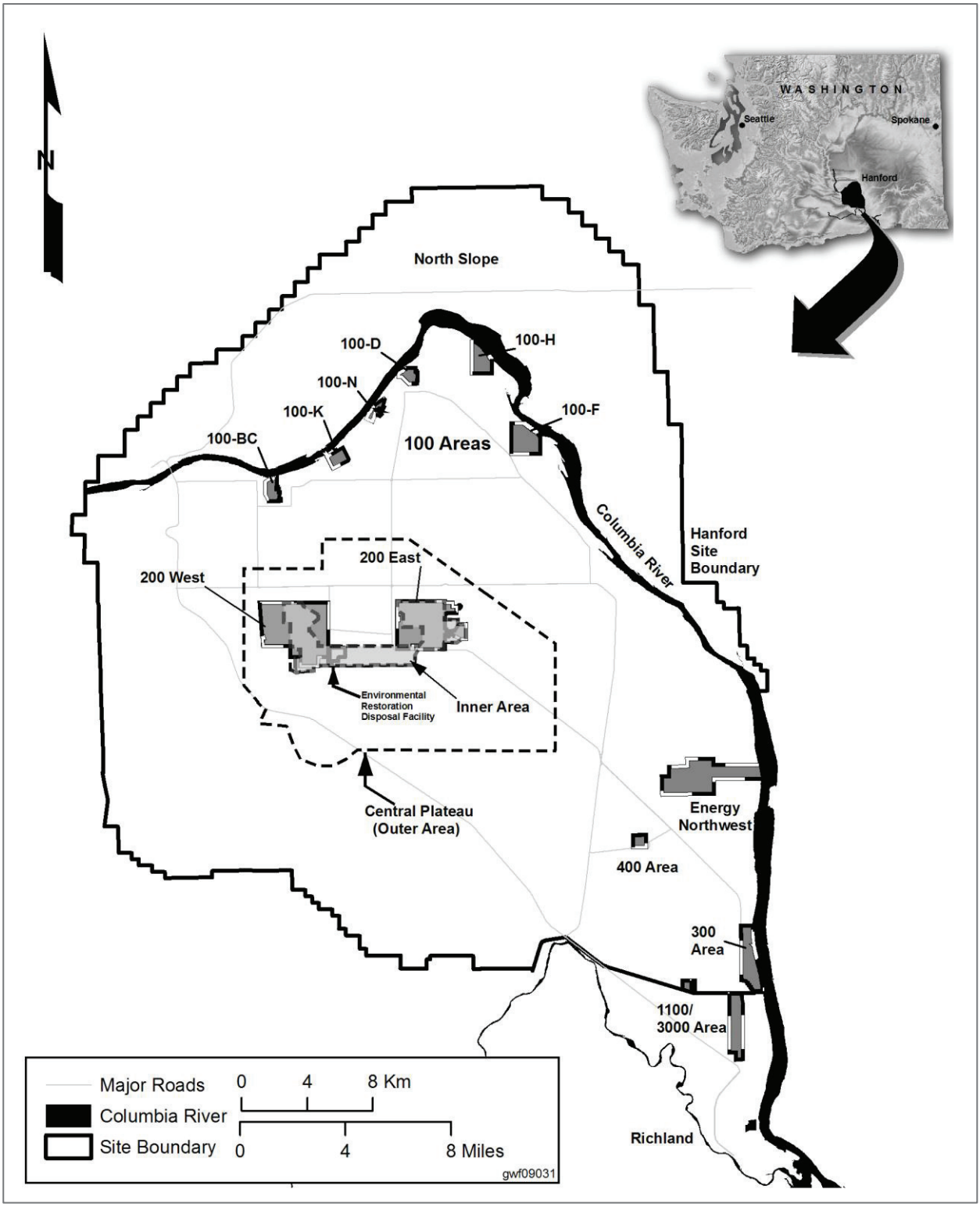

Figure 2. Hanford Site and 200 East Area

The Hanford Site is characterized by a semiarid, shrub-steppe climate in the driest and warmest portion of the Columbia Basin. Surface winds blow predominantly from the northwest during winter and summer and from the southwest in the spring and fall. Average monthly wind speeds are lowest during the winter,

averaging 10 km/h (6 mi/h) and highest during the summer, averaging 15 km/h (9 mi/h). The monthly average temperature ranges from a low of -0.24°C (31.7°F) in January to a high of 24.6°C (76.3°F) in July. Annual precipitation measurements typically range from approximately 8.7 to 28.8 cm (3.4 to 11.3 in.). Most precipitation occurs during late fall and winter, with more than half of the annual amount occurring from November through February. Winter monthly average snowfall ranges from 0.8 to 13.5 cm (0.3 to 5.3 in.).

1.4.2 Nature and Extent of Contamination

Sludge that will be contained in the STSCs originated primarily from 105-KE Basin floor and pits, and the 105-KW Basin floor and pit, fuel canisters, and fuel washing. The contaminants in the sludge consist of a SNF corrosion products (including metallic uranium, uranium hydrides and oxides, plutonium, fission and activation products, and aluminum and zirconium compounds from the cladding), metal oxides from corrosion of basin equipment including aluminum canisters, ion exchange media from the water treatment system, concrete grit from the basin walls, sand, and dirt. A characterization of the different sludge types can be found in HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Technical Databook, Vol. 2, Sludge.* Segregation of sludge waste stream sources is maintained via ECs currently stored in the KW Basin as follows:

- Engineered Container 210—KW Basin floor and pit sludge
- Engineered Container 220---KW Basin floor and pit sludge and segregated settler material
- Engineered Container 230—KW Basin Settler Tank Sludge
- Engineered Containers 240, 250, and 260—KE Basin floor and pit sludge

Sludge in these ECs was sampled and analyzed in accordance with the following data quality objectives and Quality Assurance Project Plans:

- HNF-36985, *Data Quality Objectives for Sampling and Analysis of K Basin Sludge*
- KBC-33786, *Quality Assurance Project Plan/Sampling and Analysis Plan for Sludge in the KW Engineered Containers*
- KBC-40467, *Quality Assurance Project Plan/Sampling and Analysis Plan for Containerized KW Settler Sludge*

Segregation of sludge waste streams will not be maintained when sludge is removed from the KW Basin and placed in STSCs for transport to T Plant for storage. Sludge will be removed from 105-KW Basin, transferred to STSCs, and then transported to T Plant, in accordance with 10 CFR 830, "Nuclear Safety Management." Characterization data for sludge samples from Engineered Containers 220, 240, 250, and 260 can be found in HNF-SD-SNF-TI-015. Based on sludge characterization data, sludge in the ECs designates as a remote-handled (RH) transuranic (TRU) polychlorinated biphenyl (PCB) remediation waste.

2 Basis for Remedial Action

This chapter provides a brief description of the selected remedy, RAOs, and applicable or relevant and appropriate requirements (ARARs) for the work covered in this RD/RAWP.[2]

2.1 Selected Remedy

The K Basins Interim Remedial Action ROD Amendment requires sludge to be treated, packaged for disposal, interim stored pending shipment, and shipped to a national repository for disposal. It explained that sludge would be treated at 100-K Area or another EPA-approved 200 Area facility. This RD/RAWP addresses the work necessary to retrieve sludge from STSCs received from storage at T Plant, treat and package the sludge, and place the treated and packaged sludge into interim storage (as needed) pending disposal at a national repository. Consistent with the ESD (16-AMRP-0173), T Plant cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L, 105-KW Basin and the Environmental Restoration Disposal Facility (ERDF) are all considered onsite in accordance with Section 104(d)(4) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

2.2 Remedial Action Objectives

Achievement of the RAOs identified in the K Basins Interim Action ROD that are applicable to this RD/RAWP will be as follows.

- RAO: Reduce the potential for future releases of hazardous substances from the K Basins to the environment:
  - Remove hazardous substances from the K Basins near the Columbia River in a safe and timely manner.
  - Provide for safe treatment and packaging of the sludge removed from the K Basins.

  This RAO will be met in part through: (1) removal of sludge from the K Basins in accordance with DOE/RL-2010-63 and transfer to T Plant for storage in cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L and (2) treatment, and packaging of the sludge for interim storage in accordance with this RD/RAWP. The treatment, storage, and final disposition of water and debris removed from the K Basins is addressed in separate RD/RAWPs (DOE/RL-99-89, *Remedial Design Report and Remedial Action Work Plan for the K Basins Interim Remedial Action*, and DOE/RL-2010-52, *Remedial Design/Remedial Action Work Plan for the K Basins Interim Remedial Action: 105-K West Basin Deactivation*).

- RAO: Reduce occupational radiation exposure to workers at the basins:

  This RAO will be met through a U.S. Department of Energy (DOE)-approved radiation protection program that implements the requirements of 10 CFR 835, "Occupational Radiation Protection" and through implementation of ALARA measures.

[2] The work is being planned for performance in accordance with ARARs based on the assumption that the storage, treatment and packaging of these hazardous substances, pending transport to a national repository for disposal, will all be performed on the Hanford Site in accordance with CERCLA Section 121.

- RAO: Address the sludge management concerns identified in Section 5.2.1 of K Basins Interim Action ROD:
  - The surface dose for an unshielded container of sludge is many times higher than the 200 mrem/hr limit for contact-handled waste. The contact dose associated with floor and pit sludge could be as high as 128,000-mrem/hr, and the contact dose rate associated with canister and wash sludge could be as high as 1.75 million-mrem/hr. Because of this, it is anticipated that containers of sludge will need to be managed as a RH waste unless special overpacking is provided.
  - The high concentrations of fissile materials (i.e., uranium and plutonium) require careful evaluation of criticality control for all activities involving the sludge.
  - Metal fines and metal hydrides in the sludge (e.g., uranium, uranium hydride, and zirconium) are potentially pyrophoric, reactive, and capable of generating flammable gas.

  This RAO will be met through design considerations, such as: (1) remote handling, use of radiation shielding in the processing, packaging, and transportation of sludge to interim storage, (2) conducting criticality safety analyses based on the characteristics of the different sludge types and application of requisite engineering and administrative controls, and (3) the oxidation of uranium to a more stable uranium oxide state and that any nonradioactive pyrophoric material is under the limits specified in the waste acceptance criteria of the waste repository. Safety studies[5] that include analyses of sludge properties (e.g., engineering reports regarding gas generation, retrievability, and other conditions that would affect the safe storage for a longer period of time) have been performed for the interim storage of untreated sludge at T Plant. Safe sludge storage will be achieved through requirements for receipt, handling, and storage of sludge transport system (STS) casks and STSCs containing K Basin sludge materials.

2.3 Remedial Action Goals

Remedial action goals were not specified in the ROD or ROD amendment for this interim remedial action. End-point criteria for sludge treatment are identified in HNF-20632, *End Point Criteria for the K Basins Interim Remedial Action.*

2.4 Applicable or Relevant and Appropriate Requirement Compliance

Section 121 of *Comprehensive Environmental Response, Compensation, and Liability Action of 1980* (CERCLA), the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300), K Basins Interim Action ROD (EPA/ROD/R10-99/059), and K Basins Interim Action ROD Amendment (EPA et al, 2005, *Amendment to the Record of Decision for the U.S. Department of Energy Hanford Site 100 K Area K Basins Interim Remedial Action*) require that remedial actions comply with federal and state ARARs. Table 2 identifies which ARARs apply to the scope of this RD/RAWP and how those ARARs will be met during the associated work. The K Basins Interim Action ROD Amendment also identified To Be Considered information that is not promulgated regulations but should be considered in determining the action necessary for protection of human health and the environment.

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[5] Detailed information on safety studies associated with untreated sludge is provided in the administrative record in the following documents: PRC-STP-00241, *Sludge Treatment Project-Engineered Container Retrieval and Transfer System – Thermal and Gas Analyses for Sludge Transport and Storage Container (STSC) Storage at T Plant;* PRC-STP-00579, *Sludge Treatment Project Engineered Container Retrieval and Transfer System: Status Report for Long Term Monitoring of K Basin Sludge Samples;* and PRC-STP-TR-00482, *Test Report for Sludge Treatment Project Engineered Container Retrieval and Transfer System Aged Sludge Retrieval Test*.

Table 2 identifies specific regulatory sections (as provided in the K Basins Interim Action ROD Amendment) that are ARAR or to be considered (TBC) to this work, with corresponding explanatory text.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
"Designation, Reportable Quantities, and Notification" (40 CFR 302)	ARAR	These requirements apply to new releases of CERCLA hazardous substances that occur or are discovered. Determinations under 40 CFR 302 are based on the identification of any release that exceeds the regulatory RQs for a listed hazardous substance.	The substantive requirements of 40 CFR 302 for determination of RQs will be applied to any new release that is identified and notification to DOE and EPA project managers will be made if a new release occurs or is discovered during the work. This is an action-specific requirement.
Regulations pursuant to the *Toxic Substances Control Act (TSCA)*, 15 USC 2601 et seq.			
"Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," "Applicability" (40 CFR 761; 40 CFR 761.1(b)(4)) "Applicability," "PCB Waste"(40 CFR 761.50(b)(3) and (7))"Applicability," "Storage for Disposal" (40 CFR 761.50(c)) "PCB Remediation Waste" (40 CFR 761.61(a)(4); 40 CFR 761.61(c)) "Decontamination Standards and Procedures" (40 CFR 761.79(h))	ARAR	These regulations apply to the storage and disposal of PCB wastes including liquid PCB wastes, PCB items, PCB remediation waste, PCB bulk product wastes, and PCB/ radioactive wastes at concentrations greater than 50 ppm. These regulations also provide options for decontamination of materials contaminated with PCBs.	Some materials and/or debris addressed under this remedial action could include various forms of PCB wastes including, but not limited to, PCB items, PCB liquids, PCB articles, PCB remediation waste, and/or containers that would be managed in accordance with the substantive requirements of these standards if encountered and/or generated during the remedial action. The substantive provisions of this regulation apply to sludge that will be treated, packaged, and disposed. The substantive provisions of 40 CFR 761.65 apply to the storage of untreated sludge at T Plant in cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L. This is a chemical-specific requirement.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
Regulations pursuant to the *Clean Air Act of 1977*, 42 USC 7401, et seq., as amended			
"National Emission Standards for Hazardous Air Pollutants" (40 CFR 61) "Standard" (40 CFR 61.92) "Emission Monitoring and Test Procedures" (40 CFR 61.93)	ARAR	This regulation sets limits for radionuclide emissions, which cannot exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem/yr or greater. Emissions shall be monitored per 40 CFR 61.93.	Some activities under this remedial action could potentially contain radioactive constituents. Potential emissions from work under this action would be performed in accordance with this standard. The treatment, packaging, and interim storage of sludge will occur in an EPA-approved facility in the Hanford Site's 200 Area. This facility will vent filtered and monitored emissions to the environment generated during the treatment and packaging of sludge. Substantive requirements limiting emissions, emission controls, and emission monitoring apply. This is an action-specific requirement.
"Standard for Demolition and Renovation" (40 CFR 61.145; 40 CFR 61.145(a)(1) and (2); 40 CFR 61.145(c)) "Standard for Waste Disposal for Manufacturing, Fabricating, Demolition, Renovation, and Spraying Operations" (40 CFR 61.150)	ARAR	These standards apply to demolition activities, including the removal of RACM. The standards of 40 CFR 61.145(a)(1) and (2) are used to determine when the requirements of 40 CFR 61.145(c) apply to demolition activities. The standards of 40 CFR 61.150 are used to control emissions during collection, processing, packaging, and transport of any asbestos-containing waste material.	Some work under this remedial action will involve materials that contain asbestos. The substantive provision of 40 CFR 61.145(c) would comply with 40 CFR 61.145(a)(1) and (2) for demolition of structures that contain RACM under this remedial action. The substantive provisions of 40 CFR 61.150 would be met during activities that involve collection, processing, packaging, and transport of asbestos-containing waste material under this remedial action. This is an action-specific requirement.
***Atomic Energy Act* (42 USC 2011, et seq.)**			
"Standards for Protection Against Radiation" (10 CFR 20)	ARAR	The dose limits considered relevant and appropriate are the doses to an individual member of the public that cannot exceed 0.1 mrem/yr (100 mrem/year) total effective dose equivalent, and the 2 mrem/hr from external sources in an unrestricted area.	DOE performs a comprehensive sitewide environmental monitoring program at the Hanford Site. This is an action-specific requirement.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
"Licensing Requirements for Land Disposal of Radioactive Waste" (10 CFR 61)	ARAR	This standard provides for licensing for land disposal of radioactive wastes by the Nuclear Regulatory Commission.	The substantive provisions of the general prohibition on near-surface disposal of greater-than-Class-C radioactive waste and the general performance objectives of 10 CFR 61.40, "General Requirement," are relevant and appropriate to this work. No disposal will occur except at a compliant facility.
"Environmental Radiation Protection Standards for Nuclear Power Operations" (40 CFR 190)	ARAR	The dose standards considered relevant and appropriate are the public dose limit of 25 mrem/year to the whole body, 75 mrem/year to the thyroid, and 25 mrem/year to any other organ.	DOE performs a comprehensive sitewide environmental monitoring program at the Hanford Site. This is an action-specific requirement.
"Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes" (40 CFR 191)	ARAR	These standards apply to facilities used for disposal of SNF, high-level, and TRU wastes. Onsite disposal at the Hanford Site of TRU and high-level waste is prohibited.	TRU waste will be sent to 200 Area Waste Management facilities for interim storage before and after treatment and packaging for disposal. This remedial action does not involve onsite disposal of SNF, high-level, or TRU waste. This is a chemical-specific requirement.
"Occupational Radiation Protection" (10 CFR 835)	ARAR	This regulation is applicable to all activities undertaken by the K Basins Interim Remedial Action.	A DOE-approved radiation protection program is in place that implements the requirements of 10 CFR 835 and describes how radiological design reviews are to be performed, to ensure that the DOE requirements for radiological design are incorporated into the designs for new facilities and equipment, and modifications of existing facilities and equipment. This is an action-specific requirement.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
***Hazardous Materials Transportation Act* (49 USC 1801-1813)**			
"General Information, Regulations, and Definitions" (49 CFR 171)	ARAR	This regulation is applicable to any offsite transportation of potentially hazardous material, including samples and waste generated by the K Basins Interim Remedial Action.	Treated and packaged sludge that is classified as TRU waste is expected to ultimately be shipped offsite to a national repository. Samples shipped offsite will be in conformance with work processes designed to satisfy the transportation requirements. The substantive standards of these regulations will apply to wastes packaged for transport from the 200 Area interim storage facility to a national repository. This is a chemical-specific requirement.
Endangered Species Act of 1973 (16 USC 1531 et seq., subsection 1536 (c))	ARAR	These laws and implementing regulations prohibit actions by federal agencies that are likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.	The remedial action will be implemented at a location where protected species could be affected by work activities. No threatened or endangered species are expected to be present in the specific locations where this work will be performed. If unanticipated impacts on such species are discovered, mitigation measures will be taken, This is a location-specific requirement.
"*National Historic Preservation Act of 1966*" (16 USC 470, Section 106) "Protection of Historic Properties" (36 CFR 800)	ARAR	The *National Historic Preservation Act of 1966* requires that historic properties be appropriately considered in planning federal initiatives and actions. These laws also require federal agencies to consider the impacts of their undertaking on cultural properties through the identification, evaluation, and mitigation processes, and consultation with interested parties.	Based on extensive past identification of cultural and historic sites at the Hanford Site, these types of sites will be avoided or, if discovered during excavations, appropriate mitigation will be undertaken. This is a location-specific requirement.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
Archeological and Historic Preservation Act of 1974 (16 USC 469a-1 – 469a-2(d))	ARAR	These laws apply to activities that could cause the loss of any archaeological or historic data. This Act mandates preservation of the data and does not require protection of the actual site.	Based on past identification of archaeological and historic sites at the Hanford Site, the substantive requirements of this Act are potentially applicable for actions that might disturb these sites. Based on known cultural resource data and any new discoveries made during the course of implementation, appropriate mitigations will be made in accordance with standards of the law This is a location-specific requirement.
Hanford Reach Study Act (Public Law 100-605)	ARAR	This law required an analysis of protection alternatives for the Hanford Reach.	Based on the fact that the activities under this work plan will not take place near the Columbia River. The substantive requirements of this act are not anticipated to be applicable.
***Resource Conservation and Recovery Act* (42 USC 6901, et seq.)**			
"Land Disposal Restrictions" (40 CFR 268)	ARAR	These standards provide for the treatment of dangerous wastes that will be land disposed.	The substantive provisions of this regulation will be applicable to dangerous and/or mixed wastes that may be generated during this work, if such wastes will be land disposed.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
Regulations pursuant to the *Washington Clean Air Act*, RCW 70.94			
"Radiation Protection—Air Emissions" (WAC 246-247) "General Standards" (WAC 246-247-040(3) and (4)) "Monitoring, Testing and Quality Assurance" (WAC 246-247-075(8))	ARAR	These regulations establish the monitoring, testing, and quality assurance requirements for radioactive air emissions from major sources. These regulations also include requirements for continuous sampling and provide for periodic (grab samples) in cases where continuous sampling is not practical and radionuclide emission rates are relatively constant. These regulations also provide the means by which alternative effluent flow rate measurement procedures or site selection and sample extraction procedures may be used, as approved by the lead agency. These regulations also establish requirements to monitor nonpoint and fugitive emissions of radioactive material.	The potential exists for generating fugitive, diffuse, and/or point source emissions during this remedial action. Untreated sludge will be stored in T Plant cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L during this remedial action. Requirements for emission controls and emission monitoring apply. The existing T Plant ventilation system will provide abatement for storage of the radioactive component in the untreated sludge. Additionally, the T Plant ventilation system will monitor emissions to the environment from storage of untreated sludge. The treatment and packaging of sludge will occur in an EPA-approved facility in Hanford's 200 Area. This facility will vent filtered and monitored emissions to the environment generated from the treatment and packaging of sludge in accordance with best available radionuclide control technology. Requirements limiting emissions, emission controls and emission monitoring apply. Fugitive emissions from the treatment and packaging facility, and the facility used for interim storage of the treated and packaged sludge will be monitored in accordance with substantive requirements. The location of the MEI for determining compliance with standards for radionuclide air emissions is at the northern boundary of the Hanford Site North Slope. This is an action-specific requirement.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
***Hazardous Waste Management Act* (70.105 RCW)**			
"Dangerous Waste Regulations," "Identifying Solid Waste" (WAC 173-303-016)	ARAR	This regulation applies for determining which materials are and are not solid waste. This determination is used to establish which wastes are subject to the designation procedures of WAC 173-303-070(3).	Wastes that are newly generated during the work will be subject to the substantive provisions of this regulation to determine, what portion, if any, is subject to the procedures of WAC 173-303-070(3). This is an action-specific requirement.
"Designation of Dangerous Waste" (WAC 173-303-070(3))	ARAR	This regulation applies for the evaluation of solid wastes to determine if such wastes are designated as dangerous or mixed waste. Solid wastes that are designated as dangerous or mixed wastes are subject to management and disposal standards of WAC 173-303.	The nonradioactive component of wastes that are newly generated from the work will be evaluated according to the substantive provisions of this regulation. Wastes that are determined to designate as dangerous or mixed wastes will be managed in accordance with the requirements of WAC 173-303 upon receipt to the receiving facility.
			The nonradioactive component of the sludge is not designated as a dangerous waste under WAC 173-303. New waste streams that designate and that are not treated to remove dangerous waste characteristics prior to transport from the basin would be managed as radioactive mixed waste at the receiving facility. This is an action-specific requirement.
"Land Disposal Restrictions" (WAC 173-303-140(4))	ARAR	This regulation establishes state standards for land disposal of dangerous waste and incorporates by reference the federal land disposal restrictions of 40 CFR 268 that are applicable to solid waste that designates as dangerous or mixed waste in accordance with WAC 173-303-070(3).	Dangerous and/or mixed wastes that are newly generated during the work will be treated to meet land disposal restrictions if destined for land disposal. This is an action-specific requirement.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
"Requirements for Generators of Dangerous Waste" (WAC 173-303-170(3))	ARAR	This regulation establishes standards for the temporary management of wastes that are designated as dangerous or mixed waste. WAC 173-303-170(3) includes by reference the substantive provisions of both the satellite accumulation standards for management in containers under WAC 173-303-630, "Use and Management of Containers," and tanks under WAC 173-303-640, "Tank Systems."	Dangerous and/or mixed wastes that are newly generated during this response action will be managed in accordance with the substantive provisions of these standards. This is an action-specific requirement.
"General Regulations for Air Pollution Sources" (WAC 173-400) "General Standards for Maximum Emissions" (WAC 173-400-040(3) and (8)) "Requirements for New Sources in Attainment or Unclassifiable Areas" (WAC 173-400-113)	ARAR	These laws and regulations require all sources of air contaminants to meet standards for visible emissions, fallout, fugitive emissions, odors, emissions detrimental to persons or property, sulfur dioxide, concealment and masking, and fugitive dust. Requires use of RACT. This regulation applies to new and modified sources and requires that methods of controls be employed to minimize the release of associated criteria and toxic air emissions. Emissions are to be minimized through application of best available control technology.	The potential exists for fugitive emissions during performance of the remedial action. Substantive requirements of the general standards for control of fugitive emissions would be applied, as appropriate, to minimize the generation of fugitive dust that occurs during building modification and material transfer activities. This is an action-specific requirement. Substantive requirements of this regulation would be applicable to remedial actions performed at the site if treatment technology emits regulated air emissions. This is an action-specific requirement.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
"Ambient Air Quality Standards and Emission Limits for Radionuclides" (WAC 173-480) "General Standards for Maximum Permissible Emissions" (WAC 173-480-050) "Emission Monitoring and Compliance Procedures" (WAC 173-480-070(2))	ARAR	This regulation establishes general standards for all radionuclide emission units and requires emission units to meet WAC 246-247, requiring every reasonable effort to maintain radioactive materials in effluents to unrestricted areas, ALARA. The regulation indicates that control equipment for facilities operating under ALARA shall be defined as RACT and ALARACT. This regulation limits emissions of radionuclides in the air so as not to cause a maximum effective dose equivalent of more than 10 mrem/y to the whole body to any member of the public, which is defined in an unrestricted area where any member of the public may be.	The potential for point source and fugitive and diffuse emissions during building modification and material transfer activities will require efforts to minimize these emissions. This is an action-specific requirement. Point source and fugitive and diffuse emissions resulting from activities under this remedial action will be managed in substantive compliance with the public dose standard during the work. This is an action-specific requirement.
		This regulation applies for determining compliance with the radioactive emission standard. Compliance with the public dose standard is determined by calculating exposure at the point of maximum annual air concentration in a location in which the public may be located in an unrestricted area.	
"Controls for New Sources of Toxic Air Pollutants" (WAC 173-460) "Applicability" (WAC 173-460-030) "Control Technology Requirements" (WAC 173-460-060) "Ambient Impact Requirement" (WAC 173-460-070) "Table of ASIL, SQER and de Minimis Emission Values" (WAC 173-460-150)	ARAR	These regulations apply for determination of de minimis emission values and establishment of control technology as appropriate for new or modified toxic air pollutant sources likely to increase toxic air pollutant emissions. Requires T-BACT and demonstration that emissions of toxic air pollutants will not endanger human health or safety.	It is not expected that work accomplished under this remedial action will trigger standards for T-BACT. However, substantive requirements of these regulations potentially would be applicable if treatment technology approaches are needed that would emit toxic air emissions. This is an action-specific requirement.

Table 2. ARARs and TBCs for K Basins Sludge Storage, Treatment, Packaging, and Disposal Interim Remedial Action

Citation	ARAR or TBC	Requirement	Means of Implementation
Environmental Restoration Disposal Facility Waste Acceptance Criteria (WCH-191)	TBC	This document establishes waste acceptance criteria for the ERDF.	Waste destined to the ERDF shall be shown to conform to the waste acceptance criteria.
Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant (DOE/WIPP-02-3122)	TBC	This document establishes waste acceptance criteria for WIPP.	Waste destined to WIPP must be shown to conform to the waste acceptance criteria.
Remote Handled TRU Characterization Program Implementation Plan (DOE/WIPP-02-3214)	TBC	This document establishes accepted means of characterization of RH TRU waste.	Waste destined for WIPP must be characterized in accordance with this Transuranic Waste Characterization Program Implementation Plan for WIPP.
"Radiation Protection of the Public and the Environment," 10 CFR 834, proposed at 58 FR 16268	TBC	This proposed rule included public dose limits of 100 mrem/ year total effective dose equivalent.	These public dose limits are to be considered as limits for activities undertaken as part of the remedial action. Note that these TBC standards are the same standards as enforceable Nuclear Regulatory Commission and state ARARs identified in this section.

3 Remedial Design

This chapter addresses the design basis and the design development approach for treatment and packaging work under this RD/RAWP. In March 2012, the DOE Richland Operations (DOE-RL) completed the sludge treatment and packaging technology evaluation report (PRC-STP-00465, *K-Basin Sludge Treatment Project – Phase 2 Technology Evaluation and Alternative Analysis*) as required by TPA Milestone M-16-171. The report provides the technical baseline for the Sludge Treatment Project, Phase 2, Treatment and Packaging Project. In accordance with TPA Milestone M-016-173, the remedial design information reflected in this document from PRC-STP-00465 is pre-conceptual design information that is subject to change as the design matures. Therefore, the specific treatment process to be used and the location where treatment and packaging will be performed have not yet been established. These will be determined by DOE through further evaluation. This work plan will be updated accordingly.

3.1 Design Basis

The K Basins Interim Remedial Action ROD Amendment indicates that the sludge will be treated, packaged for disposal, interim stored pending shipment, as needed, and shipped to a national repository for disposal. The ROD further indicates that sludge would be treated at the 100-K Area or another EPA-approved 200 Area facility.

A key DOE objective is to remove the sludge from the 105-KW Basin and River Corridor as soon as possible, which will reduce risks to the environment, allow for remediation of contaminated areas underlying the basins, and support closure of the 100-KR-2 and 100-KR-4 Operable Units.

To complete removal of sludge from the River Corridor requires the sludge be retrieved from the 105-KW Basin, packaged as slurry into the STSCs/sludge transport system cask, transported to the 200 Area Central Plateau, and placed into storage at T Plant in cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L until a treatment and packaging facility is available. The untreated sludge will be in storage at T Plant prior to treatment and packaging for disposal at WIPP. It is anticipated that less than 5 percent of the metal will be oxidized during storage in T Plant.

The design includes site selection; identification of technology needs; testing; design of systems, structures, and components; and issuance of engineering design media documents. The remedial design scope for the treatment and packaging of sludge involves the following functions:

- Retrieval of STSC from T Plant and transport to the Sludge, Treatment and Packaging Facility
- Retrieval of sludge from STSCs for treatment and packaging
- Uranium metal oxidation treatment of sludge (as necessary)
- Solidification and packaging of treated sludge
- Transport of treated sludge to interim storage

The bases for design of the retrieval, treatment and packaging include the following:

- DOE nuclear safety regulations
- DOE/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*
- DOE/WIPP-02-3214, *Remote-Handled TRU Characterization Program Implementation Plan*
- RH-72B, *Remote Handled Transuranic Waste Authorized Methods for Payload Control*
- HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Technical Databook, Vol. 2, Sludge*

For purposes of this RD/RAWP, it is assumed that solidification will be achieved by grouting for the aqueous processes, and through formation of borosilicate glass for the vitrification process. Both have been previously shown to be feasible and acceptable solidification approaches for this type of material.

3.2 Remedial Design Development Approach

The development of the remedial design has been and continues to be in accordance with a DOE internal process and includes the following technology readiness steps:

- Determination of technology needs
- Preparation of a technology maturation plan
- Completion of a series of technology readiness assessments

Mock-up testing of components and integrated systems will also be performed using sludge simulants to demonstrate that sludge can be treated and packaged in a safe and predictable manner.

Currently, five technologies are under the following three primary technical approaches still being considered as viable options through ongoing evaluations based on demonstrations that the basic processes are feasible for treating the sludge:

- **Oxidation/Dissolution—**Three oxidation/dissolution technologies remain under evaluation with warm-water oxidation representing the least complex of the three approaches.

- **Control Hydrogen Evolution in Immobilized Sludge—**The use of nitrate addition remains under evaluation and has been demonstrated with use of either grout or AquaSet™ Clay.

- **In-Container Vitrification (ICV)—**The use of joule-heating to vitrify sludge directly in disposal drum remains under evaluation.

Size-reduction technology, which can provide design and operational benefits for several of the above processes, has been shown to be feasible in bench top testing, and is still under consideration. Size-reduction technology will be considered as a part of future design and testing activities.

Decision planning for remedial design will proceed by applying the results of the basic feasibility testing to advance the design to engineering-scale feasibility, and evaluate preliminary costs and schedules for treatment of the sludge. Each of the five technologies under the three primary technical approaches are discussed in greater detail in Section 3.4.

Testing on means of retrieval of sludge from STSCs and oxidizing the sludge has already commenced. Based on testing of different processes for the oxidation of the uranium in the sludge, conceptual design of that process can commence.

3.3 Remedial Design Submittal Strategy

The selection of the technical approach for remedial design will continue in accordance with internal DOE requirements.

3.3.1 Remedial Design Report

As design levels advance toward 90 percent completion, RDRs will be prepared as addenda to this RD/RAWP and submitted to EPA for review and approval. The RDRs may include the following items:

- Testing program
- Retrieval, treatment, packaging, and assay system design
- Treatment and packaging facility design

3.3.2 Operations and Maintenance Plan

An Operations and Maintenance Plan will be prepared describing the plan and schedule for the treatment and packaging of sludge for interim storage.

3.4 Remedial Treatment Design Options

These sections provide basic design overviews and key information for each of the remaining treatment options under consideration for use. The basic approach for these options was determined to be feasible for sludge treatment during the ongoing evaluation (Table 3). All alternatives would be operated and maintained remotely within a shielded process facility.

3.4.1 Warm-Water Oxidation Process

Warm water (95.7°C [203°F]) would be used where necessary to oxidize the uranium metal particles to reduce hydrogen generation for long-term sludge management. The oxidized sludge would be immobilized by mixing with grout, then would be packaged in 55-gallon drums (or other approved containers) for final disposal at a national repository. The basic process is depicted in Figure 3.

Table 3. Technical Approaches and Technologies Under Consideration

Technical Approach	Flowsheet	Scale Tested	Established Feasible Process Conditions(s)	Basic Process Feasibility Demonstrated	Immobilization Approach
Aqueous Oxidation/ Dissolution	Warm-Water Oxidation	Bench top – U-Simulant	Yes	Yes	Grout AquaSet Clay or BoroBond
	Fenton's Reagent (Fe++ with Peroxide)	Bench top – U-Simulant	Yes – Continuous peroxide addition	Yes	Grout AquaSet Clay or BoroBond
	Carbonate/ Peroxide	Bench top – U-Simulant	Yes – Continuous peroxide addition	Yes	Grout AquaSet Clay or BoroBond
Control Hydrogen Evolution in Immobilized Product	Nitrate Addition	Bench top – U-Simulant K Basins sludge	Yes	Yes – with both grout and AquaSet™ Clay	Grout AquaSet Clay or BoroBond
Vitrification	Joule-Heated ICV	Production Scale Dryer – KW Basin Simulant ICV – KW Basin Simulant	Yes	Yes	Borosilicate Glass

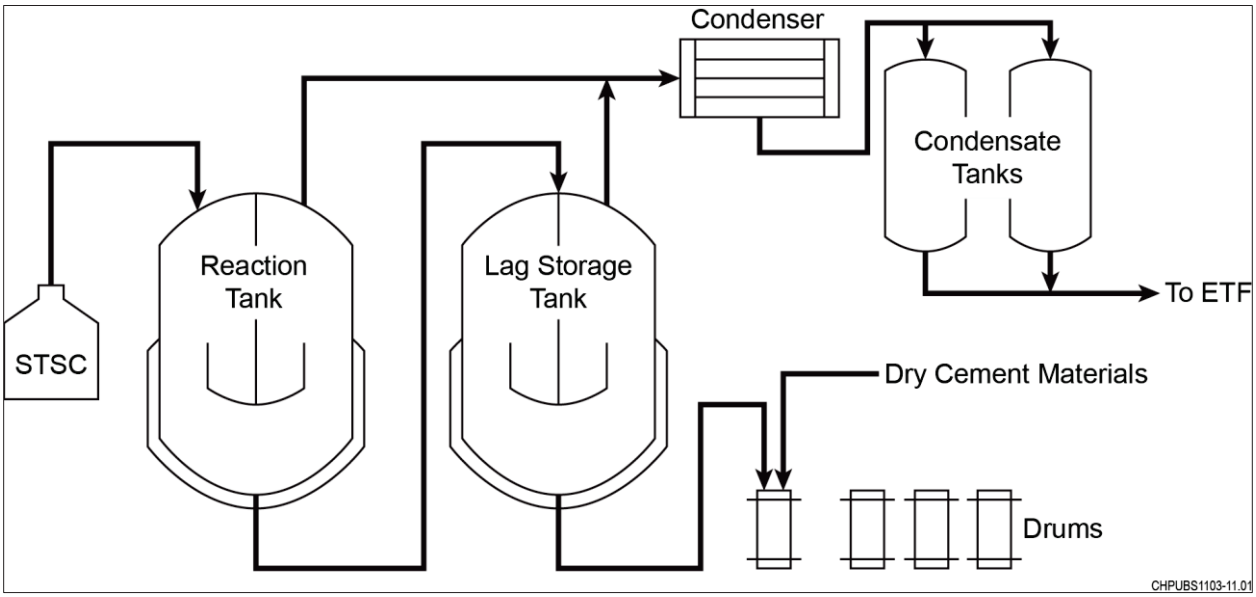

Figure 3. Warm-Water Oxidation Process Simplified Flow Diagram

3.4.1.1 Retrieval from STSCs and Transfer to Receiver/Reaction Tank

Sludge (with flush water) would be transferred from an individual STSC to an agitated receiver/reaction tank. Nitrogen would be used to purge the tank so that anoxic conditions can be established that will accelerate the oxidation reaction, and to ensure that headspace hydrogen concentrations remain below flammability limits. Agitators and air lift circulators would be used to help maintain suspension and flow of heavier solids (and would be designed to include, as needed, other methods to facilitate clearing/ flushing of lines/ports).

3.4.1.2 Concentration and Oxidation

After receipt in the reaction vessel, evaporation would be induced to achieve an appropriate solids concentration to initiate the reaction. Water vapor would be entrained by an off-gas system and carried through a demister, then condensed and routed to one of two condensate holding tanks where it would be sampled for disposal through the 2025E effluent treatment facility (ETF).

The sludge in the oxidation tank would be heated via a steam jacket. Controllers would be used to maintain the sludge at a constant temperature of (95.7°C [203°F]). Negative pressure would be maintained within the tank at –2.5 psi via a nitrogen purge control valve and an eductor.

The tank would be provided with capability for measuring the pressure at the bottom and top of the tank. The differential pressure and tank level would be measured to provide information to calculate the volume percent of solids in the sludge. Heating would continue until a concentration of 20 percent by volume is attained, after which time a second STSC could be transferred to the tank and the concentration process repeated.

After the two batches of sludge are concentrated to approximately 20 percent solids by volume, agitation of the tank would continue while maintaining the target reaction temperature until the uranium metal is fully oxidized. Batch reaction time is variable in proportion to the uranium metal content, but would typically range between ~30 days for settler tank material and ~150 days for 105-KE and 105-KW container sludges.

Processed sludge would be removed from the oxidation tank using slurry pumps designed to handle up to 20 percent by volume abrasive solids. The pumps would be operated from a location within the tank above the bottom. A reliable self-priming pump capable of keeping the sludge moving through a 1.5 in. pipeline would be required.

3.4.1.3 Solidification

The sludge, along with associated flush water, would be transferred to an agitated lag storage tank fabricated from stainless steel and designed to adequately handle the abrasive properties of the sludge. A recirculation loop would be used in addition to in-tank agitation to maintain a uniform 20 percent by volume slurry. The slurry would be cooled to ambient conditions prior to solidification.

A batch of slurry would be drawn from the recirculation loop, charged to the waste packaging drum along with dry cement materials, and blended within the drum using a “lost-paddle” technique. Required flushes would also drain to the drum and be accounted for in the formulation recipe, ensuring that a homogeneous solidified waste form of good quality is produced. The filled drum would then be transferred to a holding room where the sludge would be allowed to solidify.

3.4.2 Fenton's Reagent Oxidation Process

Wet chemical oxidation would be performed with hydrogen peroxide in the presence of an iron catalyst to encourage rapid oxidation of the uranium metal in a few days. Overall throughput would be controlled by the rate of solidification of the oxidized slurry in the waste packaging. Figure 4 presents a schematic drawing of the basic process.

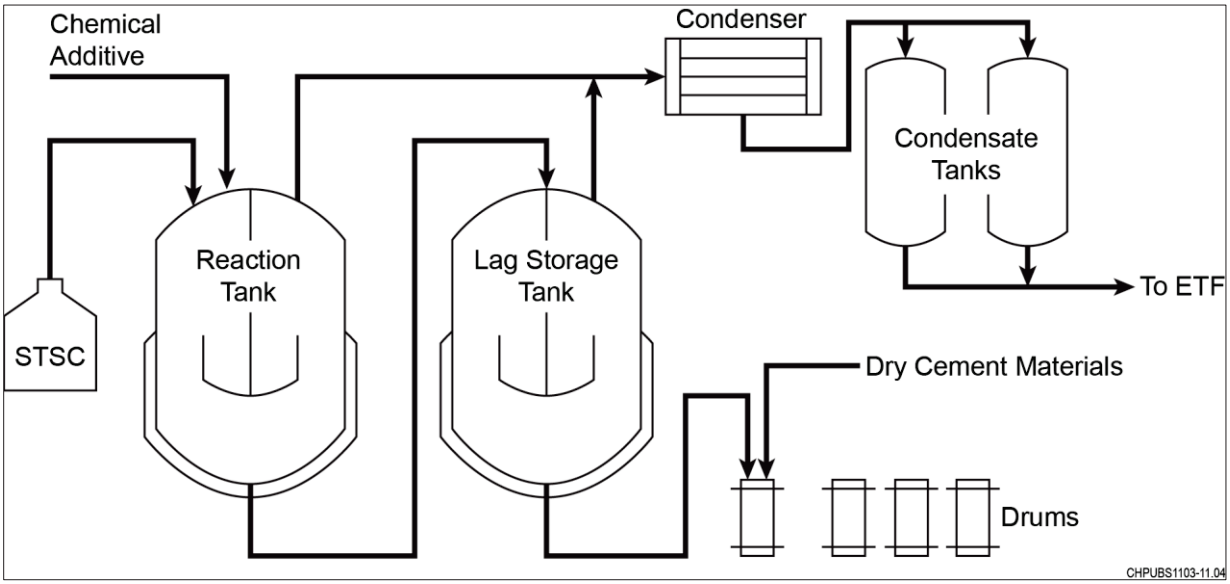

Figure 4. Fenton's Reagent Oxidation Process Simplified Flow Diagram

3.4.2.1 Retrieval from STSCs and Transfer to Receiver/Reaction Tank

Retrieval from STSCs and transfer to the receiver/reaction tank would be the same as discussed for the warm-water oxidation process except that contents of only one STSC (rather than two STSCs) would be received for each reaction batch.

3.4.2.2 Concentration and Oxidation

Concentration would be the same as described for the warm-water oxidation process. Reagents would be added and after oxidation is complete, additional water would be removed via low or near-boil evaporation. Vapors would be collected and routed through a demister and condenser.

The slurry would be concentrated to approximately 20 percent by volume solids, cooled to ambient conditions, and a small amount of chloride ion would be added, along with soluble iron. The slurry pH would be adjusted as necessary between 1 and 4 by the addition of acid. A 30 percent peroxide solution would then be continuously added until the uranium metal is oxidized. It is expected that the reaction would be completed within 4 days. The concentrated sludge slurry would then be delivered to an agitated tank with a recirculation loop for measurement of mass and radiation loadings.

3.4.2.3 Solidification

Solidification would be the same as for the warm-water oxidation process.

3.4.3 Peroxide Carbonate Oxidation Process

Hydrogen peroxide would be used to oxidize the uranium metal to U (VI), followed by reaction with carbonate in solution to form uranium carbonate.[6] A key advantage of this reaction is that no hydrogen is evolved and no uranium hydride is produced (as it is when uranium reacts with water). The process is depicted in Figure 5.

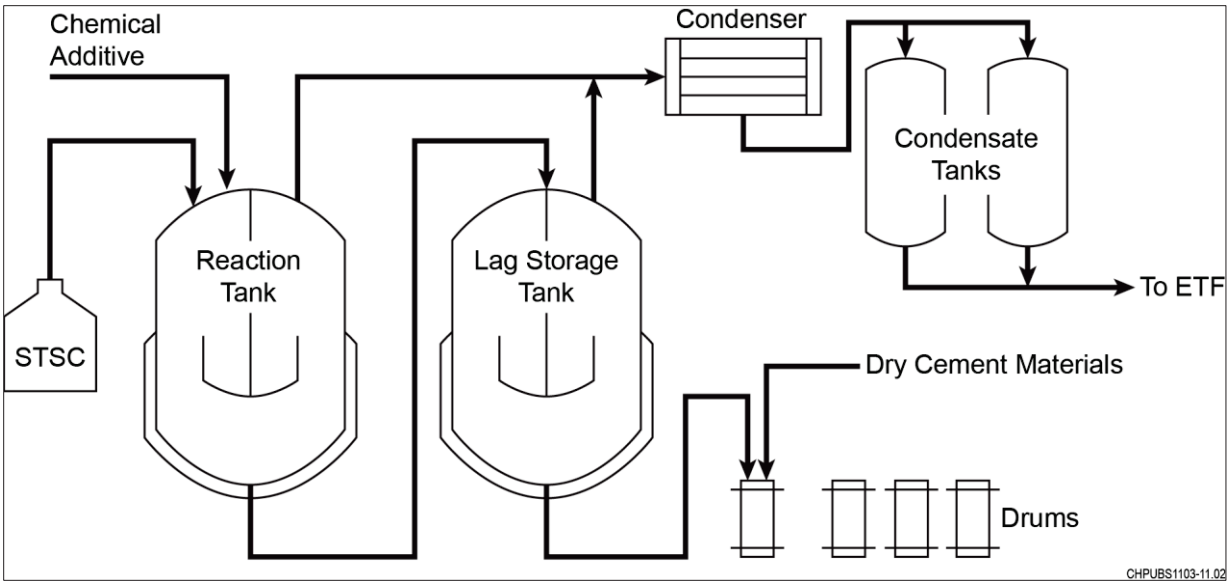

Figure 5. Peroxide Carbonate Oxidation Process Flow Diagram

3.4.3.1 Retrieval from STSCs and Transfer to Receiver/Reaction Tank

Retrieval from STSCs and transfer to the receiver/reaction tank would be the same as discussed for the warm-water oxidation process except that contents of only one STSC (rather than two STSCs) would be received for each reaction batch.

3.4.3.2 Concentration and Oxidation

Concentration would be the same as described for the warm-water oxidation process and would be complete when a concentration of approximately 20 percent by volume solids and cooling to ambient conditions are achieved.

Sufficient 12M ammonium bicarbonate would be added to the tank to achieve bicarbonate concentrations of 1M. To initiate reaction, concentrated (50 percent) hydrogen peroxide would be continuously added at a rate of up to 70 L/hour and 12M ammonium bicarbonate would be added at a rate of up to 8.7 L/hour to the tank. During reaction, the total carbonate and bicarbonate concentration would be maintained at a concentration of 1M. Decomposition of peroxide would occur during the reaction to produce water and oxygen. As the reaction volume increases during treatment, the tank contents would be periodically volume-reduced through evaporation. This would be accomplished by first terminating reagent feeds and then heating the contents to a nominal 90°C [191°F] by feeding steam through the jacket. At the evaporation temperature, ammonium bicarbonate present in the tank would decompose to form carbon dioxide, ammonia, and water. Some ammonia would further react with hydrogen peroxide within the tank

[6] The hydrogen peroxide would also serve as a good ligand for the uranium, so some uranium may be present after reaction as a complex with the hydrogen peroxide.

to form nitrogen and water. The slurry batch would be re-concentrated to ~20 percent by volume solids, cooled to ambient conditions, and chemical additions would be restarted.

Water vapor removed during the concentration operations would be condensed and collected in one of two condensate holding tanks. Any ammonia entrained with the water vapor could be treated by the addition of a small amount of peroxide prior to sampling and shipment to the ETF for final treatment and disposal. Condensate would be recycled within the facility to the extent practicable.

The duration allowed for reaction would be determined by measuring reaction rates under similar (full-scale) conditions. It is estimated that the complete reaction of the uranium metal would require approximately 25 to 71 days, depending on the quantity of uranium metal present in each batch.

3.4.3.3 Solidification

Solidification would be the same as for the warm-water oxidation process.

3.4.4 Nitrate Addition Chemical Inhibitor Process

Sodium nitrate would be added to the concentrated slurry to achieve a 1M nitrate concentration in the immobilized sludge. Experimentation has shown that nitrate can be used to control the evolution of hydrogen from the sludge to acceptable levels. The basic approach for this activity is depicted in Figure 6. It should be noted that the chemical inhibitor approach would mitigate the potential for release of hydrogen resulting from the reaction of uranium metal with remaining water. This approach would not result in reaction of the radioactive pyrophorics as would occur with the other approaches.

3.4.4.1 Retrieval from STSCs and Transfer to Receiver/Reaction Tank

Retrieval from STSCs and transfer to the receiver/reaction tank would be the same as discussed for the warm-water oxidation process except that contents of only one STSC (rather than two STSCs) would be received for each reaction batch.

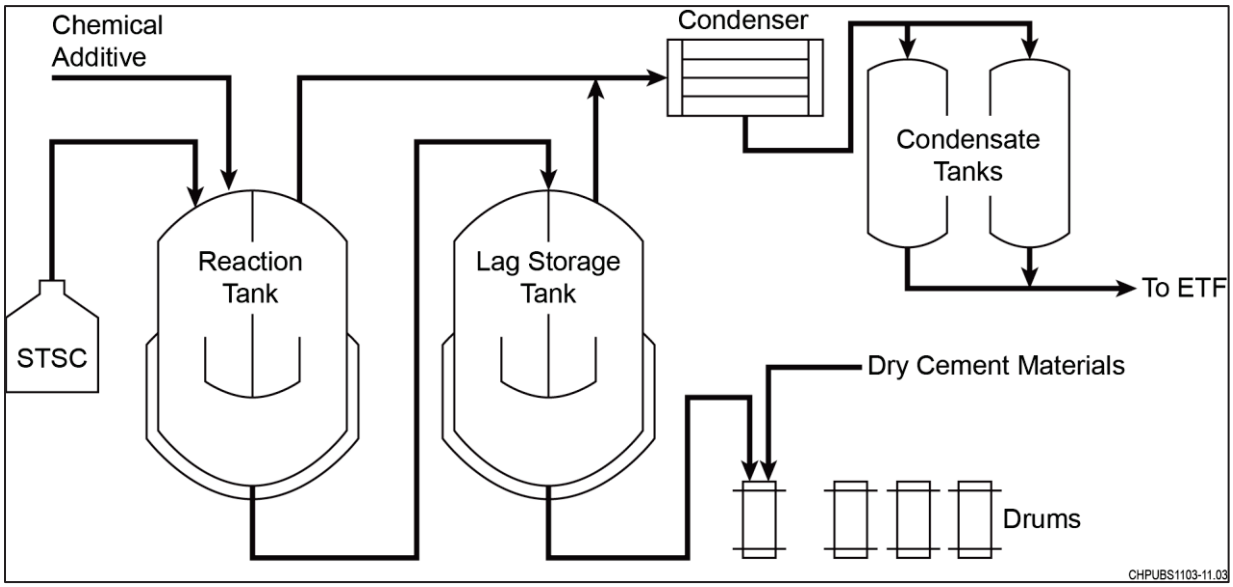

Figure 6. Nitrate Addition Chemical Inhibitor Process Simplified Flow Diagram

3.4.4.2 Concentration

Concentration would be the same as described for the warm-water oxidation process. Sodium nitrate solution (~7M) would be added during the slurry concentration step to achieve a 1M nitrate concentration in the final immobilized product. The nitrate ion would not preclude the ongoing reaction of the uranium metal, but instead would react with the intermediate hydrogen radicals and would significantly reduce hydrogen released during oxidation of uranium with water in the immobilized waste form, as well as hydrogen produced from the radiolysis of water.

3.4.4.3 Solidification

Solidification would be the same as for the warm-water oxidation process.

3.4.5 Joule-Heated In-Container Vitrification Process

A high-temperature process would be used to oxidize and immobilize the sludge within the waste packaging drums. Uranium metal would be quickly and fully oxidized via vitrification, permanently immobilizing radionuclides into a high-integrity waste form. Figure 7 provides a diagram summarizing the process.

3.4.5.1 Retrieval from STSCs and Transfer to Receiver/Reaction Tank

Sludge would be retrieved from the STSC as a dilute slurry, which is collected in the 11.35 m^3 (3,000-gal.) feed receiver. As needed, mixer dryer batches of the dilute slurry are collected in a 0.56 m^3 (150-gal.) single-batch holding/assay tank.

3.4.5.2 Drying

The dilute sludge slurry would be incrementally conveyed by gravity to a steam-jacketed horizontal shaft plow-style dryer/mixer. The unit would be operated under vacuum, thus only requiring low-temperature steam and reducing the quantity of organic and/or radioactive constituents volatilized during drying. This in turn helps to minimize any secondary liquid waste fraction in the liquid condensate generated. Prior to addition of the sludge slurry, glass-forming minerals (GFM) would be added to the dryer/mixer.

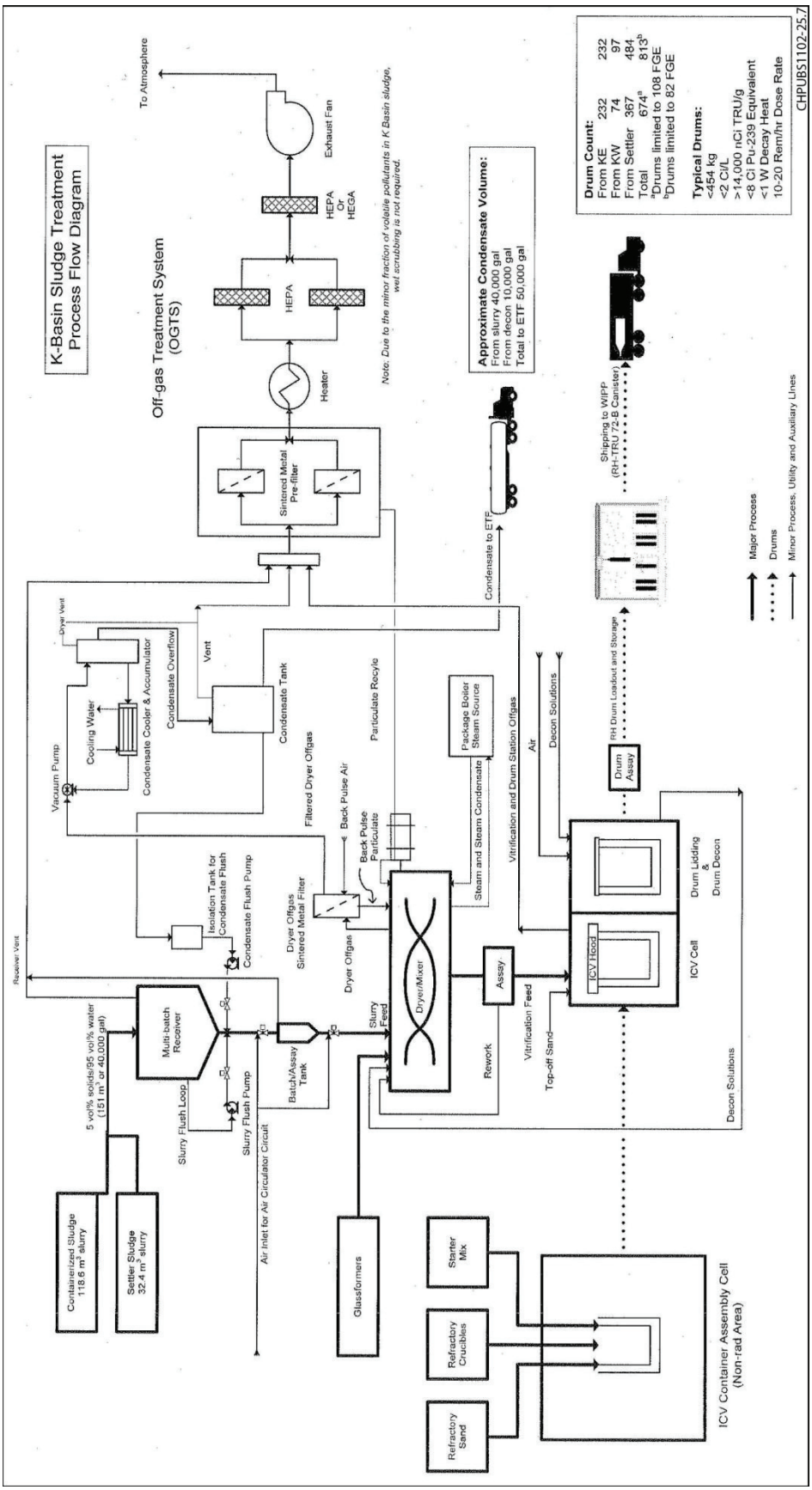

Figure 7. Vitrification Diagram

3.4.5.3 Vitrification

The dried sludge would be mixed with GFM and gravity-fed to a pre-staged waste packaging drum for vitrification. The drum would be prepared for vitrification by the installation of a refractory liner and a graphite current starter path. After charging the batch of dried mixture to the lined drum, a process lid would be attached that has two electrodes and connections for emission to the off-gas system. An electric current would be initiated between the two electrodes, producing heat and ultimately melting the materials to produce a solidified waste form. During the melt process, uranium and any organic materials would be oxidized and dissolved into the glass melt. The process would be continued until the target temperature is achieved. After the drum has cooled and the glass melt has solidified, the process lid would be removed, leaving the carbon electrodes in the glass. Sand would be added to "top off" the drum and a disposal lid would be installed. The lidded drums would then be stored to allow cooling to occur. Once the external drum temperature has decreased to the level that allows safe handling, the drum would be moved to interim storage. The lidded drums would also serve as shipping and disposal containers that would be placed in WIPP-approved transport canisters (e.g., RH-72B). Treatment in the relatively small batches would limit the in-process inventory of uranium and other radionuclides directly involved in any potential off-normal event.

Off-gas treatment would be via a system designed to meet substantive air emission standards. The system would consist of a plenum for collection of entrained particulates from the various vents and filters, a heater, high-efficiency particulate air (HEPA) filters, and an exhaust train with fan. Collected solids would be recycled back to the mixer/dryer for incorporation into the next drum batch.

4 Remedial Action Management and Approach

This chapter describes the work elements and management approach associated with implementation of the planned sludge treatment and packaging work under this RD/RAWP. Details for storage of untreated sludge in T Plant cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L are provided in Chapter 5.

4.1 Project Team

The term "project team" includes the individuals working to accomplish the remedial action. Accordingly, the project team includes the lead regulatory agency, U.S. Department of Energy, Richland Operations Office (DOE-RL), the remediation manager, and the site project manager, both agents of DOE. The DOE remedial project manager will also serve as the primary interface for all routine contact between the Agencies and the Project Contractor. The Project organization is described in DOE-RL and contractor Project Execution Plans.

- **Lead Regulatory Agency (EPA)—**EPA is the lead regulatory agency for CERCLA remediation activities at the Hanford Site, as described in the TPA, and will provide oversight for the work identified in this RD/RAWP.
- **Remedial Project Manager (DOE)—**DOE is the government agency responsible for the response actions throughout the Hanford Site. DOE also assigns remedial project managers to each main area and tasks involved with remediation activities. The remedial project manager is responsible for managing their assigned activities, which include scope, budget, schedule, and contracts.
- **Remediation Contractor—**The remediation contractor is responsible for implementation of the work, including development and design, construction, operation, as well as document preparation, field and field support activities, qualified engineers, and other experts.

4.2 Change Management

Implementation of this work may require changes in the requirements set forth in the K Basins Interim Action ROD (EPA/ROD/R10-99/059) and/or K Basins Interim Action ROD Amendment (EPA et al, 2005) if unexpected wastes and/or site conditions are encountered. Three types of changes in the remedial action could necessitate changes to the requirements in the ROD:

1. A **fundamental change** is a change that does not meet the requirements set forth in the ROD or that incorporates remedial activities not defined in the scope of the ROD.
2. A **significant change** generally involves a change to a component of a remedy that does not fundamentally alter the overall cleanup approach. All significant changes will be addressed in an explanation of significant difference.
3. A **minor change** will not have a significant impact on the scope, performance, or cost of the remedy. These minor changes should be documented in the appropriate post-decision project file (for example, through interoffice memoranda or logbooks). Non-significant changes will not impact the requirements of the ROD, nor will they impact the functional requirements.

In accordance with the TPA Action Plan (Ecology et al., 1989b, Hanford Federal Facility Agreement and Consent Order Action Plan), Section 9.3, minor changes to approved plans including this RD/RAWP that do not qualify as "minor field changes" can be made using the TPA Change Notice process, as appropriate.

4.3 Remedial Action Work Tasks

Remedial action work tasks for sludge treatment and packaging work under this RD/RAWP include those addressed in the following subsections.

4.3.1 Design and Testing

The design includes site selection; identification of technology needs; testing; design of systems, structures, and components; and issuance of engineering design media documents. The remedial design scope for the treatment and packaging of sludge involves the following functions:

- Receipt of STSC from T Plant to the Sludge, Treatment and Packaging Facility
- Retrieval of sludge from STSCs for treatment and packaging
- Treatment and packaging of sludge

4.3.2 Procurement and Construction

Construction will include preparation of a siting study and the fabrication of a building to house the sludge treatment system. The following subsections outline key activities associated with construction-related work.

4.3.2.1 Pre-Mobilization

Prior to mobilization for each remedial action task, documentation to support the work control for that task will be prepared. Job safety analyses, radiological work permits, as low as reasonably achievable reviews, operational and test procedures, and other work control forms will be prepared for major aspects of the remedial action, as appropriate.

4.3.2.2 Mobilization

Mobilization activities are required for construction of the facilities for treatment and packaging of treated waste pending disposal at a national repository.

Site preparation for these activities may require site grading and/or addition of base material, installation of temporary barriers and signs, and establishment and erection of temporary equipment.

4.3.2.3 Control of Fugitive Dust

Operations (e.g., delivery of raw materials) and construction activities (e.g., deployment of equipment) are likely to create fugitive dust. The application of water or other commercially available dust suppressants via trucks, hoses, and misting equipment, will be used as necessary to control dust in work areas.

4.3.2.4 Control of Air Emissions

All technical approaches for sludge treatment would result in recovery of most of the water vapor, and condensate would be recycled to the extent practicable within each individual process. Incondensable gases would undergo multiple stages of HEPA filtration to meet ARARs and DOE requirements. No specific recovery of chemicals or gaseous radioisotopes is expected to be required for the technical approaches under consideration. Potential-to-emit calculations and potential for onsite or offsite exposures have not been completed at this early technology evaluation stage; but will be completed at the appropriate design phases of the project and described in the RDR. The location of the maximally exposed individual (MEI) for this purpose is at the northern boundary of the Hanford Site North Slope, which is included in the lands administered within the Hanford Reach National Monument.

4.3.2.5 Demobilization

Demobilization will be required at completion of construction activities associated with the treatment and packaging of sludge.

4.3.3 Sampling and Analysis Plans

Sampling and Analysis Plans (SAPs) used for work under this RD/RAWP will be developed using the guidance in EPA/600/R-96/055, *Guidance for the Data Quality Objectives Process*, and EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*. SAPs have previously been developed for use in the collection of data to support characterization of sludge. Additional SAPs or revisions to existing SAPs may be required during this project to characterize sludge for treatment options. New SAPs and revisions to existing SAPs are subject to review and approval by DOE and EPA.

4.3.4 Startup Testing

This information will be provided in the RDR.

4.3.5 Commission System

This information will be provided in the RDR.

4.3.6 Operations

This information will be provided in the RDR.

4.3.7 Access Controls

This information will be provided in the RDR.

4.3.8 Institutional Control Plan

DOE has developed a sitewide institutional control plan, DOE/RL-2001-41, *Sitewide Institutional Control Plans for Hanford CERCLA Response Actions*, which integrates the sitewide requirements and further specifies additional requirements for specific locations identified in RODs.

4.3.9 Spill Minimization and Response Program

Hazardous materials handled and used (e.g., diesel fuel for equipment) and wastes generated during work under this RD/RAWP will be stored and handled in a safe manner to minimize the potential for spills. Any spills of such hazardous substances will be responded to in a manner that is consistent with existing contractor processes for spill response. Notifications for release of hazardous substance(s) into the environment will be performed in compliance with 40 CFR 302, "Designation, Reportable Quantities, and Notification."

4.3.10 Reporting

Progress reporting will be accomplished using existing forums, which include monthly project manager meetings and quarterly TPA milestone review meetings.

5 Environmental Management and Controls

This chapter describes environmental management approaches and controls that will be implemented for the treatment and packaging work performed under this RD/RAWP. This chapter also addresses requirements for the storage of untreated sludge in T Plant cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L.

5.1 Air Emissions

The planned activities covered under this RD/RAWP have the potential to generate both radioactive and criteria/toxic airborne emissions.

5.1.1 Radiological Air Emissions

In accordance with 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," radionuclide airborne emissions will be controlled so as not to cause the 10 mrem/yr site standard to be exceeded. The same regulation addresses point sources (i.e., stacks or vents) emitting radioactive airborne emissions, requiring monitoring of such sources with a major potential for radioactive airborne emissions, and requiring periodic confirmatory measurement sufficient to verify low emissions from such sources with a minor potential for emissions. Under state implementing regulations, the federal regulations are paralleled by adoption and require added control of radioactive airborne emissions where economically and technologically feasible (WAC 246-247-040, "Radiation Protection—Air Emissions," "General Standards").

The substantive aspects of these regulations, as low as reasonably achievable control technology, based on best or reasonable control technology, will be addressed for treatment and packaging by ensuring that applicable emission control technologies (those successfully operated in similar applications) will be used when economically and technologically feasible (i.e., based on cost/benefit). Additionally, the substantive aspect of the requirements for monitoring fugitive or non-point sources emitting radioactive emissions, WAC 246-247-075(8), "Monitoring, Testing and Quality Assurance," will be addressed by sampling ambient air, as appropriate, using reasonable and effective methods.

The work under this RD/RAWP involving storage of untreated sludge has been evaluated for potential-to-emit radionuclides from any point source or diffuse/fugitive source. To accomplish this, the total unabated

potential release (in curies) has been determined, and the annual dose to the offsite MEI has been calculated using the DOE guidance for calculating potential-to-emit radiological releases and doses (DOE/RL-2006-29, *Calculating Potential-to-Emit Radiological Releases and Doses*). Based on potential-to-emit calculations (ECF-HANFORD-14-0033, *Calculation for T Plant Estimated PTE with Receipt of K Basin Sludge*), it has been established that the T Plant ventilation system will provide the appropriate emission monitoring and controls to ensure compliance with substantive air emission standards.

5.1.2 Nonradiological Air Emissions

The potential emissions of target organic compounds (i.e., semivolatile and volatile toxic air pollutants) associated with the removal of sludge from the 105-KW Basin were estimated (ECF-100KR2-12-0083, *New Source Review KW Basin ECRTS*). This estimate determined the mass (in pounds per WAC 173-460-150 averaging period) of toxic air pollutants potentially discharged to the environment. This evaluation determined that the total emissions are below the de minimis thresholds for toxic air pollutants listed in WAC 173-460-150, with the exception of potential PCB emissions which are less than the small quantity emission rate without the application of best available control technology. Based on this information, it is concluded that no toxic air pollutants exceeding acceptable levels are anticipated based on the characterization of the sludge and the nature of the operations associated with both storage of untreated sludge and the treatment and packaging of the material. Therefore, use of treatment technologies for controlling emissions of toxic air pollutants is not necessary.

5.2 Waste Management

Activities associated with the storage of untreated sludge could result in generation of waste. Waste generated and managed under this RD/RAWP will be in accordance with waste management ARARs.

- The substantive requirements of WAC 173-303, “Dangerous Waste Regulations,” will be met for any dangerous and mixed wastes that may be generated during the work.
- The substantive requirements of 40 CFR 761, “Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions,” will be met for the storage of untreated sludge in T Plant cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L.
- Waste generated from work associated with storage of untreated sludge may be staged in T Plant cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L. After initial accumulation of up to 55 gallons, such waste will be stored in established CERCLA waste management areas.
- Containers of waste generated from work associated with storage of untreated sludge will be marked or labeled with the container contents and the date that the waste was placed in the CERCLA waste management area.
- ERDF is the preferred location for disposal of wastes generated from work associated with storage of untreated sludge. ERDF waste acceptance criteria must be met for any waste to be disposed at ERDF (WCH-191, *Environmental Restoration Disposal Facility Waste Acceptance Criteria)*. Waste that does not meet ERDF acceptance criteria will be sent to other onsite locations.

Requirements for storage of untreated sludge at T Plant in cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L are discussed in the following subsections.

5.2.1 Toxic Substances Control Act Standards

The sludge is highly radioactive waste that resulted from long term storage of nuclear fuel in underwater basins. Because PCB sampling of the sludge has detected the presence of PCB contamination $\geq$ 50 parts

per million (ppm), the sludge will be stored as a PCB/radioactive waste. The provisions of 40 CFR 761 that are considered an ARAR will be met for storage of the sludge.

5.2.1.1 Storage Area Standards

Storage of the sludge at T Plant will meet the substantive requirements of 40 CFR 761.65(b)(1). The sludge will be stored in STSCs within the T Plant canyon in cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L. The canyon and these cells have adequate walls to prevent rainwater from reaching the PCBs. Each of these cells will also provide adequate containment volume equal to at least two times the internal volume of the largest PCB container or 25 percent of the total internal volume of all sludge-containing STSCs stored. The storage area will be marked consistently with 40 CFR 761.40(a)(10).

5.2.1.2 Container Standards

The STSCs will be non-leaking containers that will meet requirements of 40 CFR 761.65(c)(6)(i)(A). The STSCs will meet other applicable federal requirements for control of radioactive materials as required by the substantive provisions of 40 CFR 761.65(c)(6)(i)(B) and (C).

5.2.1.3 Monitoring/Cleanup of Leaks and Storage Area Closure

While stored in cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L, the PCBs in the untreated sludge will be monitored for water loss due to evaporation and replenished with water as necessary to ensure that the sludge remains fully wetted. The sludge will also be monitored for leaks using leak detection equipment capable of readily detecting a release from an STSC. Any leaks of sludge (including PCBs) from an STSC would result in transfer of the sludge into an STSC overpack using a sump pump. Material from such leaks would be managed as PCB remediation waste and any needed cleanup would be performed consistent with standards for cleanup of PCB remediation waste. Additionally, after removal of the sludge from cells 3L, 8R, 9L, 10L, 13L, 14R, and 15L, any remaining PCB contamination resulting from the sludge storage will be cleaned/disposed in accordance with PCB disposal standards.

5.2.2 Safe Storage of Untreated Sludge

Untreated sludge will be stored at T Plant in accordance with 10 CFR 830, "Nuclear Safety Management." Current plans are for the STSCs to be American Society of Mechanical Engineers Section VIII stainless steel pressure vessels with a working pressure of approximately 1,030 KPa (150 psig) and a design life of 30 years. The vessels are free-standing, each of which is supported with a skirt. Nozzles for purging and inerting the STSCs are incorporated into the design. After receipt of an STSC (with STS cask) at the T Plant railroad tunnel, the STS cask will be vented and purged with nitrogen gas to remove any hydrogen gas accumulation from the interior airspace to ensure that hydrogen concentrations below the lower flammability limit are achieved prior to offloading the STSC. After venting and purging the STS cask, the cask lid will be remotely removed and the STSC will be purged with nitrogen gas to ensure that less-than-lower-flammability-limits are achieved. After purging, sintered metal vent filter assemblies will be removed and a vent pipe will be installed on the STSC. The STSC will be remotely removed from the STS cask, weighed, and lowered into a shielded storage cell using the canyon bridge crane. Each cell[7] used will have space for up to six STSCs. These cells will hold up to five loaded STSCs; the sixth

[7] Seven cells (3L, 8R, 9L, 10L, 13L, 14R, and 15L) have been identified as candidates for sludge storage. Four cells (3L, 10L, 13L, and 15L) were previously modified for large diameter container storage and are ready for use. Three additional cells (8R, 9L, and 14R) have been selected as candidates for additional storage. Current plans include installing storage racks in cells 8R and 14R, with 9L available for use if necessary. One of the Perma-Cons® (registered trademark of Radiation Protection Systems, Groton, Connecticut) installed over 3L would have to be removed to provide access to the cell should a decision be made to store sludge in cell 3L.

location can hold a loaded STSC or an STSC overpack for a damaged or leaking STSC as a contingency if a failure occurs.

During storage, headspace in the STSCs will be vented with natural circulation through two vents on the STSC at different elevations. This "chimney effect" is driven by the density difference between the environment and the headspace, where the gas in the environment is denser than in the headspace. The concentration of hydrogen is calculated to be less than 1 volume percent in the T Plant cells and in the headspace of an STSC through operation of the T Plant exhaust ventilation system; hydrogen concentration is not measured. Calculations indicate that if the T Plant exhaust ventilation system becomes inoperable, natural circulation of air through the T Plant cell cover blocks will also maintain the concentration of hydrogen at less than 1 volume percent in the T Plant cells and less than 4 volume percent in the headspace of the STSC.

Specific Administrative Controls have been designated for those administrative controls where preventive or mitigative functions, credited in the safety analysis, would rise to the level of safety class or safety significant if the functions were performed by the structures, systems, and components. The specific administrative controls for storage of untreated sludge define measures to prevent or minimize occurrence of waste container-related accidents. Specific elements include provisions for receipt, handling, and storage of STS casks and STSCs containing sludge. The following surveillances will be performed in accordance with the current revision of HNF-15280, *Technical Safety Requirements for the Solid Waste Operations Complex* (Section 5.6.5)[8] to determine whether the specific administrative controls are being met. When the original surveillance is performed at the 105-KW Basin and/or the 105-KW Annex, the data and verification will be recorded on the STSC Compliance Data Form that travels with the sludge-filled STSC when it is shipped from the KW Annex and received at T Plant. These verifications are independently performed at the 105-KW Basin and/or the 105-KW Annex.

Upon receipt at T Plant, surveillance will include the following activities:

- Verify that the sludge in the STSC and received at T Plant has been transported in a Quality Assurance approved STSC of the following number series (as verified at T Plant):
  - ECRT-CON-W-401 to ECRT-CON-W-424
- Verify that the sludge in the STSC and received at T Plant is from the following Engineered Containers (as verified at KW Basin), which have been characterized as documented in HNF-SD-SNF-TI-015:
  - SCS-CON-210
  - SCS-CON-220
  - SCS-CON-230 (layered with sludge from SCS-CON-240, -250, -260)
  - SCS-CON-240, -250, -260
- Verify the sludge loaded in the STSC at KW Annex, did not exceed the buoyant load weight setpoints, as specified in PRC-STP-00754, *STP ECRTS Setpoint Determination*.

[8] If there is conflict between the language of this RAWP and the requirements of HNF-15280 for safe storage of untreated sludge, then the requirements of HNF-15280 will take precedence.

- Verify the final level in the STSC at KW Annex, did not exceed the Final Fill Levels, as specified in PRC-STP-00754.

During storage at T Plant, surveillance will include the following activities:

- On an annual basis, verify that the water level is maintained and replenished in stored STSCs at T Plant
  - The STSC is weighed (gross weight) when being moved into storage at T Plant, using the STSC Maintenance Lift Fixture
  - The STSC will be weighed annually, using the STSC maintenance lift fixture, and water will be added to the STSC to maintain the gross weight (i.e., to maintain the same weight as noted upon receipt).

5.3 Cultural/Historic/Ecological Resources

Extensive cultural and historic reviews of real properties potentially eligible for listing on the National Register of Historic Places have already been conducted for many portions of the Hanford Site. If any potentially eligible property is identified during the course of planning and execution of the scope of work covered by this RD/RAWP, evaluation and consultation with the State Historic Preservation Officer, Tribal governments, etc., as appropriate, will be conducted. Systems and structures planned for the treatment and packaging of sludge would be designed pursuant to ARARs to protect the environment.

5.4 Safety and Health Program

A health and safety plan (HASP) that addresses the scope of work identified in this RD/RAWP would be prepared and maintained, as appropriate, by the project. The HASP would address chemical, radiological, and physical hazards and would specify the controls and requirements for work activities. Access and work activities would be controlled in accordance with approved work packages, as required by established internal work requirements and processes. The HASP would address the health and safety hazards of each phase of site operation and would include the requirements for hazardous waste operations and/or construction activities (29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response"). As part of work package development, a job or activity hazards analysis would be written to identify the hazards associated with specific tasks in addition to the HASP.

In addition to the HASP, radiological work permits (RWPs) would be prepared, as needed, for work in areas with potential radiological hazards. The RWP extends the Radiological Protection Program to the specific work site or operation. All personnel assigned to the project and all work site visitors would strictly adhere to the provisions identified in the HASP and RWP. Before work and before each activity begins, a pre-job briefing would be held with the involved workers. This briefing would include reviews of the hazards that could be encountered and the associated requirements. Throughout an activity, daily briefings also could be held, as well as special briefings before major evolutions.

5.5 Quality Assurance Program

Quality assurance is implemented in accordance with contractor-approved internal work requirements and processes, which, in turn, implements DOE O 414.1C, *Quality Assurance*, and 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements" and the *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD) (DOE/RL-96-68). Applicable SAPs also include the quality requirements applicable to work performed using a graded approach.

6 Remedial Action Completion

Completion of the sludge management activities identified in this RD/RAWP will be achieved by meeting the end-point criteria specific to this work scope.

6.1 End-Point Criteria

End-point criteria for the sludge treatment are identified in HNF-20632, *End Point Criteria for the K Basins Interim Remedial Action*.

6.2 Project Closure Documentation

Project closure documentation will be prepared to document completion of the scope covered by this work plan. The report will describe the activities performed to meet the end-point criteria and describe achievement of the RAOs identified in Section 2.2.

7 Milestone, Cost, and Schedule

7.1 Milestones

The M-016-140 Milestone was negotiated in 2008 to promote integration of the K Basins Sludge Treatment Project (STP) with 100-K Area closure activities. Modifications to the TPA milestone schedule relevant to activities described in this RD/RAWP are presented in Table 4.

Table 4. Summary of Relevant Tri-Party Agreement Milestones

M-016-171	Complete K Basin sludge treatment and packaging technology evaluation report and submit a schedule including proposed new interim milestones for bench scale or identified testing in order to meet M-016-173	March 31, 2012 Completed
M-016-173	Select K Basin sludge treatment and packaging technology and propose new interim sludge treatment and packaging milestones	09/30/2022

7.2 Cost and Schedule

Table 5 summarizes the key cost and schedule elements for the planned work included in this RD/RAWP.

Table 5. Estimated Cost and Schedule

Activity	Cost	Schedule
Complete Conceptual Design	TBD	TBD
Complete Preliminary Design	TBD	TBD
Complete Final Design	TBD	TBD
Construction and Readiness Reviews	TBD	TBD

Table 5. Estimated Cost and Schedule

Activity	Cost	Schedule
Complete Treatment and Packaging of First Container of Sludge	TBD	TBD
Complete Treatment and Packaging of Last Container of Sludge	TBD	TBD

All cost and schedule information in Table 5 is TBD in accordance with Milestone M-016-173.

8 References

10 CFR 20, "Standards for Protection Against Radiation," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol1/xml/CFR-2010-title10-vol1-part20.xml.

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol2/xml/CFR-2010-title10-vol2-part61.xml.

61.40, "General Requirement."

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol4/xml/CFR-2010-title10-vol4-part830-subpartA.xml.

10 CFR 834, "Radiation Protection of the Public and the Environment," rule proposed at 58 FR 16268, *Code of Federal Regulations*. Available at: https://www.gpo.gov/fdsys/pkg/FR-1995-09-13/pdf/95-22626.pdf.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol4/xml/CFR-2010-title10-vol4-part835.xml.

29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title29-vol5/xml/CFR-2010-title29-vol5-sec1910-120.xml.

36 CFR 800, "Protection of Historic Properties," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title36-vol3/xml/CFR-2010-title36-vol3-part800.xml.

6.301, "Applicant Requirements."

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol8/xml/CFR-2010-title40-vol8-part61.xml.

61.92, "Standard."

61.93, "Emission Monitoring and Test Procedures."

61.145, "Standard for Demolition and Renovation."

61.150, "Standard for Waste Disposal for Manufacturing, Fabricating, Demolition, Renovation, and Spraying Operations."

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