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Phase 2 RCRA Facility Investigation/Corrective Measures Study Master Work Plan for Single-Shell Tank Waste Management Areas

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Abstract: This document was prepared to fulfill the requirements of Hanford Federal Facility Agreement and Consent Order (HFFACO) Milestone M-45-58 and HFFACO Action Plan, Appendix I, Section 2.3. It identifies a high-level strategic, regulatory, and technical framework for performing Resource Conservation and Recovery Act (RCRA) soil corrective actions to support closure of the single-shell tank (SST) waste management areas (WMA). The approach to integration of corrective actions with other regulatory processes such as RCRA permitting of the tank system and Comprehensive Environmental Response, Compensation, and Liability Act remediation is presented, as well as corrective measure and characterization technologies and criteria for sequencing WMA corrective actions at SST WMAs.

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EXECUTIVE SUMMARY

This Phase 2 master work plan document identifies the strategic approach for performing RCRA corrective actions to support closure of the single-shell tank (SST) waste management areas (WMA). The scope of this document was developed in coordination with the Washington State Department of Ecology (Ecology), the U.S. Department of Energy (DOE), and its contractors. Not included are detailed work elements for individual WMAs or performance schedules that are associated with site-specific work plans developed under the *Resource Conservation and Recovery Act of 1976* (RCRA) corrective action process. This information will be developed in subsequent WMA-specific work plans. Instead, this master work plan presents a high-level strategic, regulatory, and technical framework to guide the development of the WMA-specific work plans.

The SSTs are located in the 200 Areas of the DOE's Hanford Site near Richland, Washington, and are divided into seven WMAs based on geographic proximity. Past releases to soil have resulted in contamination that requires evaluation and cleanup under the RCRA corrective action program in accordance with the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology et al. 1989), also known as the Tri-Party Agreement. "Phase 2" indicates the second phase of RCRA corrective actions associated with SST WMA contaminated soil. Elements of the Phase 2 corrective action process include soil characterization, assessment of risk from past releases to soil, evaluation and selection of corrective measure alternatives, and implementation of the selected corrective measures.

A Phase 1 characterization effort was completed and the results were published in the Phase 1 DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*. DOE/ORP-2008-01 concludes that all SST WMAs have impacted soils and degraded groundwater quality. The responsible Federal agency, the DOE Office of River Protection, along with the lead regulatory agency, Ecology, have agreed to evaluate the releases and, as appropriate, to implement corrective measures to protect human health and the environment for all pathways and contaminants of concern through the implementation of the SST WMA Phase 2 corrective action process.

This Phase 2 master work plan fulfills the requirement of HFFACO Milestone M-45-58 and HFFACO Action Plan, Appendix I Section 2.3. A high-level strategy is presented that identifies DOE's current and proposed approaches for the development of corrective actions to support final closure of the SST WMAs. The regulatory framework was developed in accordance with state and federal corrective action requirements as well as the requirements specified in the HFFACO. The regulatory requirements and process are described for implementing Phase 2 corrective actions under RCRA, the *Hazardous Waste Management Act of 1976* and the *Model Toxics Control Act of 1989*, and also described is how the requirements of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), the *National Environmental Policy Act of 1969* (NEPA), and the *Atomic Energy Act of 1954* will be fulfilled by and integrated with the RCRA corrective action requirements. The key SST WMA regulatory documents associated with the RCRA corrective action process are described in this master work plan and include interim measure proposals, the data quality objectives report, and the RCRA facility investigation/corrective measures study work plan.

Phase 2 corrective actions for releases to soil are only a part of those necessary for final closure of a WMA. The RCRA closure actions for SST structural components, CERCLA remedial actions for source waste sites inside and adjacent to the WMAs, and CERCLA remedial actions for contaminated groundwater will be required as well. Cleanup decisions for these actions will occur through separate regulatory processes that will be integrated to achieve final closure of the WMAs. The integration of these activities is important to optimize the use of resources and provide an understanding of cumulative impacts. For example, the decision to place a surface barrier at a WMA and its subsequent size and design features will need to be evaluated taking into account risks from various sources of contamination contiguous to the WMA, including those from CERCLA waste sites. Another area requiring integration is the path forward for the WMA ecological risk assessment. This risk assessment, where appropriate, will build from and integrate with the Central Plateau ecological risk assessment. This Phase 2 master work plan describes the approach to integration of corrective actions with these other processes as required by HFFACO Appendix I, Section 2.3. In addition, agency initiatives are presented that are in progress to more effectively integrate or streamline WMA actions.

The Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS) is currently in development under NEPA and will in part analyze SST system closure alternatives, including contaminant removal and landfill closure. After the final EIS is complete, DOE will issue a Record of Decision (ROD). The decisions from the TC&WM EIS ROD and Ecology's *State Environmental Policy Act of 1971* (SEPA) determinations will outline a path for closure of the WMAs.

For contaminated soil, viable and innovative corrective measure technologies have been developed for WMA corrective actions. A previously completed screening of technologies (RPP-ENV-34028, *Central Plateau Vadose Zone Remediation Technology Screening Evaluation*) resulted in a list of potentially viable technologies for application in WMA soil, particularly with respect to remediation of soils in the deep vadose zone. The screening process was based on the criteria of effectiveness, implementability, and cost. From this screened set of technologies, as well as other technologies that may be developed as part of ongoing treatability studies, corrective measures alternatives will be assembled, evaluated in detail, and compared to one another in the WMA Corrective Measures Study. Potential interim measures, notably the application of interim surface barriers, are discussed in this plan. Interim surface barriers have the potential to reduce the impacts from past leaks and spills by reducing the infiltration rate during the extended period prior to final closure of the WMA.

Standard and innovative characterization technologies, including boreholes, direct push, surface geophysical exploration, surface characterization methods, and use of existing historical information will be used during Phase 2 corrective actions. Surface geophysical exploration and other characterization tools will require development and validation for use in future WMA characterization activities.

Milestones already exist in the HFFACO for implementing the Phase 2 corrective action process specifically at WMA C. As required by HFFACO Action Plan Appendix I, the Phase 2 master work plan develops selection criteria and a process for sequencing subsequent WMA Phase 2 RCRA corrective actions as required. Criteria such as (1) avoidance of interferences from nearby operational facilities or waste retrieval activities and (2) accommodation of CERCLA remedial action schedules are proposed for sequencing subsequent WMA corrective actions.

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ABBREVIATIONS AND ACRONYMS

AEA	*Atomic Energy Act of 1954*
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COC	contaminants of concern
CWA	*Clean Water Act*
DOE	U.S. Department of Energy
DQO	data quality objective
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FR	*Federal Register*
HAB	Hanford Advisory Board
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HRR	high resolution resistivity
HWMA	*Hazardous Waste Management Act of 1976*
IAEA	International Atomic Energy Agency
MCL	maximum contaminant level
MTCA	*Model Toxics Control Act of 1989*
NEPA	*National Environmental Policy Act of 1969*
NRC	U.S. Nuclear Regulatory Commission
ORP	U.S. Department of Energy, Office of River Protection
PA	performance assessment
RCRA	*Resource Conservation and Recovery Act of 1976*

RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	U.S. Department of Energy, Richland Operations Office
ROD	Record of Decision
RPP	RCRA past practice
SAP	sampling and analysis plan
SDWA	*Safe Drinking Water Act*
SEPA	*State Environmental Policy Act of 1971*
SGE	surface geophysical exploration
SST	single-shell tank
TC&WM	Tank Closure and Waste Management
TOC	Tank Operations Contractor
TSD	treatment, storage, and disposal unit
UPR	unplanned release
WAC	*Washington Administrative Code*
WMA	waste management area

1. INTRODUCTION

This Phase 2 master work plan identifies the strategic approach for performing RCRA corrective actions to support final closure of the Hanford Site single-shell tanks (SST) waste management areas (WMA) (see Figure 1-1). The Phase 2 master work plan is a *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology et al. 1989) (also known as the Tri-Party Agreement) requirement (Milestone M-45-58; Change Control Form M-45-06-03) for submittal to the State of Washington Department of Ecology (Ecology) by December 31, 2008.

Two *Resource Conservation and Recovery Act of 1976* (RCRA) programs, corrective actions for releases to soil and closure actions for SSTs and ancillary equipment, comprise the actions necessary for "final closure" of the SST WMA under RCRA. These actions are authorized under the state RCRA program by the Washington State Department of Ecology (Ecology) *Hazardous Waste Management Act of 1976* (HWMA), *Revised Code of Washington* (RCW) 70.105, and *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations." The RCRA corrective action portion of final closure is the subject of this Phase 2 master work plan; however, the integration of these two RCRA programs is addressed.

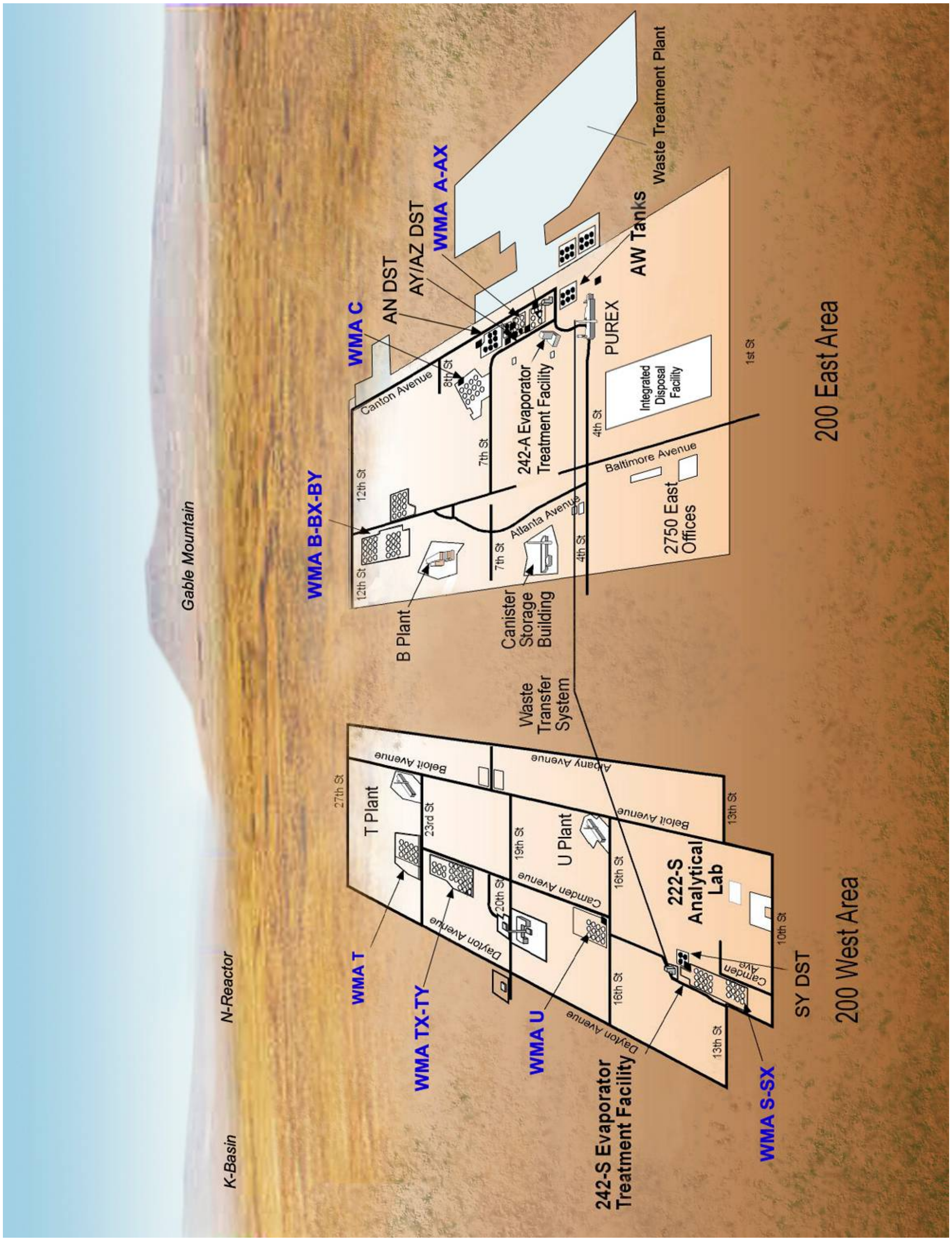
The scope of this document was developed in coordination with Ecology, the U.S. Department of Energy (DOE), and its contractors. Not included are detailed work elements for individual WMAs or performance schedules that are associated with site-specific work plans developed under the RCRA corrective action process. This information will be developed as part of WMA-specific work plans. Instead, this plan presents a high-level strategic, regulatory, and technical framework to guide the development of the detailed documents that will be used to direct and manage the WMA-specific Phase 2 corrective action activities.

DOE and Ecology have agreed through a separate milestone (M-45-60) that submittal of a Phase 2 RCRA Facility Investigation (RFI)/Corrective Measures Study (CMS) work plan and sampling and analysis plan (SAP) for WMA C will occur concurrently with this Phase 2 master work plan. The Phase 2 WMA C RFI/CMS work plan will be developed as a separate document. DOE and Ecology have agreed that this work plan will include the specific actions and schedules for WMA C while also serving as an initial template (subject to change based on WMA-specific conditions) for subsequent WMA RFI/CMS work plans.

The DOE has completed Phase 1 RCRA corrective actions, which are described in DOE/RL-99-36, *Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan for the Single-Shell Tank Waste Management Areas*. Phase 1 activities included research and characterization of contaminated soil and the implementation of interim measures in the WMAs.

DOE has initiated Phase 2 of the corrective action program which will focus on continuing interim measure development, obtaining additional subsurface soil characterization information, determining final corrective measures in a CMS, and implementing those measures at the SST WMAs. Specific requirements of the Phase 2 master work plan are delineated in HFFACO Appendix I, Section 2.3.

Figure 1-1. SST WMAs and Adjacent Facilities in the 200 East Area and 200 West Area of the Hanford Site



A Phase 2 corrective action process master Work Plan will describe the overall corrective action conceptual process and sequencing approach for all single shell tank farms. The milestones defining the corrective action schedule for WMA C are shown in milestones M-45-60, -61, & -62. Elements of the Phase 2 Master Work Plan will include:

- Discussion of the approach to complete the Phase 2 data quality objective process including confirmation of developmental characterization tools such as high resolution resistivity (HRR or Subsurface Geophysical Evaluation [SGE]).
- Discussion of integration with the groundwater program, tank closure and adjacent operable units, as appropriate.
- Discussion of the WMA approach to corrective action and closure.
- Selection criteria for implementing Phase 2 RCRA corrective actions at subsequent WMAs.

A number of strategies critical to the success and efficiency of this Phase 2 program are currently under evaluation through various Ecology and U.S. Environmental Protection Agency (EPA) forums. These strategic initiatives are discussed in Sections 4.4 and 5.4, and it is anticipated that this Phase 2 master work plan will be updated by DOE as agreed to by Ecology should the framework for performing Phase 2 corrective actions be modified by Ecology and EPA, Where information regarding treatment, management, storage, and disposal of the radioactive source, byproduct material, special nuclear material [as defined by the *Atomic Energy Act of 1954* (AEA)] and/or the radionuclide component of mixed waste has been addressed in this Phase 2 master work plan, it is not for the purpose of asserting regulation of the radiation hazards of such components under the authority of Ecology’s RCRA corrective action program (RCW 70.105).

1.1 GENERAL SINGLE-SHELL TANK BACKGROUND

For more than four decades beginning in 1944, the Hanford Site produced defense materials, primarily from uranium fuels. The process of extracting defense materials from irradiated fuels generated radioactive and dangerous wastes. Between 1943 and 1964, 149 SSTs were constructed in the 200 East and 200 West Areas to store waste underground. From 1944, the DOE and its predecessors routed wastes from spent fuel reprocessing and other operations in the Hanford Site 200 East and 200 West Areas via buried lines to underground tanks for storage. Further historical summary information on the SSTs is provided in DOE/RL-99-36.

Grouped into 12 tank farms, the tanks, piping, ancillary equipment, soil, and groundwater make up the SST system. These 12 tank farms are geographically grouped into seven WMAs, as shown in Figure 1-1. The seven WMAs are closing treatment and storage units under WAC 173-303.

Over time, some waste has leaked from the SST system or was discharged in an unplanned manner immediately adjacent to or within the SST farms. Groundwater monitoring data for the SSTs indicate that SST wastes have contaminated groundwater at all WMAs (see Chapter 2). As a consequence, corrective actions for these releases must be assessed in accordance with applicable regulatory requirements (see Chapter 3) including establishment of the Phase 1 and Phase 2 corrective action processes described in this master work plan.

1.2 OVERVIEW OF THE PHASE 1 PROGRAM

The HFFACO was proposed to be modified in 1998 (Change Control Form M-45-98-03) to require corrective actions at SST WMAs after determining that the groundwater under the SST WMAs had been impacted by the release of waste from four SST WMAs (WMAs S-SX, B-BX-BY, T and TX-TY). The HFFACO was modified based on this proposal in 2001 [Letter TSD S-2-4, "Requirements for a Corrective Action Program to Address Releases to the Environment at Eight (8) Single-Shell Tank Farms"]). The Phase 1 program was developed to meet the corrective action milestone requirements, which focused on major unplanned release events, and includes approximately 10 years of research and investigation activities, including borehole and lateral reentry data and the development of innovative sampling techniques such as direct push and surface geophysical exploration (SGE). This program included, among many accomplishments, diagonal drilling in SX Farm, the first time to be executed at the Hanford Site as well as implementation of interim measures to control infiltration in and around the WMAs. Chapter 2 presents a summary of the efforts and results of the Phase 1 program.

The U.S. Department of Energy, Office of River Protection (ORP) developed DOE/RL-99-36 in response to pending HFFACO milestones to address the impacts of past and potential future tank waste releases to the environment. DOE/RL-99-36 was developed to define an overall approach for the RCRA corrective action activities, including the recognition that such activities could require a "phase 2" program to complete the evaluation and selection of final WMA corrective measures

The Phase 1 program culminated in the publication of DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*. DOE/ORP-2008-01 presents the state of knowledge on characterization, research, and interim measure implementation during the 10 years of the Phase 1 corrective action program. Its contents include SST WMA background information, an explanation of the field activities performed, and descriptions of the findings and results, including summaries from the field investigation reports and the DOE/ORP-2005-01, *Initial Single-Shell Tank System Performance Assessment for the Hanford* Site (see Chapter 2 and Section 3.4).

Since the RFI Report, DOE/ORP-2008-01, characterization efforts have continued at WMA C. RPP-35169, *Near-term Data Quality Objectives for Vadose Zone Characterization Waste Management Area C*, and RPP-PLAN-35341, *Work Plan for Near-Surface Vadose Zone Characterization Utilizing the Hydraulic Hammer / Direct Push Technology for 35 Direct Pushes in FY08*, were developed to guide this effort that has focused on collecting data at two release sites: Unplanned Release (UPR) -86 and UPR-81. This effort was completed in FY 2008. During this work, deep electrodes were placed to support the confirmation testing of SGE at WMA C. The data obtained from the near-term activities will be incorporated into the Phase 2 characterization database that will be used in the WMA C RFI/CMS.

1.3 PURPOSE OF THE PHASE 2 PROGRAM

Since the development of the Phase 1 master work plan (DOE/RL-99-36), DOE and Ecology agreed that a Phase 2 characterization effort would be required to obtain all data necessary to make final corrective action decisions. Figure 1-2 provides a summary of the Phase 1 and Phase 2 corrective action milestones and their relationship within the corrective action process. The Phase 2 milestones are currently associated with the first WMA to undergo corrective action (WMA C). Subsequent WMAs will undergo corrective action using this same process. The purpose of the Phase 2 program is to complete the characterization of the vadose zone in the WMAs such that final soil remedy decisions can be made. The Phase 2 characterization will begin where the Phase 1 program ended as described in the RFI report (DOE/ORP-2008-01). The final corrective measures identified in the WMA CMSs will be incorporated into the overall planning for closure of the SST WMA under RCRA.

Phase 2 will include the following:

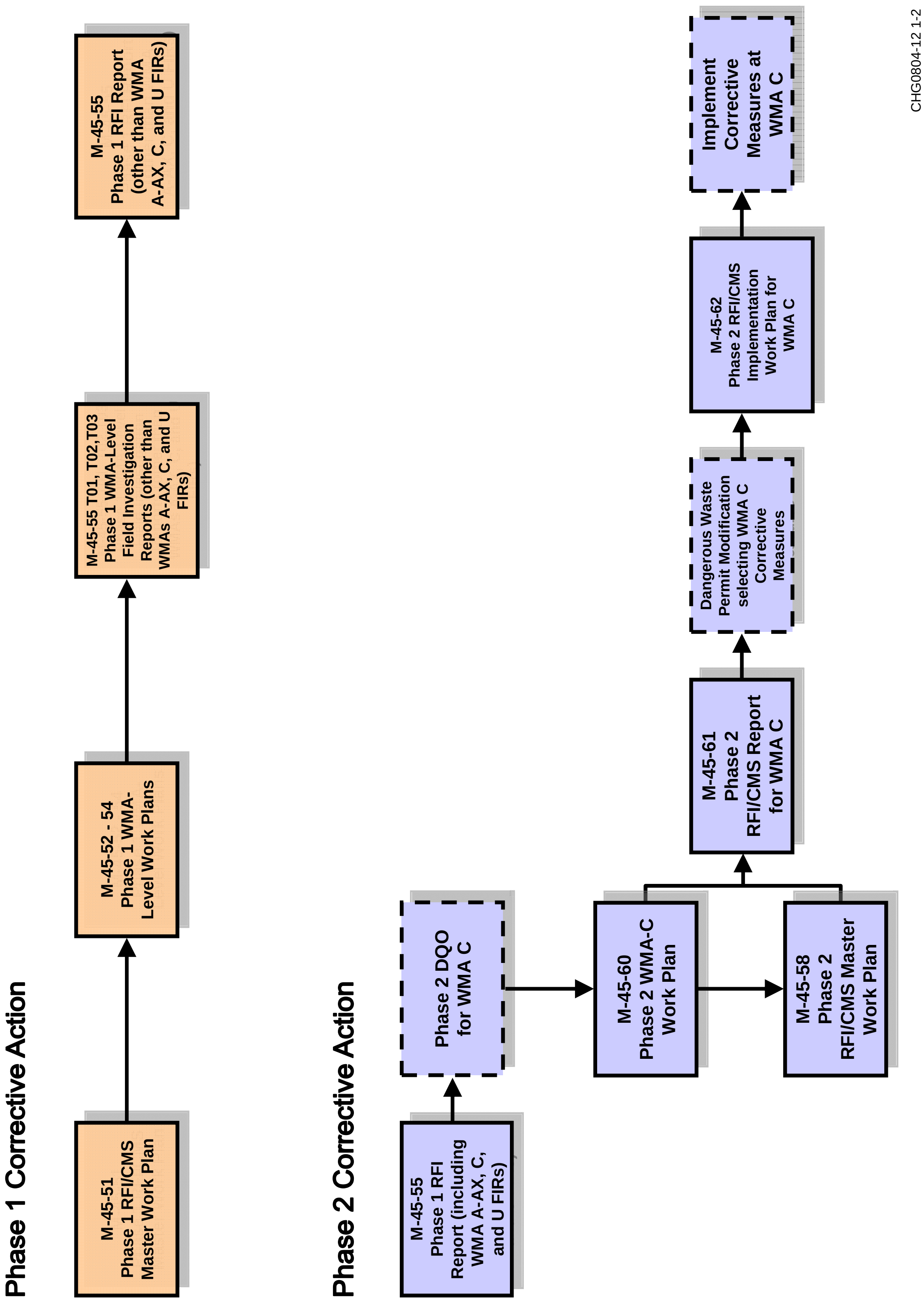
- Additional characterization within and adjacent to each of the seven WMAs as required to define the nature and extent of contamination and perform alternatives analyses for final corrective actions within the WMA.
- Evaluation of the characterization data to determine risk to all pathways (including groundwater, inadvertent intruder, direct human contact, and ecological contact).
- Preparation of WMA RFI/CMSs and selection of final cleanup actions in the Site-Wide Permit.
- Implementation of additional interim measures pursuant to HFFACO Milestone M-45-56 where it is deemed appropriate.

Specific elements of the Phase 2 program are discussed in Section 3.2.

1.4 SCOPE DIFFERENCES BETWEEN THE PHASE 1 AND PHASE 2 MASTER WORK PLANS

The Phase 1 master work plan (DOE/RL-99-36) provided the framework to meet the Phase 1 milestones developed under Change Control Form M-45-98-03. This framework has changed in response to new HFFACO milestones, Change Control Form M-45-06-03 [Letter 0702362 "Hanford Federal Facility Agreement and Consent Order (HFFACO) Change Control Form M-45-06-03 for Milestones M-45-55, M-45-58, and M-45-60”], for Phase 2 corrective actions (see Section 3.1.3). This Phase 2 work plan reflects the regulatory and strategic framework needed to comply with these changes

Figure 1-2. Phase 1 and Phase 2 SST Corrective Action Program HFFACO Milestones



DOE/RL-99-36 also provided the framework for corrective action, waste retrieval, and tank closure. This Phase 2 master work plan focuses solely on corrective actions for past releases to soil. In accordance with Appendix I of the HFFACO, waste retrieval and tank closure planning is being developed through tank waste retrieval work plans and RCRA closure plans and permitting, respectively, and therefore is not part of the scope of this work plan.

Another difference in scope between the Phase 1 work plan (DOE/RL-99-36) and this work plan is the location of common work plan elements (e.g., quality assurance project plans, health and safety plans, and waste management plans) for use in subsequent WMA-specific field investigation work plans. These common work plan elements were contained in the Phase 1 master work plan (DOE/RL-99-36). For the Phase 2 program, DOE and Ecology have agreed in workshops preceding development of this master work plan that these elements will be developed as part of the WMA C work plan. The WMA C work plan will then serve as a guide for future Phase 2 WMA-level work plans. Table 1-1 provides a summary of the key differences in content between the Phase 1 (DOE/RL-99-36) and Phase 2 master work plans. Locations of the scope items are included in parentheses for the respective plans.

Table 1-1. Scope Differences between the Phase 1 and the Phase 2 Master Work Plan (2 sheets)

Scope	Phase 1	Phase 2
Regulatory and strategic framework for corrective action	Included. Based on Phase 1 corrective action milestones (Chapter 2)	Included. Based on Phase 2 corrective action milestones (Chapter 3)
Common work plan elements for WMA-level work plans	Included. Includes quality assurance project plan, general health and safety plan, waste management, data quality objectives templates, and risk assessment components (Appendixes A, B, C, D)	Not included. This information will be contained in WMA-level work plans using the Phase 2 WMA C work plan as a guide
Integration with Central Plateau and RCRA closure activities	Included. Includes information regarding Central Plateau organizations at the time of report preparation (Section 7.3)	Included. Expands and focuses on final cleanup decisions on the Central Plateau and the process that will be used to integrate final Phase 2 WMA decisions with these closure activities (Chapters 4 and 5)
Characterization technologies	Included. Defines characterization technologies as they were developed at the time of report preparation (Appendix E)	Included. Provides references that have expanded new and innovative technologies for performing characterization activities during Phase 2 corrective actions (Chapter 7)
Corrective measures technologies	Included Includes general response actions and the process that will be used to screen technologies based on effectiveness, implementability, and cost (Appendix I)	Included. Provides references that identify the screening process that was performed for corrective measures technologies including deep vadose zone treatment and assessment technologies (Chapter 6)
Waste retrieval and closure	Included.	Not included.

Table 1-1. Scope Differences between the Phase 1 and the Phase 2 Master Work Plan (2 sheets)

Scope	Phase 1	Phase 2
framework	The scope of the Phase 1 work plan includes the decision framework for corrective action as well as waste retrieval and closure decisions (Various including Sections 5.4 and 5.5)	In the 10 years since the Phase 1 master work plan was produced, the waste retrieval and closure decision pathways have been developed pursuant to HFFACO Appendix I. The Phase 2 master work plan includes information with regard to integration of these programs with corrective actions
Summary of Existing Information	Included. Includes pre-Phase 1 information (Chapter 3)	Included. Includes summary of results from Phase 1 (Chapter 2)
Risk Assessment Approach	Included. (Chapter 4)	Included. (Section 3.4)

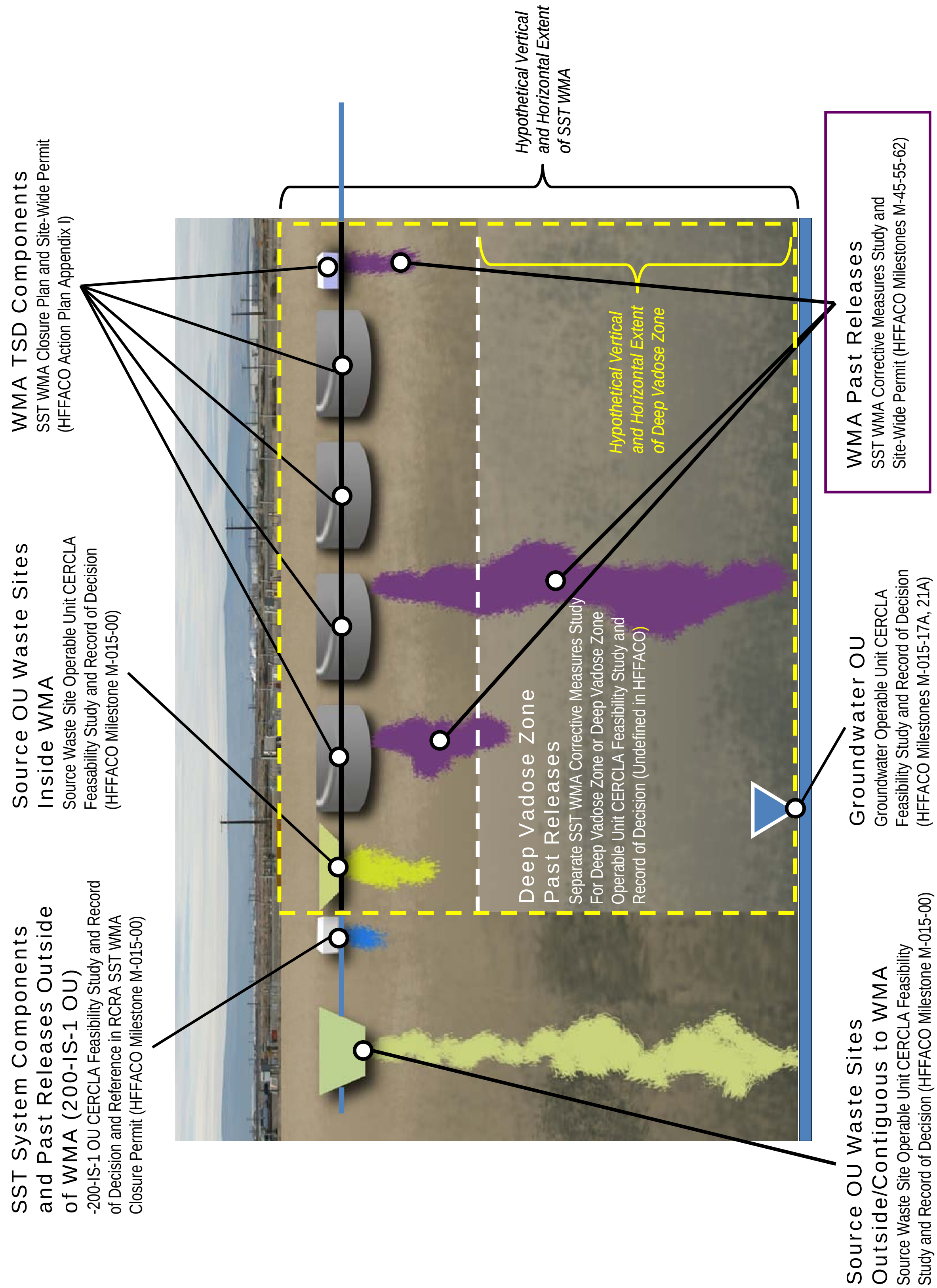
1.5 SINGLE-SHELL TANK WASTE MANAGEMENT AREA CLEANUP THROUGH CORRECTIVE ACTION, CLOSURE, AND CENTRAL PLATEAU CLEANUP DECISIONS

The cleanup of SST WMAs will be accomplished under the Phase 2 RCRA corrective action process described in this work plan as well as under the RCRA closure process and the Central Plateau *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) process. Figure 1-3 illustrates the different decision pathways that will be required to close the WMA SST system and its contiguous area. Integration between pathways will be necessary to ensure effective WMA and Central Plateau cleanup and closure. Integration work planning is discussed in Chapters 4 and 5.

1.5.1 RCRA Decision Pathway for Corrective Actions and Closure

The HFFACO Appendix I and milestones M-45-55 through -62 include separate RCRA processes for making cleanup decisions within each of the SST WMAs: RCRA closure (WAC173-303-610) for the SST System (tanks and ancillary equipment) and the state RCRA corrective action program (WAC 173-303-646) for past releases to soil from the SST System. These separate processes will be problematic in that each is designed to determine the same overall cleanup action for the WMA. Integration strategies and issues associated with remedy decision-making through these programs are discussed in Chapter 4.

Figure 1-3. Decision Pathways for SST WMAs and Adjacent Operable Units



1.5.2 CERCLA Decision Pathway for Contamination Inside and Outside the SST WMA

Two situations exist within the WMAs that will require integration with a CERCLA decision path. One situation is where contaminated buildings that are not associated with SST operation as a RCRA treatment, storage, and disposal unit (TSD) exist within the WMA. Decommissioning surplus Central Plateau buildings will be consistent with the requirements of CERCLA based on the DOE and EPA Memorandum, "Policy on Decommissioning Department of Energy Facilities Under CERCLA," and it is anticipated that decontamination and decommissioning of these buildings will occur as part of a CERCLA engineering evaluation and cost analysis process. The other situation is where CERCLA disposal waste sites are situated within a WMA fenceline (see Chapter 5 for further details on these sites). These waste sites will undergo remedy decision-making as part of the CERCLA operable unit, as defined in the HFFACO, for which they are currently identified pursuant to Milestone M-015-00. However, because of the potential impact of WMA remedy selection on these sites, coordination of the sequence and implementation of the remedies for CERCLA waste sites need to be considered when making corrective action decisions and schedules for WMA closure

Outside of the WMAs, contiguous contaminated soil sites within CERCLA operable units that may be impacted by WMA-selected remedies will require close coordination with WMA characterization, corrective actions, and closure activities. For example, waste sites that are in close proximity to an effective surface barrier for a WMA may most effectively be remediated through expansion of the WMA barrier.

One specific CERCLA operable unit, the 200-IS-1 Operable Unit, includes portions of the SST system ancillary equipment and contaminated soil located outside of the WMAs. DOE/RL-2002-14, *Tanks/Lines/Pits/Boxes/Septic Tank and Drain Field Waste Group Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes: 200-IS-1 and 200-ST-1 Operable Units* was issued in 2008. A discussion of this and other CERCLA operable units associated with each WMA is contained in Chapter 5.

1.5.3 Deep Vadose Zone Decision Pathway

Figure 1-3 shows a hypothetical vertical and horizontal zone of contamination in the WMA deep vadose zone. Cleanup actions in this zone may undergo a separate decision pathway either through separate RCRA WMA corrective actions or through an integrated Central Plateau RCRA/CERCLA process for the following reasons:

- Corrective measures that are proven to remediate all but the deep vadose zone in the SST WMA (i.e., removal to the extent technically possible or containment) do not appear to be able to affect this zone of contamination (see Section 6.1 for further discussion).
- Treatability testing of technologies that are viable for remediation of this zone are being evaluated under HFFACO Milestone M-015-50 (see Section 6.3 for further discussion).

Until it is understood what alternatives are available to mitigate contamination in the deep vadose zone, the corrective action process for a WMA cannot fully evaluate or select corrective measures in this zone. Thus, it is anticipated that a separate decision pathway will occur for

WMA C at a minimum for deep vadose zone cleanup if a need for action is warranted as determined through Phase 2 and associated Central Plateau characterization activities.

1.6 DOCUMENT STRUCTURE

This Phase 2 work plan is organized to present information as follows:

- **Chapter 1**, *Introduction*, identifies the approach and scope of this work plan.
- **Chapter 2**, *Single-Shell Tank Waste Management Area Phase 1 Background*, provides background on the results of the Phase 1 characterization and implementation of interim measures.
- **Chapter 3**, *Single-Shell Tank WMA Phase 2 Corrective Action Framework*, provides the regulatory and strategic framework for the Phase 2 corrective action program as well as the planned approach for conducting a comprehensive risk assessment for the SST WMAs.
- **Chapter 4**, *Integration of RCRA Corrective Actions with RCRA Closure Activities*, discusses current integration planning between the Phase 2 RCRA corrective action program and the permitting program for SST and ancillary equipment, as well strategies that are under development to streamline integration efforts.
- **Chapter 5**, *Central Plateau Operable Unit and Waste Management Area Corrective Actions Integration*, discusses current and proposed integration planning between the Phase 2 RCRA corrective action program and CERCLA remedial activities associated with the rest of the Central Plateau, including those for source operable units and groundwater operable units.
- **Chapter 6,** *Corrective Measures Alternatives at Single-Shell Tank Waste Management Areas*, provides a discussion of corrective measure technologies that are anticipated to be viable within the SST WMA.
- **Chapter 7**, *Characterization Technologies in Phase 2*, provides a discussion of characterization technologies available for use during Phase 2 characterization and presents the decision-making process that will be applied to these characterization technologies.
- **Chapter 8**, *Sequencing Waste Management Area Corrective Actions*, presents proposed selection criteria and a process for finalizing the criteria and developing the sequence of WMAs for corrective actions.
- **Chapter 9**, *References*, provides references for material cited.

2. SINGLE-SHELL TANK WASTE MANAGEMENT AREA PHASE 1 BACKGROUND

DOE/ORP-2008-01 provides the data collected, the information synthesized, and the understandings achieved during the 10 years of Phase 1. This chapter provides a summary of DOE/ORP-2008-01 and includes the following:

- The characterization efforts in Phase 1 (Sections 2.1 and 2.2).
- The interim measures installed to mitigate further movement of contaminants (Section 2.3).
- Introduction of the initial SST performance assessment (PA) (Section 2.4).
- Data needs not fulfilled by Phase 1 or new needs identified (Section 2.5).

Major Phase 1 characterization efforts (field sampling, geophysical measurements, laboratory measurements, and associated risk assessments) focused on the largest releases. These efforts (see Section 2.1) were organized around each SST WMA. However, many of the results (see Section 2.2), particularly those dealing with transport processes, have wide application to multiple WMAs.

2.1 CHARACTERIZATION EFFORTS IN PHASE 1 BY WASTE MANAGEMENT AREA

The HFFACO organized the Phase 1 efforts by WMAs with characterization priorities determined by extent of past releases.

Table 2-1 contains a summary of Phase 1 characterization techniques that were applied and key findings by WMA (see DOE/ORP-2008-01). Soil samples were obtained using boreholes and direct push techniques. New and existing drywells in the tank farms (over 800) were investigated using passive gamma radiation detectors (to measure natural and man-made gamma radiation as a function of depth) and active neutron detectors (to measure moisture content). In some drywells (mainly in the SX Farm) temperature readings as a function of depth were also collected. Under some tanks (A and SX Farms), lateral pipes were installed in the 1960s, and some of these laterals were recharacterized using passive gamma and neutron detectors.

Samples obtained from boreholes and direct push probe holes were sent to the Pacific Northwest National Laboratory for analysis. A three-tier analytical process was developed to determine contaminant concentrations and enhance understandings of geology, moisture movement, and contaminant transport.

Table 2-1. Phase 1 Characterization Efforts by WMA (2 sheets)

WMA	Phase 1 Investigations	WMA Goals	Key Findings	Implications for Phase 2
A-AX	Laterals in A Farm	Determine if significant amount of ^{137}Cs released, particularly from A-105	^{137}Cs concentrations much less than expected	Even though tank A-105 has the largest volume of released tank waste, relatively little ^{137}Cs was found Still need to perform SGE in WMA
B-BX-BY	2 Boreholes 21 Direct push sites SGE	Understand largest release (primarily U) in 200 East Area Determine contaminated region that may have been caused by BX-101 releases Understand U interactions with sediments Investigate strange gamma readings near B-110 Investigate reports of releases near diversion boxes	Plume from BX-101/102 is laterally extensive. A perched water layer exists above the groundwater. U is retarded in comparison to Tc and NO_3 Radiation readings from B-110 plume were due to ^{90}Sr brehmstralung (^{90}Sr emitted electromagnetic radiation) SGE did identify plumes from surrounding cribs, but did not identify uranium plume	Understanding of U geochemistry significantly improved, but further improvements needed Work needs to be tightly integrated with surrounding cribs and trenches and underlying groundwater unit Work has generated alternate depictions on how contaminants move through vadose zone U plumes may be poorly seen by SGE What are implications of perched water layer
C	1 Borehole 26 Direct Push Sites (Vertical and Slant) SGE	Investigate biggest suspected sources of releases (UPR-86) Investigate why area around C-105 had ^{137}Cs contamination Test of direct push technology	^{99}Tc and other contaminants are underneath C-105 UPR-200E-82 has ^{99}Tc down to at least 80-foot bgs Demonstrated capabilities of direct push	Do not know the bottom of UPR-86 plume Area around tank C-105 is contaminated, but probably from pipe leaks Direct push technology very successful Waste pipeline leaks are likely more important in farms than previously thought
S-SX	3 Boreholes (1 slanted beneath tank SX-108) 8 Direct Push Sites SGE (northern S Farm only)	Understand why ^{137}Cs traveled so far Determine if released waste affected sediment properties. Investigate very large releases near SX-107, -108, -109, and -115 as well as S-104. Test SGE in simulated S-102 release	S-104 plume extends to groundwater SX-108/9 plume extends to at least western edge of SX-109 SX-107 plume extends mainly vertically Found very high Tc levels in SX-115 groundwater well Better understand Cs mobility and waste-sediment interactions	Basic geochemistry is an important tool in understanding contaminant behavior. Do not model from time of release (too many unknowns), but from a time when plume has equilibrated with the natural system. Need SGE in SX and southern part of S Farms Need to know how far west plumes from SX-108/109 and SX-115 extend for barrier

Table 2-1. Phase 1 Characterization Efforts by WMA (2 sheets)

WMA	Phase 1 Investigations	WMA Goals	Key Findings	Implications for Phase 2
T	2 Boreholes 12 Direct pushes sites SGE	Determine if T-106 plume has moved Understand interactions between tank waste and sediments Understand releases from T-101 Test SGE in tank farms	See movement of mobile contaminants since 1994 tank T-106 borehole Most mass is above Cold Creek Unit SGE used in design of interim barrier See plumes to groundwater from T-7 Crib High levels of Tc seen in groundwater downgradient of WMA and deep in groundwater	T-106 plume centroid has moved downward about as expected until reaching Cold Creek Unit (which seems to be acting as a spreading horizon)
TX-TY	3 Boreholes 24 Direct push sites	Investigate suspected releases	Better understanding of U mobility (SGE is being performed in FY 2008)	U geochemistry is somewhat different than that of WMA B-BX-BY Awaiting SGE results
U	10 Direct push sites SGE	Test SGE (through deployment and targeted sediment samples) Understand U-104 release	Found extensive subsurface moisture (probably from ditches outside of farm) Confirmed losses from U-104 and U-110.	U Farm has best distribution of deep electrodes for SGE Sediment samples consistent with 2-dimensional SGE

The data and information obtained during Phase 1 were synthesized and future impacts were estimated. These results are documented in the following Field Investigation Reports:

- WMA S-SX (RPP-7884, *Field Investigation Report for Waste Management Area S-SX*).
- WMA B-BX-BY (RPP-10098, *Field Investigation Report for Waste Management Area B-BX-BY*).
- WMAs T and TX-TY (RPP-23752, *Field Investigation Report for Waste Management Areas T and TX-TY*).
- WMA U (RPP-35484, *Field Investigation Report of Waste Management Area U*).
- WMAs C and A-AX (RPP-35485, *Field Investigation Report of Waste Management Areas C and A/AX*).

Data and analyses subsequent to the issuance of the Field Investigation Report for a particular WMA are described in Chapter 6 and Appendix J of DOE/ORP-2008-01. In addition, DOE/ORP-2005-01 estimated future impacts not only from past releases but also from future releases (e.g., potential tank waste retrieval leaks and residual waste left in tanks and associated infrastructure).

2.2 PHASE 1 CHARACTERIZATION EFFORTS THAT CROSS-CUT WASTE MANAGEMENT AREAS

Although characterization efforts focused on WMAs in sequence, much of the understandings developed in Phase 1 cross-cut the WMAs. Major results are discussed in Sections 2.2.1 through 2.2.4.

2.2.1 Conceptual Models

The National Research Council in “Conceptual Models of Flow and Transport in the Fractured Vadose Zone,” defines a conceptual model as “… an *evolving* hypothesis identifying the important features, processes, and events controlling fluid flow and contaminant transport of consequence at a specified field site in the context of recognized problem.” Furthermore, as the 2006 Darcy Lecture for the National Groundwater Association, Dr. Eileen Poeter (Colorado School of Mines) recommended using "multiple working hypotheses" (alternative conceptual models) when studying complex geohydrologic systems. This section provides an overview discussion the alternative conceptual models supporting the data quality objectives process for the Phase 2 characterization data needed for the WMA C corrective measure study. As more data are collected during the Phase 2 characterization activities, these conceptual models will be updated and revised as necessary.

With regard to the unintentional discharge of waste from SST infrastructure into the subsurface at various WMAs on the Central Plateau, the nature and extent of contaminant release and subsequent migration have been conceptualized in terms of the source term properties (e.g., contaminant inventory and release mechanisms), the driving forces that move contaminants (e.g., recharge rates), and the properties of the medium through which contaminants move (e.g., subsurface stratigraphy). The following discussion emphasizes the variability of key factors over time (e.g., the local water flux controlling contaminant migration can vary by orders of magnitude when considering the leak event, operational recharge events, and long-term recharge through an engineered cover). Similarly, some critical factors may differ depending on the location (e.g., variability in operational fluid discharges at one WMA versus another that contact and move contaminants in the subsurface).

2.2.1.1 Alternative 1: Phase 1 Conceptual Model

This model is documented in Chapter 16 of DOE/ORP-2008-01 and was derived from process records, gross gamma logging information collected from the 1960s through the 1990s,[1] spectral gamma data collected in the late 1990s to early 2000s,[2] and the data collected during the Phase 1 characterization efforts conducted from 2000 to 2007.[3] One of the primary goals of the Phase 1 characterization effort was to understand the relationship of the inventory of contaminants (that adversely impact groundwater) observed in the vadose zone to the concentrations of those contaminants in the groundwater. To accomplish this, the Phase 1 characterization effort focused on collecting soil samples at major tank leaks with known high ^{137}Cs concentrations (10,000,000 pCi/g) in the nearby soils to find depth of the mobile contaminants (i.e., ^{99}Tc, nitrate, etc.) based on the relationship between ^{137}Cs and ^{99}Tc in the fission process.

The complete Phase 1 conceptual model is described in DOE/ORP-2008-01 (Appendix A). Rather than evaluating individual leaks sequentially, this summary discussion is oriented toward comparisons of similar information related to several leak events where possible, particularly the larger leaks that are more completely characterized. The purpose of these comparisons is to emphasize and describe those key characteristics and processes that are common to all leak events and therefore are indicative of systematic behavior. At the same time, it is important to keep in mind that each tank waste release site is unique in some way and that site-specific factors not emphasized in this general discussion may provide significant impacts to contaminant behavior in the subsurface. These factors, which must be determined from site-specific evaluation, may result in more refined or alternative conceptual models that are most appropriate for a given site.

At a summary level, the following key characteristics and processes are concluded to be the primary components of the conceptual model and common to all major tank leak events.

- Initial leak period.

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[1] See reports on analysis of historical gross gamma data: HNF-3531, HNF-3532, HNF-3831, HNF-4220, HNF-5433, RPP-6088, RPP-6353, RPP-7729, RPP-8321, RPP-8820, RPP-8821.

[2] See DOE's Grand Junction Office reports and Associated Addendum: Vadose Zone Characterization Project at the Hanford Tank Farms: DOE/ID/12584-268, DOE/ID/12584-268A, GJO-96-2-TAR, GJO-96-2-TARA, GJO-97-13-TAR, GJO-97-13-TARA, GJO-97-14-TAR, GJO-97-14-TARA, GJO-97-1-TAR, GJO-97-1-TARA, GJO-97-30-TAR, GJO-97-30-TARA, GJO-97-31-TAR, GJO-97-31-TARA, GJO-98-39-TAR, GJO-98-39-TARA, GJO-98-40-TAR, GJO-98-40-TARA, GJO-98-64-TAR, GJO-98-64-TARA, GJO-99-101-TAR, GJO-99-101-TARA, GJO-99-113-TAR, GJO-99-113-TARA.

[3] See Field Investigation Reports RPP-7884, RPP-10098, RPP-23748, and DOE/ORP-2008-01 Appendixes L and M.

- Unintentional discharges of tank waste were events that occurred because waste transfer pipelines and storage tanks were compromised and allowed waste releases to the subsurface. The primary degrading waste storage conditions of tanks were overheating and overfilling.

- Following release into the vadose zone, waste fluids increased ambient moisture content and perturbed the local geochemical conditions at the point of entry and beyond. Natural physical and chemical processes sometime after the leak event began to eliminate these perturbations.

- Waste fluids were distributed rapidly over limited areas of the vadose zone until ambient moisture contents were essentially restored. Key characteristics and processes were unsaturated flow and lateral migration that resulted from hydrogeologic controls. Consequently, waste contacted an expanded vadose zone volume compared to the initial volume of the released waste.

- Chemical reactions between tank waste fluid and the vadose zone soil-water system occurred as waste fluids were distributed in the vadose zone. Key characteristics and processes were moderation of the high local elevated pH conditions typical of tank waste fluids and sorption/precipitation of reactive contaminants onto soil surfaces. In some cases, tank waste chemistry altered the reactivity of specific contaminants relative to their behavior under ambient conditions [notably, for waste with high sodium content (SX-108), ^{137}Cs mobility was temporarily enhanced]. By the time ambient moisture content was essentially reestablished, contaminants were variably distributed in the vadose zone volume contacted by tank waste, depending on their reactivity. Maximum distribution occurred for nonreactive constituents (e.g., ^{06}Ru, ^{99}Tc, nitrate).

- Current Conditions

  - Following the initial waste fluid release and distribution into the vadose zone, lateral and vertical waste migration continued, but controlling physical and chemical processes changed in some respects. Migration was driven by local recharge conditions that were dictated by the permeability of the gravel fill that covers SST system in the tank farm. Chemical reactions continued that were primarily controlled by the ambient environment.

  - To date, observable migration has occurred only for nonreactive to slightly reactive contaminants (mostly nitrate and ^{99}Tc and to a lesser extent ^{60}Co, chromium, and uranium, where present). The exception to this observation is at SX-108 where enhanced ^{137}Cs mobility occurred due to the presence of high sodium concentrations in the tank waste (RPP-10098).

  - Under natural recharge conditions through a gravel cover, vertical migration rates of 0.3 to 0.9 m (1 to 3 ft)/year in the vadose zone for ^{60}Co have been observed at a few dry wells in WMAs C and B-BX-BY, most notably at dry wells 22-03-09, 22-06-05 (HNF-3532; RPP-8321, *Analysis of Historical Gross Gamma Logging Data from BY*

Tank Farm) and 30-08-02, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm - 200 East Area*.

- A number of characterization boreholes were installed during the Phase 1 characterization activities. Technetium-99 was found approximately between 26 m (85 ft) bgs and 46 m (15 ft) bgs for the 200 West WMAs and 40 to 52 m (130 to 170 ft) bgs for the 200 East WMAs (DOE/ORP-2008-01). Drilling depths were sufficient to reach and in some cases pass through a maximum concentration zone where ^{99}Tc concentrations at the deepest location were one or more orders of magnitude below the highest recorded values in the borehole. Based on these analyses, the bulk of the inventory for ^{99}Tc is inferred to still reside in the vadose zone, approximately 21 to 46 m (70 to 150 ft) above the unconfined aquifer.

- The lower Cold Unit is present in the 200 West Area, but not in the 200 East. Due to the cementing within this layer, this may form a hydraulic break to the vertical flow causing contaminants to move laterally across the top of this unit.

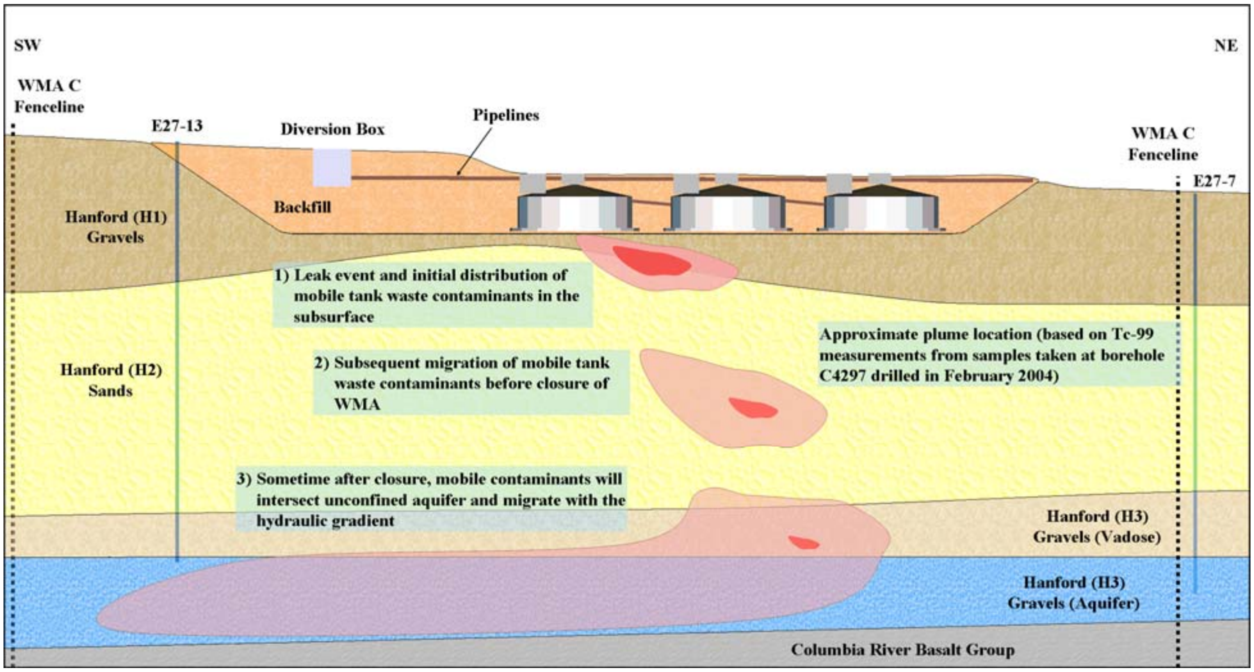
- Future Conditions

  - Future migration rates are expected to diminish if an engineered barrier is installed. If installed, an engineered barrier will reduce recharge rates from approximately 100 mm/y to much less than 1.0 mm/yr for some time (DOE/ORP-2005-01). This rate is expected to experience an eventual small increase with barrier degradation. Ambient chemical conditions will be maintained and only highly mobile or slightly retarded contaminants ($K_d < 0.6$ mL/g) will reach the unconfined aquifer in a period of several thousand years. For those mobile contaminants currently in the shallow vadose zone, significant increases in travel time and reductions in peak groundwater concentrations relative to current conditions are projected.

  - For those contaminants deeper in the vadose zone, the engineered barrier is less effective, and if no remedial actions take place, the inventory of nonreactive contaminants in the vadose zone will continue to migrate to the unconfined aquifer causing the ground concentrations to rise and to peak over the maximum contaminant level (MCL) sometime in the future (RPP-7884, RPP-10098, RPP-23752, DOE/ORP-2005-01).

  - These general periods are shown as different plume locations in Figure 2-1. The depicted plumes can be considered as the distribution of highly mobile contaminants that always migrate with the waste fluid. The data and analytical results collected during Phase 1 characterization indicate the bulk of the contaminant inventory remains in the vadose zone.

Figure 2-1. Alternative 1: Phase 1 Conceptual Model



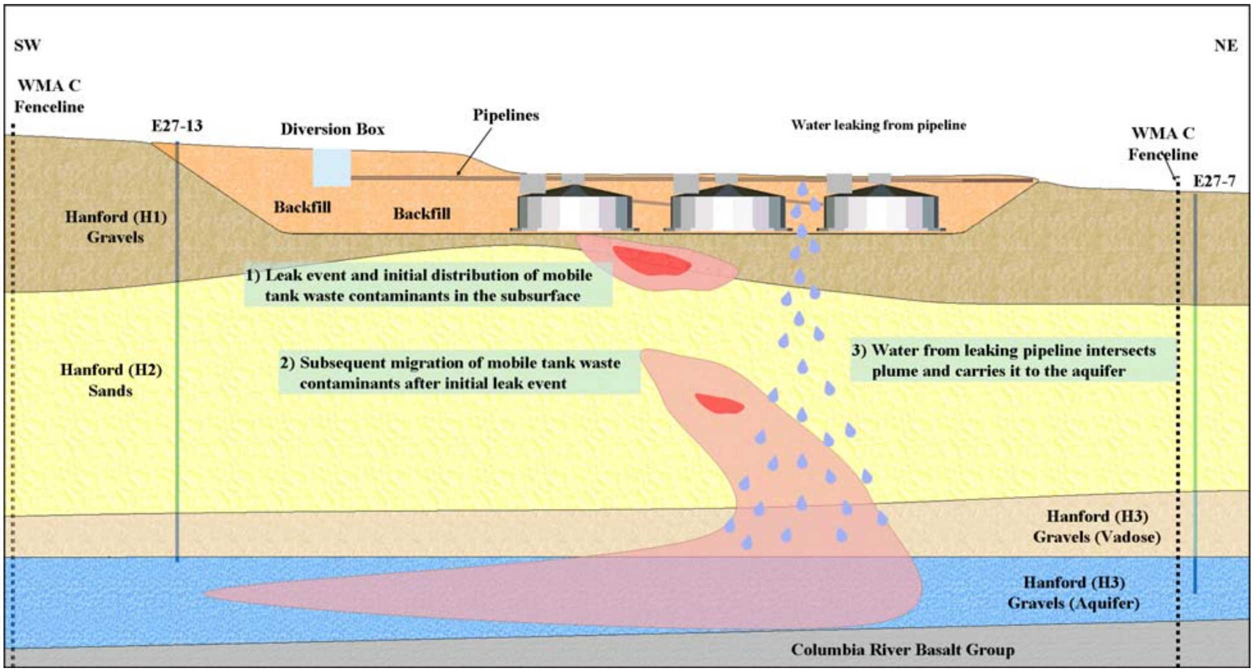
Importance of Water as a Driving Force

Despite the measurement of the highest levels of nonreactive to slightly reactive contaminants (^{99}Tc, chromium, nitrate) in the vadose zone approximately 21 to 37 m (70 to 120 ft) above the water table, groundwater monitoring data from wells near waste management area fencelines indicate that some tank waste has reached the aquifer in discrete locations, notably on the southern side of the SX Farm, the northeastern corner of the T Farm and, east of BX Farm and south of C Farm. These sites are noted for high ^{99}Tc concentrations (above the MCL of 900 pCi/L) in nearby groundwater monitoring wells and high uranium concentrations (above the MCL of 30 μg/L) at BX Farm as well. If these contaminants were initially present in leaked tank waste, the Phase 1 conceptual model must be expanded to explain these observations.

Examination of site-specific conditions at the WMAs suggests a mechanism that explains these observations. This mechanism is enhanced recharge of raw water or waste water by one of more of the following (1) localized unintentional from leaking pipelines, (2) flooding of the tank farm due to rapid snow melting, and/or (3) intentional releases from nearby cribs, trenches, and ditches. The following are specific examples of known enhanced recharge within the WMAs:

- At the southeast corner of SX Farm, a several year period of steady water loss from an operating raw water pipe line (pipes are not routinely monitored at all and normal construction specifications allow minimal leakage rates) in the early 1990s was indicated by sustained growth of a tree at that location. Also, during field characterization, the moisture content in sediments retrieved from a nearby borehole was anomalously high, suggesting recent additions of water to the vadose zone locally (RPP-7884). Enhanced recharge [RPP-7884 (Appendix E and Attachment E3) and DOE/ORP-2005-01] through a vadose zone area previously contaminated by tank waste would accelerate the migration rate of mobile contaminants in the vadose zone and in several instances has apparently driven these contaminants completely through the vadose zone and into the nearby unconfined aquifer (see Figure 2-2).

Figure 2-2. Expanded Phase 1 Conceptual Model Accounting for Artificial Recharge due to Pipeline Leak



- Water losses of several liters per minute (lpm) for several years above a vadose zone contaminated by tank waste could result in effective recharge rates well above average recharge rates from precipitation of about 100 mm (4 in.) per year. For example, if a pipe joint leak occurs at the rate of about 2 lpm (0.5 gpm), the yearly volume output is 995,000 L (262,800 gal). If this fluid volume migrates through a flux plane of 100 m^2, the equivalent annual volume discharge from ambient recharge of 100 mm/yr would be 10,000 L (2642 gal). Thus, the leak recharge rate is effectively 100 times the ambient recharge rate. This differential can quickly increase with higher leak rates and/or distribution over smaller flux planes.

- At T Farm, there was a large snow melt event in February 1979, which created temporary ponding over the farm followed by rapid infiltration into the subsurface. At that time, the drywells were not grouted to 27 m (90 ft) and could have provided preferential pathways for vertical migration to that depth (RPP-23752).

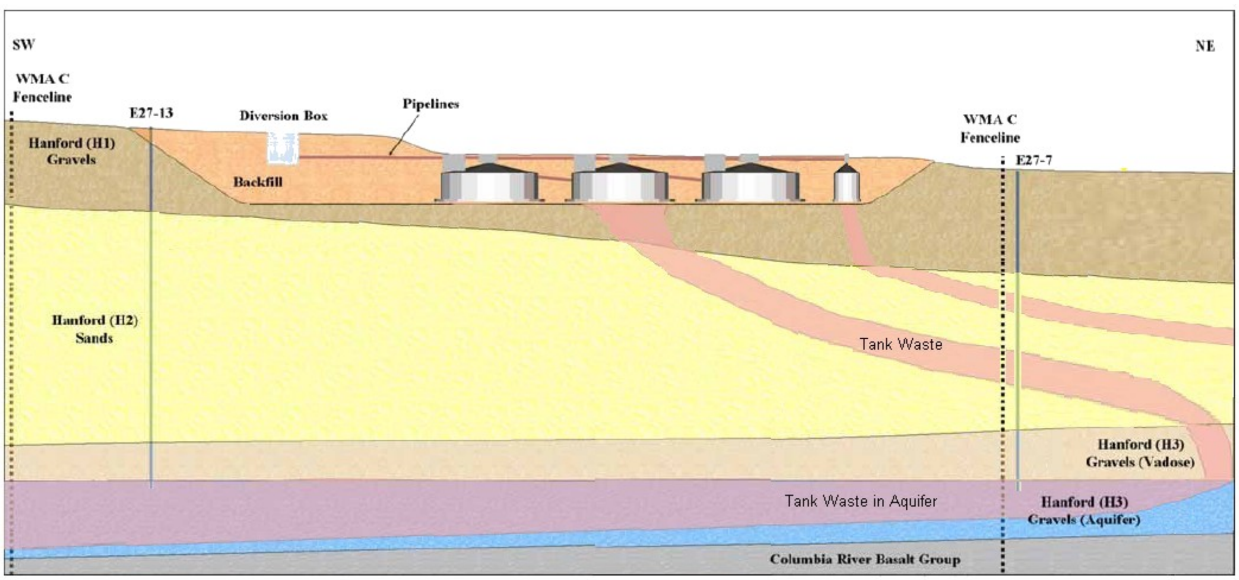
- Large intentional discharges of raw water or waste water occurred in cribs, trenches, and ditches close to WMAs B-BX-BY, and U. WMA B-BX-BY is bounded on the west and north by cribs that have received approximately 30,000,000 gal of liquid effluent. At this location, a perched water table is observed approximately 67 to 73 m (220 to 240 ft) bgs. If tank waste as it travels through the vadose zone encounters a perched water table, the perched water table will impact when and where contaminants from the vadose zone will enter the unconfined aquifer. At WMA U, the 216-U-14 trench is located to the east, while 216-Z-20 trench is located to the west. Large volumes of water (~346,000,000 gal) were discharged to these water trenches during their operational lifetime. Perching occurred on top of the Cold Creek unit, and elevated moisture content was observed in the vadose at WMA U (DOE/ORP-2008-01 Appendix M). Intentional discharges to cribs, ditches, and trenches ceased in the mid-1990s.

It is inferred from these observations that when enhanced recharge encounters tank waste in the vadose, tank waste is transported to the unconfined aquifer. Because of the detrimental impact of enhanced recharge in the tank farms, a series of interim measures (Section 2.2) has been implemented to prevent enhanced recharge.

2.2.1.2 Alternative 2: Movement of Contaminants Down Stratigraphic Dip Conceptual Model

An alternative conceptual model, "Characterization of the 241-C Tank Farm and Recent Groundwater Contamination at the Hanford Site, Washington," was presented by Dr. Stan Sobczyk of the Nez Perce Tribe at the *6th Annual Washington Hydrogeology Symposium* (Sobczyk 2007). This conceptual model correlates transport of ^{60}Co from spectral gamma measurements at WMA C with the stratigraphic dip to the northeast. Dr. Sobczyk provided an updated depiction of his 2007 conceptual model (see Figure 2-3). Dr. Sobczyk suggested a similar conceptual model for the release from BX-102 for the movement of uranium from the BX-102 overfill event.

Figure 2-3. Alternative 2: Movement of Contaminants Down Stratigraphic Dip Conceptual Model



2.2.1.3 Alternative 3: Preferential Pathways Conceptual Model

Preferential pathways have been hypothesized as a method of moving contaminants through the vadose zone. These are typically small-scale features with physical properties that can enhance the movement of contaminants vertically downward through the vadose zone. The ones cited most frequently at Hanford are poorly constructed wells and/or clastic dikes. Of these two features, the poorly constructed well would likely be associated with larger void spaces and therefore allow a greater migration rate.

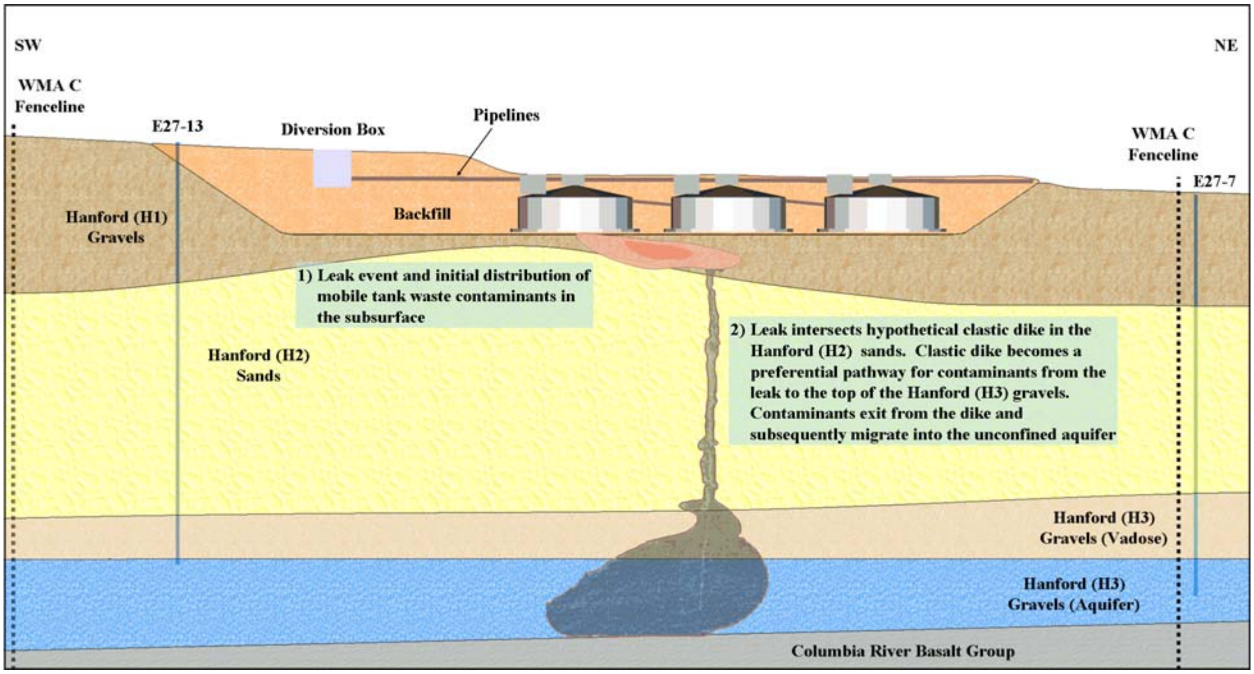
Poorly constructed wells might allow the contaminant to move vertically downward between the casing and the surrounding media. However, at tank farms, the depth of almost all drywells within the tank farms is 30 m (100 ft) bgs, while groundwater is 70 to 90 m (230 to 300 ft) bgs. It is unlikely that a poorly constructed drywell within a tank farm is providing a preferential pathway all the way to groundwater. On the other hand, in some locations nearby groundwater monitoring wells extend to the aquifer and could have provided a sufficient pathway for aquifer contamination. This may have occurred in WMA B-BX-BY where some ^{99}Tc and uranium from the BX-102 leak may have reached the unconfined aquifer.

Clastic dikes are common structures that occur in many geologic units in the Pasco Basin and vicinity (BHI-01103, *Clastic Injection Dikes of the Pasco Basin and Vicinity – Geologic Atlas* Series). Clastic dikes are tubular and tapered intrusive bodies that are composed of continental clastic sediments. BHI-01103 includes a photograph (Figure 9-44 on p 9-55) of irrigation on top of a clastic dike. In this photograph, water can be seen moving down the clastic dike until it reaches the bottom of the dike at which point water began spreading laterally and vertically. This photograph illustrates the potential for clastic dikes to become preferential pathways. However, it should be noted that BHI-01103 in describing this clastic dike noted the following:

- The highest observed hydraulic infiltration within an infilling unit was in a random occurrence dike network located in Lind Coulee east of Warden, Washington (32 km north of the Pasco Basin).
- The rate of moisture movement was not measured, but water could be observed moving down the dike at rates estimated at least 10 times the rates observed in other dikes in this study. The clastic dike acted as a conduit to transmit soil moisture downward through a preferential pathway to the base of the dike before spreading out into the host sediments.
- "The very high moisture velocity in the infilling unit that was observed is due to the unconsolidated, well-sorted nature of the sediments. **The characteristics of this infilling unit are unique compared to infilling units observed in the Pasco Basin and vicinity**."

Clastic dikes have been noted in the vicinity of all tank farms. However, due to the small-scale nature of these features, it is not possible to address this conceptual model in the DQO process for Phase 2 characterization, but movement down a hypothetical clastic dike can be captured in the CMS assessment of groundwater impacts. The likelihood of effectively locating, retrieving, and analyzing clastic dike materials is too small to successfully execute a dedicated characterization effort. Instead, modeling analyses must be relied on to evaluate the significance of this conceptual model as a mechanism for enhancing contaminant migration through the vadose zone. Figure 9-44, p 9-55 of BHI-01103, was used to develop a conceptualization of contaminant movement down a clastic dike (Figure 2-4).

Figure 2-4. Preferential Pathways (Clastic Dikes) Conceptual Model



2.2.1.4 Alternative 4: Unknown Leak Event Conceptual Model

Another possibility that could occur within a tank farm is a waste pipeline leak that did not manifest itself at the surface. The transport of contaminants from a new source, such as an unknown leak event, would follow one of the previous transport models.

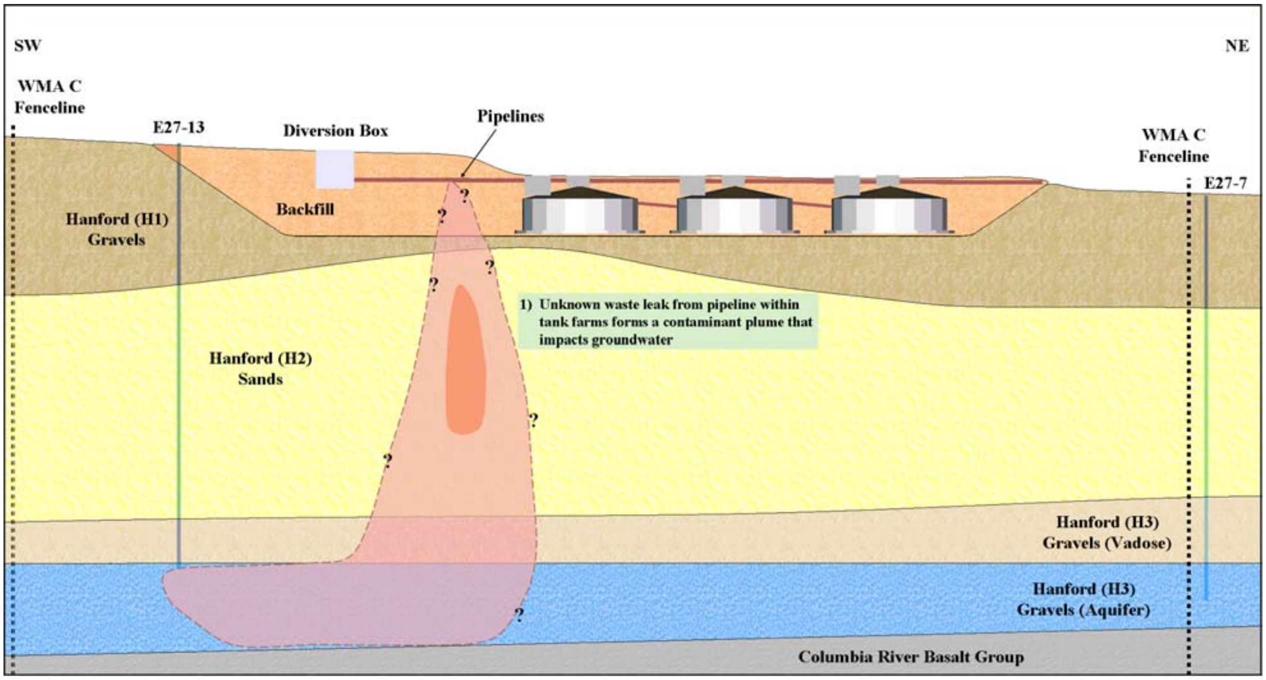
Each WMA contains miles of pipeline; it is plausible that one or more of these pipelines leaked without any knowledge of such a leak. These leaks, if they occurred, could lead to large volumes [i.e., >114,000 L (30,000 gal)] of waste discharged over a period of years resulting in localized volumes of soil with elevated levels of tank waste contaminants. Figure 2-5 shows this conceptualization.

2.2.2 Contaminant Mobility

At the start of the Phase 1 program in the late 1990s, ^{137}Cs was found far from its source (SX-108). This raised concerns that ^{137}Cs would soon reach groundwater.

Laboratory analyses of many sediment samples confirmed that in some tank releases with high sodium concentrations, the sodium locks onto the sediment sites that normally bind the cesium. Some cesium binds, but almost all of it continues to move deeper in the soil (tens of feet below the release point); the amount of sodium is reduced and cesium starts to compete for the sediment sites. Eventually, the sodium the amount of available is low enough and cesium stops moving.

Figure 2-5. Unknown Leak Event Conceptual Model



If it can be demonstrated that SGE can discriminate subsurface anomalies in the tank farm environment, it may be possible to target specific areas that may be representative of this model. A final determination of the application of SGE to help locate unknown leaks will be made following the confirmation testing around UPR-81, -82, and -86.

2.2.2.1 Importance of Past Releases

At the start of the Phase 1 program, it was believed that the most important risks to the environment were the residual wastes to be left in the tanks after waste retrieval. However, the SST PA has shown (see Figure 2-6) that past releases will have far more impact (by many orders of magnitude) than the residual waste.

Another important contaminant is uranium. Much information was gained during the Phase 1 program on uranium mobility and on what environmental parameters (e.g., pH, carbonate/bicarbonate concentrations) are important (PNNL-17031, *A Site-Wide Perspective on Uranium Geochemistry at the Hanford Site*).

Figure 2-6. Estimated Groundwater Impacts from Past Releases and Residual Tank Waste

Performance Objective	Maximum Contaminant Level a				Exposure Scenarios b		
	Beta-Photon 4 mrem/yr	Tc-99 900 pCi/L	I-129 1 pCi/L	Cr 0.10 mg/L	All-Pathways Farmer 15 mrem	Radiological ILCR Industrial 1.0E-4 to 1.0E-6	WAC 173-340 Hazard Index Method B 1.0
WMA	**Tank Residuals**						
S-SX	◇ blue	◇ blue	◇ blue	◇ teal	◇ blue	◇ blue	◇ teal
T	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue
TX-TY	◇ teal	◇ teal	◇ blue	◇ blue	◇ blue	◇ teal	◇ blue
U	◇ teal	◇ teal	◇ blue	◇ blue	◇ blue	◇ teal	◇ teal
C	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue
B-BX-BY	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue
A-AX	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ teal
WMA	**Past Releases**						
S-SX	● red	● red	◇ teal	● red	◇ teal	● yellow	● yellow
T	● red	● red	◇ teal	● red	◇ teal	● yellow	◇ teal
TX-TY	● red	● red	◇ teal	● yellow	◇ blue	◇ teal	◇ teal
U	● red	● red	◇ blue	● yellow	◇ blue	◇ teal	◇ teal
C[c]	● red	● red	◇ blue	● yellow	◇ blue	● yellow (4.3E-06)	◇ teal
B-BX-BY	● red	● red	◇ blue	● yellow	◇ blue	◇ teal	◇ teal
A-AX	● red	● red	◇ blue	● yellow	◇ blue	◇ teal	◇ teal

Below Performance Objective:
- ◇ blue Greater than a factor of 10
- ◇ green Less than a factor of 10

Above Performance Objective:
- ● red Greater than a factor of 10
- ● yellow Less than a factor of 10

[a] Evaluated from year 2000 to 12032.
[b] Evaluated from year 2332 to 12032.
[c] Results for WMA C were updated in RPP-35484 Rev. 1 as a result of finding ^{99}Tc at 80 bgs during the characterization activities at UPR-200-E-82

ILCR = incremental lifetime cancer risk

2.2.3 Lateral Movement of Contaminants

Gravity may move moisture and contaminants downward, but hydraulic forces can cause lateral movement. Such forces become larger when the sediments are dry (typical of the semiarid environment of Hanford) and when the sediments are layered (typical of the relatively young flood deposits in the Hanford formation). Thus, Phase 1 characterization has shown vadose zone plumes extending laterally more than 50 ft from the point of entry (e.g., leaks from SX-108 and BX-102). However, sometimes available characterization data reveal (e.g., from SX-107 and SX-115) little lateral plume movement. Lateral movement can alter contaminant migration rates and ultimately aquifer concentrations.

2.2.4 Contribution of Waste Releases from Nearby Facilities

Inadvertent tank releases may have collectively resulted in the discharge of about 3.8 million L (1 million gal) of waste. However, nearby many of the tank farms are cribs and trenches where hundreds of millions of liters of waste were intentionally discharged. Much of this intentionally discharged waste came from tanks. Surface geophysical exploration indicates vadose zone plumes from the bottoms of cribs next to B, BX, BY, and T Farms extend down to groundwater. Moisture measurements throughout WMA U show high moisture levels that may have been supplied by unlined ditches to the east and west of the farm that carried billions of liters of water and waste to nearby ponds. A similar situation may exist in the WMA B-BX-BY area where a perched water layer exists near groundwater and numerous nearby cribs and trenches received large amounts of waste water historically.

2.3 INTERIM MEASURES PERFORMED DURING PHASE 1

Interim measures completed during Phase 1 are shown in Table 2-2. For more information, see Chapter 11 and Appendix K of DOE/ORP-2008-01. Such measures consisted of the following:

- Installing leak-tight caps in existing boreholes.
- Testing all water lines going into the SST farms and capping those that were not needed or were leaking.
- Installing berms and gutters to divert water (particularly from storms and snow melt) away from the farms.
- Installing an interim surface barrier (T Farm) to reduce moisture from precipitation entering the surface.

2.4 INITIAL SINGLE-SHELL TANK PERFORMANCE ASSESSMENT

In Appendix I of the HFFACO, the SST PA was identified to evaluate whether SST system closure conditions are protective of human health and the environment for all contaminants of concern (COC), both radiological and nonradiological. The SST PA was intended to provide a single source of information that DOE could use to satisfy potentially duplicative functional and/or documentation requirements. As such, the methodology presented in the SST PA would be used to develop WMA-specific PAs. WMA-specific PAs would be prepared to evaluate the risk reduction associated with the waste retrieval, closure or cleanup of different components of the tank waste system.

Table 2-2. Phase I Interim Measures (Milestone M-45-56)

Year Completed	Action Completed
1999	Installed 786 new leak-tight well caps in WMAs A-AX, B-BX-BY, C, S-SX, T, TX-TY, and U
2000	Decommissioned four noncompliant RCRA monitoring wells near SST farms
2001	In WMA S-SX and U leak tested five waterlines; cut and capped two waterlines
2001	IN WMAs S-SX, T, TX-TY designed and constructed upgradient surface water run-on controls: soil berms, concrete gutters, gravel roads, asphalt paving, riprap, and a concrete cover over a waste transfer line
2002	In WMAs A-AX, B-BX-BY, C, and TX-TY excavated for leak testing, cut and capped three waterlines and designed and constructed upgradient surface water run-on controls: gutters, asphalt paving, drains, culverts, soil berms and riprap
2003	Quarterly groundwater monitoring in SX-Farm
2004	Decommissioned two failed wells and constructed two replacement wells in WMA A-AX
2006	Cut and capped water line in WMA B
2008	Constructed a polyurea interim surface barrier over the T-106 tank leak; installed four soil moisture monitoring probes

DOE/ORP-2005-01 provided information to support a range of tank waste closure decision-making. It provided a methodology for documenting the risk reduction associated with tank waste retrievals, helped identify data gaps to be addressed in Phase 1 and Phase 2 characterization activities, and supported evaluation of interim measures such as infiltration barriers for reducing the migration of vadose zone contaminants. DOE/ORP-2005-01 also was used to provide justification that the extent of retrieval of waste from an SST is sufficiently protective of human health and the environment when retrieval goals cannot be achieved through the Appendix H process in the HFFACO. C-106 is currently under evaluation for exemption from the retrieval goal (DOE/ORP-2008-01).

Section 3.4 describes the role of the initial SST PA in the Phase 2 RCRA corrective action program.

2.5 DATA NEEDS

When the Phase 1 program started in the late 1990s, 22 high-priority needs were identified (HNF-2603, *A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination*). Phase 1 has fully or partially satisfied 14 of the high-priority needs. Based on the experience of Phase 1, additional data needs were identified (RPP-33441, *An Evaluation of Hanford Site Tank Farm Subsurface Contamination, FY 2007*), and those associated with soil corrective action data needs are shown in Table 2-3.

Table 2-3. Current High Priority Corrective Action Data Needs

Data Need	Path Forward
Waste retrieval leak inventories	Potential waste retrieval leak inventories are calculated using the Hanford Tank Waste System Operations Simulator and the associated leak volume.
Current distribution of past tank waste discharges	Data from spectral gamma logging and characterization boreholes. Analyses in Field Investigation Reports (RPP-7884, RPP-10098, RPP-23752, RPP-35484, RPP-35485) show less sensitivity to this issue than previously thought. Surface geophysical exploration is being applied to locate contamination and develop three-dimensional plume distributions and guide location of additional boreholes or direct pushes
Near-surface soil concentrations-inventories	Characterization efforts will be identified through RCRA Corrective Measures Study process. Hydraulic hammer direct-push technology makes characterization more efficient and cost effective. Impacts from direct exposure may need to be considered
Past leak volumes	Work with Ecology to refine past leak volumes.
Recharge through gravel surfaces	Measure recharge under tank farm gravel surfaces (e.g., ^{36}Cl and chloride data).
Timing of initial barrier placement	Timing of initial barrier placement is not defined. Path forward is to perform sensitivity studies on the impact of barrier placement timing.
Recharge effects from tank farm infrastructure (past events)	Impacts from past operations were evaluated. Corrective interim measures are deployed where appropriate. This need will be revisited as additional information becomes available.
Vapor flow under low recharge	Review past work at other sites (Beatty, Nevada; Ward Valley, California; Australia) as analogs to evaluate importance of potential vapor flow under low infiltration.
Hydraulic properties at low saturation	Review past Hanford work on soil hydraulic properties (e.g., ultracentrifuge measurements) and at other sites to extend existing database on relatively wet and intermediate water contents.
Waste chemistry effects on uranium(VI) mobility in the vadose zone	Continue leaching studies for sediments at BX-102, TX-104, and other tank farms (e.g., U) to determine the processes controlling uranium geochemistry at each location with the overall goal to determine a “unifying” conceptual model for uranium (VI). Tank residuals in C Farm are highly enriched in uranium and vadose zone impacts after leaching will need to be addressed.
Contaminant contribution to vadose zone/ groundwater from nearby non-tank-farms sources	The two DOE Field Offices, RL and ORP, are having the Hanford Site contractors integrate efforts on source and groundwater contamination. Path forward is to include stable and radioactive isotope signatures.
Variation in groundwater contaminant concentrations	Measurements show vertical and short-term temporal changes. Current models do not account for these variations. Determine the importance of variations.

This information will help target specific data needs that must be addressed as part of the WMA-specific DQO process and subsequent WMA RFI/CMS work plans and RFI/CMS.

WMA-specific data needs were also identified in the Field Investigation Reports (RPP-7884, RPP-10098, RPP-23752, RPP-35484, and RPP-35485). Table 2-4 summarizes some of the WMA-specific data needs. This information will also be used in the WMA-specific DQOs to target characterization necessary to complete the RFI/CMS.

Table 2-4. Characterization Data Gaps by WMA

WMA	Characterization Data Gaps[a,b]
A-AX	Inventory loss in A-105 event SGE with deep electrodes Borehole/direct push at the north side of A-105.
B-BX-BY	Extensive characterization being performed for BP-5 groundwater operable unit. Await results to define additional characterizations. [Field Investigation Report suggested borehole near BX-101]
C	Determine bottom of UPR-200E-82 Tc plume Complete near-term Phase 2 characterization activities SGE with deep electrodes
S-SX	Determine accuracy of S-104 SGE results Determine western extent of SX-108/9 plumes (for interim barrier) Perform SGE for entire WMA Possible additional characterization near SX-107 and 115.
T	Continue Monitoring of T Interim Barrier performance Work with Central Plateau contractor of characterization of cribs/trenches/releases outside of farm SGE using deep electrodes
TX-TY	To be determined after SGE results
U	SGE using deep electrodes Find bottom of U-104 plume Find bottom of smaller plumes from U-101, U-110, and U-112. Determine with Central Plateau contractor of the extent of high moisture content in region

[a] As identified by Phase 1 RCAP activities. Phase 1 focused on contamination deeper than ~10 ft.
[b] Most identified data gaps are important for multiple WMAs and are not listed here. See Table 2-3.

3. SINGLE-SHELL TANK WASTE MANAGEMENT AREA PHASE 2 RCRA CORRECTIVE ACTION FRAMEWORK

This chapter provides the regulatory framework for the SST WMA Phase 2 corrective action program.

3.1 RCRA CORRECTIVE ACTION REQUIREMENTS

A discussion of federal and state corrective action requirements including the HFFACO is provided in this section. For the purposes of this work plan, federal and state requirements associated with corrective actions are identified as "RCRA corrective action" requirements.

3.1.1 Federal Regulatory Background

In the 1984 Hazardous and Solid Waste Amendments to RCRA, Congress directed the EPA to require corrective action for all releases of hazardous waste and hazardous constituents from solid waste management units at facilities seeking RCRA permits. Solid waste management units include any unit in which solid wastes have been managed at any time. Facilities seeking RCRA permits include facilities at which hazardous wastes are treated, stored, or disposed. In 1990, EPA proposed detailed corrective action regulations forming what is commonly referred to as "Subpart S." In 1996, EPA proposed an advanced notice of proposed rulemaking (61 FR 19432, "Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities; Proposed Rule"). This rulemaking was subsequently abandoned due to corrective action programs that were already in progress in authorized states. However, EPA has used the corrective action regulations of Subpart S as guidance for implementing the RCRA corrective action program.

3.1.2 HWMA and Model Toxics Control Act Requirements

The EPA authorized Ecology to implement the corrective action program in 1994 (59 FR 55322, "Washington: Final Authorization of State Hazardous Waste Management Program Revisions"). Ecology implements the corrective action programs via the Washington HWMA, WAC 173-303, "Dangerous Waste Regulations," and unit specific permits. For releases of dangerous waste and dangerous waste constituents from solid waste management units, which would include the SST WMAs, WAC 173-303-646 requires that corrective actions be instituted as necessary to protect human health and the environment for all releases of dangerous wastes and dangerous constituents, including releases from all solid waste management units at the facility.

WAC 173-303-64620(4) specifies that corrective actions must be consistent with the specified requirements of WAC 173-340, the implementing regulations of the Washington MTCA.

Consistency is defined as that "necessary to select a cleanup action consistent with WAC 173-340-360, 173-340-350, state remedial investigation and feasibility study. Information that is adequate to support selection of a cleanup action consistent with WAC 173-340-360 but was developed under a different authority (e.g., as part of closure under WAC 173-303-610 or as part of a federally overseen cleanup) may be used."

3.1.3 HFFACO Corrective Action Requirements

3.1.3.1 General Requirements

Solid waste management units on the Hanford Site have been classified in the HFFACO as either TSD units subject to regulation under Ecology's dangerous waste regulations (WAC 173-303) or past practice units subject to either CERCLA or RCRA corrective action.

EPA, Ecology, and DOE emphasized in the HFFACO that the past practice RCRA corrective action program and the CERCLA remedial action program are considered "functionally equivalent." Article IV 17 of the HFFACO states:

> …the Parties intend that activities covered by Part Three [*Remedial and Corrective Actions*] of this Agreement will achieve compliance with CERCLA, 42 U.S.C. Section 9601 et seq.; will satisfy the corrective action requirements of the HWMA, Sections 3004(u) and (v) of RCRA, 42 U.S.C. Section 6924(u) and (v), for a RCRA permit, and Section 3008(h), 42 U.S.C. Section 6928(h); and will meet or exceed all applicable or relevant and appropriate federal and state requirements to the extent required by Section 121 of CERCLA, 42 U.S.C. Section 9621.
>
> The HFFACO also emphasizes that corrective actions will ensure a protective remedy is achieved for both radioactive and chemical contaminants with the caveat that "nothing in this Agreement shall be construed to require DOE to take any action pursuant to RCRA which is inconsistent with the requirements of the *Atomic Energy Act of 1954* (AEA), as amended.

3.1.3.2 HFFACO Action Plan Appendix D

HFFACO Appendix D contains the work schedule for SST corrective action in the Milestone M-045-00 series. The most recent revisions to the corrective action milestones in this series were made through HFFACO Change Control Form M-45-06-03. In this revision, Ecology and DOE agreed that a Phase 2 program would be required to characterize and select final corrective measures for SST WMA and provided specific work elements for completion of this process at WMA C.

The following Phase 2 (and Phase 1 DOE/ORP-2008-1) milestones were revised or included pursuant to the HFFACO Change Control Form M-45-06-03:

M-45-55 Due 1-31-08 (completed)

SUBMIT TO ECOLOGY FOR REVIEW AND APPROVAL AS AN AGREEMENT PRIMARY DOCUMENT A PHASE 1 RFI REPORT INTEGRATING RESULTS OF DATA GATHERING ACTIVITIES AND EVALUATIONS FOR ALL SST WMAS, INCLUDING A SUMMARY OF IMPACTS FROM THE INITIAL SST PERFORMANCE ASSESSMENT, WITH CONCLUSIONS AND RECOMMENDATIONS. RESULTS FROM THE WMAS A-AX, C, AND U WILL BE INCLUDED AS APPENDICES TO THE RFI ROLLUP REPORT ADDRESSING THE SST WMAS UNDER RCRA CORRECTIVE ACTION, SO THAT A SINGLE DOCUMENT CONTAINS AVAILABLE INFORMATION FOR THE 200 AREA SST WMAS AND WILL SUPPORT SST RETRIEVAL AND CLOSURE.

M-45-58 Due 12-31-08

SUBMIT TO ECOLOGY FOR REVIEW AND APPROVAL AS AN AGREEMENT PRIMARY DOCUMENT A PHASE 2 MASTER WORKPLAN THAT DESCRIBES THE PROPOSED APPROACH FOR THE COMPLETION OF CORRECTIVE ACTION TO MEET FINAL CLOSURE REQUIREMENTS IN THE WASTE MANAGEMENT AREAS AS DESCRIBED IN APPENDIX I, SECTION 2.3

M-45-60 Due 12-31-08

SUBMIT TO ECOLOGY FOR REVIEW AND APPROVAL AS AN AGREEMENT PRIMARY DOCUMENT, DOE’S PHASE 2 RFI/CMS WORK PLAN AND SAMPLING AND ANALYSIS PLAN (SAP) FOR WMA C.

M-45-61 Due 12-31-10

SUBMIT TO ECOLOGY FOR REVIEW AND APPROVAL AS AN AGREEMENT PRIMARY DOCUMENT A PHASE 2 RCRA FACILITY INVESTIGATION / CORRECTIVE MEASURES STUDY REPORT FOR WMA C.

M-45-62 Due 12-31-12

SUBMIT TO ECOLOGY FOR REVIEW AND APPROVAL AS AN AGREEMENT PRIMARY DOCUMENT A PHASE 2 CORRECTIVE MEASURES IMPLEMENTATION WORK PLAN FOR WMA C.

3.1.3.3 HFFACO Action Plan Appendix I

The HFFACO Action Plan Appendix I contains the “Single-Shell Tank System Waste Retrieval And Closure Process.” Section 2.3 of Appendix I contains specific provisions for the SST WMA corrective action process. The general corrective action process is shown graphically in context to the SST waste retrieval and closure process in HFFACO Action Plan Figure I-1. HFFACO Change Control Form M-45-06-03 has added to or revised the process depicted in Figure I-1 through the requirements of the Phase 2-specific milestones such as development of the Phase 2 master work plan and development of WMA-C specific documentation including a combined RFI/CMS document and a corrective measures implementation work plan. In addition, the role of the SST System PA relative to WMA-specific PAs in the corrective action process has been evolving from that depicted in Appendix I-1 through ongoing DOE and Ecology workshops (see Section 3.4).

3.2 ELEMENTS OF THE PHASE 2 SINGLE-SHELL TANK WASTE MANAGEMENT AREA CORRECTIVE ACTION PROCESS

This section describes the key documents, approval process, public involvement, and implementation steps for the Phase 2 corrective action process. Figure 3-1 illustrates the process. HFFACO primary documents are identified in this figure. As primary documents, their review and comment follows Figure 9-1 of the HFFACO Action and allows for using a dispute resolution process if agency comments cannot be resolved. The HFFACO also specifies that the CMS is the basis for SST Permit revision by Ecology. “Approval” for the CMS occurs through permit modification in the same manner closure plans are approved. The Phase 1 report, DOE/ORP-2008-01, is added to this process discussion for completeness as it forms the basis for development of data needs for the subsequent Phase 2 steps.

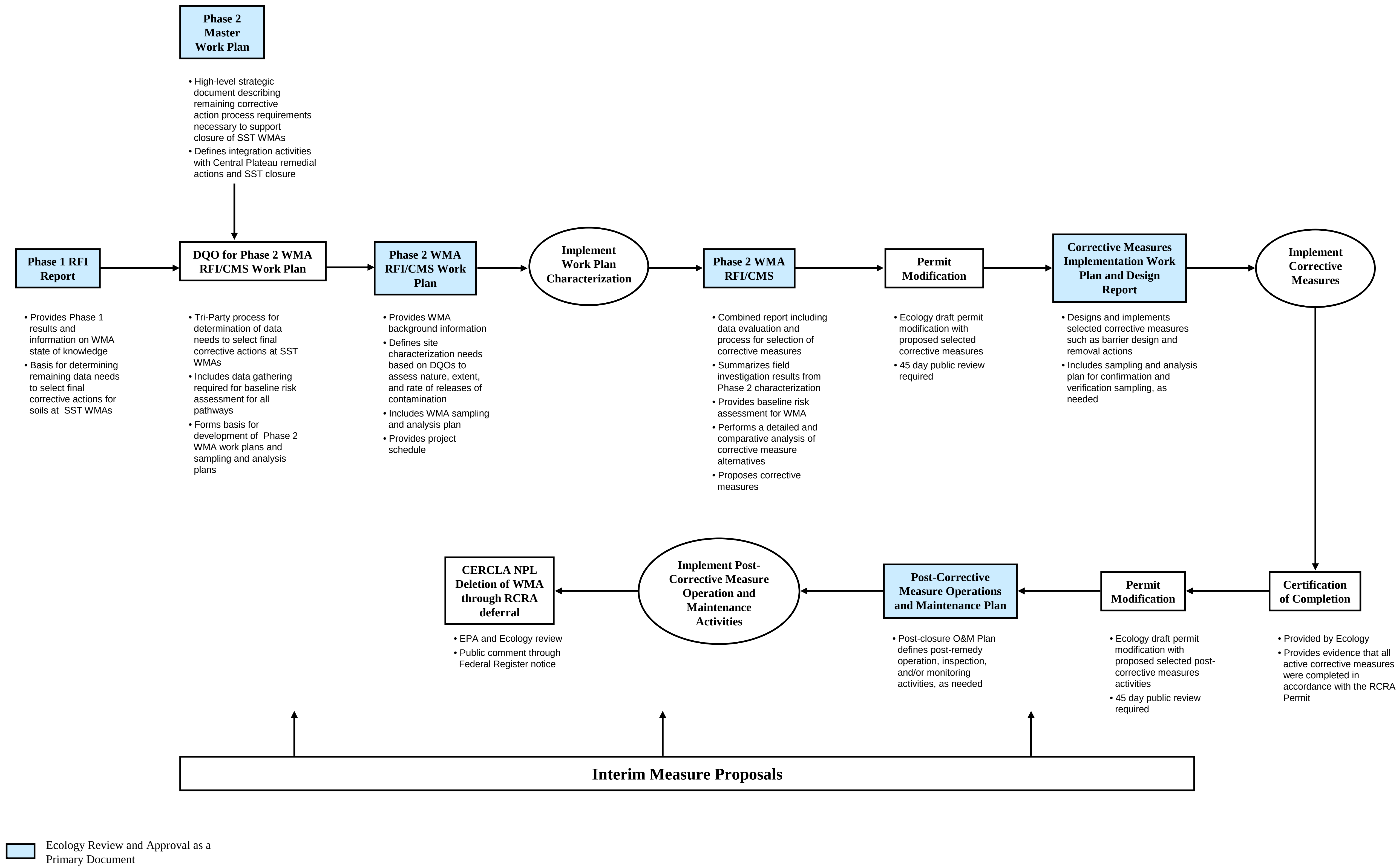
3.2.1 Phase 1 RFI Report

Pursuant to Milestone M-45-55, the Phase 1 report, DOE/ORP-2008-01, summarizes the state of knowledge for Phase 1 characterization and research activities at all WMAs. This report provides the state of knowledge on characterization and research gained during the 10 years of the Phase 1 program. DOE/ORP-2008-01 contents include SST WMA background information, field activities performed, and descriptions of the results, including summaries from the field investigation reports and the initial SST PA (DOE/ORP-2005-01) (see Section 3.4). This document is a primary document and will be reviewed and approved by Ecology.

DOE/ORP-2008-01 contains the following information:

- Integration of results of data gathering activities and evaluations for all Hanford Site SST WMAs with conclusions and recommendations.
- Field Investigation Reports and summary results from WMAs A-AX, C, and U field investigations.
- All available information for the SST WMAs that support SST waste retrieval and closure.
- Data and information obtained in the WMAs after the publication of the Field Investigation Report for each respective WMA except WMAs A-AX, C, and U (Chapter 6 of DOE/ORP-2008-01).
- A summary of knowledge needed for risk assessments dealing with the SSTs.

Figure 3-1.
Phase 2 SST WMA Corrective Action Process



A series of public information meetings were held to familiarize Ecology with the report and increase the understanding of the results.

3.2.2 Interim Measures Proposals

The purpose of an interim measure is to control or abate imminent threats to human health and/or the environment from releases and/or to prevent or minimize the further spread of contamination while long-term remedies are pursued. Interim measures can be performed at any point during the corrective action process.

During the Phase 2 program it is expected that new information may prompt the need for further interim measures at the SST WMA. Phase 2 interim measures may include further interim barrier placement or other measures required to mitigate future impacts to human health and the environment through expedited actions. The HFFACO Action Plan Section 7.2.4 defines requirements for the conduct of interim measures, including the requirement for submittal to Ecology of a proposal for the interim measure as a primary document and public comment requirements. For Phase 2 corrective actions this is interpreted to include associated characterization for interim measures, as needed. The HFFACO Appendix D includes a milestone (M-45-56) requiring that Ecology and DOE meet yearly to assess the adequacy of information and the need for the establishment of interim milestones and target dates for additional interim measures.

3.2.3 Phase 2 RFI/CMS Master Work Plan

This document provides a high-level regulatory and strategic framework for Phase 2 RFI/CMS activities that will be required to complete corrective actions for contaminated soil and support closure of all seven SST WMAs. An important function of the Phase 2 program is to ensure integration of WMA corrective actions with both RCRA closure activities for WMA tanks and ancillary equipment and the balance of cleanup activities on the Central Plateau.

3.2.4 Phase 2 WMA Data Quality Objectives Report

The DQO process is undertaken to ensure appropriate data are collected to support Phase 2 corrective actions and will cover all sampling and analytical activities for that purpose. The Phase 2 DQO process will be implemented in accordance with EPA QA/G-4, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, with some modifications to accommodate project or WMA-specific requirements and constraints.

The initial step for each WMA in the Phase 2 process is to define the WMA DQO requirements that further characterization efforts must meet to make WMA corrective action remedy decisions. The Phase 2 data, along with the Phase 1 data, will be used in developing a baseline risk assessment and completing the understanding of nature and extent of contamination, both of which will be used in the evaluation of alternatives and proposed selection of a remedy in the corrective measures study. The DQO process will include team members from both Tank Farm and Central Plateau contractors, ORP, DOE Richland Operations Office (RL), Ecology, and EPA. In addition, input from the tribes, the State of Oregon, and other interested public will be sought. A report will be generated at the conclusion of the DQO process for each WMA to document the data quality requirements for the Phase 2 characterization and alternatives analysis for each WMA-specific Phase 2 RFI/CMS Work Plan.

The DQO process is intended to be iterative. Therefore, changes to the Phase 2 WMA DQO Reports will be made as required during the time the DQO is in effect. The DQO will be updated when requirements change (e.g., addition or deletion of constituents to be analyzed), changes in available equipment, etc. Changes to the DQO document can be initiated by involved or affected groups [i.e., Ecology, ORP, and CH2M HILL Hanford Group, Inc. (CH2M HILL) organizations]. In addition, these groups will be informed of all changes that occur prior to the action taking effect.

3.2.5 WMA RFI/CMS Work Plans and Sampling and Analysis Plans

The DQO report for each WMA will form the basis for the RFI/CMS work plan and its appended sampling and analysis plan. The requirements for the RFI/CMS work plan, functionally equivalent to the CERCLA Remedial Investigation/Feasibility Study (RI/FS) work plan will include the requirements of HFFACO Action Plan 7.3.2. The RFI/CMS work plan assembles available site data that assist in developing a conceptual understanding of the site or operable unit through an initial conceptual model or alternatives, identifies additional data needs, and identifies potential corrective measure technologies. In addition to the sampling and analysis plan, the work plan will include a health and safety plan, quality assurance project plan, information management overview, waste management information, and proposed work schedule. The RFI/CMS work plan requires approval from the lead regulatory agency; there is no regulatory or HFFACO requirement for a public review.

Oftentimes, work plans and SAPs will include a list of preliminary cleanup levels for all contaminants of potential concern. This list is developed to set appropriate detection levels and begin the process of setting final standards. However, for the Phase 2 WMA C work plan, preliminary cleanup levels will not be developed until the CMS phase. This is due to continuing discussions among EPA, Ecology, and DOE on significant issues that will require resolution prior to setting standards. The issues include land use, points of compliance, exposure scenarios, and use of fate and transport modeling. For WMA corrective actions, these standards must be established to develop an assessment of risk associated with soil contamination and subsequent selection of corrective measures to mitigate this risk. In the absence of these preliminary cleanup levels, detection levels are set at unrestricted cleanup levels in the WMA C work plan and SAP to ensure that the data collected will be viable regardless of the outcome of these issues. It is anticipated that WMA-level work plans and SAPs that are developed post-WMA C will include a listing of preliminary cleanup levels as these issues will be resolved by then.

As specified in the HFFACO Action Plan Section 7.3.2, site screening and survey activities may precede submittal of the work plan. These include survey of site location, surface radiation surveys, surface geophysical surveys, air sampling, soil gas, and biotic surveys. For Phase 2 activities, “geophysical surveys” are interpreted to include resistivity measurements (i.e., SGE) and drywell or lateral logging. These activities would not include direct push, borehole drilling, or sampling and analysis.

3.2.6 WMA RFI/CMS

Under RCRA corrective action, the evaluation of corrective measure alternatives is performed in a CMS. Often, as is expected for the SST WMA corrective action process, the evaluation of data (the RFI) is included as part of the CMS, including the refined conceptual model. Typical contents of a CMS include the following:

- Site-specific characterization information.
- Applicable or relevant and appropriate requirements
- Corrective action objectives and preliminary cleanup levels.
- Risk assessment results.
- Detailed cost estimates.
- Descriptions of corrective measures under consideration.
- Detailed and comparative analysis of alternatives.
- Justification for a recommended alternative.

Unlike a TSD closure, consideration of two or more alternatives is generally part of the CMS. The CMS report becomes the basis for revision of the RCRA permit through the modification process in which the recommended corrective action is documented.

Section 7 of the HFFACO Action Plan requires that the information obtained through the RFI/CMS must be functionally equivalent to the information obtained in the CERCLA RI/FS process. As such, the following nine criteria used to evaluate alternatives in the detailed and comparative analysis of alternatives for the RFI/CMS will be similar to that of the criteria used for an RI/FS:

- Overall protection of human health and the environment.
- Compliance with the applicable or relevant and appropriate requirements (ARAR).
- Long-term effectiveness and permanence.
- Reduction of toxicity, mobility, or volume through treatment.
- Short-term effectiveness.
- Implementability.
- Cost.
- State acceptance.
- Community acceptance.

These criteria are divided into three categories: threshold, balancing, and modifying criteria. The first two criteria (threshold criteria) determine which alternatives are eligible for consideration. The next five criteria (balancing criteria) help describe relative technical and cost differences. The last two criteria (modifying criteria) may prompt remediation plan changes based on state and community comments and concerns. In addition, an analysis of any RCRA or MTCA evaluation criteria not covered by the above will be included in accordance with WAC 173-303-64620(4).

The MTCA evaluation criteria are contained in WAC 173-340-360. These criteria are consistent with CERCLA and RCRA corrective action evaluation criteria; however they are arranged in a slightly different manner. The criteria include threshold requirements which must be met for an alternative to be selected as a final remedy and “other requirements” and “action specific requirements” that modify the threshold requirements:

- Threshold requirements
  - Protect human health and the environment
  - Comply with cleanup standards
  - Comply with applicable state and federal laws
  - Provide compliance monitoring
- Other requirements
  - Use permanent solutions to the maximum extent practicable
  - Provide a reasonable restoration time frame
  - Consider public concerns
- Action specific requirements
  - Non-permanent groundwater cleanup actions
  - Institutional controls
  - Releases and migration/dilution and dispersion
  - Remediation levels

To ensure that MTCA alternatives are met for SST WMA corrective actions, a separate or combined evaluation of MTCA criteria will be used in the RFI/CMS.

Activities conducted as part of RCRA corrective action must comply with any other applicable laws and regulations (see Section 3.3). The RFI/CMS will include a discussion of these ARARs. The CMS report is made available for public review and comment as part of the draft permit modification package.

3.2.7 Site-Wide Permit Modification for WMA Corrective Actions

The public comment process and Ecology approval process are the same for a permit modification for RCRA corrective action as for a permit modification to add TSD-specific permit conditions. Ecology will write draft permit conditions that specify the selected corrective actions and a schedule for implementation. Ecology will seek public comment, respond to any comments, and make a final RCRA permit modification.

3.2.8 WMA Corrective Measures Implementation Work Plan

RCRA corrective action is implemented in accordance with the requirements and schedule specified in the permit modification. As stated in Section 7 of the HFFACO Action Plan, at Hanford the content of the Corrective Measures Implementation (CMI) work plan will be functionally equivalent to the CERCLA remedial action work plan. Typical contents of the CMI work plan include corrective measures project management, site preparation activities, waste management, air emission control activities, worker safety activities, corrective measures criteria and design, and project schedules. The WMA CMI work plan requires approval from the lead regulatory agency; there is no regulatory or HFFACO requirement for a public review.

3.2.9 Certification of Completion

State regulations do not specifically define a closeout process for corrective action units. The HFFACO states that on satisfactory completion of the CMI phase, the lead regulatory agency will issue a certificate of completion of the corrective action.

3.2.10 Post-Implementation Documentation Requirements

State regulations do not specifically define a post-implementation process for corrective action units. However, as part of a RCRA permitted unit, it is expected that corrective measures operations and maintenance activities would be incorporated in the Site-Wide Permit as part of the SST system post-closure permit requirements contained in accordance with WAC 173-303-800 through -840 and the Site-Wide Permit.

3.2.11 CERCLA National Priorities List Deletion through RCRA Deferral

The SST WMAs will be deleted by EPA and Ecology from the 200 Area National Priorities List (NPL) through their determination that actions implemented as part of RCRA closure and corrective action are consistent with CERCLA requirements for NPL site closeout. EPA's 60 FR 14641, "The National Priorities List for Uncontrolled Hazardous Waste Sites; Deletion Policy for Resource Conservation and Recovery Act Facilities," later amended to make the policy applicable to Federal Facility sites (62 FR 62523, "The National Priorities List for Uncontrolled Hazardous Waste Sites; Listing and Deletion Policy for Federal Facilities") states that

> EPA believes it is appropriate to delete sites from the NPL based upon deferral to RCRA under certain circumstances. Deletion of sites from the NPL to defer them to RCRA Subtitle C corrective action authorities would free CERCLA's oversight resources for use in situations where another authority is not available, as well as avoid possible duplication of effort and the need for an owner /operator to follow more than one set of regulatory procedures.

EPA will be required to publish a Federal Register notice of its deletion proposal through RCRA deferral and provide for public comment on the deletion.

3.2.12 Other Studies and Assessments

Other studies and assessments that are not specific elements of the regulatory process for corrective actions will be conducted in support of DQOs, risk assessments, RFI/CMS, and interim measure proposals. These include studies to provide a technical basis for interpreting data, inputs to models (e.g., recharge rate, K_d parameters, analyte inventories), engineering studies to screen alternatives, treatability studies, and interim measure designs.

One example of an assessment that is being performed to support Phase 2 corrective actions is the development of a technical basis for inventory estimates and uncertainties for past releases and vadose zone contamination in WMAs, which will be developed jointly with Ecology through a tank farm leak assessment process (RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*). Inventory estimates will be calculated using the Soil Inventory Model or other site standard. These inventories will be used in risk assessments and in the RFI/CMS.

3.2.13 Accounting for Change during the Phase 2 RCRA Corrective Action Process

The RCRA corrective action process is intended to be flexible to account for the dynamic and iterative nature of site characterization and remedy evaluation, selection, and implementation. The elements of the corrective action process are often done in phases (as reflected in HFFACO Action Plan Section 7) to build from the findings of earlier information, account for new information, and redirect actions as necessary. In the 1996 EPA advanced notice of proposed rulemaking (61 FR 19432), EPA stated:

> …a successful corrective action program must be procedurally flexible. In addition, these cleanup elements [Site investigation, site characterization, interim actions, remedy evaluation, and selected remedy implementation] should not become ends in themselves; EPA continues to encourage program implementers and facility owners/operators to focus on the desired result of a cleanup rather than a mechanistic cleanup process. These 5 elements should be viewed as evaluations necessary to make good cleanup decisions, not prescribed steps along a path.

At any point in the corrective action process, including post-remedy implementation, new release information (e.g., groundwater monitoring results), new regulatory requirements, policy changes, or changes in the ability to physically perform the work at a WMA could require revision of existing documents or decisions. Below are examples of changes that may occur during the Phase 2 corrective action process:

- As stated in Section 3.2.4, the DQO process is often an iterative process. The DQOs may require revision to facilitate a more efficient and accurate characterization of the site.
- WMA-level RFI/CMS work plans may require revision or development of additional work plans to fill data gaps identified during planned field characterization or to better focus subsequent sampling efforts. It is possible that the sampling identified in the RFI/CMS work plans will encounter unexpected results that will require reevaluation of

the type and quantity of data being collected. Also, newly identified treatability investigations may require work plan revisions.

- The WMA-level RFI/CMS may require revision to modify or augment information presented on corrective measure alternatives being evaluated should innovative technologies be identified during the evaluation phase.
- The selected remedy may require modification in the RCRA Site-Wide Permit should new information reveal that it is not protective of human health and the environment.

3.3 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section discusses key ARARs associated with WMA soil cleanup. In addition, specific discussions are included for the AEA and, although not specifically defined as an ARAR under CERCLA, *the National Environmental Policy Act of 1976* (NEPA) and its state counterpart, the *State Environmental Policy Act of 1971* (SEPA). These statutes are discussed in further detail due to their significant role in contributing to the framework of the SST WMA corrective action program.

3.3.1 Application of CERCLA ARARs to RCRA Corrective Actions

Section 7.5 of the HFFACO Action Plan states: "The parties intend that ARARs, as appropriate, will apply at units being managed under the [*RCRA Past Practice*] RPP program at the Hanford Site to ensure continuity between the RCRA and CERCLA authorities." In addition, HFFACO Appendix I states that Ecology will seek the involvement of EPA during SST closure activities to ensure that "work is not inconsistent with future CERCLA remedial decisions."

Appendix F of the Phase 1 master work plan (DOE/RL-99-36) provides tables of key ARARs and their rationale for inclusion as ARARs under CERCLA. These ARARs are pertinent to the Phase 2 corrective action program and include the following:

- Federal ARARs
  - *Safe Drinking Water Act of 1974*, 42 USC 300, et seq.
  - *Atomic Energy Act of 1954*, 42 USC 2011, et seq.
  - *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq.
  - *Toxic Substances Control Act of 1976*, 15 USC 2601 et seq.
  - *Endangered Species Act of 1973*, 16 USC 1531, et seq.
  - *Clean Air Act of 1977*, 42 USC 7401, et seq.
  - *Hazardous Materials Transportation Act*, 49 USC 1801, et seq.
- State ARARs
  - *Model Toxics Control Act of 1989*, chapter 70.105D Revised Code of Washington (RCW).

- *Hazardous Waste Management Act*, chapter 70.105 RCW.
- *Water Pollution Control/Water Resource Act of 1971*, chapter 90.48 RCW/Chapter 90.54 RCW.
- Department of Health Standards for Public Water Supplies, WAC 246-290.
- State Radiation Protection Requirements, Chapter 70.98 RCW.
- *Washington Clean Air Act*, chapter 70.94 RCW and chapter 43.21A RCW.

3.3.2 AEA Requirements

Historically, DOE implemented the AEA through a series of non-promulgated orders. DOE orders are not ARARs under CERCLA. DOE O 450.1A, *Environmental Protection* Program, acknowledges that some environmental management activities of DOE are extensively but not entirely regulated by EPA and state and local environmental agencies under their CERCLA or RCRA authorities. DOE O 435.1, *Radioactive Waste Management*, and the associated manual (DOE M 435.1-1) and guidance (DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1, Radioactive Waste Management Manual*) set requirements for radioactive waste management activities at DOE sites, including disposal.

Several regulations have been promulgated by the U.S. Nuclear Regulatory Commission (NRC) or the EPA that are also relevant to the closure process at Hanford. Two relevant regulations are Title 10, *Code of Federal Regulations*, Part 61, “Licensing Requirements for Land Disposal of Radioactive Waste” (10 CFR 61), cited in DOE M 435.1-1 Chapter IV and 40 CFR 191, “Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule,” cited in DOE M 435.1-1 Chapter III.

General requirements for radioactive waste management under DOE O 435.1 identified are the following:

- Protect the public from exposure to radiation in accordance with DOE O 450.1A.
- Protect the environment in accordance with DOE O 5400.1 and DOE O 5400.5
- Protect workers in accordance with radiation protection standards in 10 CFR 835, “Occupational Radiation Protection.”
- Comply with applicable Federal, state, and local laws, Executive Orders, and DOE directives.

These requirements must be met during implementation of Phase 2 corrective actions. Although the SSTs will not be closed as part of corrective actions, DOE M 435.1-1 also specifies requirements for closure of radioactive waste management units and contains specific closure requirements according to the classification of the disposed waste. These requirements are discussed in detail in Chapters II through Chapter IV of DOE M 435.1-1 and the associated guidance, DOE G 435.1-1. Disposal of wastes under Chapter III or Chapter IV requirements will also include a PA and a composite analysis that must be updated and maintained.

DOE M 435.1-1 also has requirements for characterization of wastes. Specifically, DOE M 435.1-1 states

> ...waste shall be characterized using direct or indirect methods, and the characterization documented in sufficient detail to ensure safe management and compliance with the waste acceptance requirements of the facility receiving the waste.

DOE M 435.1-1 also states “the data quality objectives process, or a comparable process, shall be used for identifying characterization parameters and acceptable uncertainty in characterization data.”

DOE G 435.1-1 requires corrective actions at radioactive waste management facilities whenever necessary to ensure that the requirements of DOE O 435.1 and DOE M 435.1-1 are met. Chapter IV of DOE Order 5400.5 specifies end-point criteria for the cleanup of residual radioactive material and the release of real property (including soil and groundwater) that may impose final cleanup standards for a waste site.

3.3.3 NEPA and SEPA Requirements

In addition to RCRA closure requirements, other regulatory programs would drive corrective action planning in the WMAs. RCRA corrective actions in contrast to CERCLA remedial actions, require separate determinations under NEPA and Ecology’s SEPA. Regulations implementing NEPA state that the NEPA process is intended to help public officials make decisions that are based on understanding environmental consequences of proposed actions, and take actions that protect, restore, and enhance the environment [40 CFR 1500.1(c)].

NEPA was created to integrate environmental awareness and environmental factors early in the planning process of all federal actions. Compliance with NEPA provisions calls for federal agency planning and analysis that fully considers and documents, on a timely basis, the environmental considerations and alternatives to the proposed action. NEPA requires federal agencies to consider environmental impacts when proposing federal actions that may significantly affect the quality of the human environment. An environmental review is conducted early in the planning and decision-making process to determine whether significant environmental impacts are anticipated. This review is used to determine if the proposed action can be modified or redesigned to lessen or eliminate environmental impacts and to determine if further investigation is required before proceeding with the action.

The Tank Closure and Waste Management (TC&WM) Environmental Impact Statement (EIS) is currently under development and will in part analyze SST system closure alternatives, including clean and landfill closure. After the final EIS is complete, DOE will issue a Record of Decision (ROD). The decisions from the TC&WM EIS ROD and SEPA determinations will outline a path for closure of the WMAs.

NEPA is a requirement for federal agencies. The SEPA is intended to ensure that environmental values are considered during decision-making by state and local agencies during the permitting process. It gives state and local agencies the tools to allow them to both consider and mitigate environmental impacts of proposed actions.

The SEPA rules state that no action that would foreclose options shall be taken until a SEPA analysis is completed. SEPA requires decision-making agencies, such as Ecology, to conduct an evaluation of proposals in accordance with WAC 197-11"SEPA Rules," to determine the potential significance of impacts to the environment and public health. In lieu of preparing a separate SEPA EIS, Washington State has the option to adopt a NEPA EIS if certain requirements in WAC 197-11-610(3) are met or if they cooperated with a federal agency that is preparing an EIS. As a cooperating agency, Ecology may participate in a range of activities associated with the preparation of an EIS, including co-authoring a document, providing input to development of alternatives, or similar actions. The decisions that result from both the final TC&WM EIS and subsequent ROD and Ecology's SEPA determinations will impact corrective action and closure at WMAs.

3.4 RISK AND PERFORMANCE ASSESSMENTS IN THE RCRA PHASE 2 CORRECTIVE ACTION PROCESS

Corrective actions for soil and closure activities for the SST system will be supported by various types of risk and PAs. Risk assessments are performed to support RCRA decisions associated with nonradionuclide contamination. A PA is performed for radionuclides as required under DOE O 435.1 to support decisions about closure activities at facilities with radioactive waste and waste determinations.

Through HFFACO Action Plan Appendix I, the regulatory agencies elected to develop and maintain as part of the SST system closure plan one performance/risk assessment that meets all the requirements for evaluating radionuclide and nonradionuclide contaminant releases and to call it a PA. This is described in HFFACO Appendix I, Section 2.5 (Ecology et al. 1989) and is given as follows:

> Ecology, as the lead agency for SST system closure, EPA, and DOE have elected to develop and maintain as part of the SST system closure plan one performance assessment for the purposes of evaluating whether SST system closure conditions are protective of human health for all contaminants of concern, both radiological and nonradiological. That SST PA would incorporate by reference relevant performance requirements defined by RCRA, HWMA, Clean Water Act, Safe Drinking Water Act, and the Atomic Energy Act of 1954 (AEA), and any other performance requirements that might be an applicable or relevant and appropriate requirement under CERCLA, and would represent a single source of information to satisfy potentially duplicative functional and/or documentation requirements. The SST PA was not identified as a primary document within Appendix I, and did not require regulatory agency approval. The WMA-specific PAs will be approved by Ecology and DOE pursuant to their respective authorities. Ecology approval means incorporation by reference, into the Site-Wide Permit through closure plans.

> As individual components are retrieved or characterized, or other component closure activities are completed, the resulting component characterization information will be incorporated into the WMA PA to determine its relative risk compared to the entire WMA performance. In doing this, the Parties will be able to make interim closure decisions for individual components. Initially, the WMA PA will be based on assumptions and available data describing component characterization information. As each WMA proceeds toward closure, its respective PA will be updated to address all pertinent new results and findings – and will, as a minimum, incorporate the following results as they become available: actual volumes of tank waste residuals left after retrieval, results of leak investigations, new geologic and ancillary equipment waste characterization information, and the results of new barrier and tank residual stabilization and fill performance studies and tests. Final WMA closure decisions will be made after all components are retrieved and/or characterized, and all other component closure activities have been completed and a final WMA PA is completed.

This section summarizes how this performance assessment will meet the *performance requirements defined by RCRA, HWMA, Clean Water Act (CWA), Safe Drinking Water Act (SDWA), AEA, and any other performance requirements that might be an applicable or relevant and appropriate requirement under CERCLA.* RCRA corrective action is currently scheduled to occur first at WMA C. Using WMA C as an illustration, the linkages between PA and other elements of the corrective action process are discussed in this section. These linkages between PA and the corrective action process are shown in Figure 3-2. The WMA C PA will use information from RCRA corrective action Phase 2 characterization activities, WMA C closure activities, and other information as agreed to between Ecology and DOE. The PA will provide the risk basis for the WMA C RFI/CMS, WMA C closure plans, waste determinations, and the site-wide composite analysis.

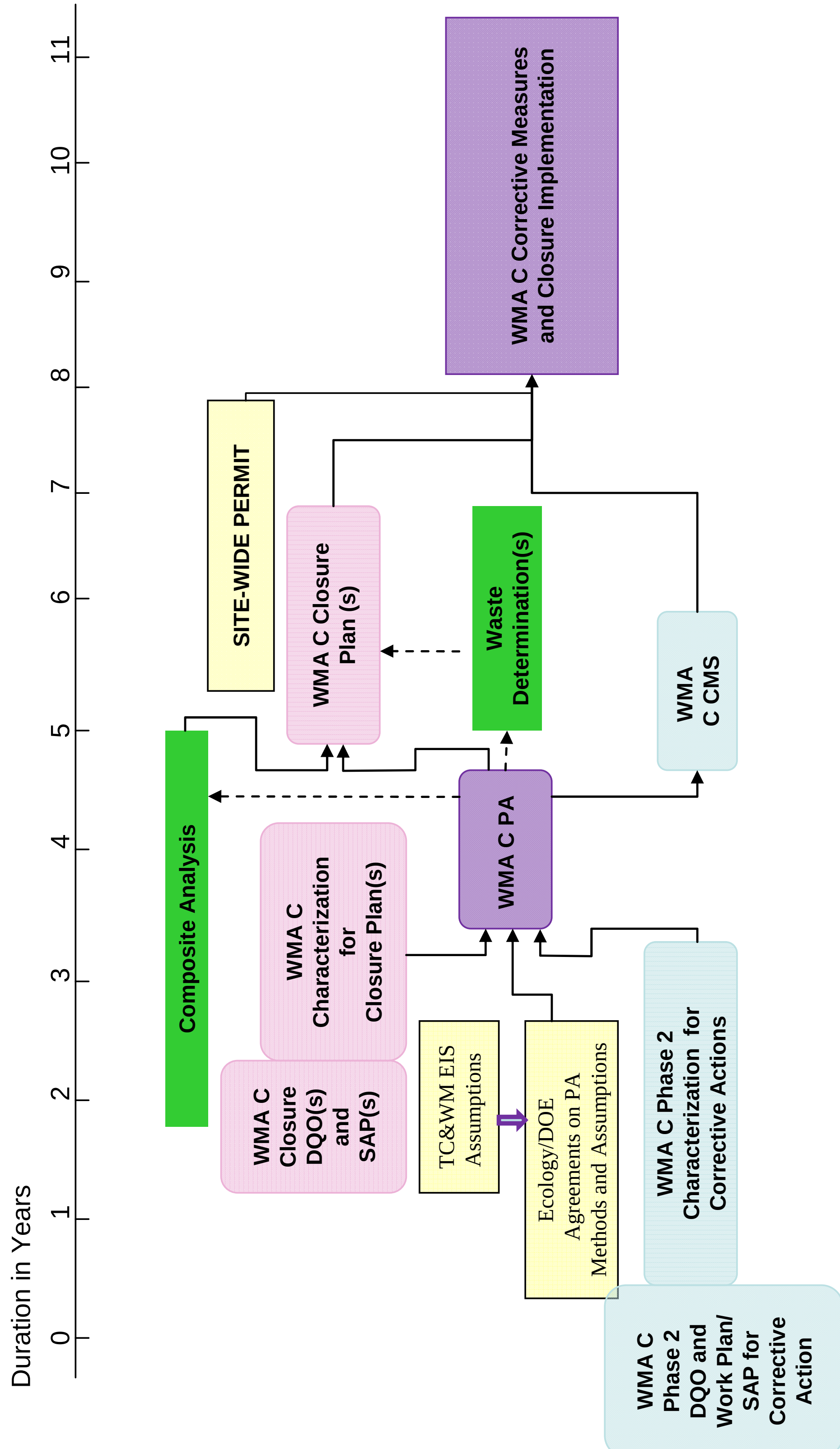
3.4.1 Objectives for the HFFACO Appendix I WMA Performance Assessments during the Phase 2 RFI/CMS

Performance assessments supporting the Phase 2 RFI/CMS will need to achieve the following objectives:

- Support RCRA, HWMA, CWA, SDWA, and CERCLA requirements risks associated with contaminants in the soils based on reasonable maximum exposure[4] from possible future land use options (residential, industrial, …) are evaluated. This includes impacts to groundwater and surface water, risks to human health from direct contact exposure pathways, and risks to ecological receptors.
- Support development of media cleanup standards (OSWER Directive 9902.3-2A, *RCRA Corrective Action Plan*) to establish a need for corrective actions and for use in evaluating corrective measures alternatives.

[4] WAC-173-340-708(3)(b). The reasonable maximum exposure is defined as the highest exposure that is reasonably expected to occur at a site under current and potential future site use.

Figure 3-2. Linkages between the WMA C Performance Assessment and other Elements of WMA C Final Closure



- Support DOE O 435.1 evaluation of dose estimates to a representative member of the public for (1) all exposure pathways and (2) the air pathway (including release of radon from the facility [DOE M 435.1-1, Chap IV, Sections P 1A – 1C]).
- Support DOE O 435.1 evaluation of impacts to a hypothetical person assumed to inadvertently intrude for a temporary period into the facility (DOE M 435.1-1, Chap IV, Section P 2h).
- Integrate the data collected for the corrective measures study with the WMA-specific PA needed as defined in HFFACO Appendix I Section 2.5.
- Integrate with human health and ecological risk assessments conducted as part of CERCLA RI/FSs for operable units on the Central Plateau.

To accomplish these key objectives, the PA approach for the Phase 2 RFI/CMS must address the following:

- Agreements made with Ecology and EPA on methods and assumptions for conducting a WMA-specific PA. These methods and assumptions must be consistent with assumptions on risk assessments (as applicable) conducted as part CERCLA RI/FSs for operable units on the Central Plateau through management project teams that include members from site contractors, RL, ORP, Ecology, and EPA. Furthermore, these methods and assumptions must also be consistent with DOE processes for conducting a performance assessment.
- The process to engage stakeholders and members of the public on the key elements of the performance assessments.
- Technical peer review of the fate and transport process.
- Agency and outside peer review comments regarding risk assessment/performance assessment approaches for the SST system. Examples include the initial PA (DOE/ORP-2005-01) (see Section 2.4) and DOE/ORP-2003-11, *Preliminary Performance Assessment for Waste Management Area C at the Hanford Site*.
- Integration and coordination of characterization of soil data with post-retrieval data of tanks and ancillary equipment under the existing framework as outlined in Appendix I of the HFFACO for using PAs in support of closure planning.
- Integration of existing site characterization data with data to be collected as part of Phase 2 investigations to characterize human health and ecological risks.
- Storage of site characterization data in Hanford Site databases and, when appropriate, make this data available to the public using three-dimensional visual capabilities (i.e., three-dimensional visualization tool developed for WMA C)
- Coordination with groundwater modeling and risk analyses conducted for the TC&WM EIS.

- Uncertainties in the milestones schedule for primary deliverables, specifically the milestone for submittal of the Phase 2 RFI/CMS for WMA C (HFFACO Milestone M-45-61) such that necessary data and decisions are logically linked.

3.4.2 Regulatory Agency Involvement

Involvement by the regulatory agencies, Tribal Nations, and stakeholders throughout the process of developing the technical approaches to the WMA-specific PA is key to producing acceptable and approvable PA. Ecology, Tribal Nations, and stakeholder representatives have participated in DQO workshops conducted in support of sampling and analysis plans for individual WMAs (e.g., see RPP-RPT-38152, *Data Quality Objectives Report Phase 2 Characterization for WMA C, Corrective Measures Study*).

Visualization of site characterization data is an important element in developing conceptual models that support risk assessments. Therefore, as part of the DQO for WMA C (RPP-RPT-38152), CH2M HILL developed a method for integrating geological, hydrogeological, and contaminant distribution data into a three-dimensional representation, which is distributed in a Portable Document Format (PDF) (CH2M-37668-VA, *Draft Three-Dimensional Model of the Stratigraphy and Contamination at WMA C*). In addition, risk communication and interaction with stakeholders can be facilitated through these data visualizations, which can be sent through e-mail and viewed using Adobe® Reader®.[5] Tools such as this would be developed for each WMA and will be used in DQO processes and for communication with the regulators and stakeholders.

Ecology commented extensively on the initial SST PA (DOE/ORP-2005-01). DOE is using Ecology's comments and the lessons learned from the initial SST PA to develop a process for future PAs. Through a series of workshops, Ecology and DOE will develop a common understanding of the methods and assumptions that will be used for the WMA C PA. The WMA C PA is anticipated to be the first site-specific WMA PA to be prepared and will provide a template for interactions with the regulatory agency on future PAs. Workshop topics include PA methodology using the framework for PAs presented in NRC guidance (NUREG-1573, *A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal: Recommendations of NRC's Performance Assessment Working Group*) to guide the topics to be addressed. The main objective of the workshop process is to develop consensus on performance objectives, conceptual models, and modeling methodologies and assumptions that will support primary decision documents. Regulatory approval of the assumptions methods and approaches to be developed in these workshops will be obtained through the WMA PAs submitted to Ecology for review.

3.4.3 Integration of Key Decision Parameters between the RCRA Corrective Action and Closure Processes

Table 3-1 presents key decision parameters for RCRA corrective action and RCRA closure that will be evaluated through the iterative process to result in the final WMA PA. Concurrence between DOE and Ecology will need to be achieved regarding each of these parameters prior to

[5] Adobe® Reader® is a registered trademark of Adobe Systems Incorporated, San Jose, California.

Table 3-1. Key Decision Parameters for Performance Assessments Supporting WMA Corrective Action and Closure (2 sheets)

Key Decision Parameter	Role in WMA Performance Assessment	
	RCRA Corrective Action (Soil)	**Closure of WMA (Tanks and Ancillary Equipment)**
Principal requirements/guidance	MTCA requirements: WAC 173-340-700 through 760; excluding WAC 173-340-745 EPA guidance: 61 FR 19432 (RCRA Subpart S guidance); EPA/540/1-98/002, *Risk Assessment Guidance for Superfund* EPA OSWER Directive 9902.3-2A (*RCRA Corrective Action Plan*)	DOE O 435.1 Guidance for PA preparation provided by DOE-EM (Low-Level Federal Radioactive Waste Management Group) NUREG-1854 WAC 173-303-610 and WAC 173-303-640
Cleanup decision being supported by the PA	RCRA corrective action Purpose of this PA is to assess risks to future receptors from contaminants in the vadose zone where the nature and extent of contamination are based on the available site characterization data. Results from this assessment will identify media and contaminants that may warrant corrective measures; the results are used to develop media cleanup standards that are used to evaluate corrective measures alternatives.	RCRA closure of WMA Purpose of the PA is to assess risks to future receptors associated with the proposed closure approach for the WMA. The PA assesses these risks based on the assumption that the proposed closure approach will meet the requirements of HFFACO M45, WAC 173-303-610, WAC 173-303-640, DOE O 435.1, and agreements on modeling approach and assumptions among Ecology, EPA, and DOE.
Land use assumptions	Future land uses for the Core Zone are described in DOE/EIS-0222-F, *Final Hanford Comprehensive Land Use Plan EIS*, and in the letter 02-HAB-0006, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area."	
Exposure scenarios	The scenarios used for WMA-specific PA will be based on the agreements on modeling approach and assumptions among Ecology, EPA, and DOE. However, these scenarios shall be consistent with those developed for baseline risk assessments prepared as part of RI/FSs for CERCLA operable units on the Central Plateau. These scenarios are based on EPA/540/1-98/002 and associated technical guidance. (See also Notes 1 and 2.)	The scenarios used for the WMA-specific PA will be based on the agreements on modeling approach and assumptions among Ecology, EPA, and DOE. The scenarios that were used in the initial SST PA (DOE/ORP-2005-01) are summarized in HNF-SD-WM-TI-707, *Exposure Scenarios and Unit Factors for the Hanford Tank Waste Performance Assessment.* The development of these scenarios is consistent with DOE O 435.1 and with NRC guidance for review of PAs prepared in support of waste determinations (NUREG-1854). Some of the scenarios presented in HNF-SD-WM-TI-707 are derived from DOE/RL-91-45,

Table 3-1. Key Decision Parameters for Performance Assessments Supporting WMA Corrective Action and Closure (2 sheets)

Key Decision Parameter	Role in WMA Performance Assessment	
	RCRA Corrective Action (Soil)	Closure of WMA (Tanks and Ancillary Equipment)
		Hanford Site Risk Assessment Methodology. Assumptions developed in DOE/RL-91-45 are generally consistent with EPA/540/1-98/002. (See also Notes 1 and 2.)
Exposure pints/points of compliance	Direct contact exposure pathways for both human and ecological receptors are evaluated for soils from surface to 15 ft. Leaching from vadose zone to groundwater: point of compliance to be determined in consultation with regulators. Future land use and technical impractibility of corrective measures will be considered in selecting points of compliance	According to DOE O 435.1, the point of compliance in groundwater is 100 m from the edge of the WMA. Intruder scenarios are based on the assumption that contaminants can be brought to the surface (either from drill cuttings or contaminated groundwater). WAC 173-303-645 (6) (a) requires the point of compliance to be a vertical plane extending to groundwater at the downgradient boundary of the WMA.

Notes:

1. 02-HAB-0006 recommends evaluating risks associated with Tribal scenarios. Tribal scenarios are developed to support the analysis of remedial alternatives against balancing and modifying criteria under CERCLA, as part of RI/FSs developed for operable units on the Central Plateau. A parallel process currently is not available for using Tribal scenarios in the evaluation of corrective measures alternatives under RCRA Corrective Action.

2. 02-HAB-0006 recommends evaluating risks using an inadvertent intruder scenario. The inadvertent intruder scenario is evaluated in accordance with DOE O 435.1 for purposes of establishing limits on radionuclides that may be disposed of near-surface. The use of risks from an inadvertent intruder scenario for determining the need for remedial or corrective action is not described either in CERCLA or RCRA regulations and guidance.

initiating a PA. Engagement of the regulatory agency throughout the PA process will be necessary to successfully complete and use the WMA-specific PA for RCRA corrective action and WMA closure.

3.4.3.1 Regulatory Requirements and Guidance

Requirements and guidance used in preparing the WMA-specific PA will include portions of the MTCA (WAC 173-340), EPA's guidance for corrective action (49 FR 19432, "Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities; Proposed Rule) and EPA/540/1-98/002, *Risk Assessment Guidance for Superfund*, as well as supporting technical guidance for risk assessments prepared in accordance with CERCLA requirements.

The PA will address the regulatory requirements for radioactive waste management outlined in DOE O 435.1, including supporting the preparation of a waste determination. DOE provides guidance for preparation of PAs (DOE G 435.1-1) from the Low-Level Federal Radioactive Waste Management Group. Specific discussion of the requirements for PAs is provided by NRC as part of its guidance for the review of waste determinations prepared by DOE (NUREG-1854, *NRC Staff Guidance for Activities Related to U.S. Department of Energy Waste Determinations – Draft Final Report for Interim Use*).

3.4.3.2 Final Closure Decisions

The WMA-specific PA will support final closure of a WMA (corrective actions and closure actions) for a WMA by evaluating potential human health and ecological risks from contamination in the soils associated with past releases. Under RCRA, EPA's intent is to clean up sites in a manner consistent with available protective risk-based media cleanup standards (e.g., MCLs and state cleanup standards) or, where such standards do not exist, to clean up to protective media cleanup standards developed through site-specific risk assessment (49 FR 19432). The PA will accomplish the following objectives: (1) an assessment of the site impacts under existing conditions, in the absence of corrective measures, (2) the basis for developing media cleanup levels, and (3) evaluation of the residual impacts that remain following implementation of corrective measures and closure actions.

The PA also supports closure planning for the WMA, including tank waste residuals following retrieval, ancillary equipment, and past releases. In addition to evaluating existing soil conditions necessary for the CMS, the PA also assesses impacts associated with the proposed WMA corrective measures and closure actions. The assumed conditions of the WMA following implementation of the corrective measures and closure actions will be incorporated into the estimates of potential contaminant releases, and the modeling of contaminant transport through the vadose zone to groundwater.

3.4.3.3 Land Use Assumptions

Land use assumptions are needed to develop exposure scenarios both for assessing impacts for corrective action and closure purposes. The land use assumptions for the WMAs will be consistent with future land uses for the Core Zone are described in DOE/EIS-0222-F, *Final*

Hanford Comprehensive Land Use Plan EIS, and in the letter 02-HAB-0006, "Consensus Advice #132: Exposure Scenarios Task Force of the 200 Area." DOE/EIS-0222-F identifies an industrial-exclusive land use area encompassing that area within and between the existing 200 East and 200 West Area fencelines for the next 50 years. As described in letter 02-HAB-0006, the Core Zone will have an industrial scenario for the foreseeable future.

3.4.3.4 Exposure Scenarios

Exposure scenarios used in the WMA-specific PA will be based on the agreements on modeling approach and assumptions among Ecology, EPA, and DOE. However, these exposure scenarios will be consistent with exposure pathways and exposure factors that were developed for baseline risk assessments prepared for RI/FSs for operable units on the Central Plateau. These exposure scenarios are based on EPA/540/1-98/002 and supporting risk assessment guidance documents.

Scenarios used to assess risks in SST WMA PAs are presented in HNF-SD-WM-TI-707, *Exposure Scenarios and Unit Factors for the Hanford Tank Waste Performance Assessment*. These scenarios include an all-pathways farmer derived from NRC's decommissioning guidance (NUREG/CR-5512, *Residual Radioactive Contamination for Decommissioning*). Assumptions for a Columbia River receptor were derived from DOE/RL-96-16, *Columbia River Comprehensive Impact Assessment*. In addition, the residential, industrial, recreational, and agricultural scenarios originally presented in DOE/RL-91-45, *Hanford Site Risk Assessment Methodology*) are used in assessing impacts in PAs for radionuclides. In accordance with DOE O 435.1, PAs also address potential exposure pathways to an inadvertent intruder. The development and use of inadvertent intruder scenarios is consistent with DOE orders and NRC guidance (NUREG-1854).

3.4.3.5 Exposure Points

These are the locations where receptors are assumed to come into contact with contaminated media. For example, it is assumed that direct contact exposure pathways from soil can occur to soil from the surface to 15 ft per WAC 173-340-740(6)(d). This is based on the assumption that soils could be excavated for constructing a basement and therefore become accessible. The exposure point encompasses both spatial extent and depth and defines the group of samples used to estimate exposure point concentrations; exposure point concentrations are the representative concentrations in soil that a receptor comes into contact.

The exposure points also potentially represent points of compliance. Points of compliance define the location on a site where cleanup standards must be achieved. The selection of points of compliance are derived from the exposure points and exposure pathways addressed in a risk assessment. In addition, regulatory requirements (such as WAC-173-340-720 through 760) may also specify points of compliance.

3.4.4 Implementing the Performance Assessment in the Corrective Action Process

This section discusses how the one PA identified in HFFACO Section 2.5 will be prepared and used in the WMA corrective action process. It addresses the use of risk assessments to meet the RCRA, HWMA, CWA, SDWA, and CERCLA requirements by developing DQOs and planning site characterization activities, identifies key steps in the risk assessment process, discusses tools that may be used in risk assessments, and describes a proposed process for engaging regulators regarding assumptions and methods to be used in risk assessments. Also discussed is how the results from the RCRA corrective actions process will be integrated with the assessment of impacts associated with the WMA closure actions for tanks and ancillary equipment, which will be incorporated in the WMA-specific PA.

3.4.4.1 Initial SST PA and WMA-Specific PAs

Since the development of a single PA is an iterative process in accordance with DOE O 435.1, an initial SST PA (DOE/ORP-2005-01) was prepared in 2006. DOE/ORP-2005-01 evaluated the extent of protection to human health provided by the planned closure of the SST system, based on the available investigation data, and prior to the retrieval of most of the SSTs. DOE/ORP-2005-01 evaluated impacts for closure of the SST system, which included the following assumptions:

- Retrieval of tank waste to meet HFFACO waste retrieval goals (M-45-00).
- Residual contamination in and on the tanks was stabilized to reduce releases and surface subsidence (DOE O 435.1).
- Past releases to the vadose zone, grouted residual contamination in the tanks, and residual contamination in ancillary equipment are assumed to remain
- Dangerous waste will remain after closure. Therefore, the tank system must meet the requirements of landfill closure [WAC 173-303-610 (1) (b)]. The requirements for tank system closure as a landfill are given in WAC 173-303-640 (8) and WAC 173-303-665 (6).
- A surface barrier is placed over the WMA at closure to reduce infiltration and prevent contact with residual contamination [WAC 173-303-640 (8) (b)].

Evaluation of impacts associated with these assumptions do not represent a DOE decision or presuppose an Ecology decision for landfill closure in advance of completing the NEPA, SEPA, and Ecology permitting processes.

DOE/ORP-2005-01 evaluated potential risks associated with pathways to human receptors from groundwater (following the leaching of contaminants from tank residuals and the vadose zone) and contact with tank residuals by an inadvertent intruder. Selection of these pathways was consistent with the requirements of DOE O 435.1 and NRC guidance for the review of PAs conducted in support of waste determinations (NUREG-1854).

Potential exposures to human receptors to contaminants in shallow soils within 15 ft of the ground surface or exposures to ecological receptors were not addressed in DOE/ORP-2005-01. Evaluation of the risks associated with these potential exposure pathways shall be included in the

WMA-specific PA to meet the RCRA, HWMA, CWA, SDWA, and CERCLA requirements for the WMA.

DOE/ORP-2005-01was not identified as a primary document within Appendix I and did not require regulatory agency approval. However, comments were requested from Ecology and EPA. In addition, DOE/ORP-2005-01 was submitted to NRC for comments along with the waiver from retrieval requirements for tank 241-C-106 (RPP-20658, *Basis for Exception to the Hanford Federal Facility Agreement and Consent Order Waste Retrieval Criteria for Single-Shell Tank 241-C-106*). As described in Appendix H to the HFFACO, DOE is required to coordinate with the NRC with respect to allowable waste residuals in tanks and the soil column (i.e., vadose zone). Ecology commented substantially on DOE/ORP-2005-01. Further discussion of the interaction with Ecology regarding the methodology for preparing future PAs is presented in Section 3.4.2.

3.4.4.2 Linkage between Site Characterization and WMA-Specific Performance Assessment

Data that will support assessment of human health and ecological risk will be collected as part of the Phase 2 RCRA corrective action according to DQOs developed as the initial step of Phase 2 work plans. An example of the DQO process for WMA C is presented in RPP-RPT-38152. Conceptual models of potential exposure pathways developed as an initial step in the PA process will be used in identifying soil sampling locations. Risk-based concentrations derived from exposure scenarios and target risk levels will be used to select appropriate analytical reporting limits. Examples of risk-based concentrations in soil that may be used for selecting reporting limits for chemical contaminants include EPA Region 6 "Human Health Medium-Specific Screening Levels" (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm) and MTCA Method B levels (WAC 173-340-705). These levels in soil achieve a target cancer risk level of 1×10^{-6} or a non-cancer hazard quotient of one. Risk-based concentrations for radionuclides corresponding to a dose limit of 15 mrem/year (OSWER-9200.4-31P, *Radiation Risk Assessment at CERCLA Sites: Q & A*) are developed using ANL/EAD-4, *User's Manual for RESRAD Version 6*, model for identifying reporting limits for vadose zone sampling data supporting risk and performance assessments. An example of these reporting limits is presented in DOE/RL-2002-14.

3.4.4.3 Human Health Risk Assessment

The process for meeting requirements for human health in support of RCRA Corrective Action is based on EPA/540/1-98/002 and is consistent with MTCA requirements. This process is consistent with the assumptions and methods used for baseline risk assessments conducted for CERCLA operable units on the Central Plateau. This process will support several decisions, including the following:

- Identify the need to evaluate corrective measures for vadose zone contaminants within a WMA.
- Identify contaminants of potential concern (COPC), affected media, and exposure pathways that may pose risks to human health; this information will be used in the identification and evaluation of corrective measures.

- Provide the basis for developing media cleanup levels. Media cleanup levels are also used in the evaluation of corrective measures and will provide the basis for determining that the selected corrective measure protects human health.

The information developed in the WMA PA will be used to address the requirements of a human health risk assessment. Outputs from the PA will be incorporated into the following framework for a human health risk assessment:

- **Data Collection and Evaluation.** The data collection and evaluation section describes how the site was characterized to support evaluation of potential impacts to human health and provides a discussion of the sampling and analysis of environmental media. An important output from this step is the identification of COPCs that are carried through the remaining steps of the risk assessment
- **Exposure Assessment.** The exposure assessment identifies who might be exposed, identifying the potential pathways of exposure and quantifying the rate of exposure. Chemicals and radionuclides detected in the vadose zone and potentially leaching to groundwater are considered in the exposure assessment. Exposure scenarios are developed for different exposed populations. These scenarios define the potentially complete exposure pathways, and exposure points (i.e., the ways an individual could become exposed to contaminants and the locations in soil and groundwater where exposure could occur).
- **Toxicity Assessment.** The toxicity assessment provides chemical toxicity and radioactive dose factors for use in quantifying the potential health impact associated with the levels of contaminant intake estimated in the exposure assessment.
- **Risk Characterization.** The results from the toxicity and exposure assessments are then combined to characterize health risks potentially associated with contaminants in the vadose zone. The risk characterization provides quantitative estimates of potential carcinogenic and noncarcinogenic health effects and radiation dose for each exposure scenario. The results from the risk characterization step are used to identify COPCs, exposure pathways, and contaminated media that might pose unacceptable health risks. Along with the numerical results, the risk characterization provides a narrative which succinctly describes and qualifies the risk assessment results. Supporting that narrative is an analysis of the uncertainties in the estimated risks that are associated with the various assumptions and inputs used in the risk assessment.

3.4.4.4 Vadose Zone Modeling Issues

Contaminants in the vadose zone from past releases within the WMA or the defined WMA based on the agreed-on boundary established in the DQO process will be modeled to estimate potential impact to groundwater. Sampling and analytical data from the vadose zone will be combined with inventory estimates for leaks of chemicals and radionuclides lost to the vadose zone (RPP-32681) to develop estimates of source terms that could leach to groundwater. Conceptual site models developed in the WMA-specific PA will be translated into numerical models to estimate contaminant migration to groundwater. An overview of the principal conceptual model of impacts from releases and alternative conceptual models is presented in Section 2.2.1.

Additional data collected during the RCRA corrective action Phase 2 characterization will be used to further refine these conceptual models.

Systematic evaluation of the principal and alternative conceptual models will be performed in collaboration with Ecology and appropriate subject-matter experts to create numerical abstractions that can be addressed through numerical modeling. This systematic evaluation process may be facilitated through the use of tools such as FEPs (features, events, and processes) analyses ["A Comprehensive and Systematic Approach to Developing and Documenting Conceptual Models of Contaminant Release and Migration at the Hanford Site" (Last et al.)] and decision support tools such as Evidence Support Logic (Quintessa, *TESLA: Decision Support Software. Evidence Support Logic, a Guide for TESLA Users, Version 2.1*) for evaluating the quality of information supporting various conceptual models. DOE is holding a series of workshops with Ecology to discuss methods and approaches for preparing WMA-specific PAs. Development of conceptual models and associated numerical abstractions will be topics discussed in these workshops (see Section 3.3.2).

Selection of the appropriate modeling code, modeling parameters and assumptions, types of sensitivity cases analyzed, and the point of compliance (i.e., the location in groundwater where impacts are modeled) will be performed in consultation with Ecology. The process for selecting appropriate vadose zone modeling approaches for WMA-specific PAs and site-specific risk assessments, in accordance with Ecology regulations (WAC 173-340-747), is discussed in DOE/RL-2007-34, *Regulatory Criteria for the Selection of Vadose Zone Modeling in Support of the 200-UW-1 Operable Unit*.

Modeling performed in support of RCRA Corrective Action also will need to be consistent with site-wide modeling being conducted as part of the TC&WM EIS. The EIS will help define the closure end state for the SST system and will identify a preferred alternative for final treatment and disposal of the tank wastes. The EIS will provide an analysis of groundwater impacts, including development of a site-wide groundwater model. Contaminant impacts to groundwater at adjacent groundwater operable units within the Central Plateau will need to be integrated through the site-wide groundwater model. Coordination will be needed with the Plateau Remediation Contractor regarding both modeling approaches and groundwater monitoring requirements to integrate potential impacts.

Vadose zone modeling results shall be used to develop media cleanup levels in soil underlying a WMA that achieve groundwater protection goals. In addition, vadose zone modeling will be used to evaluate the effectiveness of corrective measures; e.g., modeling will be used to simulate the effects of infiltration barriers in reducing migration of vadose zone contaminants.

3.4.4.5 Development of Media Cleanup Levels

The PA will identify COPCs, contaminated media, and exposure pathways that are associated with unacceptable human health or ecological risks. This information will be combined with target risk levels to calculate concentrations in soil that are protective of human health. The target risk levels to be used will be selected in consultation with the regulatory agencies. These target risk levels are identified along with all of the performance objectives for corrective action and closure; the identification of performance objectives is an initial step in a WMA-specific PA.

Media cleanup levels will be used to identify corrective measures that protect human health and the environment. In addition, media cleanup levels will be used to estimate target volumes of contaminated media for purposes of estimating costs for implementing corrective measures. The media cleanup levels will provide the basis for selecting media cleanup levels that will be incorporated into the WMA closure plan.

3.4.5 Ecological Risk Assessment Considerations

WAC 173-340-350 requires assessment of ecological risk as part of the determination of cleanup levels and remedial action alternatives. MTCA addresses hazardous chemicals but does not address the radionuclide contaminants that are known to have been released into the environment at WMAs. To address chemical and radiological ecological risks, the SST WMA ecological risk assessments will be performed in accordance with two sources of information used for ecological risk assessment:

- WAC 173-340-7490, “Terrestrial Ecological Evaluation Procedures.”
- DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*.

Information developed under the WMA ecological risk assessment process will be used in the development and analysis of corrective measures alternatives, including the no-action alternative. The individual SST WMA RFI/CMS work plans will contain the approach and the WMA-specific field activities that will comply with the above requirements and guidance.

3.5 RECENT INITIATIVES TO STREAMLINE THE RCRA CORRECTIVE ACTION PROCESS AT SINGLE-SHELL TANK WASTE MANAGEMENT AREAS

A number of initiatives are in progress among Ecology, DOE, and EPA to evaluate more efficient cleanup processes across the Hanford Site and within the SST WMA. These initiatives may impact the current regulatory and strategic framework of this work plan as described in Section 3.2.

3.5.1 SST Closure Planning Workshops

A series of SST closure planning workshops have been and are continuing to be conducted among Ecology, ORP, and its contractor. The purpose of the workshops is to discuss the sequence of decisions and actions that need to be taken to close a WMA with emphasis on WMA C final closure. Included in the sequencing are the various regulatory process requirements such as RCRA tank and ancillary equipment closure, soil corrective actions, and NEPA and DOE O 435.1 activities. These workshops are intended to help identify more efficient ways in which decisions can be made and actions can be performed and in so doing, sequence or re-sequence where appropriate, elements of the closure and corrective action processes.

Some of the initiatives being pursued in these workshops are summarized in Sections 3.5.1.1 through 3.5.1.3. Chapter 4 presents further details of the initiatives.

3.5.1.1 Integration of the RCRA Closure Process with the RCRA Corrective Action Process

Development of actions to more efficiently integrate RCRA closure planning for tanks and ancillary equipment with RCRA corrective actions is a focus of these workshops.

3.5.1.2 Consideration for Early Decisions on SST WMA Landfill Closure and/or Removal Under RCRA

After the TC&WM EIS ROD issuance, the workshop members discussed the option of utilizing the RCRA Site-Wide Permit to set an early closure direction under RCRA for the SST WMA. To do this, one option would be to establish criteria in the Site-Wide Permit for determination of landfill closure and/or removal of structures and soil to the extent technically practicable, shortly after the EIS ROD is published. Procedures could also be established in the Site-Wide Permit that would identify additional removal and decontamination requirements for structures that would be initiated on a WMA-by-WMA basis and would be based on meeting the RCRA closure performance standards of WAC 173-303-610(2) (i.e., protect human health and the environment, minimize the need for future maintenance, return the land to the appearance and use of surrounding land areas)

3.5.1.3 Adding, Deleting, or Re-sequencing Existing Milestones to Optimize Final WMA Closure

The HFFACO Action Plan will likely require revision should Ecology and ORP pursue any of the changes to activities that are being identified in the closure planning workshops. For the Phase 2 corrective action program, changes could include schedule modifications in milestones associated with the WMA C corrective action program or adding/deleting milestones depending on the degree of specificity envisioned by Ecology and DOE. In addition, it is anticipated that the HFFACO Action Plan Appendix I would require revision to reflect the new approach.

3.5.2 Corrective Action Decision/Record of Decision Process

In a letter from the Attorney General of Washington (Letter 2008) entitled, "Proposed 'CAD/ROD' Approach for Hanford RPP Cleanup Decisions," an approach that was termed the Corrective Action Decision/Record of Decision (CAD/ROD) approach, for cleanup of Hanford's RCRA past practice actions (units under RCRA corrective action) was outlined. The CAD/ROD approach has been and continues to be discussed by Ecology, DOE, and EPA in various forums. The following information contains background points and issues consistent with this letter and that led to the proposed CAD/ROD approach:

- The Attorney General's office states that HWMA corrective action authority does not extend to AEA radionuclides as does CERCLA past practice actions frustrating the HFFACO goal of eliminating duplicative decision processes.

- DOE has expressed the concern that RCRA past practice actions require NEPA coverage (as opposed to CERCLA past practice actions), again countering the goal of one decision process.
- The HFFACO requires that corrective actions will address all radiological and nonradiological contamination.
- The RCRA Site-Wide Permit is required to be modified to establish a remedy decision for the RCRA past practice actions (as opposed to CERCLA past practice actions).

The CAD/ROD approach would follow the CERCLA decision-making process through remedial investigation, feasibility study, proposed plan, ROD, and remedy implementation. However, it would include a one-time blanket incorporation of RCRA past practice schedules and requirements developed in the ROD into the Site-Wide Permit rather than through separate permit modifications.

The CAD/ROD approach would retain Ecology's corrective action decision-making authority while providing CERCLA coverage for radionuclide authority as well as NEPA coverage. The approach would require an amendment of the Site-Wide Permit and the HFFACO. Ecology would act as the CERCLA lead regulatory authority and the CAD/ROD would be signed by both the state (as a corrective action decision under the HFFACO) and EPA (for the CERCLA ROD).

The Attorney General's Office letter describes a simple MTCA-specific analysis that would be included in the CERCLA proposed plan preceding the CAD/ROD to ensure that that MTCA remedy decision criteria are covered into the decision-making process.

Discussions are ongoing between DOE and Ecology as to how the CAD/ROD approach could be applied at SST WMA. Discussions include the possibility of developing a CAD/ROD that would combine WMA contaminated soil from one contiguous area into one decision process. The benefits of this approach would be to provide for stronger integration of RCRA and CERCLA requirements in one soil cleanup document, provide coverage for decisions associated with radiological contaminants in WMA soil, and provide for better integration opportunities with the Central Plateau where WMA soils are commingled or contiguous with other Central Plateau waste sites.

3.5.3 Other Central Plateau Integration Initiatives

A summary is provided here to complete the discussion of the major initiatives that may impact the current Phase 2 corrective action process. Chapter 5 presents further details of these initiatives.

3.5.3.1 Shallow and Deep Vadose Zone Decision Process

The set of technology alternatives required to remediate shallow vadose zone are a different set than will be required for deep vadose zone remediation. Neither shallow soil removal nor containment alternatives will entirely mitigate risk associated with past releases in the deep vadose zone. This is true not only for WMA soils but for other Central Plateau waste sites as well. With this understanding, Ecology, DOE, and EPA have included a milestone requirement in the HFFACO for development of treatability testing in the deep vadose zone for technetium and uranium (HFFACO Milestone M-015-50).

An initiative is ongoing among Ecology, DOE, EPA, and DOE contractors to determine the best course of action to remediate the deep vadose zone across the Central Plateau recognizing the inherent similarity of characterization and remediation challenges regardless of origin. The decision process discussions are looking at ways to clarify and focus planning and responsibilities for addressing deep vadose contamination across the Central Plateau. This initiative might utilize the CAD/ROD approach (see Section 3.5.2) as the administrative process for decision-making within the deep vadose zone.

3.5.3.2 Geographic Zone Redesignation of Operable Units

Waste sites throughout the Central Plateau are currently grouped into operable units based on process history and waste site type. This has proven to be an effective grouping for the purpose of identifying the nature and extent of contamination in and around the waste sites. The geographic zone-based initiative considers grouping waste sites based on their geographic proximity, including SST WMAs, for the purpose of remedial alternative evaluation and remedy selection. This grouping facilitates consistent decisions for sites in the same geographic area. This initiative could be coordinated with the CAD/ROD approach addressed in Section 3.5.2, if implemented for WMA closure, to administratively manage operable units that contain waste sites, which are both RCRA and CERCLA past practice actions.

4. INTEGRATION OF RCRA CORRECTIVE ACTIONS WITH RCRA CLOSURE ACTIVITIES

Currently the HFFACO has separate SST WMA milestones and processes for soil corrective actions and for closure actions for structures, i.e., SST and ancillary equipment. RCRA corrective actions will be determined through an analysis and selection of alternatives in the WMA CMS and in accordance with WAC 173-303-646. The RCRA closure actions will be determined based on information submitted in the SST or ancillary equipment closure plans and in accordance with WAC 173-303-610. Both the CMS and the closure plans will provide the information that will be the basis for a modification to the RCRA Site-Wide Permit. The permit will establish the conditions required for implementation of soil corrective action, structure closures, and the resultant final closure of each WMA.

4.1 CURRENT RCRA CLOSURE PROCESS FOR SINGLE-SHELL TANK AND ANCILLARY EQUIPMENT

RPP-13744, *Single-Shell Tank System Closure Plan*, currently consists of three sections that are arranged in a hierarchy. The highest-level document section (Tier 1) addresses closure topics and issues pertaining to the SST system. The mid-level section (Tier 2) addresses specific WMA closure activities. The lowest level document in the hierarchy (Tier 3) addresses closure activities for specific components within a particular WMA. The following summarizes the general content of the Tier 1, 2, and 3 sections of RPP-13744, also currently depicted in the HFFACO Action Plan Appendix I:

- Tier 1 – *Framework Plan for Single-Shell Tank System Closure:* This tier provides a general overview of the SST system, a general description of the administrative framework and process for closure, including key definitions, and a description of the process for incorporating Tier 2 and Tier 3 with soil and groundwater cleanup, SST closure performance standards, an overall closure schedule, and an overall description of the certification and post-closure process.
- Tier 2 – *Waste Management Area Closure Action Plans*: This tier is to consist of appendixes to the Tier 1 Framework Plan, one for each of the seven SST farm WMAs at Hanford. Each appendix provides a general description of the WMA, a description of the WMA groundwater monitoring effort, a general description of closure activities, a risk evaluation of the WMA, a closure schedule for the WMA, and a description of the certification and post-closure process.
- Tier 3 – *Component Closure Activity Plans* (for specific WMA components): This tier is to consist of attachments to the Tier 2 appendixes. Each attachment provides component closure actions for one or more components within each WMA, such as for individual SSTs or pieces or groupings of ancillary equipment.

Appendix I states that closure plans for WMA components that are being retrieved (i.e., SSTs and potentially other ancillary equipment) must be submitted to Ecology approximately 4 months after characterizing end-of-retrieval tank or ancillary residuals. The initial RPP-13774 submitted to Ecology included Tier 1, a Tier 2 plan for WMA C, and a Tier 3 component plan for SST C-106. However, following this submittal, Ecology sent a letter to DOE (Ecology 0070664, "Response to Request for Temporary Suspension of Single-Shell Tank System Closure Plan Submittals") stating that the submittal of closure plans would be suspended and would resume "no later than June 30, 2009, or within 120 days after the final TC&WM EIS ROD is issued, whichever is earlier.

In addition, HFFACO Appendix I and M-045 milestones have prioritized waste retrieval and closure activities toward the goal of closing a WMA rather than closing individual tanks between WMAs. The submittal of individual component closure plans that are tied to the completion of individual waste retrieval actions may need to be revisited so that more flexibility can be built into the process for more efficient closure of the WMA. It is therefore anticipated that closure plan submittal dates will be extended and the Appendix I strategy that ties closure plan development and submittal to waste retrievals may be reevaluated; however, neither an alternative strategy nor revised dates have been established at this time.

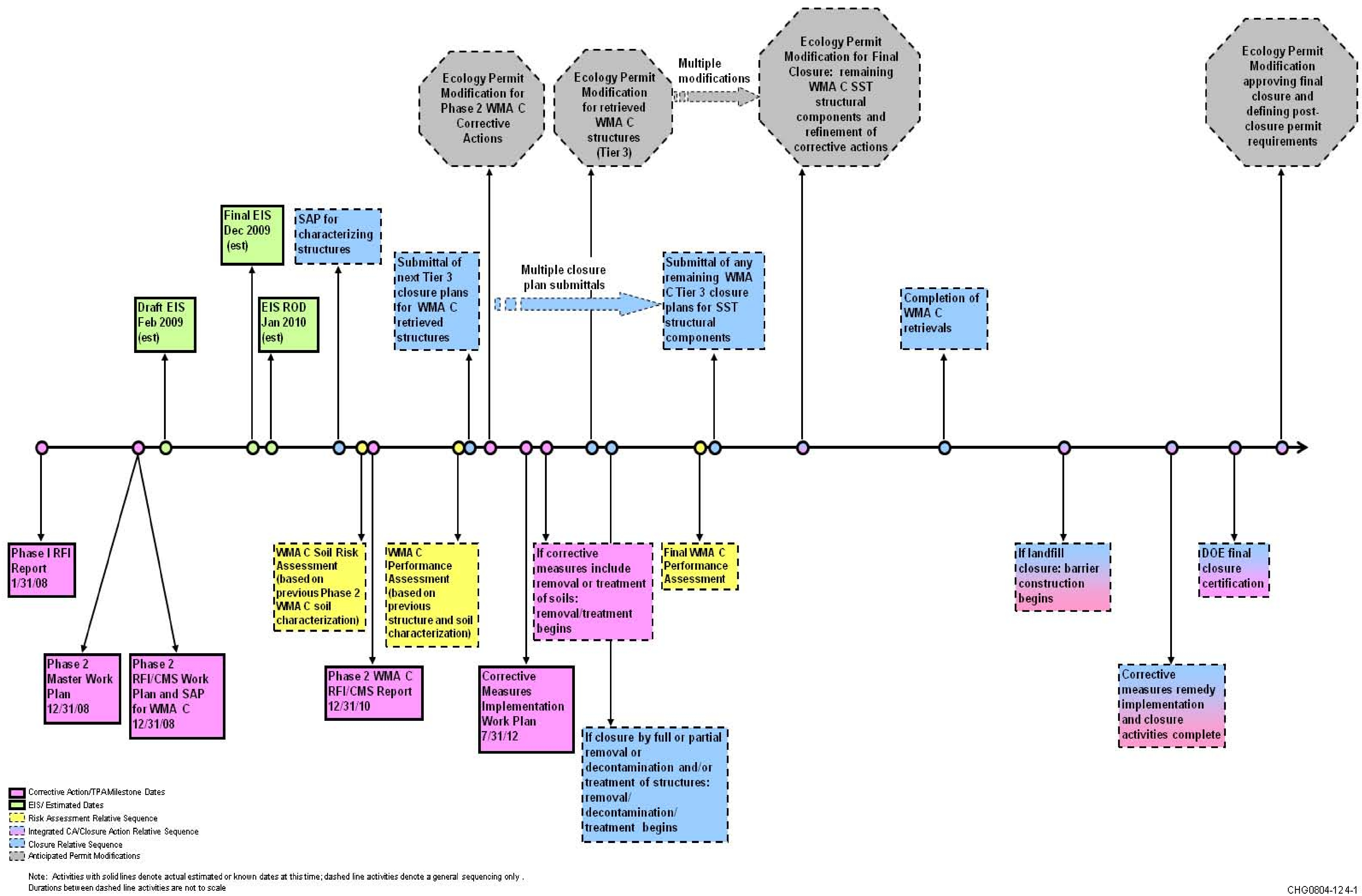
Appendix I requires that "specific SST WMA closure objectives and standards will be delineated in Hazardous Waste Management Act (HWMA) closure plans." Figure I-1 depicts the tiered closure plan process and how that process links with the corrective action process. Specifically, this interrelationship shows the CMS feeding back into closure plan "development & revision." How this feedback will occur as part of permit modifications is not specified but likely would occur through separate RCRA corrective action permit modification processes as specified in Section 7.4.3 of the HFFACO Action Plan or as part of a RCRA closure plan submittal.

Ecology is currently drafting a permit modification for the SST system. However, this modification is expected to largely contain permit conditions associated with continued operational requirements during the lengthy closure period of the SST system and will not focus on closure actions.

4.2 RELATIVE SEQUENCE OF CORRECTIVE ACTION AND CLOSURE ACTIVITIES FOR WASTE MANAGEMENT AREA C

Figure 4-1 portrays HFFACO milestones that are currently in place for completion of the corrective action process at WMA C and estimated dates for the TC&WM EIS and ROD are included. In addition, in lieu of actual dates, assumptions for the relative sequence of and durations between remaining corrective action and closure activities are provided where HFFACO milestone dates or estimated dates are not currently known. Corrective action and closure activities are color coded to denote RCRA process activities that are currently anticipated to be separate in time. Combined corrective action and closure activities are also color coded where it is anticipated that activities will encompass the requirements of both processes, such as surface barrier construction and final closure actions.

**Figure 4-1.
Relative Sequence of WMA C Corrective Action and Closure Process Activities**



4.3 INTEGRATION OF SINGLE-SHELL TANK RCRA CORRECTIVE ACTION AND CLOSURE PROCESSES

Separate RCRA decision-making processes for corrective action and closure activities will require close integration of WMA schedules and physical actions. Characterization activities, risk assessment, evaluation and selection of the remedy, and remedy implementation will all require close coordination between the two processes. This section discusses some of these challenges.

4.3.1 Characterization

A major objective for soil or structure (i.e., tanks and ancillary equipment) characterization will be to plan sampling work such that interferences with ongoing waste retrieval and operational activities are minimized. Characterization activities between soil and structures are currently planned independent from one another and for the most part this should not be problematic. Two strategies will help plan with the integration of these two characterization activities:

- Complete to the extent possible f soil and structure characterization before evaluation and decision documents are completed. A scenario could occur in which a new source of contamination is discovered during characterization for either the soil or structures that could result in the need to reevaluate work already performed for the other, such as in a completed CMS, a closure plan, or remedy decisions defined in the Site-Wide Permit.
- Maximize opportunistic sampling as part of the individual soil and structure work plans and SAPs, where feasible, to efficiently utilize resources.

4.3.2 Risk Assessment

Currently separate risk assessments are planned for soil and structures (see Section 3.4). Consistent methodology and metrics must be used between the two risk assessments and both must be consistent with the assumptions in the TC&WM EIS, which provide the NEPA coverage. The cumulative risk assessment from contaminants in both soil and structures will be performed in the WMA PA. Because of this, the risk assessment for soils can only be used to develop interim corrective measures until the WMA PA is produced and the cumulative risk from both soil and structures is taken into consideration. Future plans will include assessing ways to better integrate risk assessment from past releases with that of the structures to most effectively evaluate risk from cumulative sources of contamination.

4.3.3 Remedy Evaluation and Selection

The remedy evaluation and selection steps for RCRA corrective action and closure processes are markedly different. The RCRA corrective action program was intended to cover releases from any solid waste management units in which a need for action is established based on protection of human health and the environment. Because these situations present a wide spectrum of potential responses (various combinations of removal, treatment, containment, and institutional controls) and depending on site-specific conditions (the nature, extent, and time of the release, site hydrology, geology, depth to groundwater, etc.), many factors need to be considered before selecting a remedy. The RCRA corrective action program is based on the premise that flexible, site-specific decision-making is a necessity. The program allows for the phasing of decisions through time, the combining of decisions with other statutory decisions, and the allowance of innovative technical approaches, where appropriate. In the corrective action CMS, a set of screened corrective measures alternatives are separately described and then collectively compared against one another through the application of evaluation criteria (see Section 3.2.6). This evaluation balances protectiveness with cost and implementability to select the appropriate remedy.

In contrast, the RCRA closure process for tank systems is much more prescriptive in that it provides only two options for closure. The tank system closure requirements of WAC 173-303-640 (which apply to the SST and their ancillary equipment) require owners and operators to remove or decontaminate all soils, structures, and equipment to close the system. When complete removal is not possible, the tank system must be closed as a landfill under WAC 173-303-665, a RCRA-compliant surface barrier must be placed over the WMA, and the WMA be provided with post-closure care (including institutional controls) as long as the waste remains hazardous.

It is principally the decision on the SSTs that will determine whether landfill closure is required. The highly radioactive nature of these tanks and the logistics involved in their removal or their complete decontamination is the most technically challenging and costly alternative to be considered in the WMA. Should the tanks remain in place with waste residuals, a landfill decision will have been made due to the requirements of WAC 173-303-640(8)(b) and DOE requirements for protection of the inadvertent intruder through development of intruder barriers (e.g., relevant and appropriate requirements under 10 CFR 61 and DOE O 435.1).

Thus, the closure decision for the SSTs will direct the selection of the “principal” remedy of landfill versus removal/decontamination (i.e., clean closure) in a WMA. Further removal or treatment of soil may be required in addition to placement of a surface barrier or removal of shallow soils, particularly for a deep vadose zone that may not be affected by either a surface barrier or shallow soil removal, or for purposes of decreasing the size of the surface barrier or to further reduce risks to future receptors for perimeter contamination. These actions would need to be evaluated as part of either the CMS or closure plan process. Closure plans would also develop additional closure actions for structures, such as selective removal or treatment.

Post-closure actions, such as maintenance and monitoring activities, may be defined in the Site-Wide Permit through either separate CMS or closure plan processes (e.g., post-closure tank monitoring under RCRA closure) or through actions common to the entire WMA principal remedy (e.g., groundwater monitoring, surface barrier maintenance, maintenance of institutional controls).

The timing of the corrective measures study was set in the HFFACO for WMA C through HFFACO Change Control Form M-45-06-03. It is not understood whether the closure plans will be submitted before or after the CMS because the timing for publication of the TC&WM EIS ROD is uncertain and because multiple closure plans may be required to cover all the various tanks and ancillary equipment in the WMA. Should the CMS be developed and a permit modification issued that selects a remedy prior to the closure plan/permit modification decision for the structures, the corrective measures would likely be required to be considered interim. Optimally, the decisions would be reversed or combined in time. Regardless, close coordination between the separate processes will be required to ensure that the principal remedy and any additional corrective actions or closure actions are integrated.

4.3.4 Remedy Implementation

Remedy implementation within a WMA would ideally follow a logical progression with an early understanding of all the actions required for final closure. Systematic planning for multiple actions through time will minimize interference and rework. However, with two separate decision pathways for closure and corrective actions, it is possible that conflicts could be realized and therefore careful attention must be paid to the timing of decisions (combining or synchronizing decisions) and to the order for implementing physical corrective and closure actions.

4.4 RECENT INITIATIVES FOR INTEGRATING RCRA CORRECTIVE ACTIONS AND RCRA CLOSURE

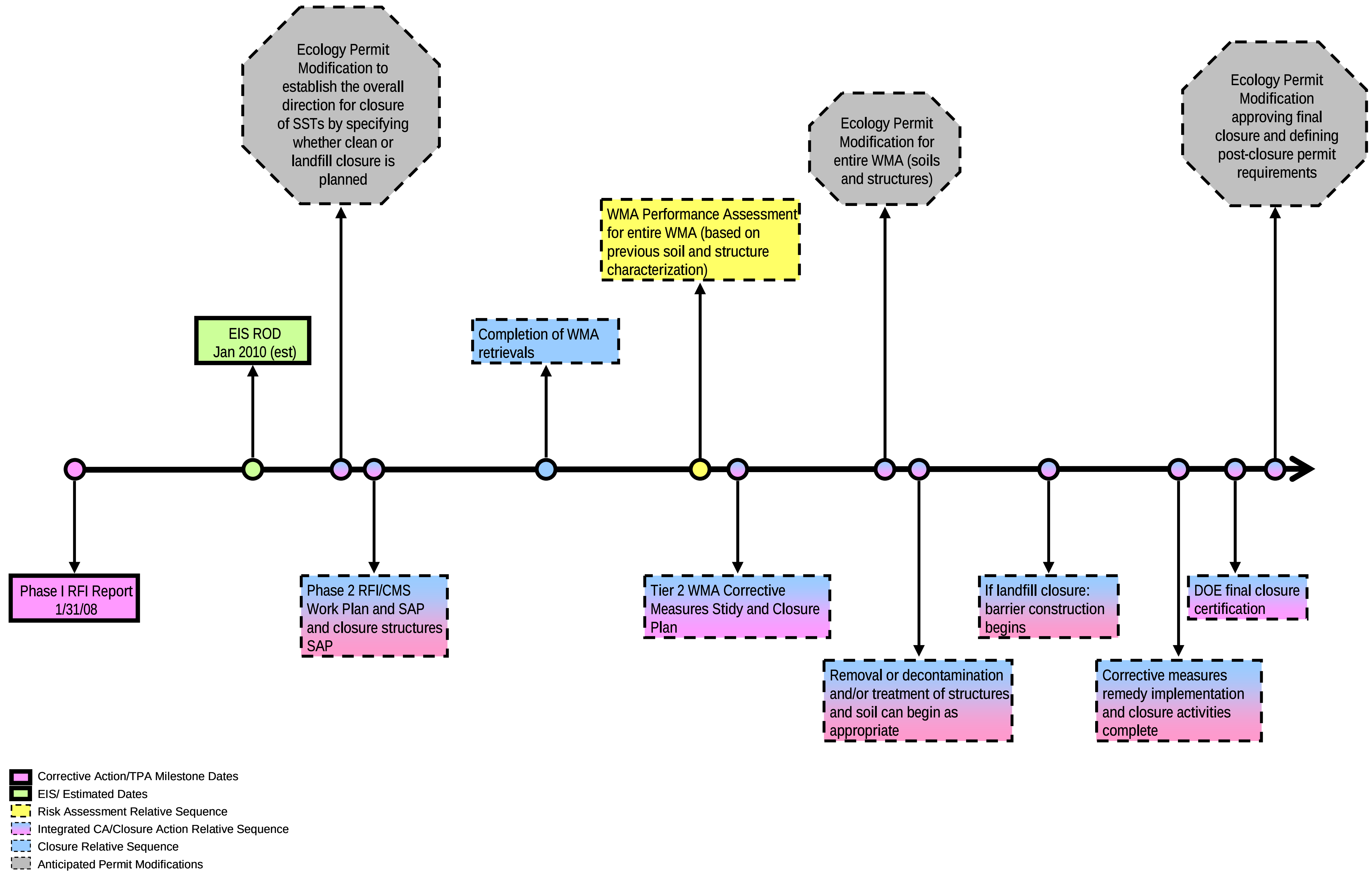
Section 3.5.1 summarizes the progress of the recent SST Closure Planning Workshops that have been ongoing since the beginning of FY 2008 among Ecology, DOE, and its contractor. The closure planning workshops are engaged in discussing initiatives to streamline the documentation and physical actions required for final closure of the WMA through planning corrective actions and closure actions systematically in time and space. The goal is to develop a process that maximizes the effectiveness of site resources and results in more protective cleanup actions.

Figure 4-2 shows the relative sequence of events from application of key closure planning workshop initiatives discussed in Sections 4.4.1 and 4.4.2. As with Figure 4-1, in lieu of actual dates, assumptions for the relative sequence of and durations between remaining corrective action and closure activities are provided where HFFACO milestone dates or estimated dates are not currently known. The Phase 1 RFI report (DOE/ORP-2008-01) and the TC&WM EIS ROD estimated dates remain in this sequence for perspective.

4.4.1 Early Principal Remedy Decision

One of the concepts discussed in the closure planning workshops was the development of an early decision on the principal remedy for WMA closure and corrective action. To develop the decision in the Site-Wide Permit, a revised Tier 1 closure plan would be submitted to Ecology establishing the principal remedy of clean or landfill closure for the SST system or for a specific group of WMAs. It would be anticipated that the new Tier 1 closure plan would be issued soon after the EIS ROD is issued. Criteria were postulated during the closure planning workshops for making the clean versus landfill decision in the Tier 1 closure plan. These criteria are as follows.

**Figure 4-2.
Closure Planning Workshop Initiatives
for WMA Corrective Action and Closure
Process Activities**



Note: Activities with solid lines denote actual estimated or known dates at this time; dashed line activities denote a general sequencing only . Durations between dashed line activities are not to scale

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- Area over which the determination would apply and specific numeric criteria that would need to be met for removal and decontamination to meet clean closure requirements.
- Technological feasibility of removal and decontamination to clean closure standards including consideration of availability of treatment/disposal technologies and space, risks to workers, and available expertise.
- Whether removal and decontamination to clean closure standards would result in disproportionate costs as defined by MTCA.

If the early decision is to set landfill closure as the principal remedy for the WMAs, the new Tier 1 closure plan would also establish procedures to identify additional removal and decontamination requirements on a component-by-component basis. This would be based on preestablished criteria designed to meet the WAC 173-303-610(2) closure performance standards (protect human health and the environment, minimize the need for future maintenance, return the land as much as possible to its appearance and use of surrounding land areas).

Early decision-making would have the benefit of focusing remaining corrective action and closure actions in the WMA, such as focusing characterization on the evaluation of additional actions above and beyond the principal remedy that are necessary to ensure protection of human health and the environment.

4.4.2 Combined Corrective Action/Closure Documentation

A concept discussed in the closure planning workshops would combine the Tier 2 (WMA-level) closure plan and the WMA CMS to evaluate all WMA-specific closure and corrective actions and using the Tier 1 remedy decision as a basis if this concept is also utilized. This combined document would evaluate any additional soil corrective measure requirements, dependent on the principal remedy decision, as well as structure removal or decontamination requirements, through a detailed and comparative analysis. This analysis would include the criteria established by Ecology and DOE for evaluation of structure removal or decontamination. Additionally, this combined document would identify those actions that ensure that all general, tank, and landfill closure requirements (as appropriate), and post-closure care and monitoring requirements of WAC 173-303 are met.

In addition, actions would be evaluated based on a common and complete assessment of risk. A combined risk assessment would take into account all soil and structure inventories to understand the cumulative impact of contaminants, both as a baseline for action and for comparison of alternatives.

The format for the combined CMS/closure plan document is still under discussion. The benefit of combining these documents from an administrative perspective is that it would significantly reduce the number closure plans prepared and permit modifications issued, e.g., Tier 3 closure plans (i.e., component-specific closure plans) would not be prepared. From a planning perspective, it would help ensure that all actions are considered holistically and in a systematic manner.

Other documents could also benefit from being combined. Work plans and SAPs for characterizing both the contaminated soils and the structures could be combined. These documents would be preceded by the development of a combined DQO. A SAP has already been developed for sampling the post-retrieved residual SST waste. Depending on the situation at the time of development of characterization plans for a WMA, it may be advantageous to "package" soil and the rest of the structural components (e.g., piping) together to ensure that sampling interferences are avoided and to provide for sampling locations that optimize, where possible, obtaining information for both corrective action and closure purposes.

Ecology would issue permit conditions for both corrective action and closure at one time under a combined approach. These conditions would likely require a Corrective Measures Implementation Work Plan-like document combining corrective action and closure activities (e.g., design, maintenance and monitoring requirements, and project schedule) into a single implementing document for both the principal remedy (landfill or full removal of structures) and any additional removal or decontamination and/or treatment activities for contaminated soil or structures.

With permit conditions established at one time for all cleanup actions within a WMA, the physical work can be performed with the highest degree of efficiency. At this point, a full understanding will be realized of the risk associated with contaminant inventories, both from a long-term and worker-risk perspective, of the breadth and complexity of the components and their respective cleanup actions, and of the impact of those actions on contiguous or nearby CERCLA operable unit waste sites.

5. CENTRAL PLATEAU OPERABLE UNIT AND WASTE MANAGEMENT AREA CORRECTIVE ACTIONS INTEGRATION

This chapter describes the need for and approach to integration of WMA corrective action work with related work occurring within operable units that are adjacent to tank farms. The source and groundwater operable units are addressed under CERCLA and are the responsibility of RL. The WMA corrective action work is addressed under RCRA and is the responsibility of ORP.

5.1 NEED FOR INTEGRATION

The need for integration between WMA corrective action and remedy investigation, selection, and implementation for adjacent waste sites and operable units is driven by the following situations.

- Groundwater has been impacted by both past tank farm releases and non-tank-farm releases (DOE/RL-2008-01). Contaminants from these sources have commingled in the groundwater. Therefore, investigations of the nature and extent of contamination, understanding of the fate and transport, and selection of protective remedies for groundwater needs to involve coordination with both tank farm and non-tank-farm sources.
- For some tank farms (e.g., WMA T and WMA B-BX-BY), there have been significant releases to the soil column from both adjacent waste sites and from tank sources. These situations provide the opportunity for wastes from various sources to commingle in the deep vadose zone. The deep vadose zone is defined as the region below the depth of effective treatment with traditional surface remedies (e.g., surface barriers). Characterization, understanding, and development of effective remedies must be coordinated for this challenging set of problems.
- Transfer lines cross WMA boundaries and connect tank farms with separations facilities and liquid discharge sites (e.g., cribs and trenches). Investigation and remediation of these components should be integrated so that common approaches and solutions can be developed.
- The final closure configuration for tank farms is likely to involve a surface barrier; while the final remedy for near-surface waste sites and pipelines is likely to include some level of removal, treatment as necessary, and disposal. The optimal size of a WMA surface barrier is likely to extend beyond the current physical boundary of the WMAs, and in some cases may include some non-tank-farm wastes within the footprint of a the barrier. Remedy selection for waste sites that may fall within this footprint should be coordinated with WMA corrective action and closure to ensure that efficient and appropriate actions are taken.

The seven SST WMAs have all had past releases of tank waste to the soils within the farms (PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*). Six WMAs, except for WMA C, are under RCRA groundwater assessment monitoring under interim status permits. All of the SST WMAs are going through RCRA corrective action process since soils have been impacted in all WMAs. WMA C appears to have impacted groundwater based on the presence of elevated levels of ^{99}Tc in the groundwater beneath and downgradient from the tank farm (PNNL-16346). Therefore, RCRA corrective actions for the WMAs must be closely coordinated with CERCLA remedial investigations, remedy selection, and remedy implementation for the underlying groundwater operable units and deep vadose zone. WMA-specific work plans will need to describe an integrated approach for these areas.

5.2 OVERVIEW OF CENTRAL PLATEAU OPERABLE UNITS

In addition to the seven tank farm waste management areas, the Central Plateau has both source and groundwater operable units. The groundwater operable units underlie specific regions of the Central Plateau while source operable units are grouped by historical or process similarities rather than geographic proximity. Consequently, the source operable units requiring integration with WMAs varies from location to location.

5.2.1 Groundwater Operable Units

Groundwater beneath the Central Plateau is divided into four operable units for purposes of remedial investigation and remedy selection. The seven WMAs overlie these operable units and will require coordination of corrective action with groundwater investigations and remediation efforts.

- **200-PO-1** is located in the southern half of the 200 East Area. The principal contaminant plumes within 200-PO-1 are the extensive tritium (~127 km^2), ^{129}I, and nitrate that extend generally east from the Central Plateau. WMA A-AX overlay the boundaries of this operable unit.

- **200-BP-5** is located in the northern half of the 200 East Area. The principal contaminant plumes within 200-BP-5 are uranium and ^{99}Tc that extend in a northwest direction from the 200 East Area. WMA B-BX-BY and WMA C overlay the boundaries of this operable unit.

- **200-UP-1** is located in the southern half of the 200 West Area. The principal contaminant plumes within 200-UP-1 are uranium and ^{99}Tc. WMA S-SX and WMA U reside within the boundaries of this operable unit.

- **200-ZP-1** is located in the northern half of the 200 West Area. The principal contaminant is a large plume (~10 km^2) of carbon tetrachloride that underlies most of the 200 West Area. There are also smaller plumes of ^{99}Tc, hexavalent chromium, trichloroethylene, nitrate, ^{129}I, and tritium. WMA T and WMA TX-TY reside within the boundary of this operable unit.

5.2.2 Source Operable Units

Of the ~1000 past practice waste sites on the Central Plateau, there are more than 400 liquid waste sites that received liquid from 200 Area operations, including tank farms. Current and potential impacts to groundwater are dominated by releases from waste sites that received liquid waste. Many of these facilities received hundreds of millions of liters of waste. These facilities will be remediated under CERCLA or RCRA.

Typical waste sites that may be found adjacent to tank farms are described in the following:

- **Cribs** are underground chambered structures used to dispose of large volumes (tens of millions of liters) of radioactive liquid waste. They usually consist of loosely spaced timbers or distribution piping 10-25 ft below ground level, creating a chamber of more than 1000 ft^3. The liquid wastes were discharged to the structure and would then percolate through the underlying soil, often reaching groundwater in less than a year. Often the source of liquid wastes for the cribs surrounding the tank farms was intentionally diverted from tanks through pipelines to the cribs.

- **Trenches** (and especially specific retention trenches) are long, usually narrow, near-surface engineered depressions used to dispose of smaller volumes of radioactive liquid waste. The maximum volume for each trench was calculated so that the resulting volume of liquid in the sediment pores beneath the trench would not exceed about 10% of their original volume. Again, the source of most of the waste was from the tanks.

- **Retention basins** are usually concrete and are used to temporarily hold liquid waste. During this time, solids would settle and some water would evaporate. The liquids would then be transported to another facility, and the settled solids would be disposed.

- **Ditches** were used as transport lines to carry diluted liquid wastes from separations plants to ponds. They are quite evident near U Farm.

- **Solid waste burial grounds** are near-surface depressions into which only solid waste is disposed. The waste could be in the form of debris, cardboard boxes, metal drums, or some other container. Because of the configuration of the waste and the lack of a significant driving force, contaminants from such facilities have not reached groundwater.

- **Pipeline systems** include the extensive network of transfer lines, diversion boxes, catch tanks, valve pits, and related infrastructure that was used to transport process waste between the separations facilities and tank farms and to divert flow to disposal sites that received liquid waste streams. Typically WMAs have a dozen or more individual transfer lines that cross WMA boundaries and connect to waste sites or facilities.

5.3 INTERFACES BETWEEN WASTE MANAGEMENT AREAS AND OPERABLE UNITS

The interfaces between each of the seven waste management areas and the surrounding operable units are shown in Figures 5-1 through 5-7. These maps show the boundaries of each WMA and provide a color code for the type of waste site and operable unit in the vicinity. Pipelines that are assigned to the 200-IS-1 Operable Unit are generally shown in red, although some appear as black lines or in the color of the operable unit of the destination waste site. summarizes the Table 5-1 groundwater and source operable units that are the most likely to require some degree of integration with WMA corrective actions. The potential for commingled deep vadose zone plumes (i.e., from tank farm and non-tank-farm sites) is also described.

5.4 INTEGRATION APPROACHES

Table 5-2 summarizes the principal objectives and approaches for integration between WMAs and operable units. These approaches are described for pipelines (200-IS-1 operable unit), waste sites, deep vadose zone, and groundwater operable units. Integration will be required at all stages of the corrective action and CERCLA processes, i.e., characterization, remedy evaluation, remedy selection, and remedy implementation.

In 2006, RL and ORP entered into a cooperative approach to improve integration of groundwater and vadose zone activities at Hanford. In June 2006, a "Memorandum of Agreement, Interface Agreement for Coordination of Groundwater and Vadose Zone Programs," between RL and ORP was put in place to foster integration. The provisions of this agreement and DOE's continuing implementation will be essential to ensuring that tank farm corrective actions and the actions for adjacent operable units yield consistent and efficient results. In addition to the Memorandum of Agreement, DOE implemented additional processes to foster integration including the following:

- DOE/RL-2007-20, *Hanford Integrated Groundwater and Vadose Zone Management Plan*.
- Multi-project teams to support integration for groundwater and vadose zone work being conducted by multiple projects in a contiguous area, e.g., around WMA B-BX-BY.
- Integrated field work schedules for all groundwater operable units that include tank farms and waste sites (http://www.hanford.gov/cp/gpp/library/programdocs.cfm).

RL/ORP, EPA, and Ecology are considering a series of approaches to streamline decision-making and completion of work at Hanford. The following changes are being considered and implementation of any of these could alter the approaches to integration described in this section.

- **RCRA/CERCLA integration through application of a Corrective Action Document/Record of Decision (CAD/ROD).** This proposed approach, if implemented, would meet both RCRA corrective action and CERCLA remediation requirements in a single document. If applied to WMAs and adjacent waste sites, it is possible that a single process could be used to guide characterization and remedy selection for the tank farms and surrounding waste sites. See Section 3.1.1 for additional detail on the CAD/ROD concept.

- **Geographic closure zones.** Another concept for improving the integration and streamlining of cleanup efforts is the definition of geographic closure zones, some of which would be defined around the tank farms and would include the adjacent waste sites that have been discussed in this section. If implemented, this concept would greatly simplify the interfaces defined in this section by ensuring that a single project and decision process is applied to the zone as a whole, thus eliminating the need to coordinate tank farm efforts with multiple operable unit processes. This approach also minimizes the likelihood of inconsistent remedies for tank farms and adjacent soil waste sites.

- **Deep vadose zone operable units.** This concept would consolidate the deep vadose zone areas of the Central Plateau in a manner analogous to groundwater operable units and would recognize that contaminant plumes have, in many cases, commingled from multiple sources. In addition, deep vadose regions will require specialized characterization and remediation approaches that are best applied on a plateau-wide basis rather than on a waste site or tank farm specific basis. This approach, if implemented, would ensure the integration of tank farm and non-tank-farm deep vadose zone problems and simplify the actions described in Table 5-2.

If any or all of these approaches are agreed to by the Tri-Parties, significant improvements would result in the ability to integrate efforts between tank farm corrective actions and non-tank-farm operable units.

Figure 5-1.
WMA A-AX Pipelines and Operable Units

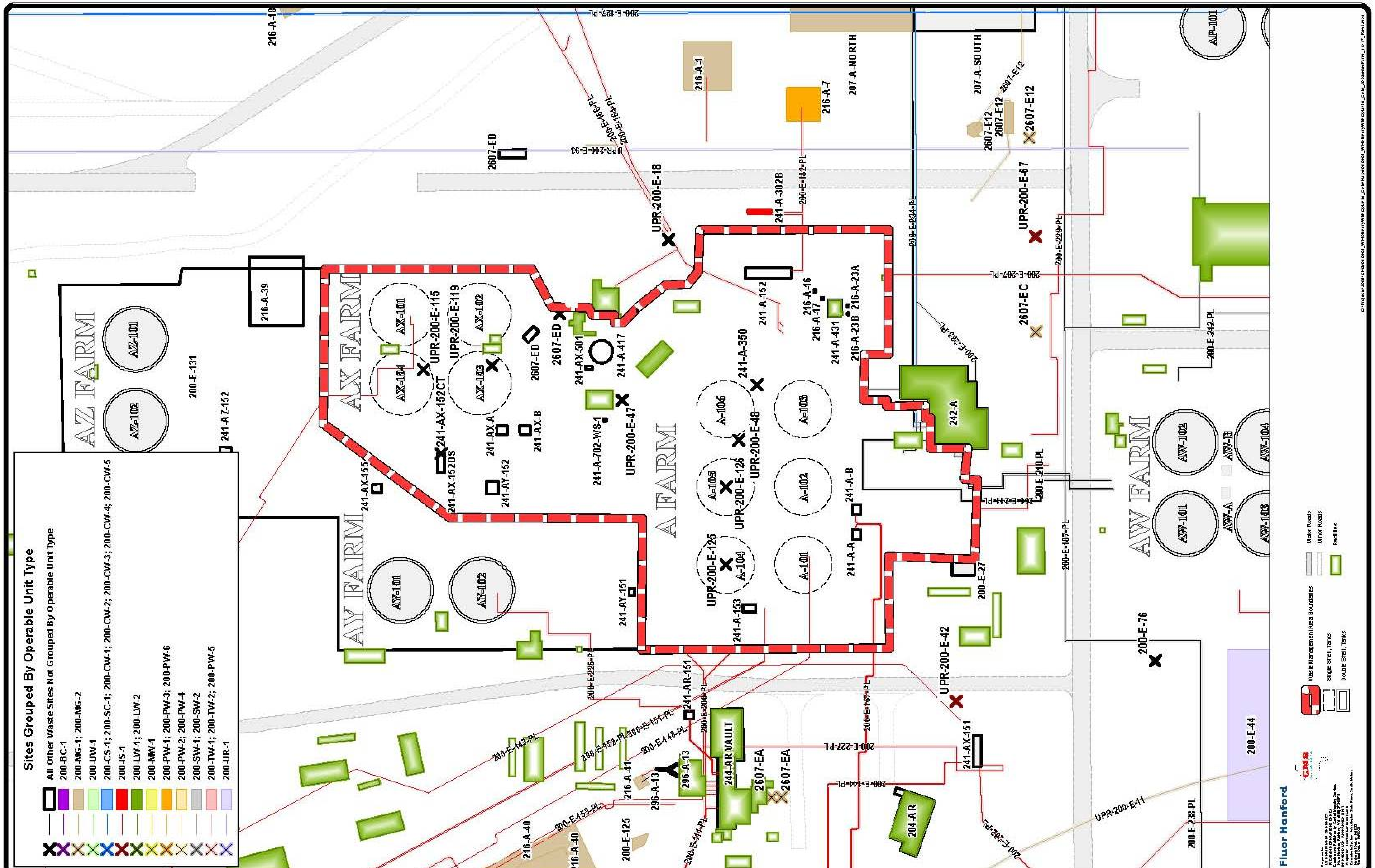


Figure 5-2.
WMA B-BX-BY Pipelines and Operable Units

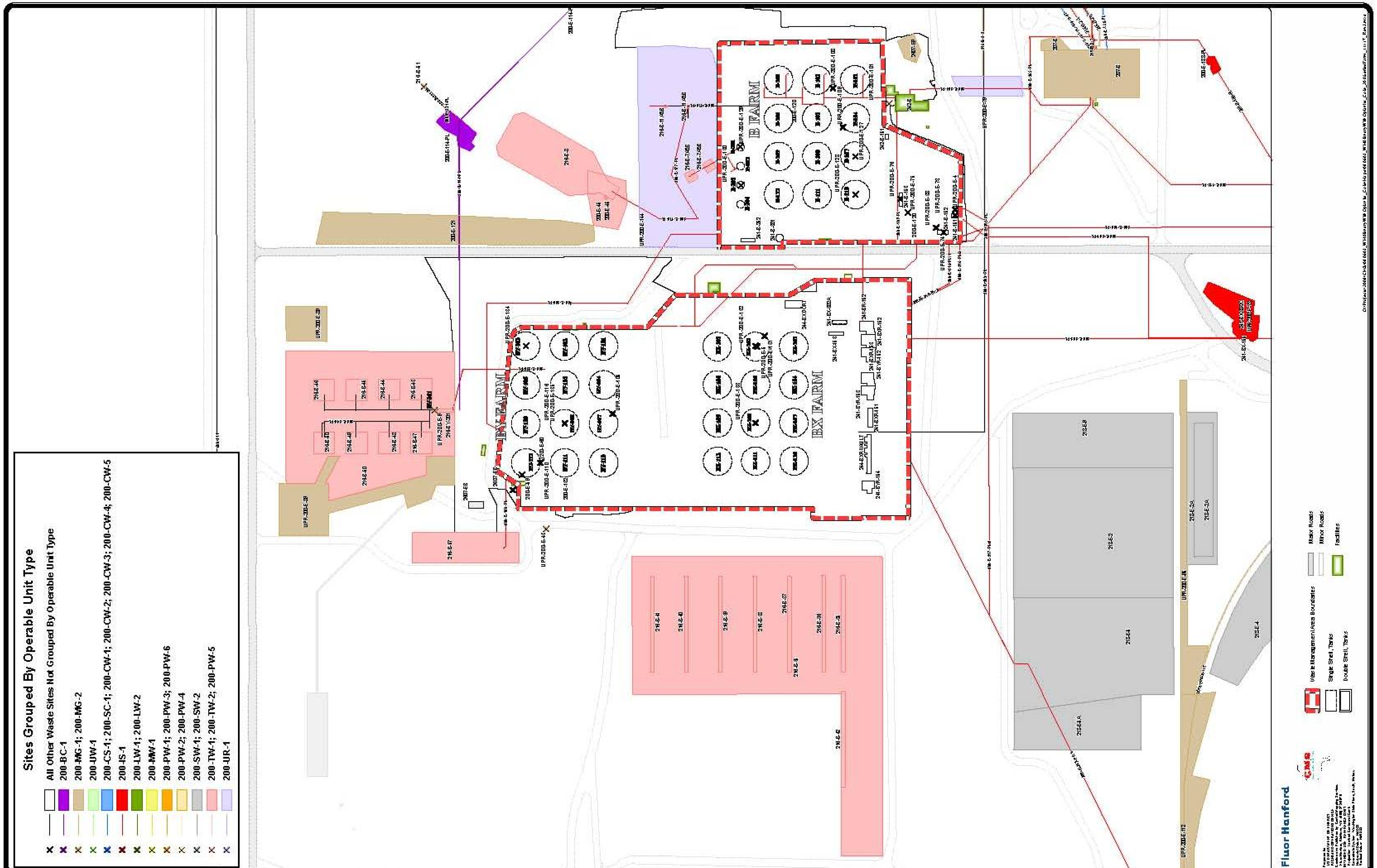


Figure 5-3. WMA C Pipelines and Operable Units

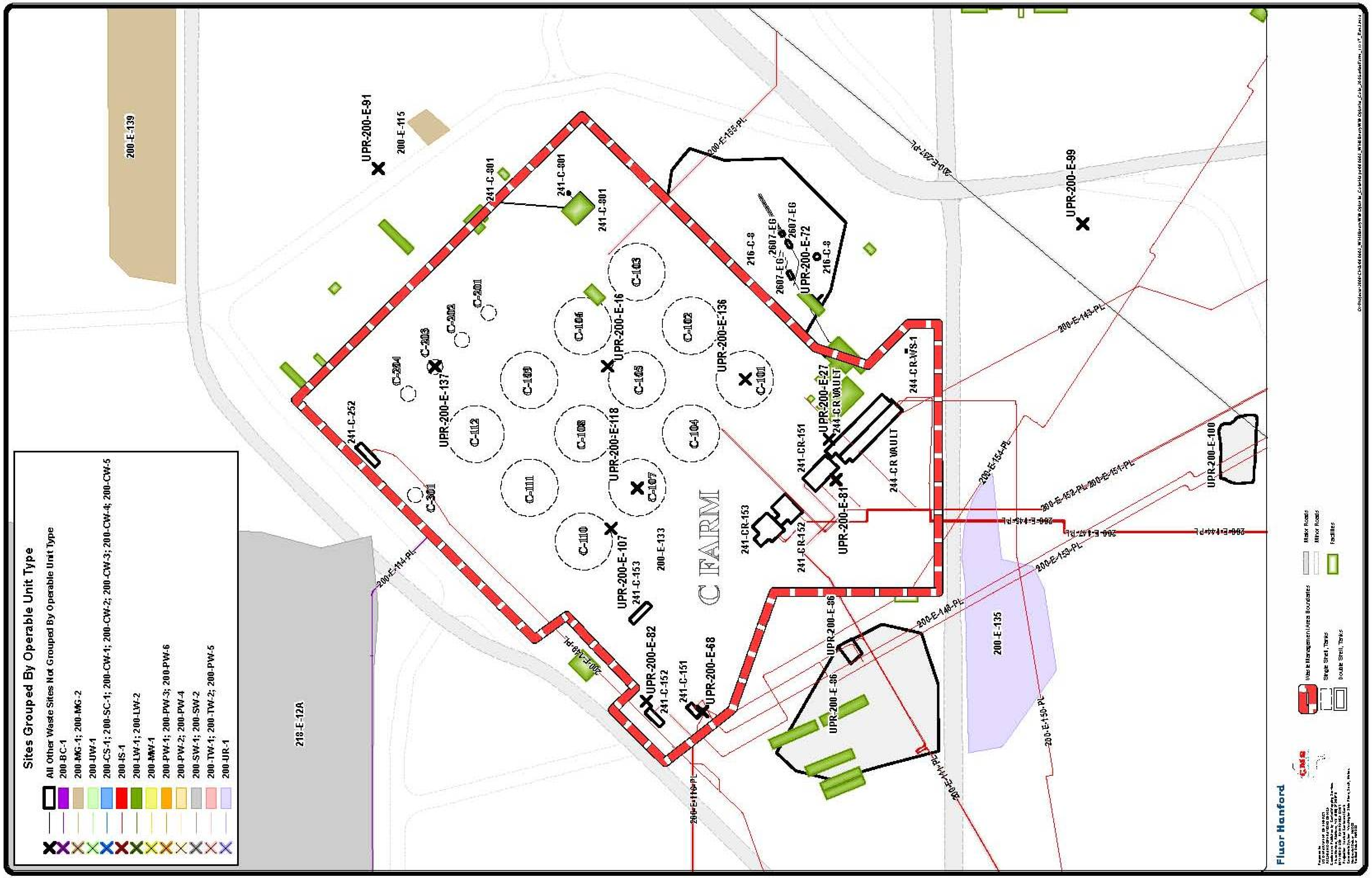


Figure 5-4.
WMA S-SX Pipelines and Operable Units

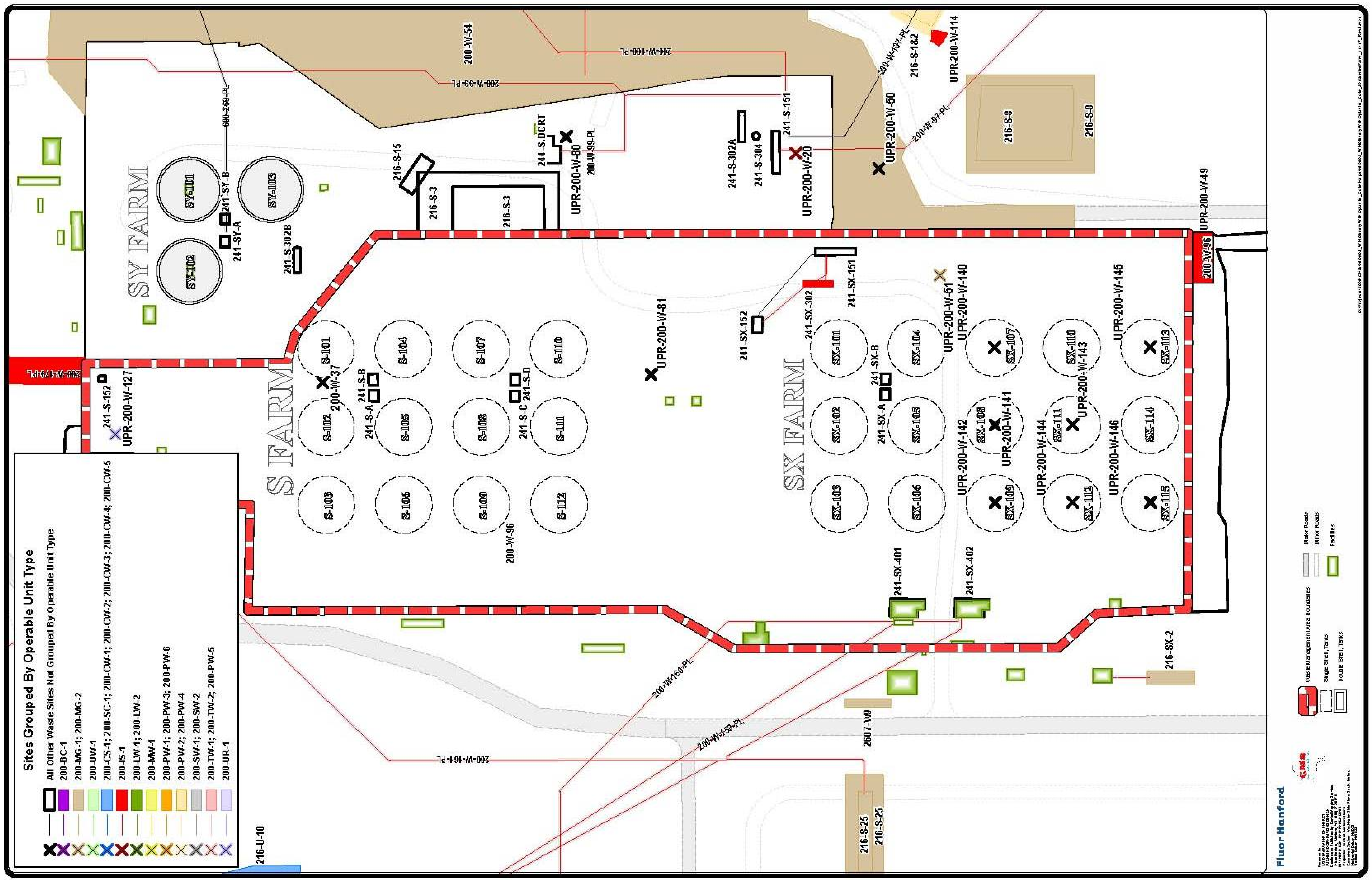


Figure 5-5.
WMA T Pipelines and Operable Units

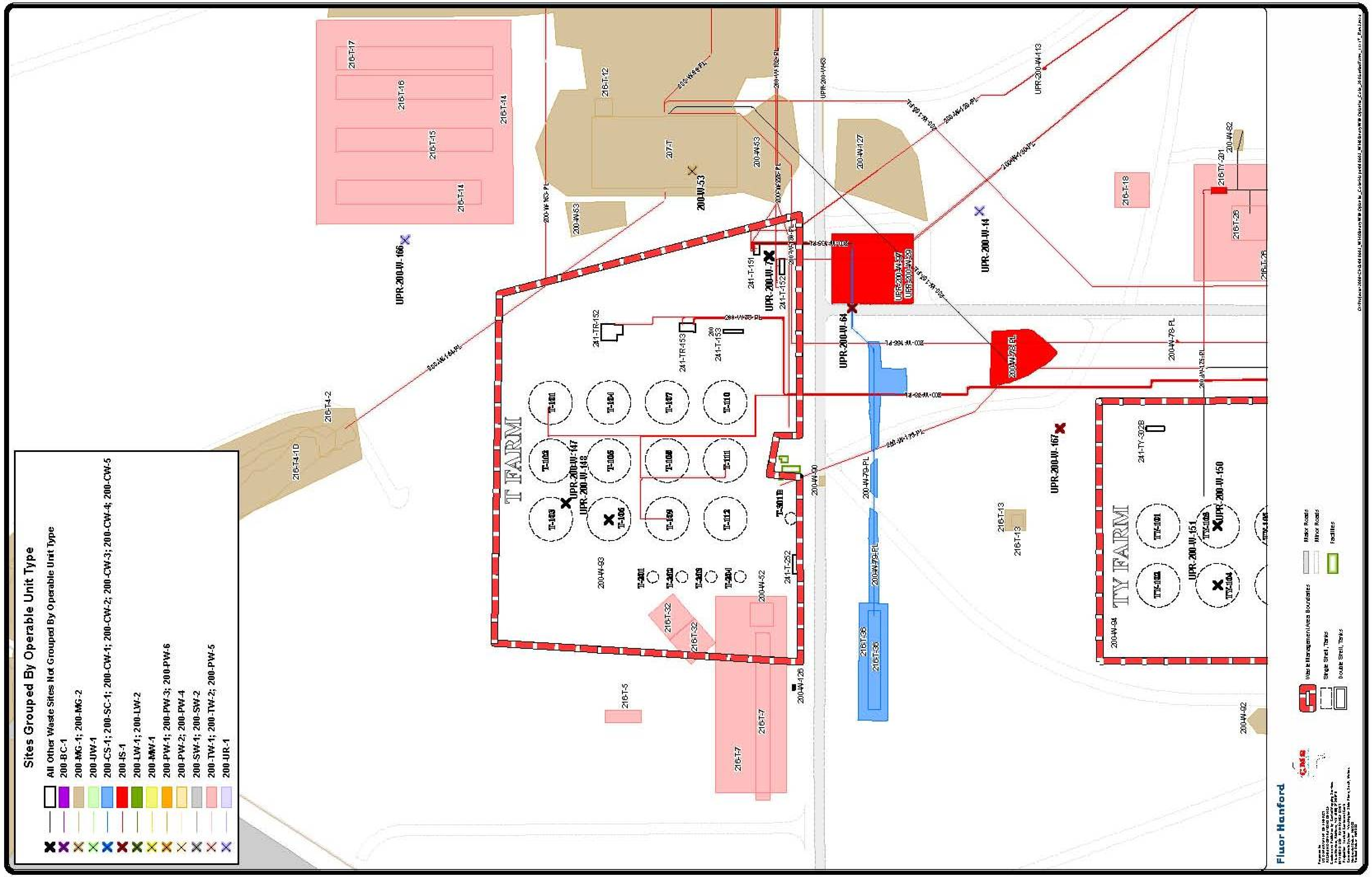


Figure 5-6.
WMA TX-TY Pipelines and Operable Units

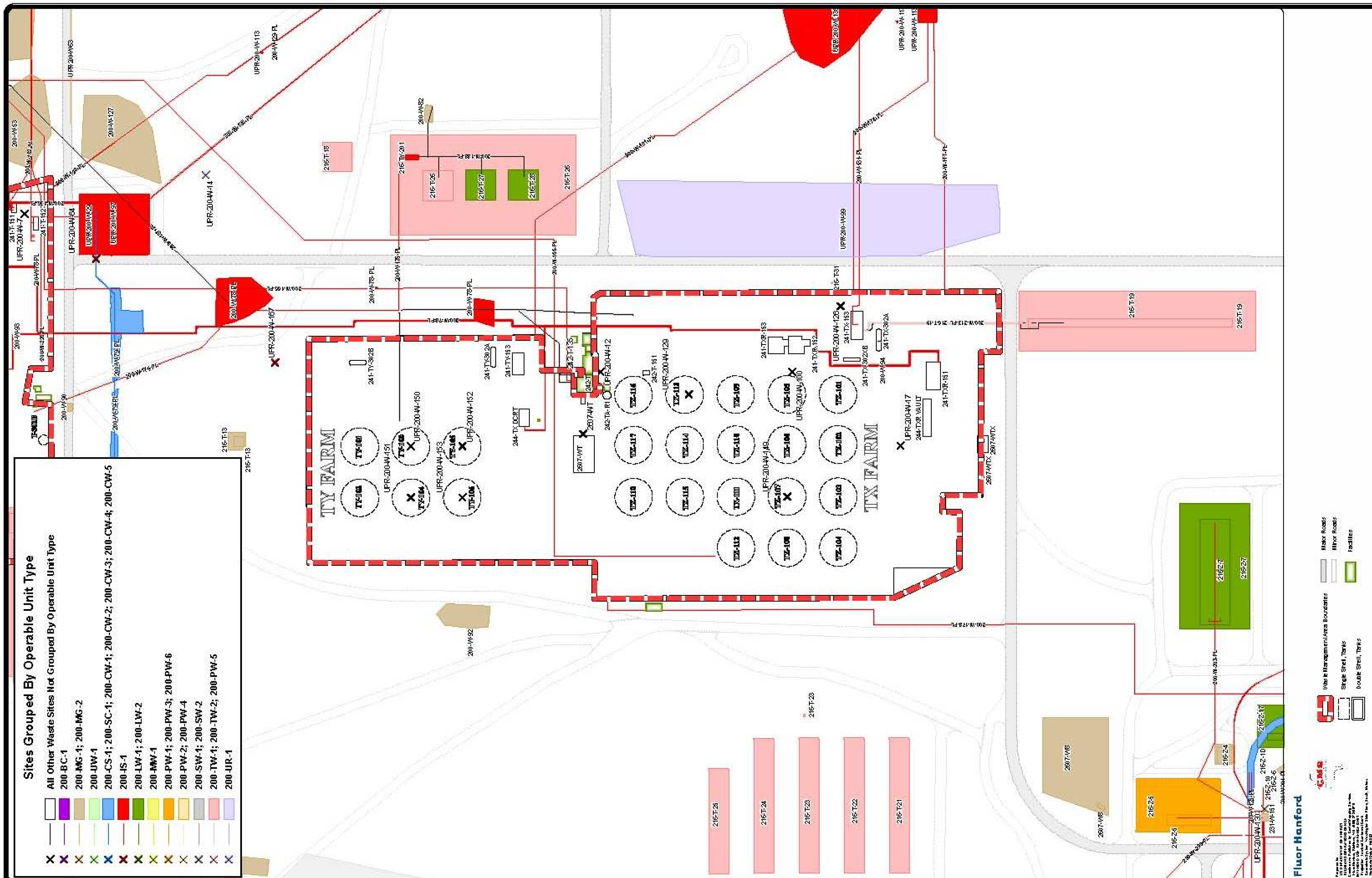


Figure 5-7.
WMA U Pipelines and Operable Units

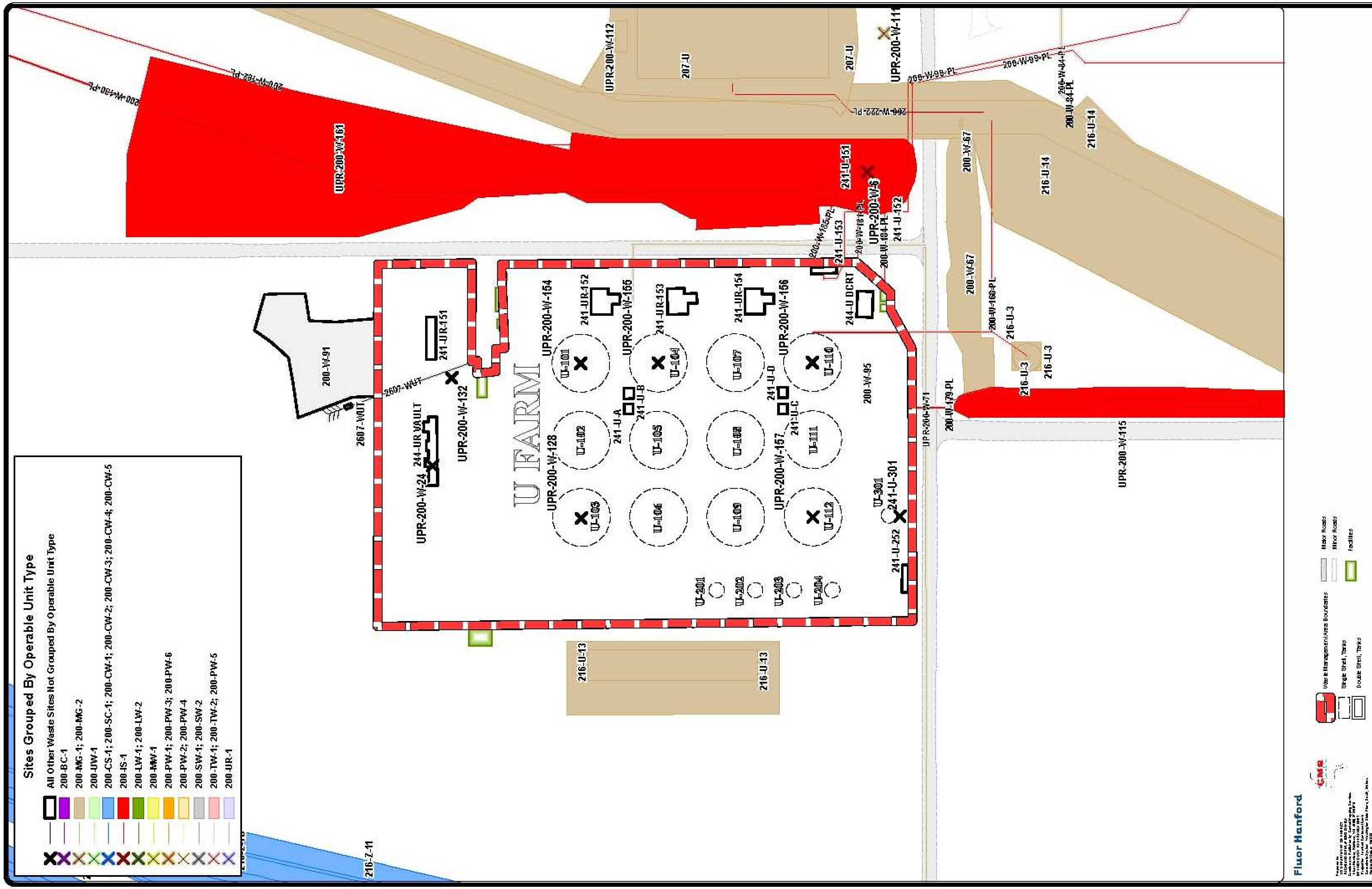


Table 5-1. Principal Interfaces between Waste Management Areas and Adjacent Operable Units (2 sheets)

Waste Management Area	Groundwater	Source Units		
		Waste Sites	200-IS-1 and Related Tank Infrastructure	Deep Vadose Zone
A-AX (See Figure 5-1)	200-PO-1	Numerous past liquid discharge sites (cribs and trenches) are immediately adjacent to this WMA. Close coordination will be required with 200-MG-1/2, 200-PW-3, and 200-PW-4 actions.	~10 200-IS-1 pipelines cross into the WMA and will require coordination between WMA corrective action/closure and IS-1 actions. The WMA also is adjacent to the 242-A evaporator and many active transfer lines and DST tank farms. There are 19 unplanned release sites in the A-AX area, but few, if any, are significant.	Current information indicates the potential commingled (tank farm and non-tank farm) deep vadose zone problem, potentially involving 200-PW-3 and 200-MG-1 waste sites.
B-BX-BY (See Figure 5-2)	200-BP-5	Numerous past practice liquid discharge sites (cribs and trenches) are immediately adjacent to this WMA. Close coordination will be required with 200-TW-1 and TW-2 actions.	~10 200-IS-1 pipelines cross into the WMA and will require coordination between WMA corrective action/closure and IS-1 actions.	Current information indicates the strong likelihood of a commingled (tank farm and non-tank farm) deep vadose zone problem, involving 200-TW-1 waste sites.
C (See Figure 5-3)	200-BP-5	Few, if any, significant waste sites.	~10 200-IS-1 pipelines cross into the WMA and will require coordination between WMA corrective action/closure and IS-1 actions.	Current information does not indicate a potential commingled (tank farm and non-tank farm) deep vadose zone problem.
S-SX (See Figure 5-4)	200-UP-1	Few, if any, significant waste sites. Principal interface will be with cribs on the east and west side of the WMA that are part of the 200-MG-1/2 and the 200-PW-2 operable unit.	<10 200-IS-1 pipelines cross into the WMA and will require coordination between WMA corrective action/closure and IS-1 actions. The WMA is also adjacent to active transfer lines and a DST tank farm.	There is the potential for a commingled (tank farm and non-tank farm) deep vadose zone problem involving a crib (200-MG-2) or other waste sites. Corrective actions may need to be coordinated with the 200-UW-1 groundwater operable unit.

Table 5-1. Principal Interfaces between Waste Management Areas and Adjacent Operable Units (2 sheets)

Waste Management Area	Groundwater	Source Units		
		Waste Sites	200-IS-1 and Related Tank Infrastructure	Deep Vadose Zone
T (See Figure 5-5)	200-ZP-1	There are three non-tank farm waste sites partially or completely within the WMA fence (200-TW-2). Several additional waste sites are in close proximity to this WMA and will require coordination between WMA corrective action/closure and 200-TW-2, 200-MG1/2 and 200-SC-1.	~10 200-IS-1 pipelines cross into the WMA and will require coordination between WMA corrective action/closure and IS-1 actions.	Current information indicates the strong likelihood of a commingled (tank farm and non-tank farm) deep vadose zone problem, potentially involving 200-TW-2 wastes.
TX-TY (See Figure 5-6)	200-ZP-1	Several past liquid discharge sites (cribs and trenches) are immediately adjacent to this WMA. Close coordination will be required with 200-TW-1 and TW-2 actions. Other potential coordination may be required with 200-PW-1 and 200-MG-1/2 sites.	~10 200-IS-1 pipelines cross into the WMA and will require coordination between WMA corrective action/closure and IS-1 actions.	Current information indicates the potential of a commingled (tank farm and non-tank farm) deep vadose zone problem, potentially involving 200-TW-2 wastes.
U (See Figure 5-7)	200-UP-1	Ditches to the east and west of the WMA released large quantities of diluted waste. Principal interface will be with 200-MG-1/2 waste sites.	~5 200-IS-1 pipelines cross into the WMA and will require coordination between WMA corrective action/closure and IS-1 actions.	Current information (particularly high moisture content below the WMA) indicates a potential commingled (tank farm and non-tank farm) deep vadose zone problem.

Table 5-2.
Integration Approaches for Waste Management Areas and Operable Units

Interface	Interface Objective	Characterization	Remedy Evaluation	Remedy Selection	Remedy Implementation
IS-1 Operable Unit (transfer lines and related components)	• Establish and implement rules for assigning components to WMA or IS-1. • Define boundary location and conditions for transfer lines that cross WMA boundaries.	• Establish consistent characterization methods, protocols and requirements for components that are inside and outside of WMA boundaries. • Support the complete identification of transfer line components to fully populate the IS-1 Operable Unit. • Provide a mechanism for sharing characterization data for transfer line components with IS-1 Operable Unit.	• Ensure that treatability testing, remedy screening, and remedy evaluation efforts are coordinated between WMA needs and IS-1 Operable Unit needs.	• Coordinate remedy selection for contiguous pipelines that are addressed by both RCRA closure/corrective action inside the WMA and by IS-1 Operable Unit outside the WMA boundary.	• Coordinate remedy implementation for contiguous pipelines that are addressed by both RCRA closure/corrective action inside the WMA and by IS-1 Operable Unit outside the WMA boundary.
Waste site operable units	• Provide clear interface with WMA RCRA closure and corrective actions as a few waste sites are inside of WMA fencelines and many other sites are adjacent to tank farms.	• Coordinate logistics and access for sampling of waste sites inside and adjacent to tank farms. • Ensure that DQOs and SAPs reflect potential information needs that could support WMA corrective action and closure. WMA and waste site DQOs/SAPs should be prepared jointly, when possible.	• Maintain awareness of treatability testing that is applicable to waste sites that are inside or adjacent to WMAs. • Waste sites will need to be cognizant of likely WMA surface barrier remedy to fairly evaluate alternatives	• Need to consider the use of contingent remedies for early waste site decisions to accommodate potential integration with final WMA closure configuration.	• Remedy implementation for adjacent waste sites will need to be coordinated with closure implementation for WMAs. • Waste site remedies will likely be at least partially delayed until WMA closure is achieved
Deep vadose zone investigations	• Ensure that deep vadose zone investigations and remedies provide holistic solutions to this cross-cutting problem. • Deep vadose zone work needs to support development of a comprehensive remedy for past releases. Provide clear interface with WMA RCRA closure and corrective actions.	• Coordinate logistics and access for sampling of deep vadose zone regions beneath tank farms. • Ensure that DQOs and SAPs reflect potential information needs that could support WMA corrective action and closure. • Recognize that deep vadose zone characterization will probably have a shallow component that can directly support tank farm CMS needs.	• Deep vadose zone treatability studies will need to support past tank leak sources in addition to non-tank farm sources. • Deep vadose zone remedies will probably need to be integrated with near surface source remediation. A single action will probably not be sufficient.	• Remedy selection will probably require integration with WMA closure configuration decisions. Deep vadose zone remedy may need to be contingent if the WMA closure decisions lag significantly in time, or if the deep vadose zone remedy could be affected by closure actions, or vice versa.	• Remedy implementation for underlying deep vadose zone plumes will need to be coordinated with closure implementation for WMAs. Some closure actions could prevent, or make difficult, some deep vadose zone actions.
Groundwater operable unit	• Groundwater remediation and decision-making needs to support RCRA closure of the WMA.	• Coordinate logistics and access for sampling of groundwater regions beneath tank farms. • Ensure that DQOs and SAPs reflect potential information needs that could support WMA corrective action and closure. • Recognize that groundwater characterization will probably have a shallow component that can directly support tank farm CMS needs.	• CERCLA process used for remedy evaluation.	• CERCLA process used for remedy selection. WMA RCRA Closure and Permit will reference CERCLA ROD, if necessary.	• Interim actions for groundwater remediation could be implemented to contain emerging plumes from past tank leaks and enable deep vadose zone and tank farm corrective action efforts to find more permanent remedies.

6. CORRECTIVE MEASURES ALTERNATIVES AT SINGLE-SHELL TANK WASTE MANAGEMENT AREAS

This chapter discusses aspects associated with the identification of corrective measures for SST WMA soil contamination.

6.1 SHALLOW VERSUS DEEP VADOSE ZONE TECHNOLOGY DEVELOPMENT

The effectiveness of a surface barrier at WMA T in retarding the movement of contaminants in the deep vadose zone, before they reach groundwater, only extends to a certain depth approximately 60 to 75% of the distance from ground surface to the water table. The depth varies depending on the infiltration and recharge rate prior to the placement of the barrier, and the distance between the contaminants and the water table (SGW-34059, *Effect of Waste Depth on Barrier Effectiveness*). In 200 West Area, this implies the deep vadose zone starts at about 180 ft bgs (RPP-33431) and for 200 East Area about 225 ft bgs (SGW 34059). Below this depth, nonadsorbing contaminants will continue to mobilize to groundwater at the same rate as a no-action alternative. Below this depth, nonadsorbing contaminants will continue to mobilize to groundwater at the same rate as a no-action alternative. Above this depth, the effectiveness of the surface barrier depends on the depth of the contamination and its proximity to the water table. Even with a surface barrier in place, this contamination will ultimately reach groundwater, but at a slower rate and at lower concentrations than without a barrier. Depending on the contaminant dispersion and diffusion in the vadose zone, the groundwater concentration may ultimately still exceed groundwater protection standards. The size of the barrier relative to the size of the contaminant plume in the vadose zone also affects barrier performance but to a much lesser degree (RPP-33431).

An evaluation of the effectiveness of an interim barrier at WMA C, where mobile contaminants appear to be approximately 46 m (151 ft) bgs and 32 m (105 ft) above the water table, indicates that the peak concentration of mobile contaminants in groundwater could be reduced by almost 60% (DOE/ORP-2005-01). Evaluations of barrier effectiveness at WMA T, where mobile contaminants appear to be approximately 35 m (115 ft) and 36 m (118 ft) above the water table, indicates that the interim barrier there could reduce peak concentrations by 40% (RPP-33431). At WMA T, the evaluation of barrier effectiveness indicated that the maximum depth of any discernable effectiveness extended to approximately 50 m (164 ft) bgs, but that contaminants located below 40 m (131 ft) bgs experienced less than 30% reduction in peak concentration in groundwater.

Additional corrective measures will need to be analyzed for the zones of contamination that containment and surface removal do not affect. This is the objective of HFFACO Milestone M-015-50, which directs DOE to submit to Ecology and EPA a treatability test plan for remediation of ^{99}Tc and uranium in the deep vadose zone. Because this effort is being conducted under a separate milestone, DOE contractor, and schedule, it is expected that an alternatives analysis generated in either a separate SST WMA CMS or CERCLA operable unit feasibility study will define cleanup actions in the WMA deep vadose zone. A summary of ongoing and planned deep vadose zone treatability testing is discussed in Section 6.3.

6.2 SCREENING WASTE MANAGEMENT AREAS CORRECTIVE MEASURES ALTERNATIVES

The first step in determining corrective measures alternatives for SST WMA deep and shallow vadose zones involves identifying all possible remedial technologies that are applicable to the type of contaminants and conditions found at the waste site. This step was accomplished in the Phase 1 master work plan, Appendix E (DOE/RL-99-36). The technologies are then screened to reduce the number of cleanup/treatment alternatives that will be evaluated in detail. The screening evaluation considers the technologies based on effectiveness, implementability, and cost. This screening step was carried out in RPP-ENV-34028, *Central Plateau Vadose Zone Remediation Technology Screening Evaluation*, which has taken into account the viability of different technologies applicable to deep and shallow vadose zones. From this screened set of technologies, as well as any other technologies determined to be viable in the future, corrective measures alternatives will be assembled and evaluated in detail and compared to one another in the CMS.

Recommended remediation technologies in RPP-ENV-34028 include the following:

- Interim surface barriers
- Surface barriers
- Subsurface barriers
- Permeation grout
- Gas-phase advection/delivery
- In-situ phosphate/calcite immobilization
- Removal, treatment, and off-WMA disposal

6.3 TREATABILITY TESTS/DEMONSTRATIONS

Treatability tests and demonstrations are conducted to obtain data in support of corrective measures studies to obtain information to evaluate technology effectiveness, implementability, safety, and cost. Three examples are “hot spot” removal, pipeline demonstrations, and deep vadose zone treatment.

“Hot spot” soil clean up tests/demonstrations would provide cost, schedule, and engineering data to evaluate waste removal and treatment alternatives for shallow contamination. The effectiveness of some remove and treat options may not require additional testing. However, data are needed to evaluate implementability, safety and cost for waste removal and treatment options, particularly for safe and effective excavation of highly radioactive (>1,000,000 pCi of

^{137}Cs/g of soil) soils. In addition the treatability test could be instrumental in early cleanup of contaminated waste sites (e.g., UPRs in C Farm).

As part of the 200-IS-1 Operable Unit work plan, a sampling program was developed to evaluate pipeline remediation alternatives (DOE/RL-2002-14). Sampling locations were planned near the UPR 200-E-86, just outside of WMA C, to address the demonstration of in-situ sampling techniques for piping, sampling of adjacent soil contamination, and pipeline removal and decontamination activities. Information on cost, worker risk, and conceptual model refinement will be developed as part of this work, and a second phase of sampling will be conducted depending on the findings.

Treatability studies to evaluate the effectiveness of deep vadose zone in-situ technologies are planned by RL and the Project Hanford Management Contractor. Following transition in FY 2009, treatability study planning will be supported by the Plateau Remediation Contractor. Results of these tests will be used to further assess tank farm technologies. DOE/RL-2007-56, *Deep Vadose Zone Treatability Test Plan for the Hanford Central Plateau*, provides a strategy and a framework to evaluate specific vadose zone remediation technologies and includes a comprehensive set of laboratory, modeling, and field tests. While the testing may include a field test at a specific waste site, characterizing and remediating a waste site are not goals of this testing. The testing will be conducted to obtain technical performance data for select technologies and thereby provide a technical basis to evaluate the technologies as part of a remedy in subsequent remedial alternative assessments. The strategy focuses on testing the most promising in-situ treatment and surface barrier technologies using previous technology evaluation efforts at Hanford as a basis. Six groups of technologies were identified; each has potential for use at Hanford as a component of a remedy for the deep vadose zone.

DOE/RL-2007-56 provides a description of the overall approach for testing selected technologies. Specific activities are planned for testing, focused on ^{99}Tc and uranium. Additional information is also provided in appendixes about specific activities planned for testing, focused on ^{99}Tc and uranium. Testing of the desiccation technology will occur first, with an initial emphasis on ^{99}Tc contamination. Desiccation testing is also relevant to other contaminants and will provide key information about applying a gas-phase technology in the vadose zone at Hanford. In parallel with these efforts, testing of reactive gas technology will be conducted with an initial emphasis on uranium contamination. Testing of reactive gas technology is initially focused on laboratory and modeling efforts and will use information gained during desiccation testing to guide subsequent field testing efforts as appropriate.

Concurrent with the phased treatability testing will be a series of ongoing related DOE and Hanford activities. These include uranium treatability testing in the 300 Area, a 300 Area Integrated Field Research Center, a variety of ^{99}Tc and uranium remediation studies performed at universities and national laboratories throughout the country, and a ^{99}Tc groundwater remediation technology demonstration at Hanford. The information derived from these activities will feed into the overall technology evaluation process.

6.4 PHASE 2 INTERIM MEASURES

Interim measures completed during Phase 1 are summarized in Section 2.3. The primary goal of these interim measures was to minimize the migration of existing soil contamination from past tank farm releases by controlling water.

Interim barriers are particularly effective for waste sites with surface conditions that maximize infiltration due to lack of soil and vegetation such as the tank farms. Fate and transport modeling results presented in the SST PA indicate that past releases at WMAs are by far the largest contributor to groundwater impacts. The unvegetated, gravel/cobble surface maintained during operations maximizes the infiltration of natural precipitation and vadose zone recharge (estimated up to 100 mm/yr). An interim barrier using a spray-on polyurea liner technology was recently completed in T Farm (Figure 6-1) as a demonstration project. The effectiveness of the barrier will be monitored over the next couple of years (PNNL-16538, *T Tank Farm Interim Surface Barrier Demonstration – Vadose Zone Monitoring Plan*).

Figure 6-1. Aerial View of the T Farm Interim Surface Barrier in April 2008

The need for additional interim measures may be identified as emerging information is obtained and corrective action strategies progress. Future interim measures may include the following.

- Isolate buried pressurized waterlines (not cut and capped in Phase 1).

- Construct or upgrade run-on control structures if existing control structures are inadequate.
- Construct interim barriers in SX-Farm, TY-Farm, U-Farm, and/or TX-Farm. Conduct engineering evaluations to further evaluate future barrier locations and design over selected vadose zone plumes.
- Decommission groundwater wells and drywells.

The need for additional interim measures will be reviewed annually by Ecology and DOE in accordance with HFFACO Milestone M-45-56. Additional interim measures will be documented through establishment of interim milestones and target dates.

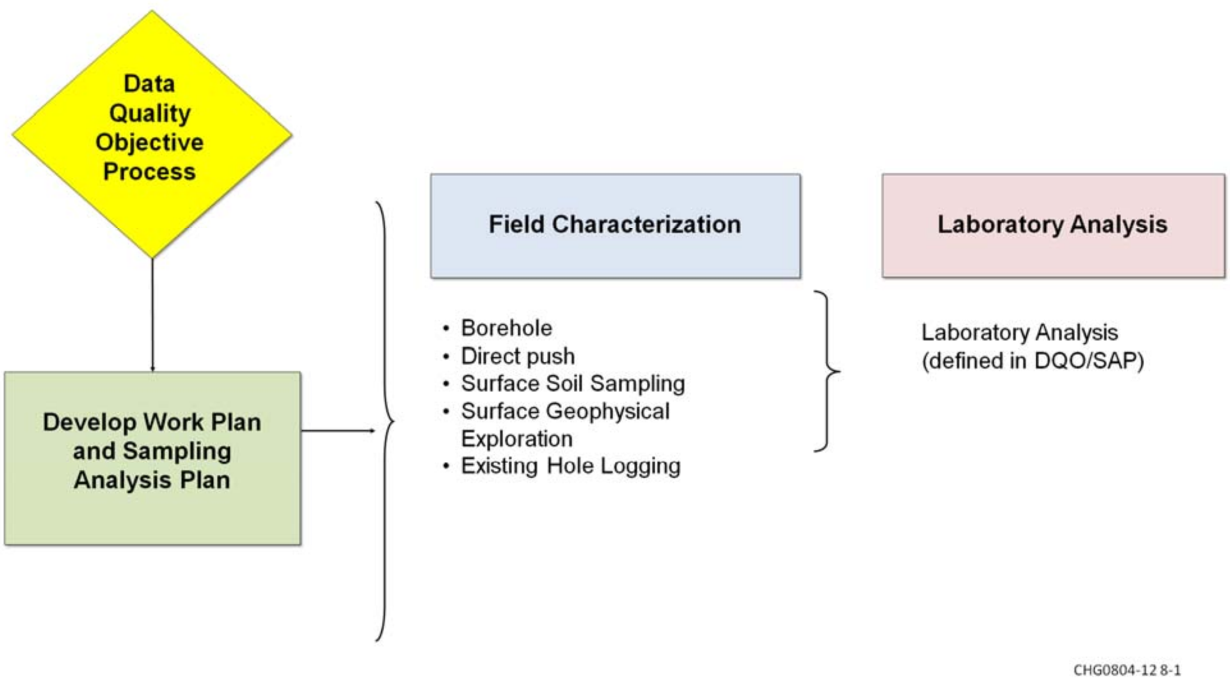
Interim measures may consist of one or more of three phases: design, construct, and monitoring. Design and construct activities will be performed in accordance with applicable project management procedures. A monitoring plan and report(s) will be prepared for monitoring to be conducted.

7. CHARACTERIZATION TECHNOLOGIES IN PHASE 2

7.1 DECISION PROCESSES FOR FIELD CHARACTERIZATION

Figure 7-1 shows the overall process for field characterization. The first step for all of the characterization processes is to determine and document the data requirements. This is performed through the DQO process, the foundation on which Phase 2 vadose zone characterization at the WMAs will be conducted. The process defines a strategic planning approach based on the scientific method that is used to prepare for a data collection activity. It provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect. Using the DQO process at each of the WMAs ensures that the type, quantity, and quality of environmental data used in decision-making will be appropriate for the intended application. In addition, it helps to guard against committing resources to data collection efforts that do not support a defensible decision.

Figure 7-1. Field Characterization Processes



RPP-RPT-38152 is the first Phase 2 DQO to be prepared. RPP-RPT-38152 was prepared using a facilitated process that involved DOE, EPA, Ecology, Tribes, stakeholders, and contractors. The process included meetings and workshops to discuss and obtain input on what are the decisions to be made from the RFI/CMS process and what are the data needed to support the evaluations that will assist in the decision-making process. RPP-RPT-38152 follows the seven-step process defined in EPA guidance and tank farm contractor procedures. Both the document and this process establish a working template (subject to change based on WMA-specific conditions) for how future Phase 2 DQOs for other WMAs will be completed.

Step 7 of the DQO process, Optimizing Data Collection Design, integrates the previous six steps of the process to define the most resource-effective methods to collect data that meet the data goals. This includes determining the most appropriate technology(ies) for collecting environmental data in the most resource-effective manner. Technology selection for data collection includes consideration of the technical characteristics of the contaminants and media, balancing sample size and measurement performance, and physical site constraints. In some cases where there is a relatively high spatial or temporal variability, it may be more cost-effective to use less expensive and less precise methods so that a relatively large number of samples can be taken. In other cases where contaminant distribution is relatively homogeneous or the action level is very near the method of detection limit, it may be more cost effective to use more expensive and more precise and/or more sensitive methods and collect fewer samples. Part of optimizing the data collection design in Step 7 involves evaluating the design options based on cost and ability to meet the DQO constraints. Selection is based on the one that provides the best balance between cost (or expected cost) and ability to meet the DQOs. Ultimately the evaluation and selection of sampling technologies must ensure the data objectives are met within the accepted error tolerances to support the decision process.

The WMA DQO requirements define the scope of the characterization effort and define candidate sampling technologies, the number of samples expected to be collected, and the candidate sample locations. These may be further discussed and refined in the WMA work plan or interim measure proposal. Final sampling locations will be established at the time of deployment of the selected sampling equipment and will be based on the limitation of the sampling technology and actual field constraints.

7.2 CHARACTERIZATION TECHNOLOGIES

A variety of tools are available that can be used to characterize the vadose zone. RPP-ENV-38838, *Tank Farm Vadose Zone Program Characterization Processes*, contains descriptions of the following tools and provides a summary of how each is used, how it relates to other characterization technologies, what are the benefits and limitations of the technology, and what future work may be performed during Phase 2 to further refine its use.

- Boreholes
- Direct push
- Geophysics using wells and laterals
- Surface geophysical exploration
- In-situ measurements
- Characterization technologies for near-surface/surface samples
- Non-tank-farm measurements

- Laboratory analyses
- Literature searches

The Phase 2 RFI/CMS process is in the early stages of implementation and the characterization effort is focused on WMA C. Currently the direct push technology is being deployed for vadose zone sample collection. As the Phase 2 characterization is expanded into other areas, other sampling technologies may be deployed.

In general, SGE and past geophysical logging results provide a guide for direct push locations, which in turn guide locations where boreholes may be needed. SGE also guides locations for surface sampling to target areas of potential contamination. Future logging and boreholes would be used to characterize deep vadose zone contamination. Decision processes for each of the characterization tools are described in RPP-ENV-38838.

Surface geophysical exploration has been applied in limited locations (WMA T, TX-TY, U, C, and B-BX-BY).

The process of confirming characterization tools such as high resolution resistivity (HRR) or SGE both electrical resistivity tools, is an integrated process that involves ORP and RL. Data to confirm the HRR and SGE tools are initially being obtained at the BC cribs and trenches and at WMA-C as described in Sections 7.2.1 and 7.2.2.

7.2.1 Confirmation of HRR at BC Cribs

Activities required to "ground truth" the HRR data at BC cribs are specified in SGW-32480, *Data Quality Objectives Summary Report for the BC Cribs and Trenches Area – High-Resolution Resistivity Correlation*." Three key requirements of the DQO were to

- Estimate the degree of correlation between HRR data and the distribution (i.e., concentration and location) of targeted COC in the vadose zone.
- Determine whether HRR and analytical data correlate sufficiently to use HHR data to assist in updating the existing CSM and evaluating remedial alternatives.
- Determine whether HRR data interpretations are useful for guiding vadose zone sediment sampling for targeted COC.

The key focuses of the HRR ground truthing efforts were to (1) gather and characterize vadose zone sediment samples from the boreholes that were strategically located where resistivity anomalies of varying intensity were identified through electrical resistance ground surface geophysical surveys, and (2) measure the concentrations of COC and develop the distribution of mobile risk-based COC in sediment samples from the boreholes. SGW-32480 explains the process for evaluating HRR geophysical interpretations by comparing the vertical and lateral extent of the HRR plume to the vadose zone pore water concentrations of major cations and anions and mobile COC in the vadose zone of the BC cribs and trenches area.

In the interest of integration and consistency between contractors, the Tank Operations Contractor (TOC) SGE work plans and reports are approved by ORP and RL and TOC has reviewed and worked with the Plateau Remediation Contractor on the BC crib report.

7.2.2 Confirmation of SGE in WMAs

Confirming SGE findings is a significant and important aspect of the Phase 2 characterization effort. Initial confirmation efforts will focus on WMA C. Analysis requirements and plans will be described in the Phase 2 WMA C DQO (RPP-RPT-38152) and work plan. Confirmation of SGE will include the following:

- Confirm as a method to screen areas to push and sample.
- Confirm for verifying plume depth. SGE can, through WTW surveys, provide an areal extent of likely contamination and thus guide the placement of interim surface barriers. If SGE is to be used to define the three-dimensional distribution of contaminant plumes, then significant additional sample collection and analysis would be performed to better define what is being “seen” by the approach.
- Confirm utility of installing deep electrodes.
- Assess/confirm correlation of SGE results with analytical data or as an indicator of specific analytes present.

Definition of resistivity anomalies and use of SGE remains an open question pending collection of data to be obtained during additional SGE analyses and drilling and sampling at WMA C. As data from sampling and analyses are made available, reanalysis of existing data sets should be performed with the new information incorporated into the modeling.

The subsurface in the WMAs contains extensive buried infrastructure that supported waste transfers in and out of the tank farms. This infrastructure interferes with the analysis and interpretation of SGE data. Electrodes were placed at depth in WMA C in the vicinity of UPRs -81, -82, and -86 to provide a means of interrogating the vadose zone from beneath the tank farm infrastructure (e. g., pipelines, vaults, and diversion boxes) to test the assumption that buried electrodes will provide significant improvement in SGE results.

The SGE may prove to have broad application across WMA C. However, as with any technology, there may be limitations in where and how it can be deployed in other WMAs. The SGE may need to be evaluated at each WMA taking into consideration the characteristics of the vadose zone and the composition of the waste released. As the Phase 2 process continues to be implemented beyond WMA C, sampling technologies will continue to be assessed and selected through the DQO process to optimize the sampling design.

Requirements documents to confirm application of SGE in the WMAs will be approved by ORP and RL to ensure integration and consistency between contractors.

7.3 DATA MANAGEMENT

Data management includes collecting and storing data, documenting data results, developing communication tools, and integrating data between contractors

Data will be collected and stored in accordance with applicable company procedures and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD). As appropriate, vadose zone sample and logging data will be stored in a site standard database [e.g., Hanford Environmental Information System (HEIS)].

Technical reports will be prepared to document field investigations and results and engineering/science studies.

Electronic communication tools, such as the WMA-C three-dimensional visualization tool, will be developed in support of data evaluations and planning specific to objectives and needs of WMAs.

Data will be shared among site contractors to minimize duplication of effort, ensure consistency, and integrate data collection, documentation, and communication needs (see Chapter 5 for integration interfaces and approaches).

8. SEQUENCING WASTE MANAGEMENT AREA CORRECTIVE ACTIONS

8.1 OVERVIEW

The HFFACO initially established a schedule for Phase 2 corrective actions only at WMA C. The implementation of Phase 2 began with the development of a Phase 2 WMA C DQO (draft RPP-RPT-38152), which results in the submittal to Ecology for approval of a Phase 2 WMA C RFI/CMS work plan and ends with the WMA C corrective measures implementation work plan (see Section 3.2). Section 2.3 of the HFFACO, Appendix I, requires that this Phase 2 master work plan include “selection criteria for implementing Phase 2 RCRA corrective actions at subsequent WMAs.” This chapter presents proposed selection criteria and a process for finalizing these criteria and developing the sequence of WMAs for corrective actions based on the criteria.

These criteria were established to develop subsequent WMA corrective action schedules of the same scope as has been established for WMA C with the objective to support final Phase 2 corrective actions and closure of the WMA. Interim measure sequencing is not considered a driving factor in sequencing WMAs for Phase 2 corrective actions. It is expected that characterization and development of interim measures will occur on an as-needed basis through continued analysis of existing and new data and through negotiations between Ecology and DOE as part of HFFACO Milestone M-045-56. Targeted characterization that is required for specific purposes at a WMA is also not a factor in sequencing WMAs for Phase 2 corrective actions. It is expected that targeted characterization may be required at any of the WMAs depending on the need for early information, e.g., to support data needs associated with groundwater source contamination, such as obtaining data from a borehole to define a specific source of groundwater contamination. These characterization activities are not part of the defining criteria because they would not provide all of the information necessary to evaluate, select, and implement final corrective measure alternatives.

8.2 CRITERIA FOR SEQUENCING WASTE MANAGEMENT AREA CORRECTIVE ACTIONS

8.2.1 Principal Criterion for Sequencing WMA Corrective Actions - Risk

The principal criterion for sequencing corrective measures at WMAs is risk of contaminants in the soil to human health and the environment. From the current state of knowledge of risk at the SST WMAs [as described in the Phase 1 RFI report (DOE/ORP-2008-01)], only key radiological and nonradiological risks to groundwater have been defined. Risks associated with direct contact and ecological receptors have not been defined. Figure 2-6 presents the estimated risks to groundwater from key radiological and nonradiological constituents by WMA from past releases to soil based on the state of knowledge. These groundwater risk values can serve as an initial basis for sequencing subsequent WMA corrective actions. As risk information matures the sequence of WMA corrective actions based on risk will need to be revisited. These risks will be defined as part of the Phase 2 characterization.

8.2.2 Modifying Criteria for Sequencing WMA Corrective Actions

Planning corrective actions at subsequent WMAs must take into account interferences and integration opportunities within and surrounding the WMAs. With the principal criterion of risk forming the foundation for sequencing WMA corrective actions, the following criteria may modify this sequence of WMAs to efficiently plan the cleanup work on the Central Plateau.

8.2.3 Contiguous Double-Shell Tanks and Other Operations

This criterion may modify the risk-based sequence of WMA corrective actions where completion of WMA final closure is constrained by contiguous DSTs or other operational activities. For example, WMA A-AX is contiguous to A Farm DSTs. At this WMA, final corrective actions, such as surface barrier placement, could not be implemented until concurrent closure of the DSTs; however certain actions such as removal actions could occur. DOE and Ecology may elect to maintain the sequence position of a WMA (based on risk) for purposes of characterization only while moving it later in the sequence for the remaining corrective action elements (i.e., alternative evaluation, remedy selection, and remedy implementation).

8.2.4 Contiguous Central Plateau Waste Site Remedial Activities

This criterion may modify the risk-based sequence of WMA corrective actions where corrective actions must be coordinated in time with other Central Plateau cleanup activities. This scenario could include the need to synchronize schedules for selection and/or implementation of common remedies such as surface barriers to meet Central Plateau waste site milestone requirements.

8.2.5 Tank Waste Retrieval Sequence and Duration

This criterion may modify the risk-based sequence of WMA corrective actions to avoid interferences with waste retrieval activities. As with WMA C, the goal for tank waste retrievals is expected to continue to focus on completing all waste retrievals within a WMA to expedite final WMA closure... Individual tanks from other tank farms may be retrieved in parallel with waste retrieval of a tank farm as needed for waste feed blending. This is expected to become a moderating factor in sequencing as the demand for an increased waste retrieval rate develops to effectively feed waste treatment and improve waste blending, which subsequently improves the properties and volume of the treated waste product and shortens the time it takes to treat all SST waste remaining in the tanks. The waste retrieval sequence for SSTs is currently identified and updated through HFFACO Milestone M-45-02N.

The waste retrieval sequence of a tank farm will impact the sequence for performing WMA Phase 2 soil characterization and implementation of corrective measures.

8.2.5.1 Phase 2 Characterization Activities

WMA characterization will form the basis for subsequent evaluation, selection, and implementation of corrective measures. Phase 2 characterization activities include completion of WMA-specific DQOs, development and approval of a WMA-specific work plans/sampling and analysis plans, field sampling and analysis, data evaluation, and reporting .

Optimizing characterization activities is a direct function of the ability to maneuver and position characterization equipment throughout a WMA. The presence of aboveground and belowground structures and equipment limit WMA characterization opportunities. Equipment, such as long lengths of hosing, dominate the surface area available for characterizing the vadose zone within the tank farms during active tank waste retrievals making it extremely difficult to maneuver characterization equipment (e.g., drill rigs, backhoes) to the optimal sampling locations. These limitations are being realized at WMA C where waste retrieval and characterization activities are occurring simultaneously. Figure 8-1 provides an aerial photograph of WMA C during active tank waste retrievals to illustrate this point.

Figure 8-1. Aerial Photograph of WMA C during Active Tank Waste Retrievals (2008)

Scheduling of Phase 2 characterization activities needs to take into consideration the timing of waste retrieval to avoid interferences. Soil characterization can generally be performed either before WMA-focused waste retrieval actions begin or after waste retrieval actions are completed. If soil characterization is performed prior to waste retrieval of the WMA and waste retrieval results in further releases of contaminants to the soil, further characterization may be required at that time.

8.2.5.2 Post-Soil Characterization Activities

Post-characterization activities include evaluation of corrective measures alternatives (including analysis of risk based on characterization information) and proposal of the remedy in the CMS, selection of the CMS remedy through modification of the RCRA Site-Wide Permit, development and approval of the corrective measures implementation work plan, and implementation of the remedy. Although it is typical to perform the evaluation and selection phases of corrective actions directly after characterization, it is usually most advantageous to do these steps at the latest date necessary to implement the remedy to take advantage of the most recent information associated with characterization, risk, and technologies to avoid reevaluation of the selected remedy.

Until waste retrieval is completed within a WMA, most corrective actions cannot be fully implemented (deep vadose zone remediation based on treatment can likely occur independent of waste retrieval of the WMA). For example, for surface barrier alternatives, placement will not occur until completion of waste retrieval, tanks and ancillary equipment closure, decommissioning and decontamination of buildings, removal of temporary structures/facilities, and site preparation. Should the selected corrective measures include soil removal, it is expected that some or all waste retrieval activities will also need to be completed to avoid physical interferences.

8.3 PROCESS FOR SEQUENCING WMA CORRECTIVE ACTIONS

WMA sequencing criteria for Phase 2 corrective actions will undergo review and comment by Ecology (pursuant to HFFACO Action Plan Figure 9-1) and the stakeholders as part of the approval process for this work plan. Based on these comments, final criteria will be developed and approved by Ecology as part of the first revision to this plan or in an alternative document. Subsequently, generated lists of sequenced WMAs for characterization activities and for post-characterization activities will be developed based on the final criteria and either placed in the revision to this plan or placed in an alternative document as agreed to by DOE and Ecology and revised as needed based on new information.

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