Remedial Design Report/Remedial Action Work Plan for Soils, Sediments, and Dynamic Characterization Strategy for Bethel Valley, Oak Ridge, Tennessee

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ACRONYMS

AHA	activity hazards analysis
AP	assessment point
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
BMP	best management practice
BV PP	Bethel Valley Proposed Plan
BV ROD	Bethel Valley Record of Decision
BV RI/FS	Bethel Valley Remedial Investigation/Feasibility Study
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	conceptual site model
COC	contaminant of concern
D&D	decommissioning and demolition
DCS	Dynamic Characterization Strategy
DNAPL	dense nonaqueous phase liquid
DOE	U. S. Department of Energy
DOT	Department of Transportation
DP	discretionary point
DQO	data quality objective
DVS	Dynamic Verification Strategy
DWP	Dynamic Work Plan
EE/CA	engineering evaluation/cost analysis
ELCR	excess lifetime cancer risk
EMWMF	Environmental Management Waste Management Facility
EPA	U. S. Environmental Protection Agency
ER-L	effect range-low
ES&H	environment, safety, and health
ESD	Explanation of Significant Difference
ETTP	East Tennessee Technology Park
EU	exposure unit
FFA	Federal Facility Agreement
FWPA	Former Waste Pile Area
HI	hazard index
LLLW	liquid low-level (radioactive) waste
LLW	low-level (radioactive) waste
LUC	land use control
M&O	Management and Operations
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MP	mid-point
NFA	no further action
NRWTP	Nonradiological Wastewater Treatment Plant
NWT	Northwest Tributary
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ORRR	Oak Ridge Research Reactor
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCCR	Phased Construction Completion Report

PDSA	Pre-Design Study Area
PEL	probable effects level
PRG	preliminary remediation goal
PWTC	Process Waste Treatment Complex
QAPP	quality assurance project plan
QC	quality control
RA	remedial action
RA Core Team	Remedial Action Core Team
RAB	remedial action boundary
RAO	remedial action objective
RAR	Remedial Action Report
RCRA	Resource Conservation and Recovery Act of 1976
RDR/RAWP	Remedial Design Report/Remedial Action Work Plan
RI/FS	Remedial Investigation/Feasibility Study
RL	remediation level
RPP	radiological protection program
SOP	standard operating procedure
SU	soil unit
SVOC	semi volatile organic compound
SWSA	solid waste storage area
TAL	target analyte list
TDEC	Tennessee Department of Environment and Conservation
TM	technical memorandum
TRU	transuranic
TSCA	Toxic Substances Control Act of 1976
VOC	volatile organic compound
WAC	waste acceptance criteria
WOC	White Oak Creek
WHP	Waste Handling Plan
XRF	x-ray fluorescence

EXECUTIVE SUMMARY

This Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) addresses soil and sediment remedial actions and characterization activities in Bethel Valley on the Oak Ridge Reservation in Oak Ridge, Tennessee as set forth in the *Record of Decision for Interim Remedial Actions in Bethel Valley, Oak Ridge, Tennessee* (DOE 2002) (BV ROD). The BV ROD defined remedial actions for soil and sediment include three materially different tasks: 1) capping at two large waste sites, 2) soil removal actions that vary in size from limited extent to large areas, and 3) removal of stream sediments from seven stream reach exposure units. The primary objectives of this RDR/RAWP are to define the scope of remediation work to be performed, identify the controls that will be implemented to protect workers and the environment, and describe the methods of accomplishment to be used to execute the work.

This RDR/RAWP further addresses the BV ROD requirement to develop a statistically based soil characterization strategy for use in acquiring additional data to address identified gaps in the nature and extent data set and to verify, following remedial actions, that the BV ROD remedial action objective requirements are met. Sampling activities included in this RDR/RAWP are expanded beyond BV ROD requirements to include contamination boundary determination to support accurate calculation of excavated material volumes and waste sampling to determine waste acceptance criteria compliance.

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1. INTRODUCTION

This Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) addresses soil and sediment remedial action (RA) and characterization activities set forth in the *Record of Decision for Interim Remedial Actions in Bethel Valley, Oak Ridge, Tennessee* (DOE 2002) (BV ROD). The BV ROD identifies several remedial actions in Bethel Valley which include soil and waste excavation and capping. Additional remedial actions may be necessary based on characterization results. With regard to soil and sediment characterization, there are two primary types of sampling activities conducted – one for characterization and one for confirmation. Characterization sampling is conducted to determine where action is necessary and to determine the boundaries of contaminated sites. Confirmation sampling is conducted to determine that a remedial action is complete and to confirm that waste materials are consistent with the waste acceptance criteria (WAC) for the point of disposal. The overarching strategy for both sampling activities is referred to as the Dynamic Characterization Strategy (DCS).

In addition, this RDR/RAWP discusses the decisions and communication necessary during the characterization phase, implementation of the remedy, and final waste disposition. The Oak Ridge Reservation (ORR) Federal Facility Agreement (FFA) provides opportunities for future modifications to primary documents.

1.1 BACKGROUND

In the mid to late 1980s a substantial remedial investigation program commenced in the portion of Bethel Valley occupied by the Oak Ridge National Laboratory (ORNL) under the Remedial Investigation/Feasibility Study (RI/FS) program conducted by Bechtel Environmental, Inc. This program did not complete a comprehensive determination for all potential contaminant release sites at ORNL and additional characterization activities were conducted throughout the 1990s. Work culminated with the publication of a series of CERCLA documents that included *Remedial Investigation/Feasibility Study for Bethel Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE 1999) (BV RI/FS), *Proposed Plan for Interim Actions in Bethel Valley, Oak Ridge, Tennessee* (DOE 2000) (BV PP) and the BV ROD. Several interim actions, action memoranda, and engineering evaluation/cost analysis (EE/CA) documents were issued allowing work to commence within Bethel Valley to address significant problem areas. The BV ROD was issued in 2002 and defined several remedial actions in the ORNL portion of Bethel Valley. The document also identified known or suspected sites at ORNL where potential releases could pose a threat to groundwater or industrial workers and which need additional investigation. In addition, the BV ROD recognized that the undeveloped land areas of Bethel Valley surrounding ORNL, although assumed to be generally uncontaminated because of lack of use for historical ORNL activities, have not been fully characterized. The methodology for obtaining these data is provided in this RDR/RAWP.

The BV ROD makes a determination of future land use as restricted industrial in the central portion of ORNL, uncontrolled industrial in the eastern and western portions of ORNL, recreational along stream reaches and at a former disposal area, solid waste storage area (SWSA) 3, located to the east of the ORNL main plant, and unrestricted in peripheral areas outside the main ORNL developed areas. The BV ROD identified exposure to soil and sediment as the primary risk driver. A risk assessment methodology based on exposure units (EUs) and a list of soil and sediment contaminants of concern (COCs) with corresponding remediation levels (RLs) are presented in the BV ROD. The RLs of the BV ROD consist of RLs for the protection of human health in all land use areas and RLs for the protection of ecological receptors in the recreational land use areas. The BV ROD also states that protection of groundwater is a remedial action goal and identifies areas where potential groundwater sources may be present and

requires additional investigation of these potential threat sites. This document addresses these potential groundwater source areas.

1.2 SCOPE

This RDR/RAWP presents the intended approach for implementing soils and sediment remedial actions as identified by the BV ROD (see Fig. 1.1). The remedial actions for landfill capping and soil and sediment excavation will be conducted under CERCLA to meet the remedial action objective (RAO) established in the BV ROD.

This RDR/RAWP addresses the portion of the Bethel Valley selected remedy pertaining to soils and sediment actions (as defined in Sections 1.4 and 2.12 of the BV ROD) including inactive facilities and the 1734-acre area spanning from the easternmost portion of ORNL westward to the Clinch River. The scope addresses soils which have been determined to be sources of groundwater contamination but does not address groundwater itself. The BV ROD divides Bethel Valley into four major administrative areas (East Bethel Valley, Central Bethel Valley, West Bethel Valley and Raccoon Creek) to facilitate discussion and documentation (Fig. 1.2). Each area has unique historical activities and a mix of land use determinations. The BV ROD further divides the East and Central Bethel Valley areas into nine EUs (Fig. 1.3) and stream reaches into seven EUs for the purposes of evaluating risk and making remediation decisions. The BV ROD also provides that other EUs may be defined in Bethel Valley if contamination is found to be present.

This RDR/RAWP further addresses the BV ROD requirement to develop a statistically based soil characterization strategy to fill identified data gaps in the nature and extent characterization data set. In addition, this document presents methods for verifying that soils and sediments meet the requirements of the BV ROD RAO following remedial actions.

1.2.1 BV ROD Selected Remedy

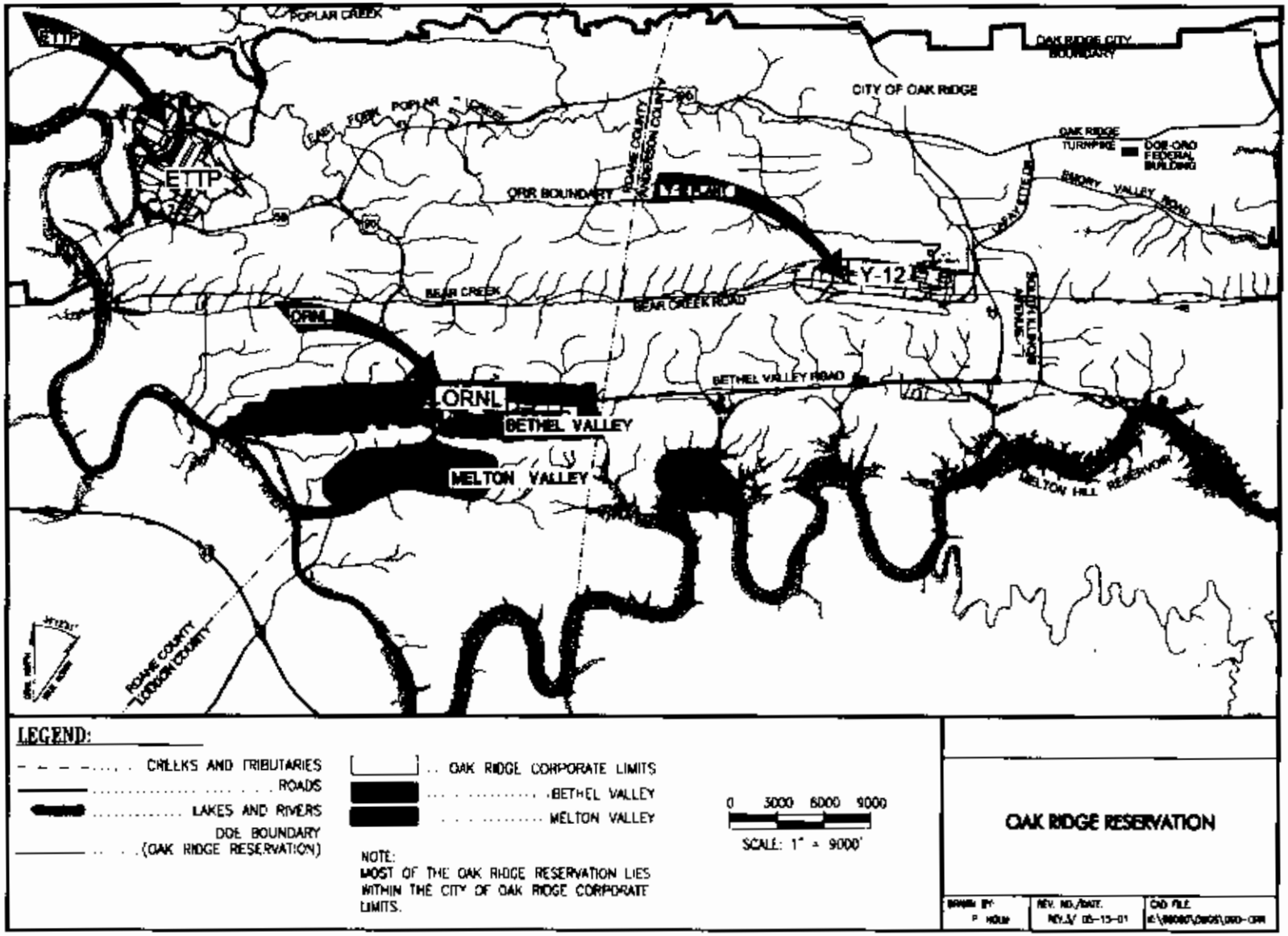
To provide reference and context, the following section describes relevant portions of the selected remedy as presented in the BV ROD, Section 1.4. Table 1.1 presents the RAO for Bethel Valley.

Table 1.1 Remedial action objective (RAO) for the selected remedy for Bethel Valley

Issue	Protection Goals
Future land use	Protect human health for (1) controlled industrial use in ORNL's main plant area, (2) unrestricted industrial use in the remainder of the ORNL developed areas, (3) recreational use of selected burial grounds, and (4) unrestricted use in the undeveloped areas, all to a risk level of 1×10^{-5}.
Protection of surface water bodies	• Achieve AWQC for designated stream uses in all waters of the state • Achieve at least 45% risk reduction from 1994 levels at 7500 Bridge • Maintain surface water and achieve sediment recreational risk-based limits to a goal of 1×10^{-5}
Groundwater protection	• Minimize further impacts to groundwater • Prevent groundwater from causing surface water exceedances in all waters of the state.
Protection of ecological receptors	Maintain protection for area populations of terrestrial organisms; protect reach-level populations of aquatic organisms.

AWQC = ambient water quality criteria

Figure 1.1 Location of Bethel Valley on the Oak Ridge Reservation



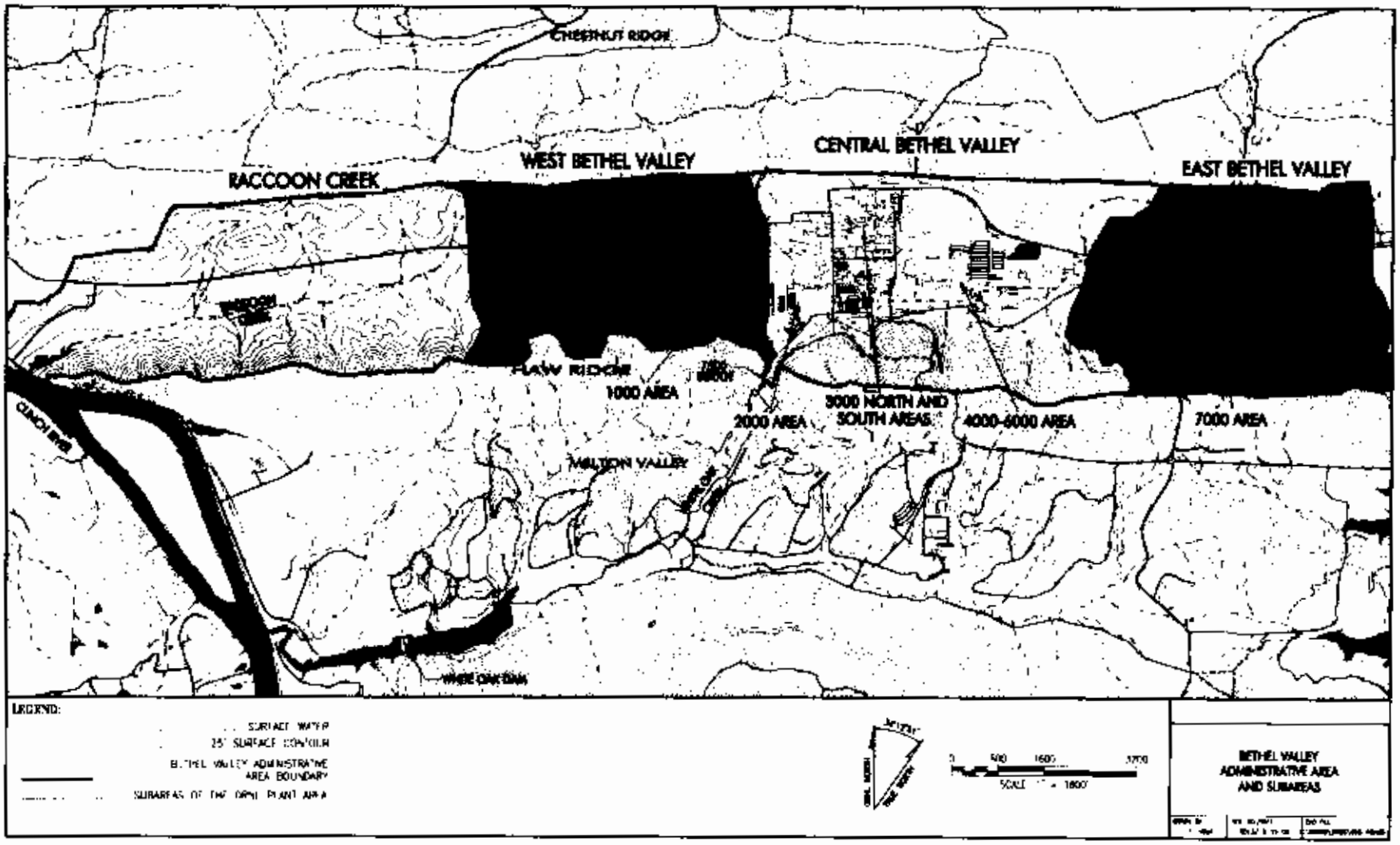
The following list provides the major components of the selected remedy as defined in the BV ROD. Only the soil and sediment remedial action components included in the scope of this RDR/RAWP are presented here.

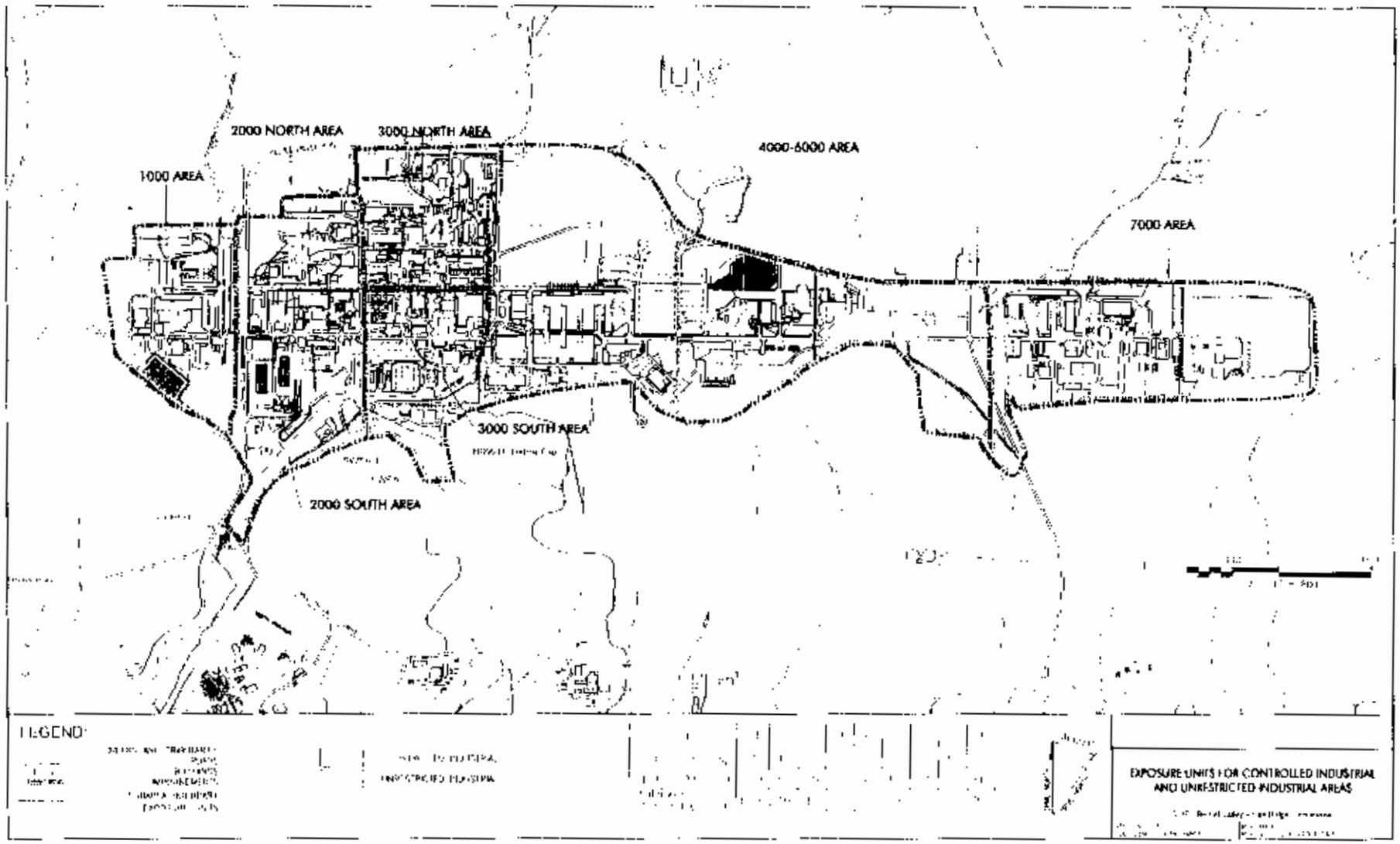
- The ORNL main plant area in Central Bethel Valley (i.e., 2000 area, 3000 area, and the western portion of the 4000 area) will be remediated to meet a controlled industrial land use. Industrial uses will be allowed of the upper 0.6 m (2 ft) of the area. Use of the subsurface below the depth of 0.6 m (2 ft) will be restricted.
- The remainder of the ORNL campus outside the main plant area (i.e., 1000 area in West Bethel Valley, the eastern portion of the 4000 area and the 5000 and 6000 areas in Central Bethel Valley, and the 6000 and 7000 areas in East Bethel Valley) will be remediated to meet an unrestricted industrial land use. Industrial uses will be allowed of the upper 3 m (10 ft) of the area. Use of the area below the depth of 3m (10 ft) will be restricted.
- Streambed sediments will be remediated to meet a recreational land use to the depth of deposition. Seven EU's have been defined along the following stream reaches: Raccoon Creek, Northwest Tributary (NWT), First Creek, Fifth Creek, White Oak Creek (WOC) between 7500 Bridge and First Creek, WOC between First Creek and Fifth Creek, and WOC above Fifth Creek.
- Streambed sediments will also be remediated to meet ecological benchmarks to the depth of deposition.
- SWSA 3 and the Contractor's Landfill will be remediated to meet a recreational land use. The three waste disposal areas in Central Bethel Valley [SWSA 1, the Nonradiological Wastewater Treatment Plant (NRWTP) Debris Pile, and the Former Waste Pile Area (FWPA)] will be included in the controlled industrial land use boundary of the main plant area.
- The undeveloped areas in Bethel Valley and the disturbed areas around SWSA 3 and the Contractor's Landfill will be remediated as needed to a condition consistent with an unrestricted land use. Contamination, if encountered above RLs, will be removed to the water table or bedrock, whichever comes first.
- Through selected source and groundwater actions, impacts to surface water designated as waters of the state will be controlled and minimized to allow streams to meet their stream use classification.
- Remediation efforts and other improvements will achieve a 45% risk reduction from 1994 levels at the 7500 Bridge, the surface water integration point for Bethel Valley. This risk reduction at the 7500 Bridge will reduce releases into the Clinch River and provide additional protection for an off-site user of surface water, which is one of the goals under the Melton Valley watershed ROD.
- The impacts from sources of groundwater contamination will be minimized.
- Ecological populations will be protected in Bethel Valley.

Land use controls (LUCs) are a necessary part of the current U.S. Department of Energy (DOE) policies/procedures for this industrial site. Objectives of the LUCs, post remediation, are as follows.

- Controlled industrial area: control excavations or penetrations below 0.6 m (2 ft) and prevent uses of the land more intrusive than industrial use above 0.6 m (2 ft);
- Unrestricted industrial area: control excavations or penetrations below 3 m (10 ft) and prevent uses of land more intrusive than industrial use above 3 m (10 ft);
- Recreational area (as applied to streambed sediments): restrict access to most streambed sediments and control worker exposure through a radiological exposure protection program;

Figure 1.2 Bethel Valley administrative areas




2000 NORTH AREA
3000 NORTH AREA
4000-6000 AREA
1000 AREA
7000 AREA
3000 SOUTH AREA
2000 SOUTH AREA
LEGEND
EXPOSURE UNITS FOR CONTROLLED INDUSTRIAL AND UNRESTRICTED INDUSTRIAL AREAS

- Recreational area (as applied to SWSA 3 and the Contractor's Landfill): restrict recreational activity to passive surface use of disposal areas; prevent unauthorized contact, removal, or excavation of waste material; prevent unauthorized destruction or modification of engineered controls; and preclude use of the areas for additional future waste disposals or alternate uses inconsistent with the management of currently disposed waste; and
- Unrestricted areas: no LUCs required.

The selected remedy and the specific components of the remedy are, where possible, prescriptive, describing the required action and the remediation goals to be met. The selected remedy, with regard to soil and sediment actions, has identified three materially different tasks for remedial action.

1. Capping at two of the large waste sites in Bethel Valley including SWSA 3 and SWSA 1. Installation and maintenance of soil covers is required for the Contractor's Landfill site in West Bethel Valley and the FWPA and NRWTP Debris Pile in Central Bethel Valley. Capping may also be considered as an option for areas that will require further investigation should the magnitude of the required action and the cost to remediate be substantially different than the assumptions made in the BV ROD.
2. Soil removal actions to meet land use criteria which vary in size from limited extent to large areas. These actions include substantial soil removal actions at SWSA 3 (soil areas 1, 2 and 3) and at numerous locations within the ORNL main campus area. These locations also include two sites where groundwater investigations were conducted post BV ROD that were subsequently identified as threats to groundwater. Recommendations that identified these additional soil removal actions are made in the *Engineering Study Report for Groundwater Actions in Bethel Valley* (DOE 2005) (Groundwater Report).
3. Removal of stream sediments in the seven stream reach EUs.

These three soils actions will be implemented with task specific requirements considering the action's impact on the immediate and larger Bethel Valley area to minimize site operations disruptions and to minimize the probability of remobilizing contaminants. The remedial action plan presented in this document addresses the three different types of actions separately and provides specific requirements and precautions to be taken during each type of remedial action.

At numerous areas in Central Bethel Valley where contamination is known or suspected to be present, no definitive data are available to support an action /NFA determination. For these areas the primary focus of this document is to define a DCS which, when implemented, will provide data adequate to support an action/NFA decision for each potential contaminated release site, define the nature and extent of the contamination to support a volume estimate for a remedial action, and provide the necessary data to support a WAC evaluation.

1.2.2 BV ROD Actions Addressed by this RDR/RAWP

This RDR/RAWP has been developed to present the process steps that will be taken for the defined soils and sediments actions and to describe the characterization process that will be used to support the action/NFA determinations for the identified sites where additional sampling is required. Actions that are specifically identified in the BV ROD that are included in this RDR/RAWP include the following.

In Central/East Bethel Valley:

- Buried Waste, SWSA 1: install a cap to protect the worker and minimize impacts to groundwater;

- Surface Soil, main plant area: remove surface soil to protect the industrial worker, controlled industrial use scenario [estimated 85,900 m^3 (112,300yd^3)];
- Surface Soil, outside the main plant area: remove surface soil to protect the industrial worker, unrestricted industrial use scenario [estimated 500 m^3 (700yd^3)];
- Deep Soil, outside the main plant area: remove soil that exceeds RLs, if any, to protect the industrial worker, unrestricted industrial use scenario; and
- Sediments and Floodplain Soils, WOC, First Creek and Fifth Creek: remove sediment to achieve recreational risk-based limits and to control cesium-137 (^{137}Cs) flux at the 7500 Bridge, remove floodplain soils to protect hypothetical recreational user [estimated 13,500 m^3 (17,600yd^3)], and as appropriate, remove sediment to protect ecological receptors.

In West Bethel Valley/Raccoon Creek:

- Buried Waste, SWSA 3: install a multilayer cap to protect the maintenance worker and minimize impacts to groundwater;
- Soils, SWSA 3, Soil Areas 1, 2 and 3: remove soil that exceeds RLs for unrestricted use;
- Soils, 1000 Area: remove soil that exceeds RLs to protect the industrial worker under an unrestricted industrial use scenario; and
- Soil, remainder of West Bethel Valley: remove soils to meet unrestricted industrial use [estimated 17,500 m^3 (22,900yd^3)]

1.3 DYNAMIC CHARACTERIZATION STRATEGY (DCS)

The goal of the DCS characterization sampling is to obtain data to support an action/NFA decision for Bethel Valley soils and sediments consistent with the anticipated land uses designated in the BV ROD, define excavation volumes, and confirm that post-remedial action soils and sediments comply with the BV ROD RAO. To gather information that will meet the BV ROD RAO while minimizing the need for multiple phases of data collection planning, the DCS integrates elements of the following.

- Guidance outlined in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (DOE et al. 2000). MARSSIM provides prescriptive, yet flexible guidance for collecting defensible data to evaluate the status of radiologically contaminated sites. MARSSIM was developed to address potential radiological contamination on surface soil and building surfaces and makes use of survey instruments designed to detect the presence of ionizing radiation in the field. In Bethel Valley there is potential radiological contamination in both surface and subsurface soils, and there are potential chemical contaminants whose presence is not detectable using the radiation detection instrumentation employed by MARSSIM. While the DCS goes beyond the scope of MARSSIM, it incorporates key elements of the MARSSIM approach. These elements include the DCS data evaluation process and use of a classification system for investigative units. Under MARSSIM, classification is the process by which a survey unit is described according to radiological characteristics. Under this DCS, soil units (SUs) are classified by estimating the likelihood, based on existing information, that an area will require a remedial action. The classification system allows resources to be focused on areas for which insufficient information exists to estimate such likelihood.
- U.S. Environmental Protection Agency's (EPA's) Triad Approach (EPA 2001), including the rigorous application of the data quality objective (DQO) process. The Triad Approach is a strategy for field investigations that is designed to obtain site-specific information in an efficient and cost-effective manner and improve decision-making confidence. There are three primary elements to the approach: (1) systematic planning, (2) dynamic work plans (DWPs), and (3) real-time measurement technologies. In general, these three elements are integrated to streamline the

approach to characterization, remediation, and decision making. Systematic planning involves a rigorous application of the DQO process to meet the needs of environmental sampling projects and to ensure that the means to satisfy those needs are fully understood (the DQO process for Bethel Valley is presented in Appendix A). The goal of systematic planning through the DQO process is to manage inherent uncertainty in a cost-effective manner, taking into consideration the number of sample measurements to be collected, the expected reduction in uncertainty from such data, and the cost of acquiring these data. The DWP describes the base set of samples (i.e., number of samples and sample locations) but is also designed to be flexible and kept current so that the project team can react to the data produced by field and laboratory analytical techniques and make decisions in the field about the direction of the fieldwork. In the event that an unanticipated situation should arise, it is important that the decision-makers have access to the data so that they can give timely instructions about how to proceed. In general, dynamic adjustments during fieldwork will entail collecting more data in response to field analytical results, thus providing a higher level of confidence that the site has been adequately characterized.

The application of applicable components of these two characterization approaches was evaluated during the Dynamic Verification Strategy (DVS) process development for the DOE East Tennessee Technology Park (ETTP) site. Because the key aspects of the DVS approach are successfully being implemented, the DVS strategy forms the basis of the DCS approach. The key to environmental field project flexibility and acquiring effective data is on-site technologies that deliver real-time information. Selection of real-time technologies is based on the project DQOs that are clearly defined during systematic planning. The capability of each technology to address site-specific contaminants needs to be adequately demonstrated prior to the technology's application, and quality checks should be made during application. Although real-time technologies are an integral part of the DCS approach, fixed laboratory analytical methods are used to provide analyte-specific data that assist in managing uncertainty and support the risk assessment portion of the decision rules as well as being a quality control (QC) tool.

A Remedial Action Core Team (RA Core Team) has been established to streamline planning and completion of actions to be performed in Bethel Valley. The RA Core Team approach is a formalized, consensus-based process where members reach agreement on key issues and strategies. The RA Core Team consists of representatives of the FFA parties, including DOE, EPA, the Tennessee Department of Environment and Conservation (TDEC), and DOE's remedial action contractor. The RA Core Team's primary function is to make programmatic decisions that facilitate and guide the specific projects as Bethel Valley progresses toward its anticipated end state. Proper use of a Core Team solicits issues and views of team members and builds consensus on the appropriate scope and direction of the work before final documentation is prepared. To perform this function while adhering to schedule, the RA Core Team must be regularly informed of issues and perform its duties on schedule and in a timely manner. The primary decisions facing the RA Core Team during characterization include what sampling to conduct and what, if any, action is required. A variety of tools discussed later in this document are used to communicate existing and newly gathered information to support these decisions.

The DCS strategy establishes a confirmation sampling approach to determine if a remedial action has been sufficient to meet the BV ROD RAO. After remediation, confirmation sampling can determine if additional remedial action is needed to meet the RAO. As with characterization sampling, systematic planning, field measurements, and use of the RA Core Team to streamline decision making are key components of confirmation sampling. Sampling conducted to support remediation may be used to evaluate site conditions beyond the action/NFA decision, such as refinement of remedial action boundaries, waste characteristic identification, or extent of saturation. These sampling activities are acknowledged as necessary and are included in project planning.

Also, during remediation implementation, communication with the RA Core Team to discuss the impacts of changing site conditions is critical. During planning of an action, potential changes are identified and a contingency plan developed for the conditions most likely to change. As the action is implemented, the site conditions are monitored and if a changed condition occurs, the RA Core Team is notified so that a decision can be made on the impact to the remedy. Communication with the RA Core Team is critical to provide concurrence that the action is complete. As with characterization results confirmation sampling results and site conditions are communicated to the RA Core Team through a variety of tools.

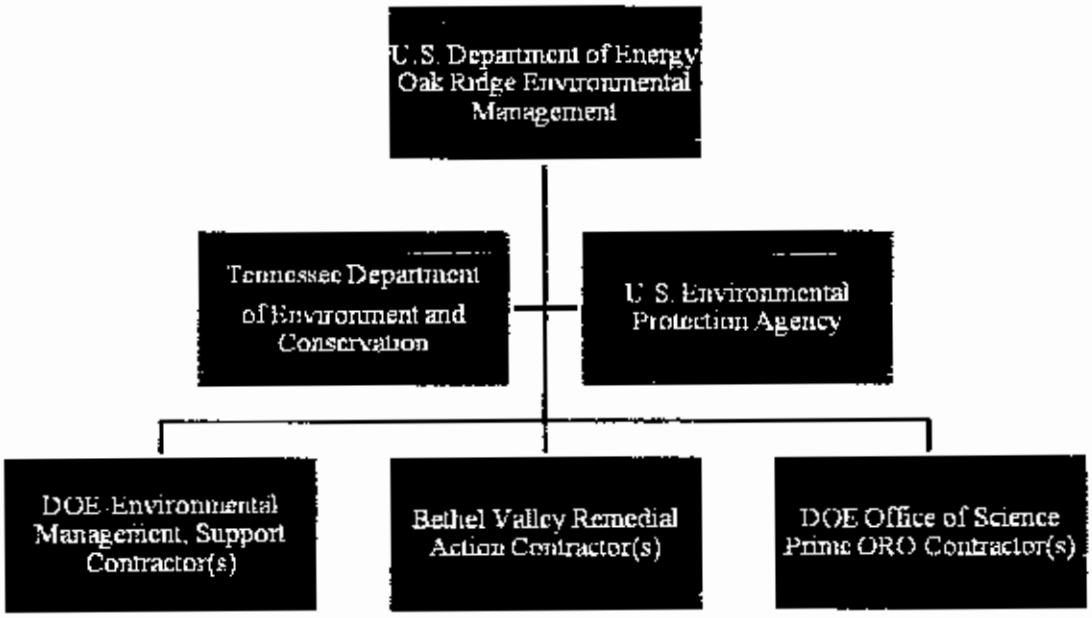
1.4 PROJECT ORGANIZATION

The following figure (Fig. 1.4) presents a programmatic overview of the key organizations involved in the Bethel Valley soils and sediments remedial actions and characterization.

The RA Core Team provides programmatic decisions and direction to the remedial action contractor(s). DOE's prime contractor(s) ensures implementation on the project level and is responsible for field implementation. DOE, EPA, and TDEC comprise the RA Core Team. DOE contractor(s) may participate in core team activities if appropriate and as necessary. The DOE prime contractor(s) is responsible for ensuring the remedial action is performed in accordance with specifications set forth in the BV ROD.

Remedial actions and characterization activities will be conducted in accordance with this RDR/RAWP after approval by EPA and TDEC. In addition, any lower-tier subcontractors must meet the DOE prime contractor requirements for developing and complying with the contractor approved site-specific work plan, transportation plan, waste management plan, work control packages, and all applicable permits and procedures. The remedial action contractor will meet all applicable DOE orders requirements during the execution of the activities described in this RDR/RAWP.

Figure 1.4 Organization Chart for Bethel Valley Soil and Sediments



2. SITE DESCRIPTION AND CONCEPTUAL SITE MODEL

This section presents a description of Bethel Valley including its location in the ORR, its general lay out, and the principal sources for contamination. The description of Bethel Valley is followed by the conceptual site model (CSM).

2.1 SITE DESCRIPTION

Oak Ridge Reservation (DOE)
Bethel Valley area at Oak Ridge National Laboratory
Oak Ridge, Tennessee
CERCLIS ID TN1890090003

The 34,516-acre DOE ORR (Fig. 1.1) is located within and adjacent to the corporate limits of the city of Oak Ridge, Tennessee, in Roane and Anderson counties. The ORR is bounded to the east, south, and west by the Clinch River and on the north by the developed portion of the city of Oak Ridge. The ORR hosts three major industrial research and production facilities originally constructed as part of the World War II-era Manhattan Project: ETTP (formerly the K-25 Site), ORNL (formerly X-10), and the Y-12 National Security Complex.

ORNL is an active laboratory that occupies approximately 3560 acres in Melton Valley and Bethel Valley and is located approximately 16 km (10 miles) southwest of downtown Oak Ridge, Tennessee. Although ORNL was originally constructed in 1943 to support the Manhattan Project, ORNL's current missions are to conduct applied research and engineering development in support of DOE programs in nuclear fusion and fission, energy conservation, fossil fuels, and other energy technologies and to perform basic scientific research in selected areas of the physical, life, and environmental sciences.

Bethel Valley is a 1734-acre area defined by the upper drainage area of WOC and its tributaries in Bethel Valley. Bethel Valley includes the neighboring Raccoon Creek watershed and a small portion of Bearden Creek (Fig 1.2). Raccoon Creek is included because contaminants detected in the surface waters are attributed to contaminant migration from releases in West Bethel Valley. Bethel Valley includes headwaters for WOC, which exits the valley through a water gap into Melton Valley. A tributary of Bearden Creek begins in East Bethel Valley and flows through the Haw Ridge and into Clinch River (Melton Hill Lake). Adjacent Melton Valley includes former waste areas derived from operations at ORNL and comprises the Melton Valley watershed administrative area.

The Bethel Valley area was divided into the following four areas for the BV RI/FS (Fig. 1.2) to simplify discussion of findings:

- East Bethel Valley,
- Central Bethel Valley,
- West Bethel Valley, and
- Raccoon Creek.

East Bethel Valley includes the ORNL plant maintenance area. Central Bethel Valley includes the ORNL main plant area, which consists of active and inactive buildings, former burial grounds, underground liquid low-level (radioactive) waste (LLLW) tanks, underground process and LLLW pipelines, and associated underground and aboveground utilities. West Bethel Valley contains a burial

ground area and a small portion of the plant area. Raccoon Creek contains primarily slightly contaminated media that have migrated from West Bethel Valley. The BV RI/FS further divided the heavily industrialized Central Bethel Valley area into subareas (based on building numbers): Central Bethel Valley 2000 North Area, Central Bethel Valley 2000 South Area, Central Bethel Valley 3000 North Area, Central Bethel Valley 3000 South Area, and Central Bethel Valley 4000-6000 Area (Fig. 1.3).

Historical processes, programs, and waste management practices associated with the missions of the laboratory have led to environmental contamination in Bethel Valley. The estimated geographical extent of contamination is approximately 160 acres. A large inventory of radioactive waste combined with other hazardous waste constituents in numerous locations, which together release contaminants into the environment at concentrations exceeding legal or risk-based criteria are present in the Bethel Valley area. The pervasiveness of contamination in the ORNL complex and the similarity of contaminants found from different source units complicate determination of well-defined contaminant plumes and distinct areas of contamination. Current releases from Bethel Valley exit the ORR via WOC at the confluence of WOC and the Clinch River.

In accordance with CERCLA Sect. 120 and 40 CFR 300.430(f)(4) and the FFA, DOE is acting as the lead agency for this action. TDEC and EPA, as parties to the FFA, provide oversight and approval of the remedy selection and related cleanup decisions.

2.2 CONCEPTUAL SITE MODEL

Bethel Valley is located in the valley and ridge physiographic province of eastern Tennessee. Elongated valleys and ridges of folded and faulted rock characterize the province. The geologic units of shale and carbonate rock were structurally deformed in the distant past. These disturbed rock units are intensely fractured and have been exposed to surface erosion for eons. The persistent humid conditions of the regional environment resulted in dissolution of the carbonate rock, leaving behind the insoluble residual fraction. The region is characterized by solution features, cavernous porosity, and open-flow conduits in the carbonate rock units, covered with a blanket of clay-rich residuum. Sharp topographic relief and small isolated surface and groundwater drainage areas are locally characteristic of Bethel Valley.

Soils in portions of Bethel Valley have become contaminated by laboratory related chemicals and radionuclides through a number of release mechanisms (chemical spills, leaking lines, landfills, pits and sumps below buildings, basins, and burn pits) and pose two problems. The first problem concerns the contaminated soils, which pose a potential risk to the health of workers who might come into contact with them. The second concern is that the contaminated soils (and associated debris or infrastructure) may be sources of contamination to groundwater.

Exposure to workers represents the primary potential exposure pathway in Bethel Valley. Exposure could occur during daily activities, such as mowing or simply walking across the site, or during construction/excavation activities. Much of the contamination has been deposited on the surface and is relatively immobile and, thus, has remained on the surface. The mobility of contaminants in the soils is affected, in large part, by the chemical nature of the contaminants and the high clay content and correspondingly high cation exchange capacity of the unconsolidated residual soils. Primary contaminants in soils consist of radionuclide and inorganic chemicals which typically have a high ion exchange affinity for soils. As a result, the soil contaminants are relatively immobile. Transport of these contaminants to groundwater will typically occur by mobilization of colloids to which the contaminants are attached. Other mobile contaminants that may pose a threat to groundwater include volatile organic compounds (VOCs). Dense nonaqueous-phase liquids (DNAPLs) are a predominant groundwater contaminant and

have typically moved from the original source location into the natural materials. These mobile contaminants are present in the relict structure, micro-fractures and pore spaces of the unconsolidated zone and bedrock materials that underlie disposal sites.

Investigation of potential sources of contamination of groundwater was conducted following the publication of the BV ROD. The findings from these groundwater investigations are incorporated in the Groundwater Report. Several additional source removal soil actions were defined by these investigations and are included in the identified soils action in this RDR/RAWP.

The BV ROD has identified specific actions and selected a remedy that will be implemented by this RDR/RAWP. Three types of remedial actions are identified: 1) partial excavation and capping of landfill and buried waste disposal sites, 2) soil removal actions, and 3) excavation and disposal of stream sediments along White Oak First and Fifth Creeks. The following discussion presents a summary-level description of the physical characteristics, distribution and special considerations for each type of remedial action. These conceptual descriptions will form the basis of the conceptual site models to be used in developing site-specific work plans. Work plans will be provided by the contractors who execute the required remedial actions at the individual sites.

2.2.1 Buried Waste (Burial Grounds and Landfills)

The principal buried waste disposal areas in Bethel Valley are SWSA 1, SWSA 2, the FWPA, the NRWTP Debris Pile, SWSA 3, and the Contractor's Landfill. Between 1943 and 1951, solid low-level radioactive waste was routinely buried at shallow depths in the subsurface soil. Early burial procedures involved using unlined trenches covered by soil or a combination of concrete caps and soil. SWSA 1, in Central Bethel Valley, is a 1-acre burial ground used from 1943 to 1944. The volume of waste in SWSA 1 is estimated at 12,400 m^3 (16,200 yd^3). SWSA 2 received waste from 1944 to 1946 in an area in Central Bethel Valley covering about 3.6 acres. The contents of SWSA 2 were later excavated and moved to the eastern end of SWSA 3 in West Bethel Valley. (The residual contamination at the SWSA 2 area is addressed in the BV ROD as an area of subsurface soil contamination.) The FWPA is estimated to have a volume of 1600 m^3 (2100 yd^3) of primarily soil and construction/demolition debris. The NRWTP Debris Pile is estimated to have a volume of 3170 m^3 (4150 yd^3) of primarily construction/demolition debris.

SWSA 3 is a 7-acre burial ground located in West Bethel Valley that received waste from multiple sources from 1946 to 1951. During this time, ORNL served as a disposal site for wastes from such facilities as the Mound Laboratory and the University of Chicago, as well as the three ORR plants. Alpha-emitting radioactive wastes were contained in drums, set on concrete, and covered with concrete. Beta-gamma-emitting radioactive wastes were buried in unlined trenches and backfilled with soil. The contents of SWSA 2 were excavated and moved to the eastern end of SWSA 3 after SWSA 2 was closed in 1946. The volume of waste and contaminated soil in SWSA 3 is estimated at 96,700 m3 (126,500 yd3).

2.2.2 Soils and Sediments

Contamination is present in sediment and surface soil [defined here as less than 0.6 cm (2 ft) deep] and in subsurface soil [defined here as greater than 0.6 cm (2 ft) deep]. Ultrasonic Ranging and Data System data indicate several areas that exhibit surface radioactivity. These areas are listed here in general order of largest areas of contaminant extent:

- WOC floodplain soils.
- South Tank Farm.
- SWSA 3.

- North Tank Farm, and
- Isotopes Area.

Analyses of soil samples reveal many different radionuclides in these areas. Cesium-137 is the most common radionuclide present, with ^{60}Co, ^{228}Ra, ^{214,212}Pb, ^{228}Ac, ^{90}Sr, and ^{208}Tl also prevalent. Cesium-137 can be found at concentrations of 28,000 picocuries per gram (pCi/g) (compared to a background concentration of 0.9 pCi/g). Cesium-137 is founded extensively in the White Oak Creek floodplain, reflecting the affinity of this constituent to sorb to soils and sediment. Other radionuclides are found disseminated throughout the Central ORNL complex, resulting from various accidental releases. Samples of surface soil collected from about 220 locations throughout Bethel Valley have been analyzed for both radiological and chemical constituents. Compared to radiological constituents, the distribution of chemicals in surface soil is less extensive and the concentrations not as high. Contaminated soils in West Bethel Valley include several discrete areas of surface soil contamination. Surface soil contamination is present over a total of approximately 3 acres in the vicinity of SWSA 3, the Contractor's Landfill, and the Closed Scrap Metal Area. Cesium-137 is common in SWSA 3 soils.

There were numerous subsurface releases at ORNL, including leaks from pipelines. Subsurface samples were collected from more than 195 locations throughout Bethel Valley and analyzed for radionuclides, metals, or organic compounds. Analytical results indicate at least four areas of significant subsurface contamination: Bldg. 3019, both the North and South tank farms, and the Isotopes Area. Soils surrounding Bldg. 3019 are contaminated from a series of historical pipeline leaks with gross beta activity as high as 16,000 pCi/g and gross alpha as high as 1043 pCi/g. Samples in the area contain elevated concentrations of radionuclides, such as ^{137}Cs, total radioactive strontium, ^{60}Co, and ^{238,239,240}Pu. Soils near a historical pipeline leak north of Bldg. 3019 contained gross beta activity as high as 1855 pCi/g and gross alpha up to 3104 pCi/g. Specific radionuclides occurring at this leak site include ^{241}Am, ^{60}Co, ^{137}Cs, ^{152}Eu, ^{244}Cm, and ^{239,240}Pu. As with other samples in the vicinity of Bldg. 3019, the highest concentrations of these radionuclides were found in samples collected from the 3- to 5-m (10- to 15-ft) depth interval.

Subsurface soil samples at the North Tank Farm exhibited up to 62,600 pCi/g gross beta activity and 2570 pCi/g gross alpha at a depth of 5 m (15 ft.). Soils surrounding Tank W-1A in the North Tank Farm are highly contaminated with alpha-, beta-, and gamma-emitting radionuclides. Gross alpha activity levels ranged from 13,000 to 84,000 pCi/g; the highest levels were detected immediately adjacent to the tank. Gross beta activity levels ranged from 40,000 to over 500,000 pCi/g. Strontium-90 concentrations ranged from 9 to 33,500 pCi/g. In addition to ^{90}Sr, radiological contamination in soil surrounding the tank (and in tank liquid samples) included ^{137}Cs, ^{60}Co, ^{3}H, ^{235,234}U, and ^{237}Pu.

Analytical results from soil borings in the South Tank Farm indicate that soil contamination is dominated by ^{90}Sr (0 to 539 pCi/g) and ^{137}Cs (0 to 760 pCi/g). Soils in the Isotopes Area exhibited activities of up to 1890 pCi/g gross alpha and 3218 pCi/g gross beta.

Mercury contamination is present in soil near buildings 3503, 3592, 4501, and 4508. The highest mercury concentrations in soil borings were detected adjacent to Bldg. 3592. The concentrations in the borings ranged from <5 mg/kg to 548 mg/kg; concentrations generally decreased with depth, suggesting a surface release. Mercury in soil underneath Bldg. 4501 is the suspected source of contamination in multiple basement sumps that are being pumped and discharged to the Process Waste Treatment Complex (PWTC) or WOC.

East Bethel Valley soils are not extensively sampled, and there are limited subsurface soil data in parts of the main plant area such as the 2000 Area. These and other uncertainties will be managed through

the use of contingent actions and decision rules, which are described in the Bethel Valley DQOs (Appendix A).

Generally, contaminated sediment has accumulated in the lower reach of WOC in Bethel Valley. Sediment from WOC below the ORNL complex has been regularly sampled, but sediment sampling data are limited for smaller tributaries. Cesium-137 is the most pervasive contaminant, with ^{60}Co, mercury, and polychlorinated biphenyls (PCBs) also present. Cesium-137 concentrations in sediment in WOC vary from 10 pCi/g to a maximum of 4160 pCi/g, with an average concentration of 20.5 pCi/g. Cesium-137 concentrations in First Creek are lower, with a maximum of 66 pCi/g. Little cesium has been detected in sediment samples collected from NWT and Raccoon Creek. Historical data reveal high concentrations of mercury in Fifth Creek sediment. For example, sediment sampled at Outfall 261 had mercury concentrations >1000 mg/kg before 1990. Those concentrations had fallen to roughly 100 mg/kg in 1996. Most of the sediment in WOC is lightly contaminated with mercury (<10 mg/kg) although concentrations in WOC sediment above Fifth Creek increased since 1993 to a 1996 maximum of 15 mg/kg. The sources of mercury are past releases that continue to migrate into surface water from sumps and storm drains that discharge to surface water. There are limited sediment data in these tributaries (three sampling stations). Samples from these stations have had contaminant concentrations mostly at or below background.

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3. REMEDIAL DESIGN REPORT

This section presents general design parameters, functional and technical requirements, and design objectives. The primary objectives of this RDR/RAWP are to define the scope of remediation work to be performed, identify the controls that will be implemented to protect construction workers and the environment, and describe the methods of accomplishment that will be used to execute the work. This section provides the approach for conducting the selected remedy for buried waste isolation by capping, soil and sediment excavations, and the general approach to the DCS process, along with decisions that the process results will support. DCS provides information to support decisions on whether action is required through characterization. Should actions be required they will generally follow the approach and decisions flow methodology presented in this section. The characterization strategy further provides an approach to support decisions on the extent of the action and whether the action is complete through confirmation sampling. In both cases, the sampling approach and the communication necessary to make the key decisions throughout the process are discussed. Decisions and communications required during remediation also are discussed.

3.1 SITE PREPARATION

All site preparation actions described below are subject to general requirements (e.g., erosion and sediment control, dust control, worker protection). Temporary erosion control measures will be implemented as needed to protect disturbed areas prior to final restoration activities. Temporary measures may include temporary seeding and mulching. On exposed soil slopes and stockpiles, rolling or tracking of soils may also be used to stabilize soils.

3.1.1 Access Roads

Existing roads will be used and maintained as required throughout the duration of the project to provide safe access for transporting materials, equipment, and waste from the remediation site. New staging areas will be established to support remedial action and characterization activities.

3.1.2 Access Control

Site access requirements may include but are not be limited to General Employee Training, Radiological Worker II, Respirator Fit, Bioassay, and acknowledgement of site-specific Activity Hazards Analysis (AHA). Not only will the administrative/security controls limit access to the sites, the remedial action contractor will provide for physical controls such as security fences to prevent inadvertent access to these areas. This contractor is required to conduct work safely and will provide a safety plan for the proposed conduct of operations at the sites.

3.1.3 Temporary Facilities

Areas will be designated on the work plans submitted for approval by the remediation contractor for parking and other temporary facilities. These facilities will be removed at the conclusion of the remedial action and appropriate site restoration will occur.

3.1.4 Clearing and Grubbing

Any vegetation that must be removed for access to the sites is not assumed to be radiologically contaminated. If it is determined that the vegetation is contaminated, it will become part of the

Environmental Management Waste Management Facility (EMWMF) waste lot. Trees and shrubs/brush will be cut as close to existing grade as practical. Roots may be left in place in some areas.

Special considerations must be made by the remedial action contractor for work in proximity to active drainages. These considerations include, but are not limited to, 1) bank stability, specifically the stability of the banks of the creeks where excavation by heavy equipment and equipment loading could separately, or in combination, result in slope failure under dry or saturated conditions and, 2) the means by which contaminated sediment will be isolated from the flowing stream during excavation. It is unacceptable for significant sediment volume to become suspended and transported downstream during excavation.

3.1.5 Decontamination Area

Controlled areas delineated for equipment decontamination will be established. Remediation activities will be designed to avoid placing contaminated materials in uncontaminated areas and minimizing the size of said areas. After the areas have been remediated and contamination levels verified to meet cleanup levels, areas will be redesignated as radiologically uncontrolled.

Debris will be removed from construction equipment that has been used in radiologically contaminated areas using low-volume water blasting before the equipment leaves the controlled areas. Decontamination will be allowed only in designated areas located at least 200 ft from any surface water and will not occur in areas sloped greater than 20 percent grade. Field screening devices will be utilized to detect the presence of chemical contaminants of concern for each remediation area. Because chemical and radiological contaminants are typically co-contaminants, it is anticipated that decontamination operations conducted for the removal of radiological contaminants will also remove chemical contaminants. However, if based on field screening, chemical contaminants of concern remain on the equipment, the chemical decontamination process will occur in an area similar to the radiological decontamination area employing the appropriate chemical decontaminant. The decontamination area(s) will establish appropriate liquid containment measures to ensure protection of workers and the environment. If chemical contaminants of concern remain on the equipment following field decontamination, a statistical sampling method will be employed to obtain samples for analytical laboratory analysis. Based on the results of the analytical laboratory analysis, a disposal decision will be made. A bermed and lined area will be selected and designed in the field for final decontamination of equipment prior to removal from the site. If necessary, the area will be constructed to address radiological contamination concerns. Decontamination fluids will be pumped into holding tanks and disposed of onsite within the soils area of contamination or transported to an onsite treatment facility.

3.2 DESIGN

A site-specific work plan that provides an integrated site plan will be prepared by the remedial action contractor for each site, or combination of sites and submitted to the RA Core Team for concurrence. For capping remedies, a detailed design will be submitted via the site-specific work plan for 30, 60 and 90% design review and approvals. The site-specific work plan will address the key components of the remedial action or characterization activity and will include, as appropriate, but not limited to, site access, site preparation, construction design, characterization planning, and site restoration. The site-specific work plan will also include a site operations plan that defines traffic flow, staging areas operational areas and exclusion boundaries. Each site-specific work plan will be incorporated into the Bethel Valley soils and sediments DWP (Sect. 5.1.2).

3.3 BURIED WASTE ISOLATIONS AND CAPPING

Buried waste will be isolated by a multilayer cap and upgradient diversion system at SWSA 3, a cap at SWSA 1, soil cover installation/maintenance at the FWPA, the NRWTP Debris Pile, and the Contractor's Landfill. The sites and the selected remedies are listed on Table 3.1 and are shown in Figs. 3.1 and 3.2.

Table 3.1 Buried waste sites and selected remedies

Site	Selected remedy	Description
SWSA 1	Install Simple Cap	Entire area of buried waste covered by cap. Infiltration limited by the cap
SWSA 3	Multilayer Cap	Entire area of buried waste covered by cap designed to meet relevant RCRA landfill cover requirements, stable of decreasing surface water concentrations, and stable groundwater conditions.
FWPA	Install and maintain 2 ft cover	All debris and contamination above remediation levels covered.
NRWTP Debris Pile	Install and maintain 2 ft cover	All debris and contamination above remediation levels covered.
Contractor's Landfill	Maintain Cap	All contamination above remediation levels covered.

A multilayer cap with a barrier and drainage layer will be installed on SWSA 3 to encompass all buried waste and protect workers and future recreational users from unacceptable exposure to radiation and to minimize further impacts to groundwater. Design will meet RCRA closure requirements. During design, the extent of buried waste will be verified to ensure that all waste is contained. An example of a multilayer cap cross section is shown in Fig. 3.3. This figure is an example of typical construction only; the actual capping configuration will be established during detailed design as approved by the regulators in the site-specific design. The cap will isolate the waste and will substantially reduce the amount of water that migrates through the buried waste, resulting in a reduced flux of contaminants to surface water via groundwater.

An upgradient surface water and groundwater diversion trench will be installed at SWSA 3 to intercept and divert laterally flowing groundwater and route it around the buried waste. The trench will be designed and constructed to minimize surface water from entering. Storm flow and shallow groundwater above the bedrock will be collected (surface water will be routed around caps using perimeter ditches). DOE intends to design and construct the upgradient trench in a way that will prevent interception of contaminated groundwater. An example of an upgradient diversion trench is shown in Fig. 3.4. This figure is an example of typical construction only. The actual upgradient diversion trench configuration will be established during detailed design as approved by the regulators in the site-specific design. Surface water monitoring for remedial effectiveness will include detection of contaminants that may have originated from the diversion trench. If diverted water contributes to surface water exceedances, it will be treated before release.

A simple cap (low permeability cover) will be installed on SWSA 1 to protect workers from unacceptable exposure to radiation and to minimize further impacts to groundwater. The cap will isolate the waste and substantially reduce the amount of water that migrates through the buried waste, thus reducing the potential for SWSA 1 contaminants to reach surface water via groundwater.

A 0.6-m (2-ft) soil cover will be provided at the NRWTP Debris Pile, the FWPA, and the Contractor's Landfill to protect workers from unacceptable exposure to radiation. Additionally, two small areas of the existing cover at the Contractor's Landfill are contaminated and will be removed and backfilled. Pre-design sampling will be conducted to determine the extent of surface contamination and thickness of existing soil cover at each area.

The East Melton Valley Borrow Site may be the source of all fill soil required. This site is located in Melton Valley on the east side of Health Physics Research Reactor Access Road. The 25-acre site has been investigated and determined to have at least 17 m (55 ft) of soil suitable for use as fill. The other potential borrow sites evaluated in the BV RI/FS may also be used. All surface debris will be removed and sent to the EMWMF or an appropriate off-site facility prior to capping or covering.

3.4 SOIL REMOVAL ACTIONS

Several soil removal actions were identified in the BV ROD (Figs. 3.1 and 3.2). In addition, the BV ROD recognizes several soils sites where the potential for remedial actions exists and acknowledges that the uncharacterized areas of Bethel Valley may hold unidentified locations, which also will require remedial actions. Table 3.2 lists the sites that have been identified for remedial action. The sites are also shown on Figs. 3.1 and 3.2.

3.4.1 Soil Characterization

The soil sites identified in the BV ROD for removal actions and any new soil sites identified for removal actions will undergo limited soil removal by excavation and transfer to the EMWMF for disposal for the protection of the workers as specified in the ROD. Initial work will require characterization as described in Sect. 3.9 to define the soil volume to be excavated and disposed of at the EMWMF and to obtain data for WAC evaluation.

3.4.2 Soil Removal

Inside the ORNL main plant area, contaminated surface soil [0 to 0.6 m (0 to 2 ft)] will be preferentially removed and backfilled with clean soil or, as determined on a case-by-case basis during design, covered to protect the industrial worker from unacceptable exposure to radiation. It is estimated that approximately 9000 m^3 (12,000 yd^3) of surface soil will be removed. There may be cases where installing a soil cover is less disruptive of active plant utilities. However, it is anticipated that these areas will be less than 10 percent of the total soil area to be remediated. In addition, an estimated total of 500 m^3 (700 yd^3) of contaminated soil will be removed in the vicinity of (1) the Tritium Target Preparation Facility (Bldg. 7025) and the 7078 Area former Dump Site to protect the unrestricted industrial worker, and (2) the Abandoned Burn Pit to achieve unrestricted use.

In the undeveloped areas around ORNL, contaminated soil will be removed and backfilled with clean soil to protect the unrestricted user from unacceptable exposure to radiation. The maximum depth of excavation will be that corresponding to bedrock or the groundwater table, whichever comes first. An estimated 16,700 m^3 (21,900 yd^3) of soil near SWSA 3 will be removed, including approximately 1600 m^3 (2100 yd^3) from the Contractor's Landfill cover. This soil from the Contractor's Landfill cover may be used as contouring fill for construction of the SWSA 3 cap. TDEC and EPA will review and approve plans to use excavated soil as contouring fill. The remainder of the soil volume near SWSA 3 [15,100 m^3 (19,800 yd^3)] will be excavated from SWSA 3 Contaminated Soil Areas 1, 2, and 3. If soil contamination from these three soil contamination areas extends below 3 m (10 ft) and is contaminated at concentrations

Figure 3.1 Actions for the selected remedy for Central/East Bethel Valley

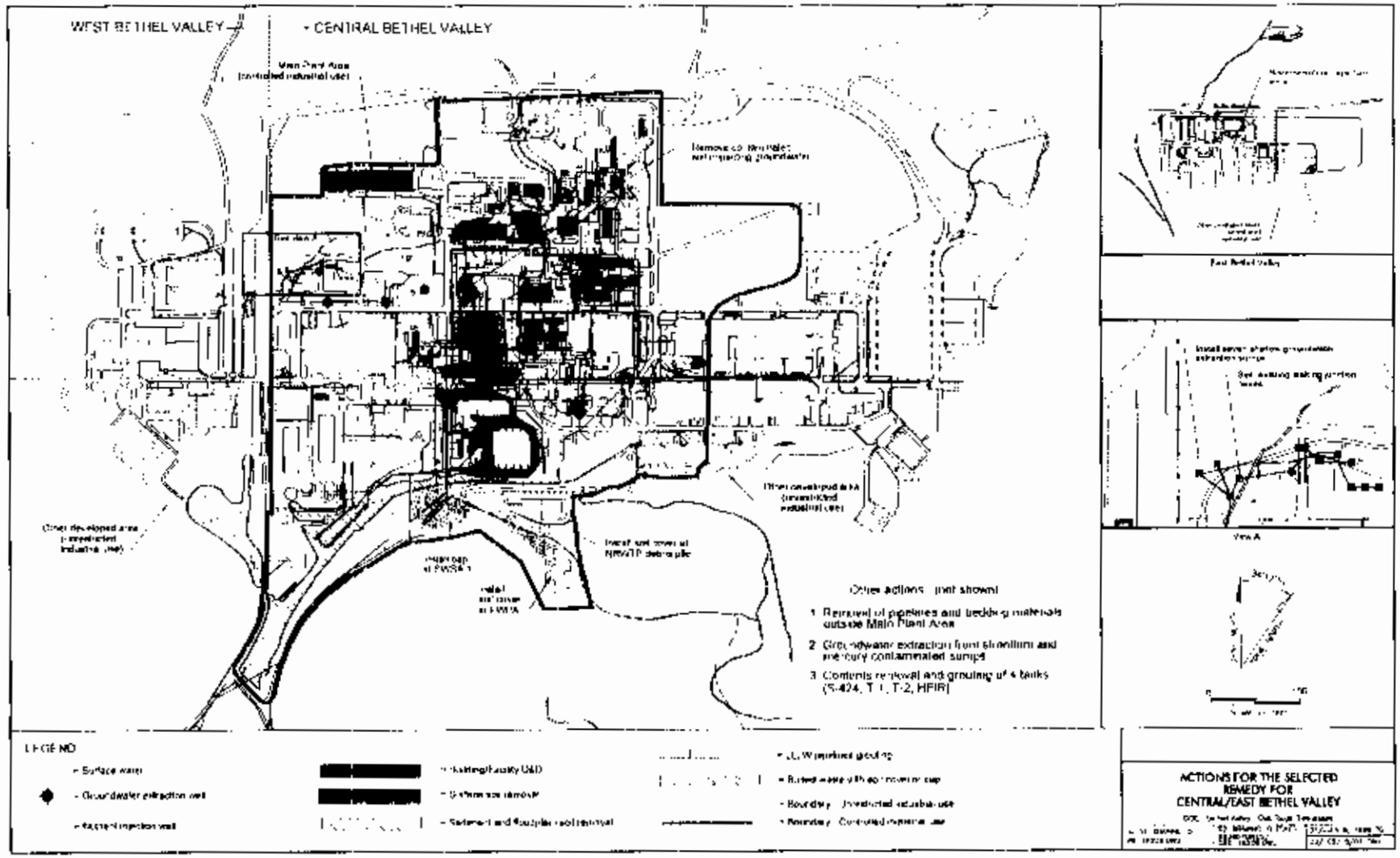

Figure 3.2 Actions for the selected remedy for West Bethel Valley/Raccoon Creek

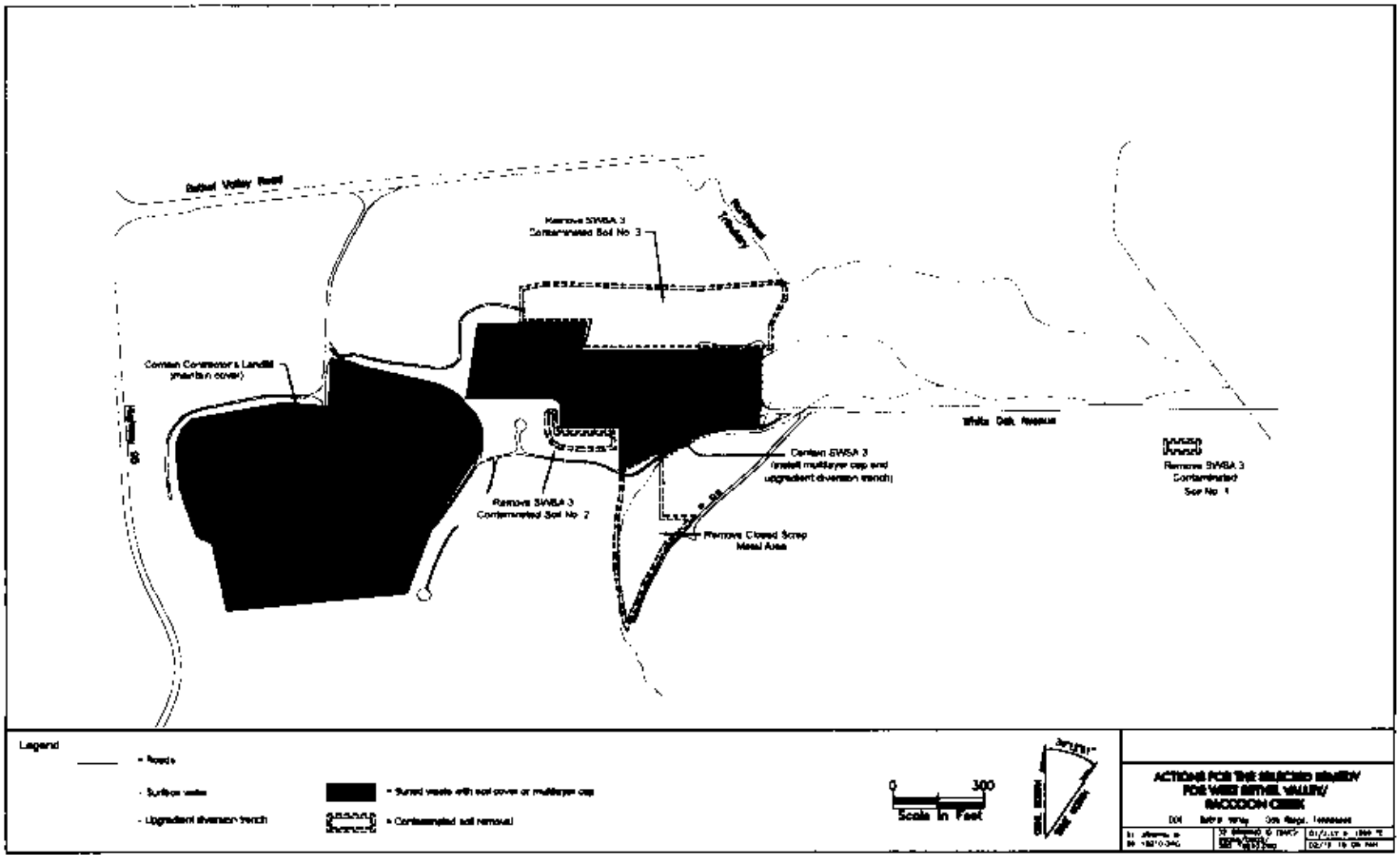

Figure 3.3 Example multilayer cap cross section

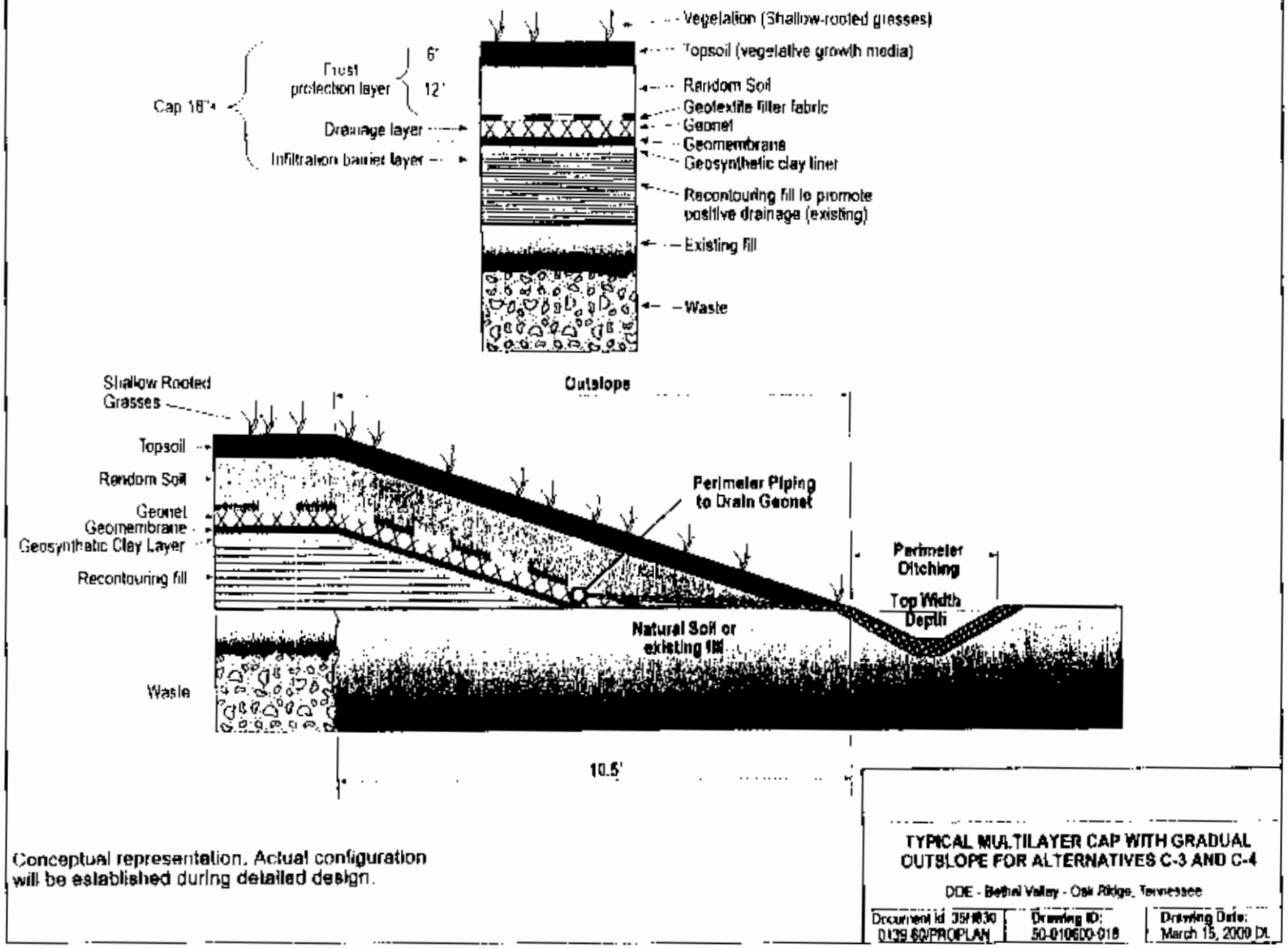

Figure 3.4 Example upgradient diversion trench

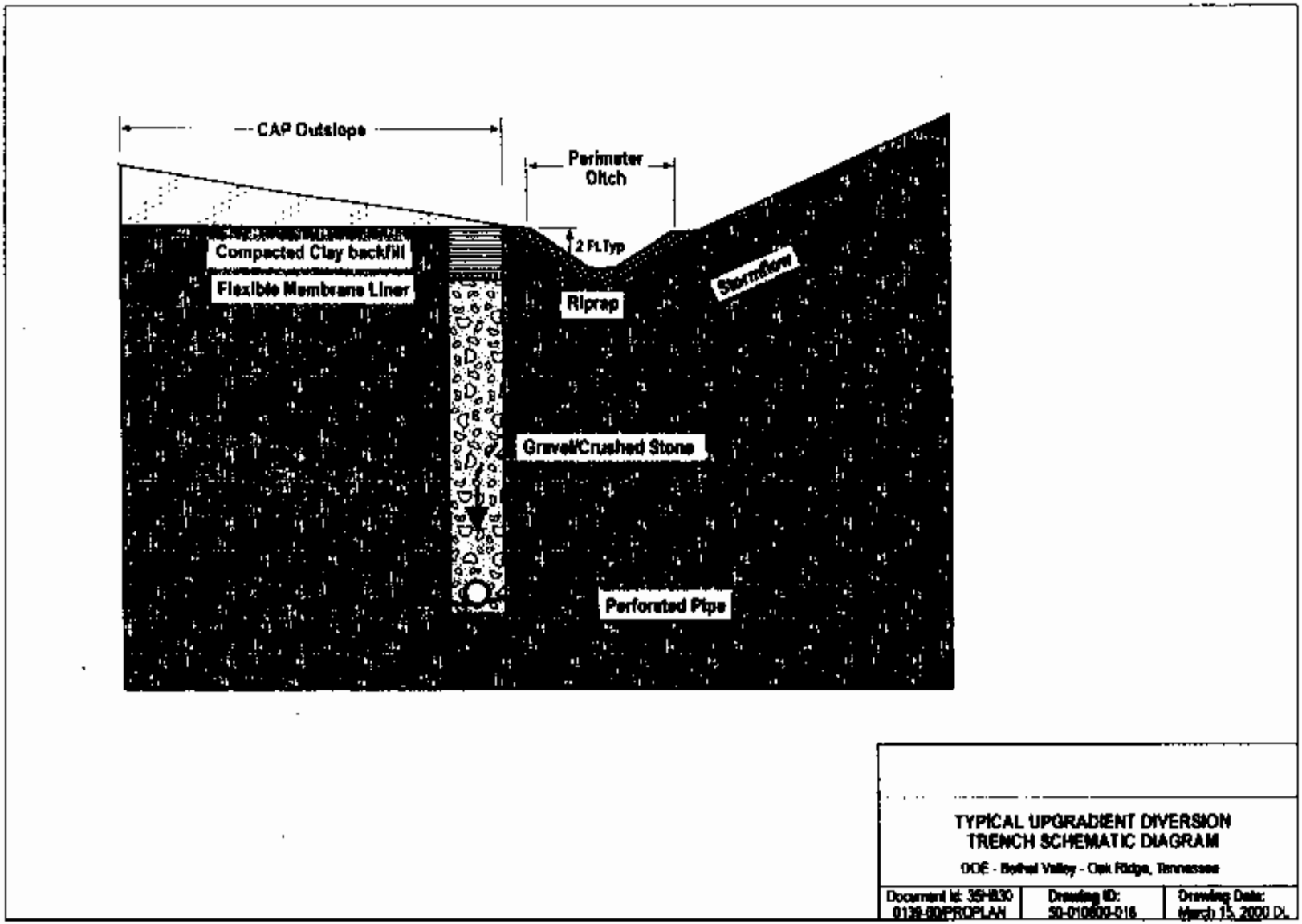

Table 3.2 Soils sites and selected remedies

Site	Selected Remedy	Description
Contaminated Surfaces and Soil from 1959 Explosion in Bldg. 3019 Cell	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil	Data needed to determine volume and WAC (main plant area volume estimated at 12,000 yd^3)
Contaminated soil detected through radiological walkover	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil	Data needed to determine volume and WAC (main plant area volume estimated at 12,000 yd^3)
SWSA 3 Soil No. 1	Excavate contaminated soils above RLs to 3 m (10 ft) depth, use contaminated soil for fill below multilayer cap at the SWSA 3 site	Data needed to determine WAC (combined volume for SWSA 3 area 1,2 and 3 =22,900 yd^3)
SWSA 3 Soil No. 2	Excavate contaminated soils above RLs to 3 m (10 ft) depth, use contaminated soil for fill below multilayer cap at the SWSA 3 site	Data needed to determine WAC (combined volume for SWSA 3 area 1,2 and 3 =22,900 yd^3)
SWSA 3 Soil No. 3	Excavate contaminated soils above RLs to 3 m (10 ft) depth, use contaminated soil for fill below multilayer cap at the SWSA 3 site	Data needed to determine WAC (combined volume for SWSA 3 area 1,2 and 3 =22,900 yd^3)
Closed Scrap Metal Area (1562)	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil	Data needed to determine volume and WAC
3517 Filter Pit Contaminated Soil (Fission Product Development Laboratory)	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil	Data needed to determine WAC, 5173 yd^3 volume estimate (area total)
Fission Product Development Laboratory LLLW Transfer Line (3517)	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil	Data needed to determine WAC, 5173 yd^3 volume estimate (area total)
Contamination at Base of 3019 Stack	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil	Data needed to determine volume and WAC
Fission Product Pilot Plant Contaminated Soil	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil	Data needed to determine volume and WAC
LLLW Lines and Leak Sites - Under Bldg. 3525	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil	Data needed to determine volume and WAC
North and South Tank Farm Contaminated Soil	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil	Data needed to determine volume and WAC

in excess of RLs for an unrestricted user, the cap of SWSA 3 may be extended over the area if approved by the FFA parties.

Where soil is a continuing source of groundwater contamination, the contaminated soil will be removed and backfilled with clean soil. To identify these hot spots, a benchmark of groundwater risk greater than 1×10^{-4} (industrial use) was used. BV ROD Appendix C includes information for use in remedial design to determine contaminated soils that require removal to minimize impacts to groundwater. The remedial action selected to address soils impacting groundwater is soil removal/excavation. Selection of the removal/excavation remedial action was based on an assumed work scope of a single "hot spot" containing low-level (radioactive) waste (LLW) [e.g., no transuranic (TRU) waste], a total excavation volume of 1500 m^3 (2000 yd^3), and a total cost of approximately $1.1 million; however, it is not yet determined to what extent contaminated subsurface soil is impacting groundwater in Bethel Valley.

Several sites were identified in the Groundwater Report for groundwater protection remedial actions. Soil removal actions were recommended at 1) the Pre-Design Study Area (PDSA) #12 soil source area, 3517 Filter Pit Contaminated Soil, and Fission Pilot Plant Contaminated soils (Fission Product Development Laboratory), 2) PDSAs 18, 19, 20, and 21 areas, Contamination at the Base of the 3019 Stack, and 3) the PDSA 41A, 41B, 41C, 41D investigation site at the North and South Tank Farm Contaminated Soils.

Fig. 3.5 presents the general response action logic diagram for soils. This logic diagram addresses any soil that may be identified in the future as a potential source of unacceptable risk. Depending on soil location (e.g., land use area), contamination concentration, depth, and migration potential to groundwater, potential actions would include removal to varying depths or placement of clean cover. The first box in the logic diagram identifies "accessible contaminated soil," indicating that contaminated soil above RLs will be removed if the soil is accessible, or as it becomes accessible. This reflects the complexity of performing remedial actions within a research complex with an ongoing mission. In some cases, currently active facilities and infrastructure impede access to contaminated soils that will require remediation to meet the final objectives of the BV ROD. "Accessible contaminated soil" is soil whose access is not currently impeded. Remediation of soils whose access is impeded may be postponed, with regulatory agency approval, until associated facilities/infrastructure have been deactivated or removed. These soil remediation decisions will be made on a case-by-case basis where the criteria for determining "accessibility" would include 1) extent of disruption to ongoing operations, 2) degree of soil contamination, and 3) logistics or coordination with other remediation or construction activities in the same or nearby area. Eventual remediation of these postponed contaminated soils would follow the same decision logic presented in the diagram once they become accessible.

3.5 SEDIMENT REMOVAL ACTIONS

Sediment removal was identified in the BV ROD as a remedial action for contaminated sediments in the following EUs: Raccoon Creek, NWT, First Creek, Fifth Creek, WOC between 7500 Bridge and First Creek, WOC between First Creek and Fifth Creek, and WOC above Fifth Creek (Fig. 3.1). In addition, the BV ROD acknowledges that the uncharacterized areas of Bethel Valley may hold unrecognized locations which also will require remedial actions.

3.5.1 Characterization

The identified sediment sites will undergo limited sediment removal by excavation and will be transferred to the EMWMF for disposal. In addition, other contaminated sediment may be identified during characterization activities in Bethel Valley. The general response action logic diagram for sediments is presented in Fig. 3.6. Initial work will require characterization as described in Sect. 3.9 to define the sediment volume to be excavated and disposed of at the EMWMF and to obtain data for WAC evaluation. The remedial action contractor will prepare a DWP as described in Sect. 3.2 for RA Core Team concurrence prior to initiating fields operations.

3.5.2 Sediment Removal

Under this activity, contaminated sediment will be removed to the depth of deposition from Bethel Valley creeks to achieve AWQC for mercury in surface water, achieve risk reduction in surface water at the 7500 Bridge, achieve recreational risk-based limits in sediment, and protect benthic invertebrates in sediment. Floodplain soils will be removed from adjacent areas to a maximum depth of 0.6 m (2 ft) and backfilled to protect the industrial worker from unacceptable exposure to radiation and to minimize the migration of contaminants downstream. It is an essential conclusion that a total of 13,500 m^3 (17,600 yd^3) of contaminated soil and sediment will be removed along these surface water drainages.

3.6 ADDITIONAL CHARACTERIZATION REQUIREMENTS

Several soil locations were identified in the BV ROD as needing additional characterization activities in order to make the action/NFA determination. Post-BV ROD characterization addressed a number of these locations. The resulting data are reported in the Groundwater Report and some of the locations that were addressed require an action, some require NFA, and some were not fully characterized. The locations still requiring characterization activities are presented below in Table 3.3. All of the locations in Table 3.3 belong to the BV ROD group of locations called "Radioactively-Contaminated Soil". Because it is clearly uncertain whether the locations listed in Table 3.3 will require remedial actions, these locations meet the criteria for Class 2 SUs (Sect. 3.10) and will be characterized according to the Class 2 SU characterization approach presented in Sect. 3.10.3. The general response action logic for making the action/NFA determination for soils is presented in Fig. 3.5.

3.7 WASTE TRANSPORTATION/DISPOSAL

Waste material will be transported to EMWMF for disposal. All of the waste material is expected to meet the EMWMF WAC. If any waste does not meet the WAC, it will be shipped off site for disposal at an approved facility or treated to meet the EMWMF WAC.

3.7.1 Transport of Waste

Waste shipments will be closely coordinated with EMWMF to allow for careful management of the generated waste forms. Truck loading areas will be protected by placing polyethylene sheeting to capture any spillage. Trucks loaded with waste destined for disposal at EMWMF will require bed liners that extend down the outer sides of the truck bed to prevent external contamination. Excavated and processed materials placed into trucks will be covered before transport. The tare weight of trucks will be determined prior to use for transporting to EMWMF. Loaded trucks will be weighed and the net weight, waste type, source location, and other required data will be recorded for compliance with U.S. Department of Transportation (DOT) requirements and recordkeeping purposes at EMWMF. A copy of each shipping document will be retained with the project records.

Figure 3.5 General response action logic diagram for Bethel Valley soils

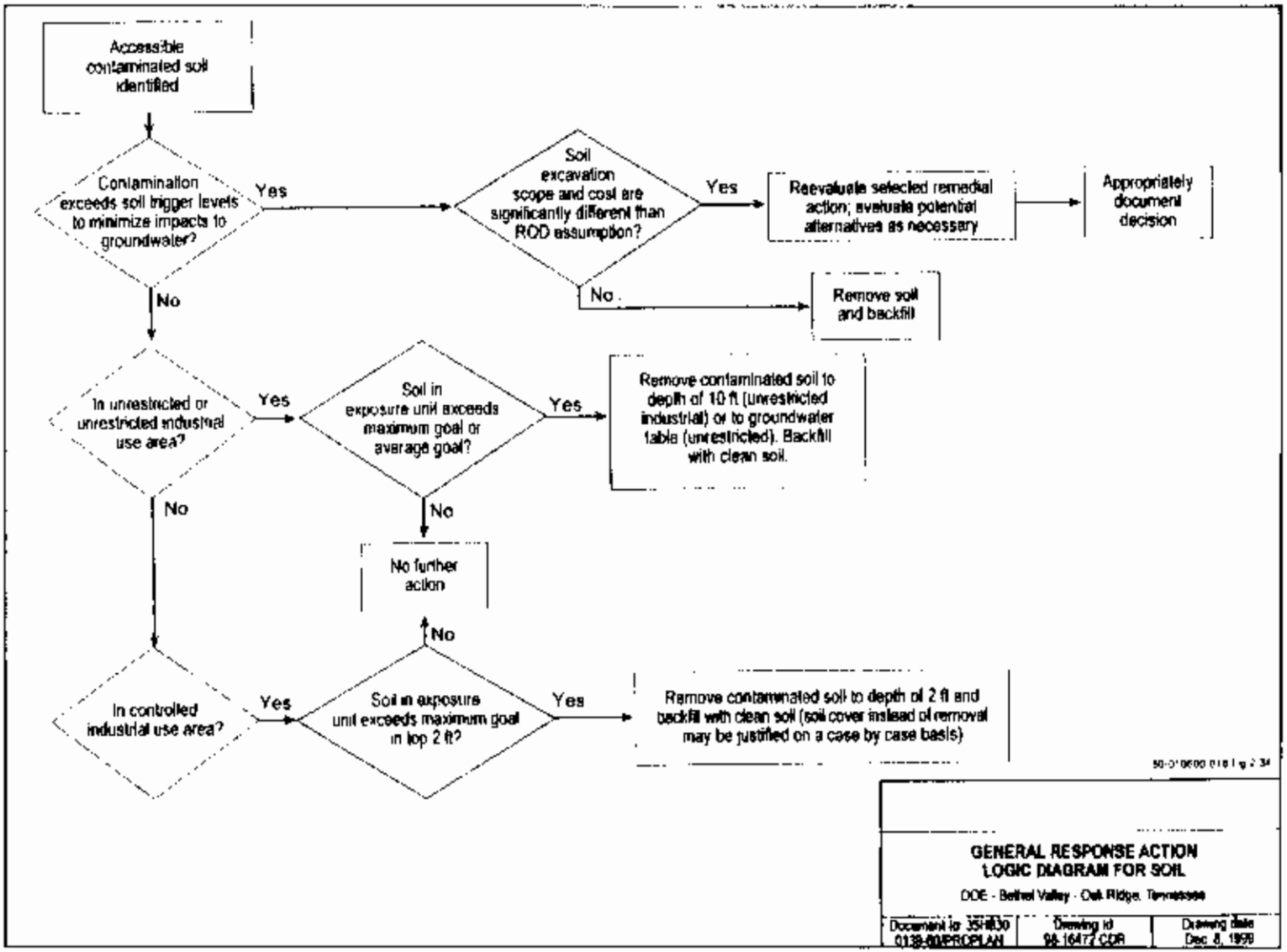

Figure 3.6 General response action logic diagram for Bethel Valley sediments

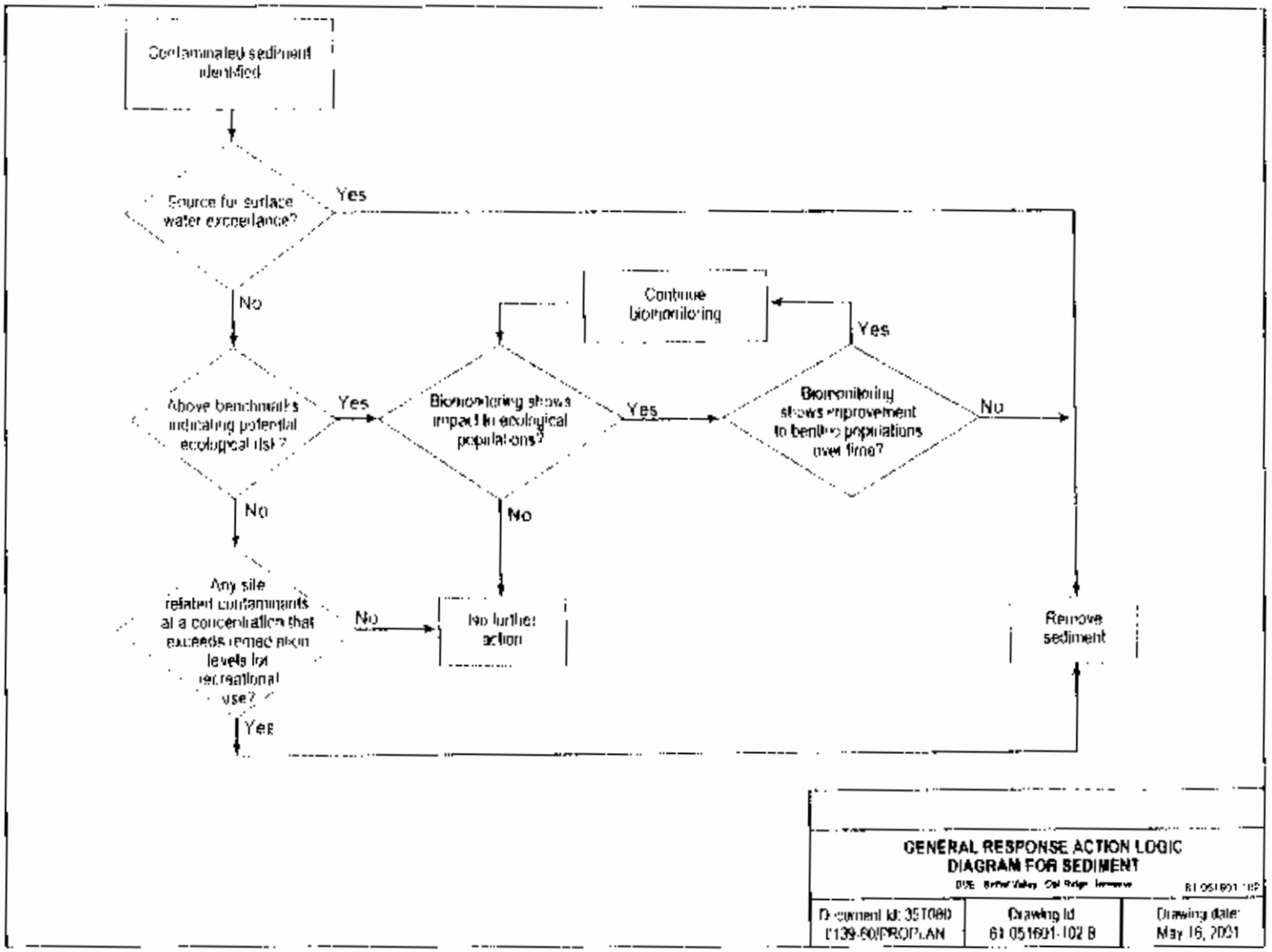

Table 3.3 Bethel Valley locations needing soil characterization

Location	Bethel Valley area	EU	SU classification	Characterization needs
7078 Area Former Construction Dump Site	na	na	2	Conduct design investigation to determine if excavation is required to 3 m (10 ft).
Abandoned Burn Pit	na	na	2	Conduct design investigation to determine if excavation is required to 3 m (10 ft).
C-14 Allocation in Woody Biomass Plantation Species	na	na	2	Conduct design investigation to determine if excavation is required to 3 m (10 ft).
West End Dump Site	na	na	2	Conduct design investigation to determine if excavation is required.
ORRR Decay Tank Rupture Site	3000 North	4	2	Conduct design investigation to determine if soil excavation is needed to protect groundwater and to determine if surface soil excavation is needed.
Decommissioned Waste Holding Basin (soil)	3000 South	5	2	0-2 ft samples needed for human health risk.
LLLW Lines and Leak Sites - Northwest of SWSA 1	2000 South	3	2	Conduct design investigation to determine if soil excavation is needed to protect groundwater and to determine if surface soil excavation is needed.
LLLW Lines and Leak Sites - East of Bldg. 2531	2000 South	3	2	0-2 ft samples needed for human health risk.
LLLW Lines and Leak Sites - Southwest Corner of Bldg. 3019	3000 North	4	2	0-2 ft samples needed for human health risk.
LLLW Lines and Leak Sites - Bldg. 3518, West	3000 South	5	2	Conduct design investigation to determine if soil excavation is needed to protect groundwater and to determine if surface soil excavation is needed.
LLLW Lines and Leak Sites - North of Bldg. 3019	3000 North	4	2	0-2 ft samples needed for human health risk.
WC-10 LLLW Line Leak Site	na	na	2	0-2 ft samples needed for human health risk.
LLLW Lines and Leak Sites - West of Bldg. 3082	3000 North	4	2	0-2 ft samples needed for human health risk.
LLLW Lines and Leak Sites - South of Bldg. 3020	3000 North	4	2	0-2 ft samples needed for human health risk.
LLLW Lines and Leak Sites - East of Bldg. 3020 Stack	3000 North	4	2	0-2 ft samples needed for human health risk.
LLLW Lines and Leak Sites - Bldg. 3503 Ground Contamination	3000 South	5	2	Conduct design investigation to determine if soil excavation is needed to protect groundwater.
LLLW Lines and Leak Sites - ORRR Water Line	3000 North	4	2	Conduct design investigation to determine if soil excavation is needed to protect groundwater.
Low Intensity Test Reactor Ponds	3000 North	4	2	Conduct design investigation to determine if soil excavation is needed to protect groundwater.

Location	Bethel Valley area	EU	SU classification	Characterization needs
Abandoned Underground Waste Oil Storage Tank 7002A (soils)	na	na	2	Conduct design investigation to determine if excavation to a depth of 3 m (10 ft) is required

EU = exposure unit
SU = soil unit
na = not available

3.7.2 Waste Water Disposal

Accumulated wastewater from decontamination runoff or groundwater seeps will be managed during excavation. Contamination levels will vary and will be evaluated to select the appropriate treatment or disposal facility. Initially, the wastewater will be characterized to determine the disposal path, returned to the AOC with appropriate runoff controls, or sent for treatment. In many cases, the waste sources are the same as those that historically sent waste to the existing facilities, and process knowledge may be sufficient to select the appropriate treatment facility. Additional laboratory analysis may be needed if process knowledge indicates a waste stream may contain constituents that will not meet applicable WAC at DOE facilities. Waste characterization may be avoided if site characterization data are sufficient to determine a disposition path.

If wastewater requires treatment prior to disposal, the remediation subcontractor shall treat waste within the area of contamination or utilize a DOE approved wastewater treatment provider. All wastes transferred to a liquid treatment facility will be treated and discharged in accordance with the facilities' current National Pollution Discharge Elimination System permit.

3.7.3 Sanitary Waste Disposal

Uncontaminated waste will be containerized, staged, and transported for disposal to an approved landfill by the Site Maintenance Forces as industrial waste. Sanitary waste from site excavation operations will be surveyed as necessary by the project and inspected for soiled conditions from excavation operations. Soiled waste will be treated as contaminated. Clean, unsoiled waste and office waste from break and office facilities will be disposed of in site-provided waste dumpsters.

3.7.4 Decontamination Areas

Controlled areas delineated for equipment decontamination will be established. Remediation activities will be designed to avoid placing contaminated materials in uncontaminated areas and minimizing the size of said areas. After the areas have been remediated and contamination levels verified to meet cleanup levels, areas will be redesignated as radiologically uncontrolled.

Soil and debris will be removed from construction equipment that has been used in radiologically contaminated areas using low-volume water blasting before the equipment leaves the controlled areas. Decontamination will be allowed only in designated areas located at least 200 ft from any surface water and will not occur in areas slope > 20 percent grade. Field screening devices will be utilized to detect the presence chemical contaminants of concern for each remediation area. Since chemical and radiological contaminants are typically co-contaminants, it is anticipated that decontamination operations conducted for the removal of radiological contaminants will also remove chemical contaminants. However, if based on field screening chemical contaminants of concern remain on the equipment, the chemical decontamination process will occur in an area similar to the radiological decontamination area employing the appropriate chemical decontaminant. The decontamination area(s) will establish appropriate liquid containment measures to ensure protection of workers and the environment. If chemical contaminants of concern remain on the equipment following field decontamination, a statistical sampling method will be

employed to obtain samples for analytical laboratory analysis. Based on the results of the analytical laboratory analysis, a disposal decision will be made.

A bermed and lined area will be selected and designed in the field for final decontamination of equipment prior to removal from the site. If necessary, the area will be constructed to address radiological contamination concerns. Decontamination fluids will be pumped into holding tanks and disposed of on site after characterization or transported to an on-site treatment facility.

3.7.5 Waste Transportation/ Disposal Activities

If contaminated soil or sediments do not meet the EMWMF WAC, it will be shipped offsite to a permitted facility. Any wastes that are transferred offsite or transported in commerce along public rights-of-way must meet the DOT requirements summarized in Appendix A for hazardous materials, as well as the specific requirement for the type of waste [e.g., Resource Conservation and Recovery Act of 1976 (RCRA), PCB, mixed]. These include packaging, labeling, marking, manifesting, and placarding requirements for the specific waste type. Additionally, CERCLA Section 121(d)(3) provides that the offsite transfer of any hazardous substance, pollutant, or contaminant generated during CERCLA response actions be to a treatment, storage, or disposal facility that is in compliance with applicable federal and state laws and has been approved by EPA for acceptance of CERCLA waste. Accordingly, DOE will verify with the appropriate EPA regional contact that any needed offsite facility is acceptable for receipt of CERCLA wastes before transfer.

All primary waste (soil and sediment) and secondary waste (contaminated personal protective equipment, decontamination wastewater) generated during remedial activities will be appropriately characterized as solid, hazardous, PCB-contaminated, radioactive, and/or mixed waste and managed in accordance with appropriate RCRA, Clean Air Act (CAA), Toxic Substances Control Act of 1976 (TSCA), or DOE order requirements for the particular waste. Wastewater collected during decontamination activities will be characterized and transported to an onsite water treatment plant. Appendix A lists in detail the requirements associated with the characterization, storage, treatment, and disposal of these waste types.

3.8 PERFORMANCE MEASUREMENT AND CONSTRUCTION QUALITY CONTROL

Contractor-approved work control documents will include provisions for construction quality control during remediation. A primary focus of the quality control program is to ensure remediation is conducted in accordance with the documented extent of remediation, which for this project is soil and sediment remedial actions, and wastes are properly identified, characterized, and disposed at the proper facility.

3.9 SITE RESTORATION

Backfilling with clean soil fill materials will be required at the soil sites. Fill materials will meet minimum clean fill criteria including but, not limited to being free of contaminants, debris, and rubble. Backfill materials will also have a low percent content of organic materials. Fill will also have less than 5 percent by volume of rocks and cobbles greater than two inches in diameter. Backfilling and recontouring of the soils sites is anticipated. Restoration will include replacing or repairing surface infrastructure (roads, sidewalks, lawns with irrigation systems and similar restoration that is consistent with, and a continuation of, the surface aspects of the surrounding area). Any infrastructure repair or replacement should be included by reference in and specifically added or exempted from the remediation contractors site specific work plans, cost estimates and schedules. Seeding and mulching to promote revegetation following excavation is expected.

Upon completion of all excavation and backfilling operations, grading the excavated and support areas will be performed in a manner that will facilitate natural drainage, with slopes that will ensure revegetation and prevent erosion. In some instances, fencing may be used to reduce the risk of inadvertent slippage into an excavated area.

Tracking or rolling soil surfaces will be performed to seal the soil surface and reduce the amount of loose soil available to contact surface water runoff. The soil base will include an application of lime, if required, to adjust the pH level of the soil. A commercial grade fertilizer will be applied in advance of seeding, with the exception of hydro-application where the application may be concurrent.

The finished ground surface will be scarified to prepare the soil for grass seeding; however, this may be accomplished in conjunction with seedbed preparation. The seed mixture will be in accordance with the requirements of Tennessee Department of Transportation Standard Specification, Subsection 918.14, Grass Seed. The seed mixture will vary depending on the time of planting.

3.10 CHARACTERIZATION APPROACH

This section presents the approach for conducting DCS characterization activities and discusses the decisions which the characterization results will support. Through characterization, the DCS provides information to support action/NFA decisions, define the extent of the action, and confirm whether the action has met the goals of the Bethel Valley RAO. Characterization under the DCS is a classification-based endeavor that is designed to facilitate flexibility and be responsive to a changing CSM. SU classifications are developed in the Bethel Valley DQOs (Appendix A) and are presented in Table 3.4. Appendix B provides descriptions of soil and sediment sites and their respective remedial actions and soil unit classifications.

Table 3.4 Bethel Valley soil unit classifications

Soil Unit	Definition
Class 1	The area has been impacted and there is a high degree of certainty that it will require a remedial action
Class 2	The area has been impacted and there is high degree of uncertainty regarding the need for a remedial action in the area.
Class 3	The area has been impacted and there is a high degree of certainty that it will not require a remedial action.
Class 4	The area has not been impacted therefore a remedial action will not be necessary.

The rationale for the DCS approach to characterization is presented in the Bethel Valley DQOs in Appendix A. What follows here is a description of the manner in which the characterization approach developed in the Bethel Valley DQOs and presented in DQO step 7 (Appendix A) will be implemented. The primary objective of DCS characterization is to provide data necessary to address the DQO decision rules (DQO step 5 in Appendix A), which are reiterated here.

Decision Rule 1

If the average concentration of any Bethel Valley COC within soils or sediments of an EU exceeds its average RL, then conduct a remedial action until the average concentration is less than the average RL, otherwise take NFA with respect to average RLs

Decision Rule 2

If the concentration of any Bethel Valley COC within soils or sediments exceeds its maximum RL over the area defined for a hot spot, then conduct a remedial action until the concentration is less than the maximum RL, otherwise take NFA with respect to maximum RLs.

Decision Rule 3

If the calculated risk for soils or sediments in a Bethel Valley EU exceeds the BV ROD risk limits, then conduct a remedial action until the EU risk is less than the risk limits, otherwise take NFA with respect to EU risk.

Decision Rule 4

If Bethel Valley EU soil compositions create an unacceptable risk in groundwater compositions as determined by the BV ROD groundwater modeling methodology, then conduct a remedial action until EU soil compositions no longer create an unacceptable risk in groundwater, otherwise take NFA with respect to protection of groundwater.

Decision Rule 5

If the horizontal and vertical extents of a remedial action boundary (RAB) are known with confidence, then conduct the remedial action, otherwise perform additional characterization to better define the RAB.

The DCS characterization program consists of a base program and additional characterization activities necessary to address a changed CSM. The base characterization program is the characterization program presented to the RA Core Team for its concurrence during DQO scoping and is the optimum characterization program to address the CSM developed for the site at the time of DQO scoping. The additional characterization activities that are part of the DCS characterization program provide the flexibility to the DCS that is needed in order to respond to changing conditions. In order for the additional characterization activities to be conducted in as cost-efficient manner as possible, it is necessary that data derived during the base program become available to decision makers while field crews are still mobilized. For this to happen requires that base program activities with the greatest potential to lead to additional characterization activities (e.g., Class 2 SU sampling and radiation walkover surveys) be conducted at the outset when a new area of interest is being addressed. If necessary, it is recommended that rapid analytical turn-around times be requested from the laboratory. Because additional characterization activities are a fundamental part of the DCS, no additional planning documents are required to conduct those activities; however, RA Core Team concurrence is required for additional characterization activities that address major changes in the CSM.

3.10.1 DQO Scoping

Under the DCS, the site-specific approach to characterization is developed during DQO scoping. The DQO scoping process involves all of the stakeholders as represented by the RA Core Team. DQO scoping is conducted for land areas of interest. In Bethel Valley, land areas of interest will generally be EUs or groups of EUs in the controlled industrial, unrestricted industrial and recreational land use areas where EUs were defined in the BV ROD but can also include newly defined EUs, hot spots, and areas needing RAB definition. The end product of DQO scoping is development of a characterization plan for the area of interest which is agreed to by the RA Core Team. The characterization plan presented to the RA Core

Team during DQO scoping is the base program. The base program is designed to address the DQO decision rules based on the CSM existing at the time the base program is developed. It is often the case that new data generate a new CSM; therefore, a fundamental aspect of the DCS, i.e., its dynamic nature, is that characterization activities can be adjusted, added, or deleted in response to a changing CSM. All changes to the base program under the DCS are done with RA Core Team concurrence.

The first step in DQO scoping is to conduct a data gap assessment for the land area of interest. A data gap assessment involves a review and compilation of all data types from all data sources listed in Appendix A, which are relevant to the Bethel Valley DQO decision rules. The purpose of the data gap assessment is to learn which locations in the land area of interest have sufficient existing data to make an action/NFA decision within the uncertainty constraints of DQO step 6 (Appendix A) and which locations do not.

Upon completion of the data gap assessment, the next step in DQO scoping is to classify the land area of interest into one or more SU according to the SU definitions in the Bethel Valley DQOs (Appendix A). On the basis of the data gap assessment, locations within the area of interest with sufficient information for decision making will be classified as one of the following: Class 1, Class 3, or Class 4 SUs; locations without sufficient information for decision making will be classified as Class 2 SUs.

The DCS approach to characterization is classification-based, therefore, when SUs in the area of interest have been defined, the base program for characterization is developed to be consistent with the characterization activities for the different SUs presented in the Bethel Valley DQOs (Appendix A) and elaborated below in Sects. 3.10.2 through 3.10.5.

When complete, the results of the data gap assessment, the SU classifications, and the base program design for the area of interest are presented to the RA Core Team in a DQO Scoping Package for their review and concurrence. The layout of the DQO Scoping Package is to first, summarize all of the decision rule-relevant existing information for the area of interest; second, present the SU classifications with justifications based on the existing information or lack of it; and third, present the sampling and analysis requirements for the area of interest including sample locations, depths and analytes.

The base program for each area of interest is documented and agreed to in a DWP with the provision that additional sampling and analysis can be added to the program with RA Core Team concurrence. The DWP identifies sample locations and analysis requirements, including the use of real-time field measurements where applicable. Fixed laboratory analyses are also specified in the DWP for a suite of analytes [volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), target analyte list (TAL) metals, PCBs, and a suite of radioanalytical methodologies that includes gamma spectroscopy, alpha spectroscopy, thorium-isotopic, uranium-isotopic, ^{90}Sr, and radium specific analyses] to ensure all potential COCs have been identified.

3.10.2 Class 1 SU Characterization Approach

The goals of characterization in Class 1 SUs are to define RABs and to obtain data to address the WAC for the point of waste disposal. If sufficient data exist to address either of these goals, then some or all of the characterization activities listed below may not be necessary. The details of the characterization approach toward Class 1 SUs in each area of interest will be consistent with the Bethel Valley DQOs (Appendix A) and will have been developed during DQO scoping and ultimately presented in a DWP. A Class 1 SU characterization involves the following steps:

1. Completion of an ecological impact assessment where significant disturbance (clearing) will be performed;
2. Clearing to provide access to the SU;
3. Performance of radiation walkover surveys where surface soils are directly accessible and geophysical surveys, as needed;
4. Selection of sample locations, as defined in the DWP, to delineate the RABs and obtain data for WAC evaluation;
5. Performance of base program sampling;
6. Evaluation of field and laboratory data; and
7. Selection of additional biased sample locations as needed to refine the RABs or WAC evaluation.

Once the DWP, including the sampling plan, has been developed and RA Core Team concurrence obtained, Phase I of the field work (Steps 1 and 2 above) begins by preparing the site and conducting an ecological impact assessment where significant clearing will occur. Currently in Bethel Valley, Class 1 SUs that will most likely require significant clearing are located along the stream reaches which have been identified in the BV ROD for sediment excavation. However, each Class 1 SU should be evaluated for clearing and the need for an ecological impact assessment during DQO scoping and DWP development.

Radiation walkover and geophysical surveys (Step 3) are performed several weeks to months prior to sampling activities. This lead time allows for evaluation of the survey data and supports the selection of biased sample locations to refine RABs and WAC evaluation. Geophysical surveys are used to define the boundaries of buried waste or the presence of other buried material and are conducted only if the SU encompasses a former burial area for which a RAB needs to be delineated or if subsurface information is needed for excavation permits. Radiation walkover surveys are conducted to delineate RABs in SUs defined as Class 1 SUs because of radiological COCs. In general, RABs delineated by radiation walkover and geophysical surveys are generally confirmed by sampling and analysis (Step 4); however, if the RA Core Team concurs that a radiation walkover or geophysical survey adequately delineates a RAB, no additional sampling may be necessary.

Following completion of radiation walkover and geophysical surveys and evaluation of survey results, Class 1 SU characterization activities commence to delineate RABs and obtain data for WAC evaluation (Step 5) unless the RA Core Team has decided that no additional characterization activities are necessary. Each Class 1 SU is characterized according to the specific details in the DWP. Soil sampling is performed using standard field methods and following EPA Region 4 standard operating procedures (SOPs). Geoprobe sampling is the predominant method of sample acquisition for subsurface soil to depths. Surface and shallow interval soil sampling is done predominantly using hand augers. Other sampling methods (e.g., trenching and drilling) may be used with RA Core Team concurrence where site-specific conditions warrant. The sampling methodology presented in the BV ROD is to composite samples from certain depth intervals, which are largely dependent on the land use. Compositing depth intervals for the different land uses in Bethel Valley are presented in Table 3.5.

Field screening methods are used as part of the field characterization activity (Step 5). VOC screening using hand-held meters and radiation screening using a core scanning device are used on soil cores. With RA Core Team concurrence, field screening for VOCs and radiation may be used in lieu of laboratory analytical data to delineate horizontal and vertical RABs. Other field screening technologies may be used, as appropriate, for RAB delineation with RA Core Team concurrence.

Table 3.5 Land use-specific depth intervals for compositing samples

Land use	Depth intervals
Controlled industrial	0 to 15 cm (0 to 6 in) 15 cm to 0.6 m (6 in to 2 ft)
Unrestricted industrial	0 to 15 cm (0 to 6 in) 15 cm to 0.6 m (6 in to 2 ft) 0.6 m to 3 m (2 ft to 10 ft)
Recreational (streambed)	0 to 15 cm (0 to 6 in) 15 cm to 0.6 m (6 in to 2 ft) 0.6 m to 3 m (2 ft to 10 ft) Maximum depth in all cases will be the depth of deposited sediments.
Recreational (other than streambed) Unrestricted	0 to 15 cm (0 to 6 in) 0 to 15 cm (0 to 6 in) 15 cm to 0.6 m (6 in to 2 ft) 0.6 m to 3 m (2 ft to 10 ft) Maximum depth in all cases will be the depth of bedrock or the groundwater table, whichever is reached first.

3.10.3 Class 2 SU Characterization Approach

The goal of characterization in Class 2 SUs is to fill identified data gaps in order to make the action NFA decision. The details of the characterization approach toward Class 2 SUs in each area of interest will be consistent with the Bethel Valley DQOs (Appendix A) and will have been developed during DQO scoping and ultimately presented in a DWP. A Class 2 SU characterization involves the following steps:

1. Completion of an ecological impact assessment where significant disturbance (clearing) will be performed;
2. Clearing to provide access to the SU;
3. Performance of radiation walkover surveys where surface soils are directly accessible and geophysical surveys, as needed;
4. Selection of sample locations, as defined in the DWP, and biased sample locations based on survey results;
5. Performance of base program sampling;
6. Evaluation of field and laboratory data; and
7. Selection of additional biased sample locations based on field measurements and laboratory results.

Once the DWP, including the sampling plan, has been developed and RA Core Team concurrence obtained, Phase I of the field work (Steps 1 and 2 above) begins by preparing the site and conducting an ecological impact assessment where significant clearing will occur.

Radiation walkover and geophysical surveys (Step 3) are performed several weeks to months prior to the actual sampling activity. This lead time allows for evaluation of the survey data and supports the selection of a set of biased locations to evaluate the survey results. Geophysical surveys are used to define the boundaries of buried waste at landfill disposal sites or the presence of other buried material. Radiation walkover surveys are used to define limits of radiological contamination in surface soils. The decision to be made from results of the radiation walkover and geophysical surveys is whether there is a need for

biased sampling locations where there is elevated radiation or geophysical anomalies (Step 4). These survey results can also be used later if contamination is identified to delineate potential RABs. After concurrence from the RA Core Team, any identified biased sampling locations from these survey results are included in the base sampling program.

Following completion of radiation walkover and geophysical surveys and evaluation of survey results, Class 2 SU characterization activities commence to gather sufficient data to make the action/NFA decision (Step 5). Each Class 2 SU is characterized according to the specific details in the DWP and biased sample locations, based on survey results, are added with RA Core Team concurrence. Soil sampling is performed using standard field methods and following EPA Region 4 SOPs. Geoprobe sampling is the predominant method of sample acquisition for subsurface soil. Surface and shallow interval soil sampling is done predominantly using hand augers. Other methods (e.g., trenching and drilling) may be used with RA Core Team concurrence where site-specific conditions warrant. The sampling methodology presented in the BV ROD is to composite samples from certain depth intervals, which are largely dependent on the land use. Compositing depth intervals for the different land uses in Bethel Valley are presented in Table 3.5. Discrete interval samples will be collected (Steps 5, 6, and 7) if:

1. A field screening methodology shows an elevated measurement in a segment of a core, or
2. Initial analytical results show that an action level (25 percent of an average RL) is exceeded in the composited sample (steps 6 and 7).

Field screening methods are used as part of the Class 2 SU characterization activity (Step 5). VOC screening using hand-held meters and radiation screening using a core scanning device are used on soil cores. Other field screening methods [e.g., hand-held x-ray fluorescence (XRF) and PCB field assay kits] may be used, as appropriate, with RA Core Team concurrence. Field screening allows for collection of the core intervals most likely to have contamination for analytical analysis in addition to the composited sample. Collection of the most-likely contaminated segment of the core will ensure existing contamination is represented in analytical results. Recognition of potential VOC contamination also will allow that segment to be analyzed prior to compositing so contamination is not lost by volatilization.

Class 2 SU samples will be analyzed for land use specific COCs which include metals and SVOCs in the industrial use areas (controlled and unrestricted), PCBs and SVOCs in the recreational use areas, and SVOCs in the unrestricted use areas, unless otherwise directed by the RA Core Team. Radionuclide and VOC analyses will be conducted if field screening action levels are exceeded. To support the risk assessment, a random 20 percent of the Class 2 SU samples will also be analyzed for VOC, SVOC, and radionuclides as part of the base program (Step 5). If laboratory-reported results indicate action levels are exceeded in the composite sample, the sample locations with the exceeded action levels are resampled for the specific parameter of concern and discrete intervals will be sampled and sent for analysis (steps 6 and 7). Depth intervals for discrete sampling will be the same depth intervals for sample compositing presented in Table 3.5.

3.10.4 Class 3 SU Characterization Approach

Class 3 SUs are characterized during walkover assessments. Decisions made either during or at the end of the walkover assessment process include the following:

- Are there anthropogenic features, elevated radiological areas, or sediment accumulation areas that require biased sampling and analysis; and
- Does the EU exceed RAOs and RLs from the BV ROD and therefore require action? (Results from Class 1 and 2 SU evaluations are needed to make this final EU-level assessment.)

Assessment of the Class 3 SUs proceeds independently of the Classes 1 and 2 SU investigations. Class 3 SU walkover assessments are performed in the winter months to facilitate inspection of the acreage in heavily wooded portions of Bethel Valley. Walkover assessments focus on identifying anthropogenic or anomalous features, delineating boundaries of the features, determining if sampling of the features is warranted, and identifying sediment accumulation areas. Walkover assessments are conducted to systematically inspect Class 3 SUs along transects to established systematic grid assessment points (APs). A systematic grid with a random starting point is used to establish each AP with approximately one point per acre. Approximately halfway to each AP, a mid-point (MP) is assessed. Discretionary points (DPs) are assessed as transects are traversed and anthropogenic or anomalous features and sediment accumulation areas are recognized. Assessment activities include mapping observed features, collecting radioactivity screening data, and recommending biased sample locations, all to support the action/NFA decision. Anthropogenic features or areas of elevated radioactivity are also characterized with 30-second counts of the field radiation detector.

Biased soil samples from identified anthropogenic or anomalous features are collected and analyzed for metals, radionuclides, and PCBs. Approximately 20 percent of the biased samples are analyzed for a larger suite of analytes to aid in identifying previously unrecognized, site-related soils contaminants.

Sediment accumulation areas are defined as areas where runoff from large portions of the SU converge and have the potential for sediment deposition. The condition of the soils or sediments in these areas is representative of the upstream conditions, and elevated levels of contamination would be indicative of an upgradient source. Biased samples collected from sediment accumulation areas are sent to a laboratory for radionuclide, metal, VOC, SVOC, PCB, and dioxin/furan analyses for identification of previously unrecognized site-related soils contaminants. If COC concentrations near the RLs or previously unrecognized site-related contaminants are found, additional survey work may be needed upstream to identify the potential source of contamination.

In areas where building slabs exist and/or infrastructure is present, biased sampling will target worst case conditions to determine if contaminant releases to EU soil have occurred. Worst case conditions may include but are not limited to:

- infrastructure exit and entry points for buildings, sumps, and structures;
- sharp line bends such as floor drain traps, 90° bends and connections, and a mid-point where appropriate;
- slab expansion joints, cracks, and patched or repaired floor excavations; and
- staining, degraded areas of concrete, and areas that have slightly elevated radioactivity based on survey information.

3.10.5 Class 4 SU Approach

Because land areas classified as Class 4 SUs have been determined to be unimpacted, no characterization activities are necessary.

3.10.6 Action/NFA Decision/Communication

When results of the field work and analytical work have been received for each area being investigated, a technical memorandum (TM) is prepared for the RA Core Team in which the results of the DCS and historical investigations are presented and an action/NFA recommendation, based on the Bethel Valley DQO decision rules, is made. Data, maps, cross sections, and any other useful information are provided to the RA Core Team in the TM to facilitate decision making. The RA Core Team reviews the

TM and decides whether to concur with the presentation of results and the recommendation for action/NFA.

In order to make the action/NFA recommendation, soil and sediment data presented in the TM are compared to risk and groundwater protection compositional limits. Risk limits are embodied in the RLs and the excess lifetime cancer risk (ELCR) and hazard index (HI) for each land use area as presented in Table 3.6. RLs are cleanup guidelines for the COCs identified in the BV ROD as major contributors to the ELCR and HI in the land use areas of Bethel Valley. There are two RLs for each COC. The maximum RL is a not-to-exceed concentration applied to a surface area of $1m^2$ or greater; the average RL is a limit on the average concentration of a COC across an EU. The ELCR and HI risk limits calculated for all chemicals and radionuclides in a baseline risk assessment are also applied across the EU. These ELCR and HI risk limits were developed in part to allow the identification of new COCs. There is uncertainty whether all COCs in Bethel Valley have been identified. If the risk assessment identifies contaminants that do not have a RL but are causing an unacceptable risk, those contaminants will be remediated. The RA

Table 3.6 Remediation levels and associated parameters for Bethel Valley soils and sediments

Parameter	Industrial use areas	Recreational areas (streambed)[a]	Unrestricted areas
Maximum depth of remediation	Controlled: 0.6 m (2 ft) Unrestricted: 3 m (10 ft)	Depth of sediment deposition.	Bedrock or groundwater table, whichever is nearer the surface.
Risk constraints	ELCR = 1×10^{-4}, HI = 1, 2000 hours/year, industrial worker.	ELCR = 1×10^{-4}, HI = 1, 75 hours/year, hypothetical recreational user. Except: cesium-137 ELCR = 1×10^{-5} Also, selected ecological benchmarks.	ELCR = 1×10^{-4}, HI = 1, 8760 hours/year, hypothetical residential receptor.
Average RL concentrations	Arsenic = 330 mg/kg Benz(a)anthracene = 260 mg/kg Benzo(a)pyrene = 26 mg/kg Benzo(b)fluoranthene = 250 mg/kg Dibenz(a,h)anthracene = 26 mg/kg Americium-241 = 450 pCi/g Cesium-137+D = 14 pCi/g Cobalt-60 = 7.4 pCi/g Europium-152 = 9.5 pCi/g Europium-154 = 11 pCi/g Europium-155 = 710 pCi/g Iodine-129 = 1400 pCi/g Lead-210+D = 270 pCi/g Plutonium-240 = 540 pCi/g Radium-226+D = 3 pCi/g Radium-228+D = 3 pCi/g Thorium-228+D = 3 pCi/g Thorium-232 = 3 pCi/g Uranium-238+D = 310 pCi/g	Aroclor-1254 = 110 mg/kg Aroclor-1260 = 110 mg/kg Benzo(a)pyrene = 62 mg/kg Hexachlorodibenzofuran = 4.8 mg/kg Cesium-137+D = 32 pCi/g Cobalt-60 = 200 pCi/g Europium-152 = 230 pCi/g Europium-154 = 270 pCi/g Ecological COCs: Mercury at 0.7mg/kg (PEL) Silver at 1.8 mg/kg (PEL) Zinc at 270 mg/kg (PEL) Cadmium at 4.2 mg/kg (PEL) PCBs at 0.18 mg/kg (PEL) PAHs at 4 mg/kg (ER-L)	Benz(a)anthracene = 86 mg/kg Benzo(a)pyrene = 8.6 mg/kg Benzo(b)fluoranthene = 86 mg/kg Dibenz(a,h)anthracene = 8.6 mg/kg N-nitroso-di-n-propylamine = 7.8 mg/kg Cesium-137+D = 7 pCi/g Cobalt-60 = 4 pCi/g Europium-152 = 5 pCi/g Europium-154 = 6 pCi/g Radium-226+D = 3 pCi/g Thorium-232+D = 3 pCi/g Uranium-235+D = 37 pCi/g Uranium-238+D = 91 pCi/g
Maximum RL concentrations	10 times average RLs.	10 times average RLs.	10 times average RLs

[a] WRSA 3 recreational area will be cleaned by virtue of the capping remedy

The alternate concentration limit of 5 pCi/g for the radium and thorium isotopes is applied over the EU and to the established depth of remediation. The radium and thorium isotopes are not included with the other COCs in the aggregate risk calculation for the EU to meet the desired risk goal of 1×10^{-4} ELCR

COC = contaminant of concern
D = radioactive decay daughter
ELCR = excess lifetime cancer risk
ER-L = effect range - low
HI = hazard index
mg/kg = milligrams per kilogram
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
pCi/g = picocuries per gram
PEL = probable effects level
RL = remediation level

Core Team can elect to develop RLs for new contaminants if the contaminants are expected to drive the need for remediation again.

Risk is evaluated in the TM by first, comparing COC data to maximum RLs. If a maximum RL is exceeded, then the need for an action is evaluated. Second, average COC concentrations are compared to average RLs and average non-COC concentrations are compared to the appropriate 10^{-5} preliminary remediation goals (PRGs). The appropriate PRGs are those applicable to the area's land use (e.g., industrial, recreational, unrestricted). Third, if an average COC concentration exceeds its average RL or if the average concentration of a non-COC exceeds its 10^{-5} PRG, then an area-weighted average calculation is performed and the results of the area-weighted average calculation is compared to the average RL or 10^{-5} PRG, as the case may be. Fourth, if a COC area-weighted average concentration exceeds the average RL, then the need for an action is evaluated and if the area-weighted average concentration of a non-COC exceeds the 10^{-5} PRG, then the need for a quantitative, baseline risk assessment is evaluated.

Area-weighted average concentrations are used because data within an EU will be unevenly distributed across the SUs (i.e., SUs with the greatest uncertainty will have a higher density of samples) and weighting adjusts SU areal extents to arrive at a more representative EU average. For those SUs with little probability of contamination and few, if any, sample results (i.e., Class 3 and Class 4 SUs) background concentrations of COCs as agreed to by the RA Core Team are used in the area-weighted average calculations for the EU risk evaluations and assessments and comparison to average RLs.

Evaluation of soil and sediment data in the TM for protection of groundwater is conducted by first, comparing compositional data to the trigger levels presented in Table 3.7. If a chemical or radionuclide concentration exceeds its trigger level, the chemical or radionuclide and the location of the exceedance are evaluated for mass of contaminant and the likelihood of mobility. Mass of the contaminant is dependent on concentration(s) and areal extent. Mobility is dependent on factors such the physico-chemical properties of the chemical or radionuclide and containment within anthropogenic and natural features. When a chemical or radionuclide exceeds its groundwater protection trigger level and it is determined that there is sufficient mass and mobility for the chemical or radionuclide to pose a potential threat to groundwater, groundwater modeling is conducted according to the methodology described in the BV ROD Appendix C.

If unacceptable contamination is found in an area not identified in the BV ROD as requiring remediation, the ROD may need to be modified prior to taking action. Small areas (contributing insignificantly to anticipated ROD volumes) will be documented with a note to the file. For areas that change the ROD volumes or warrant consideration of alternate remediation, it is planned that a single ROD modification will be made after all potential areas requiring remediation outside the ROD are identified so that a cumulative assessment of the potential impact can be made. Depending on the severity of the change, either an Explanation of Significant Difference (ESD) or a ROD amendment would be issued with appropriate public involvement as defined by CERCLA.

Table 3.7 Soil trigger levels for groundwater protection evaluation

COC	Soil trigger level	COC	Soil trigger level
	Metals(mg/kg)		
Antimony	1.74E−02	Mercury	1.52E−01
Arsenic	5.20E+01	Zinc	1.81E+05
	Radionuclides (pCi/g)		
Actinium-228	4.21E−05	Radium-226	1.53E−04
Americium-241	8.79E+03	Radium-228	1.84E−04
Carbon-14	1.51E−03	Strontium-90	1.10E+03
Cesium-134	9.63E+04	Thallium-208	6.10E+06
Cesium-137	1.44E−05	Thorium-228	7.08E−04
Cobalt-60	6.42E−04	Tritium	1.25E−03
Curium-244	2.42E+02	Uranium-232	7.55E+02
Europium-152	1.06E−04	Uranium-234	1.36E+03
Europium-154	6.42E+03	Uranium-235	1.32E−03
Lead-210	2.27E−02	Uranium-238	1.40E+03
Potassium-40	3.68E+03	Zirconium-95	2.32E−05
Promethium-147	6.75E−05		
	Volatile organic compounds (mg/kg)		
1,2-dichloroethene (total)	1.35E−01	Trichloroethene	4.63E+01
cis-1,2-dichloroethene	6.70E+00	Vinyl chloride	5.27E−02
trans-1,2-dichloroethene	1.43E−01		

mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.

3.11 CONFIRMATION SAMPLING AND REMEDIATION APPROACH

When it is decided that an area requires a remedial action, that area becomes a Class 1 SU and characterization activities are conducted as described in Sect. 3.2.2 to delineate the RABs and to obtain data for WAC evaluation. This section discusses the DCS approach toward remedial action implementation and sampling to confirm that the remedial action has been effective in meeting the Bethel Valley DQO decision rules and the BV ROD RAO. The confirmation sampling approach mirrors the characterization approach because the ultimate decision is whether further action is necessary. As with the characterization approach described in Sect. 3.2, there is a planning stage, sampling approach, and final decision. In addition, confirmation sampling and remediation anomalies encountered during the remedial action must be addressed and the site must be restored following the remedial action.

3.11.1 Confirmation Sampling Planning

Confirmation sampling efforts to support implementation occur throughout the characterization program. During the Class 1 SU characterization, samples collected to support WAC evaluation or RAB delineation may be used to determine that the remedial action will effectively remove all contamination; however, confirmation sampling can also occur during or after excavation. Therefore, planning for confirmation sampling occurs throughout the life of the project. The key element in planning confirmation sampling is identifying the decisions the data are to support, including use of the additional data in managing the uncertainties during implementation.

The remedial action is planned with an emphasis on identifying potential changing site conditions that could modify the plan. In cases where changing conditions are likely to occur, a contingency plan is

identified early to accommodate the change and minimize the need for schedule delays in the field. These actions are documented in the appropriate plans [e.g., Waste Handling Plan (WHP); Environment, Safety, and Health (ES&H) Plan]. The use of field measurements to monitor site conditions can provide immediate information and is implemented whenever conditions allow. Examples of potential changing conditions include differing levels of contamination that cause a change in health and safety requirements, waste anomalies, perched water tables resulting in dewatering requirements, or differing physical conditions of the waste.

3.11.2 Confirmation Sampling

Confirmation sampling is conducted to verify that a remedial action has been effective in removing contamination so that the encompassing EU is acceptable for NFA under the Bethel Valley DQO decision rules. There are three possible approaches for confirmation sampling.

1. A detailed sampling effort can be conducted prior to the remedial action which demonstrates that the extent of the remedial action encompasses all contamination;
2. Field analytical techniques can be used for real-time decision making during the course of the remedial action; or
3. Post-remedial action sampling can be conducted.

For the first approach, confirmation sampling is actually conducted concurrent with characterization sampling. Sufficient samples are collected around and underneath the volume of soil or sediment to be removed by the proposed remedial action. This approach works well when risk or protection of groundwater is the rationale for action because of the time required to evaluate the analytical results and level of quality required of the data. The first approach is especially useful when there are physical boundaries that define the areas of contamination, such as with a landfill. The sampling approach for this confirmation sampling is the same as the sampling approach for determining the RABs in a Class 1 SU.

The second confirmation sampling approach is ideal when the need for action is driven by a RL exceedance, the contamination being removed consists of only a few COCs, and these COCs have a readily available field screening technique that provides the detection levels required to compare to the RLs. Schedule time can be saved by beginning excavation and evaluating progress as the excavation continues.

The third confirmation sampling approach is basically the same as the first approach but is implemented after excavation. This third approach may allow for easier access to the residual contamination. This approach also may be appropriate for excavations in areas difficult to sample (e.g., currently active infrastructure that may be inactive after remediation) or when it is important to begin excavation as quickly as possible and time exists to conduct the final confirmation sampling.

3.11.3 Completion Decision

The completion decision is essentially the same as the action/NFA decision (i.e., is more action required to meet the RAOs and RLs from the BV ROD?). Consequently, the activities conducted to evaluate data are the same. To compare residual concentrations to average RLs and to conduct an EU-level risk assessment, the results are area weighted (assuming planned or excavated material is replaced by background soil). Any location known to be above maximum RLs must be removed. If the total mass remaining still presents a threat to future groundwater conditions, enough must be removed to alleviate that threat. As discussed before, this decision may occur throughout excavation activities. Technical briefings will be held with the RA Core Team to provide information necessary to reach concurrence that an

action is complete. Concurrence will be documented using the RA Core Team concurrence form and in meeting minutes before the site is backfilled or recontoured.

The RA Core Team is an active participant in the confirmation sampling, remediation communication, and decision process. The RA Core Team reviews and gives its concurrence to the documents describing the proposed remedial action. The confirmation sampling approach is documented along with details on how the RA Core Team will participate in the decision of remedial action completion. In the case of the first approach to confirmation sampling, the RA Core Team will concur with the confirmation sampling plan and results before the remedial action begins; therefore, once the remedial action has met its defined physical limits, the remedial action is complete and there is no other decision on excavation boundaries. For the second and third approaches, sampling results are shared with the RA Core Team along with any comparisons to RLs or the BV ROD RAO. When all confirmation results are available, the final decision on remedial action sufficiency is made during a scheduled technical briefing and concurrence is reached among the RA Core Team. Once the remedial action is complete, the site will be restored and the activity documented in a closure document [Phased Construction Completion Report (PCCR) or Remedial Action Report (RAR)].

Another decision made through the confirmation sampling is whether the appropriate WAC are met. This decision is not a RA Core Team decision but a disposal facility decision. During remediation, there is the possibility that an anomalous waste may be discovered that cannot be disposed of at the selected location. In this case, the RA Core Team would need to make a decision on an alternate disposal location and document this decision in a modification to the WHP.

3.11.4 Anomaly Occurrence

During the remedial action, the RA Core Team is involved in any waste anomaly detections that alter the waste profile or warrant use of an alternate disposal location. If a site condition changes causing the need to replan the remedial action, the RA Core Team also is notified. If the next planned RA Core Team meeting is more than a few days away from the date of occurrence, the RA Core Team will be notified by phone or e-mail of the occurrence or the anomaly. In general, site condition changes would have to be significant enough to stop work for a sufficient duration to cause a slip in the anticipated completion schedule or result in reporting of an occurrence before replanning is needed. It is anticipated that with sufficient initial planning, changing site conditions could result in implementation of a preplanned contingency to avoid excessive schedule delays. However, there could be some unanticipated changing conditions, such as possible identification of new COCs, which could require a replan during excavation. In all cases, communication of these events occurs in RA Core Team meetings, information telephone calls, and e-mails until the final primary closure documents are written (or a primary WHP amended).

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4. BETHEL VALLEY CLEANUP OBJECTIVES

The RAO developed for the selected remedy in Bethel Valley is presented in the BV ROD and reproduced in this document in Table 1.1. In addition to the BV ROD RAO, the selected remedy is required by Section 121 CERCLA to comply with federal and state laws determined to be applicable or relevant and appropriate requirements (ARARs) for hazardous substances. The ARARs identified in the BV ROD are included in Appendix C.

The reasonably anticipated future land use for Bethel Valley is tailored to future and past practices and is a combination of restricted use in the main developed areas of the ORNL Site, unrestricted industrial for the remaining developed area of the Central Valley and the Landfill sites in the Western portion of the site, and unrestricted use for the undeveloped areas of the valley. Depth of penetration is restricted to two feet in the central campus area and to 10 feet in the remainder of the developed site. Based on input from the three FFA parties and the public, these depth restrictions were selected to allow for most industrial uses, including activities necessary to build basements and repair or install utilities where the remediation goals were determined to be achievable. Industrial land use is a logical extension for those areas of Bethel Valley used in the past for industrial purposes because of the availability of standard utility and transportation infrastructure to support industrial activities and the relative ease of conversion to reuse for industrial purposes. Some areas in the central portions of Bethel Valley are being developed by the Office of Science for new industrial use applications.

Institutional controls preventing unrestricted use are anticipated to 2 ft in the Central Valley Area and to 10 ft in the remainder of the developed areas of the valley. Below these depths, institutional controls are in place to prevent residual deeper contamination, even by future industrial users. Where existing data or data collected under this DCS program suggest there is no significant residual contamination below the defined restricted depths, the institutional controls may be lessened or removed to allow development of the area. Additionally, where data collected under this program, in concert with existing data, show residual contamination at any depth would not cause a threat to future residents of the site, institutional controls forbidding unrestricted use may be removed to allow development.

The stated goal of the BV ROD is to remove contaminated stream sediments along the surface water drainage areas of the site that are designated as waters of the state. It is the intent of the defined remedial actions to remove contaminated stream sediments to levels where unrestricted recreational use will not pose a threat to a day use recreational individual at 1×10^{-5} risk levels. The goal also intends to achieve contaminant removal in order to meet AWQC in the streams that are waters of the state. The defined actions are calculated to result in a 45 percent risk reduction at the assessment point identified as the 7500 Bridge. The goals defined and the remedial actions identified will serve to protect terrestrial populations and will reduce or eliminate contaminants in surface water, thereby protecting aquatic species in the downstream reaches of the surface water bodies.

When the BV ROD was signed, the RAO for groundwater protection was general and not quantified. Soils study areas suspected or known to release contamination to groundwater were identified in the BV ROD for further investigation. Cleanup intends to remediate subsurface soil material posing a threat of continued or expansion of groundwater contamination or that impacts groundwater receiving surface water bodies. The BV ROD did not specify actions required for soil removal to protect groundwater. Post BV ROD actions to investigate potential groundwater contamination source areas have been conducted. The results of these investigations are presented in the Groundwater Report. The Groundwater Report includes a sampling program and approach to evaluating potential threats to groundwater and establishes an evaluation methodology (modeling assessment protocol) that was

reviewed and agreed to by the FFA parties. Additional data gathered under this RDR/RAWP may indicate a potential threat to groundwater. In these instances, the data will be evaluated according to the BV ROD Appendix C.

Soils remedial actions for the protection of groundwater in Bethel Valley were identified under the groundwater actions investigative program. The decision criteria and analytical approach is documented in the Groundwater Report and is not reproduced in this RDR/RAWP. The defined RAs will be executed under this RDR/RAWP, but the action/no-action determinations are not included in the scope of this document. The recommended actions are consistent with the BV ROD RAO for groundwater and surface water protection.

5. DOCUMENTATION AND COMMUNICATION

This section presents descriptions of the documents that will be used for project planning, implementation, and reporting. Also described in this section are means for communication between project personnel and the RA Core Team.

5.1 PROJECT DOCUMENTATION

Following are descriptions of project documents used to support identified remedial actions, implement the DCS, and fulfill reporting requirements for the scope of this RDR/RAWP. The DCS provides the overall objective and guidance for implementing characterization to determine if action is needed, how much action is needed, and when the action is complete.

5.1.1 Data Quality Objective Scoping Packages

DQO scoping packages are RA Core Team documents that represent a compilation of existing information for an area being evaluated for characterization under the DCS or for remedial actions and outline the plan to fill data gaps for the area being evaluated to ensure compliance with the BV ROD RAO. DQO scoping packages are used to assess what data are already available and support development of the DWP elements by implementing DQO Step 7 (Appendix A). DQO scoping packages will be developed for parcels of land in Bethel Valley, which will be designated based on the schedule for implementation of this RDR/RAWP. Several divisions of the Bethel Valley land area are presented in the BV ROD. Among these are Bethel Valley, the 1000 through 7000 Areas, EUs, and land use areas. Parcels addressed by the DQO scoping packages can be subdivisions of these BV ROD divisions, combinations of the divisions, or combinations of subdivisions. The purpose for creating parcels to be addressed by DQO scoping packages is to facilitate addressing Bethel Valley soils and sediments under this RDR/RAWP; however, a possible overriding consideration in developing parcels for DQO scoping is that the action/NFA decisions in Bethel Valley are made for the EU.

The first component of the DQO scoping package is the DQO Scoping Form, which is modified from the scoping checklist presented on the DQO website at http://www.hanford.gov/dqo/index.html. Information on the DQO Scoping Form includes descriptions of the process(es) that occurred within the area being evaluated, maps or other diagrams of the area, summaries of existing analytical data, and summaries of previous evaluations of risk to human health and the environment.

The second component of the DQO scoping package is evaluation of the area being scoped. The evaluation presents the rationale for selecting the SUs to be investigated, reviews DQO Steps 1 through 6, and completes DQO Step 7- Develop the Plan for Obtaining Data. In DQO Step 7, the evaluation, at a minimum, presents the following information:

- Data adequacy determination for existing data,
- Numbers of samples and assessment locations for each SU,
- Rationale for selection of sample and assessment locations,
- Types of sampling to be performed (i.e., surface or subsurface), and
- Types of surveys (e.g., radiation walkover and geophysical) to be performed in each SU.

Data adequacy evaluations are completed following the guidelines for data collection and analysis presented in the Quality Assurance Project Plan (QAPP). Because the nature of these evaluations is to assess whether adequate data exist to characterize an area, each data adequacy evaluation must take

into account all data, existing and new, for the area. The DQO scoping packages are compiled at the beginning of sample planning to reflect information available up to the point that DCS begins and, therefore, DQO scoping packages reflect the CSM at that point in time.

RA Core Team concurrence on each DQO scoping package is required. Following development, each DQO scoping package is submitted to the RA Core Team for review. A DQO scoping meeting is held during which the information in the DQO scoping package is presented and discussed. RA Core Team members submit their comments on the scoping package verbally, in writing, or both at the DQO scoping meeting. The DQO scoping package is then revised based on comments and agreements from the DQO scoping meeting and a final DQO scoping package is produced which receives RA Core Team concurrence.

5.1.2 Dynamic Work Plan

Following concurrence on DQO scoping packages, site-specific work plans will be developed to address areas designated during DQO scoping for characterization or remedial action. The site-specific work plans will be compiled under a single DWP. The DWP is a RA Core Team document and the site-specific work plans will require RA Core Team concurrence. The site-specific work plans address all requirements necessary to reach the action/NFA decision for the area being addressed. For remedial actions, site-specific work plans in the DWP serve as the design documents described in Sect. 3.1. For characterization, the DWP presents the approach to characterization as described in Sect. 3.2 and will allow decision making in the field based on field surveying and sampling data so that characterization activities can respond to a changing CSM. Information presented in the DWP will include, as appropriate, but not be limited to, the following.

- Number and location of characterization samples;
- Field screening/survey methods, equipment, and operating requirements;
- Analytical requirements;
- Proposed remedial actions;
- Remedial action remedy components;
- Estimated waste volumes; and
- Approach for confirmation sampling following remedial action(s).

As field results are received and plans modified based on those results, the DWP is also modified to reflect all new or additional activities.

5.1.3 Technical Memoranda

A TM will be developed following completion of work described in each site-specific work plan. TMs are submitted to the RA Core Team for review, comment, and response. The TM documents the activities, data, and conclusions for the area being addressed and includes the following information:

- Description of the area being addressed;
- Description of the SUs;
- Overview of activities conducted including new and historical sample locations;
- Summary presentation of new and historical data;
- Data interpretations in terms of the Bethel Valley DQO decision rules;
- Recommendations for action/NFA; and
- Remedial action confirmation summary.

Modeling of soil compositions to evaluate a potential threat to groundwater is conducted when chemical or radionuclide concentrations in soil exceed trigger levels presented in Table 3.7. The modeling methodology is described in the BV ROD Appendix C.

For EUs where action is required, the TM also documents the planned extent of excavation, estimated waste volume, and approach for any necessary confirmation sampling. Additionally, any contingency plans for handling potential changing site conditions, including the presence of new contaminants, if reasonable, are included in the TM.

The TM also will be used to document the post-completion status of remedial actions. These post-remedial action TMs will provide the RA Core Team an opportunity to review and concur on action completion before final documentation in the PCCR and RAR.

5.1.4 Plans to Support Identified Remedial Actions

For the ROD-identified remedial actions, the remediation contractor will prepare project and programmatic plans to meet the requirements of the selected remedy for the Bethel Valley soils and sediments. The plans may include, but are not limited to:

- Comprehensive Work Plan, addressing at a minimum:
  - site preparation
  - site security
  - verification
  - waste characterization
  - waste segregation
  - waste removal and loading
  - long-term monitoring
  - operations and management
- Transportation Plan,
- Waste Management Plan,
- Environmental, Safety and Health Plan,
- Radiological Protection Plan,
- Regulatory/Environmental Compliance Plan, and
- QAPP.

The Comprehensive Work Plan will include mobilization, staffing, work control processes, waste management methodology, packaging, size reduction, treatment and disposal of waste, air and noise monitoring, readiness, site restoration, and demobilization. An approved Transportation Plan will identify items such as packaging, labeling, marking, manifesting, transportation routes, spill prevention, and compliance with DOT requirements. The Waste Management Plan will delineate the remediation contractor's requirements for managing LLW, mixed waste, TSCA, and sanitary waste. It will also provide the methodology for assuring WAC compliance. The Environmental Compliance Plan will outline the activities required to assure regulatory compliance and minimization of environmental impacts during the remediation effort.

Sections 5.2 and 5.3 describe the approaches for implementing best management practices (BMPs) and waste management for the project to meet the requirements of the ROD. Section 5.5 describes the programmatic plans to implement this project, and Section 5.6 provides project schedule.

5.1.5 Phased Construction Completion Report/Remedial Action Report

A PCCR will be prepared to document work completed, any actions that occurred, and any EUs that require NFA. The PCCR is a FFA primary document that is submitted to the regulators for approval. The PCCR will summarize all of the information necessary for the FFA parties to decide whether the area can be released for its intended use. This report will be subdivided by the EUs contained within the area and will contain the results of the soil and sediment investigations and field surveys, the results of any additional data collected, and the EU risk assessment results. The final volumes excavated and disposal locations selected will be documented for those EUs where action was taken. Results of confirmation sampling will be included in the PCCR.

The RAR will summarize the conclusions from the PCCR to demonstrate completion of the BV ROD activities as well as provide more details on the actions taken since the PCCR. The RAR is scheduled to be completed in FY 2016. In general, the RAR documents agreements on no action. The RAR is a FFA primary document that will be submitted to the FFA managers for approval. The RAR will summarize all the necessary information for the FFA parties to decide whether the areas of Bethel Valley can be released for their intended use. The RAR will be subdivided by the EUs or other areas addressed in the TMs and will summarize each TM and any follow-on activities. The RAR also will document where institutional controls are required in Bethel Valley, both with respect to depth and areal extent, as a result of risk evaluation or risk assessment results. Inclusion of this information in the RAR will allow for EPA and TDEC approval of LUC boundaries. These boundaries will not be changed without regulatory approval.

5.2 BMP APPROACH

The BMP approach for this project is based on ARARs for remediation and disposition of contaminated soils and sediment from Bethel Valley and the potential impacts resulting from these activities. Controls and methods for mitigating adverse impacts from storm water runoff have been included in the ORNL Storm Water Pollution Prevention Plan, which establishes controls and methods for managing storm water runoff from the excavation/remedial action sites and preventing water quality impacts to the receiving waters. The remediation contractor will provide sketches in its project plans that provide details regarding specific controls to be used and requirements regarding maintenance of these controls.

5.3 WASTE MANAGEMENT APPROACH

The method for waste management, waste minimization, packaging, transportation, and disposal will be part of the Waste Management Plan, Comprehensive Work Plan, and Transportation Plan developed by the remediation contractor.

Contaminated material removed during the project is destined for disposal at EMWMF or other applicable, approved disposal facility. Any large items may require size reduction by the contractor to meet disposal facility WAC requirements. Waste characterization, sampling, analysis, and waste profiling will be performed by the DOE prime contractor or a designated subcontractor to ensure the waste meets the WAC of the applicable disposal facility. Decontamination fluids will be treated and disposed of as described in Section 3.7.2.

An overall Waste Handling Plan (WHP) will address the management of all other wastes from generation to disposal. This WHP will be approved by EPA Region IV and the TDEC prior to initiation of fieldwork.

WHPs are primary documents required under the FFA which discuss any sampling required to determine if the WAC for the disposal facility is met, selection of the waste disposal outlets, transportation issues, and a waste anomaly detection program. WHPs document the volumes and contents of the waste based on historical and DCS characterization data. Actual volumes may vary slightly from what is presented in the WHP.

A single WHP will be developed for Bethel Valley soils and sediment. This WHP will incorporate remedial actions identified in the BV ROD and any other remedial actions identified during characterization. Two waste lots will be defined: a high sum of fractions waste lot (smaller volume) and low sum of fractions waste lot (higher volume). The WHP will be prepared to authorize disposal of material that meets the characteristics of one of the waste lots and explain how anomalies will be handled. The extents of the remedial actions and quantities of waste will be discussed in the PCCR and RAR.

5.4 CHANGES TO THE BETHEL VALLEY ROD

The BV ROD can be changed through an ESD or a ROD amendment. An ESD, used for a significant change, will be prepared if the RA Core Team agrees the current action (i.e., excavation) is the only reasonable option but the cost or volume increases exceed 50 percent of those presented in the ROD. A ROD amendment, used for a fundamental change, will be prepared if an evaluation of other alternatives is appropriate due to the potential size of the change. Other changes to the ROD will be considered insignificant and no formal documentation will be required.

5.5 PROGRAM PLANS

DOE, its prime contractor, and all subcontractors are required to comply with 10 CFR 830.120, QA Requirements, which are mandatory requirements, and flow down to all contractors and subcontractors. The prime contractor and subcontractor QA programs identify company policies and plans or procedures that implement the business processes of each company. The programs are administered by QA organizations in each company that report to company management and are independent of project management. The QA Plan addresses the quality requirements for the project and will include requirements for compliance with plans and procedures for the project, including inspections, assessments, and training. The Environment, Safety and Health Plan of the prime contractor, which addresses hazards specific to work elements, will be adhered to during execution of this project. Each contractor and subcontractor will develop a project-specific QA Program Plan for the project. The QA programs are subject to the scrutiny of the hierarchy of the project organization. Each company must conduct management and independent audits and/or assessments of its implementation of quality. Correspondingly, each higher tiered contractor is required to conduct audits or assessments of the work processes and products or services provided by its suppliers. Subcontractors must successfully pass readiness evaluation by DOE.

All contractors and subcontractors involved in the Bethel Valley soils and sediments effort will be required to follow 10 CFR 851 and the applicable Occupational Safety and Health Administration standards from 10 CFR 1910 and 10 CFR 1926. This will be accomplished through both corporate and project specific Safety and Health Plans. The Site Safety and Health Officer for the project will have independent reporting relationships to corporate management to assure that all safety issues are properly addressed during project execution.

In addition, all work will be performed under a Radiological Protection Program (RPP), and its implementing procedures. The RPP will be prepared by the remedial action contractor to meet the requirements of 10 CFR 835. As an alternative, DOE may authorize the contractor to work under the

requirements of the Bethel Valley M&O contractor's RPP, and the Bethel Valley M&O may perform some of the radiological control duties.

For the QA Program, Safety and Health Program, and Radiation Protection Program, DOE may elect to direct the remedial action contractor to perform all work consistent with existing federal documents.

5.6 PROJECT SCHEDULE

The enforceable and other key milestones for performance of this remedial action are shown in Table 5.1. The remedial action contractor will be required to develop a comprehensive schedule for the overall effort, including all activities required to accomplish the scrap removal. This schedule will be resource loaded and will identify key milestones. Project progress will be tracked to this detailed schedule.

Table 5.1. Project Schedule

Major activity	Forecast date
RDR/RAWP submitted to regulators for review and approval (D1)	May 5, 2008
Waste Handling Plan submitted to regulators for review and approval (D1)	Sept. 26, 2008
Bethel Valley response action field activities initiated	Sept. 30, 2009
Complete Bethel Valley response actions	Fiscal Year 2015
Submit project completion reporting Phased Construction Completion Report	Fiscal Year 2015
Issue final Remedial Action Report and project complete	Fiscal Year 2016

5.7 COMMUNICATION

Multiple activities being conducted in Bethel Valley will require coordination between the concurrent characterization, remedial action, and decommissioning and demolition (D&D) programs. Project schedules may require certain activities (such as completion of characterization of a particular facility or area) be completed prior to final evaluation under the DCS. For these significant actions, a TM will be prepared to document the status of the activity, present the associated data and evaluation, and document the assessment of that activity relative to the completion of characterization. A Core Team Concurrence Form will be developed and used to ensure RA Core Team agreement on the activity. This information will then be included in the final TM for the area being addressed.

Field work activities, including D&D, may result in a maintenance action (e.g., backfill a sump or basement, concrete disposition, equipment disposition, or interim safety measure) that must be evaluated for impact to final disposition of the area being considered. RA Core Team agreement on these actions is needed prior to implementing the recommended early remediation or maintenance action. These activities will be incorporated into final documentation for the area. A description of the activity, presentation of analytical data, and an early remediation/maintenance action Concurrence Form will be developed and used to document the action to be taken. These maintenance actions will be included in the RAR.

RA Core Team Concurrence Forms also are used to document field activities that result in changes to the base sampling program defined in the DQO scoping packages and DWP. Changes such as sample location additions or deletions and SU classification changes are presented to the RA Core Team in a technical brief, and agreement is documented on the Core Team Concurrence Form.

Core Team Concurrence Forms are used to perform revisions to this document and the documents described in this section. A revision log will be developed which will be placed in the front of the most recently approved document and will be followed by a signed Core Team Concurrence Form for each revision. Each concurrence includes either the complete revision(s) (in cases of revisions to limited portions of the document) or a summary description of the revision(s) (if it permeates throughout large portions of the document). All concurrences are numbered sequentially and maintained in the Core Team log.

The signed Core Team Concurrence Form and updated revision log *.pdf files are e-mailed to the RA Core Team with each revision. Each e-mail subject line specifies the relevant document(s) and revision number(s). At an agreed upon time in the future, the revisions will be incorporated and the revised documents submitted for approval. The complete Core Team log will become part of the RAR. The RA Core Team holds regular meetings to assure all Bethel Valley soils and sediment characterization and remediation issues and actions are known, understood, and approved by all RA Core Team members. Minutes are kept at each meeting and are distributed to all attendees for review and/or revision. Should concerns arise between scheduled meetings, further communication is possible through telephone conversations or site visits. An Agreement and Action Log is maintained by the RA Core Team to document issues and decisions.

Another communication tool is the Issues Management Form set up by the FFA managers. This form is used to communicate potential areas of disagreement among the RA Core Team. Each Core Team member enters their position on the issue form. If the RA Core Team cannot reach resolution, then the matter is brought to the FFA managers' attention for resolution and closure. The FFA managers also may choose to elevate the issue to the respective agency's management. Use of this tool allows for speedy resolution of issues that cannot or should not be resolved by the RA Core Team.

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6. REFERENCES

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APPENDIX A - DATA QUALITY OBJECTIVES PROCESS

A. DATA QUALITY OBJECTIVES FOR THE BETHEL VALLEY SOILS AND SEDIMENTS DYNAMIC CHARACTERIZATION STRATEGY

This section develops and presents the data quality objectives (DQO) for the Dynamic Characterization Strategy (DCS) approach for addressing Bethel Valley soils and sediments. A rigorous approach to DQOs, such as presented here, is crucial to any environmental investigation because of the uncertainty introduced by the heterogeneous nature of the environment. As a result of this uncertainty, decision-makers are forced to rely on estimates to make their decisions. The philosophy of the DQO process involves input from decision-makers throughout the process. Through systematic planning and rigorous DQO development of the DCS, it is possible to manage the inherent uncertainties of environmental characterizations. The DQO development presented here closely follows the approach presented in the DOE workshop entitled *Managing Uncertainty for Environmental Decision-Making*. Consistent with the lessons of the workshop, DQO development begins with very general statements and gradually builds up in complexity and detail.

The DQO process includes seven steps (EPA 2006). This section is organized so that each subsection refers to a DQO step. These seven subsections lay out the reasoning and rationale for the approach taken to address Bethel Valley soils and sediments.

1. Section A.1 - State the Problem,

2. Section A.2 – Identify the Goals of the Study,

3. Section A.3 – Identify Information Inputs,

4. Section A.4 – Define the Boundaries of the Study,

5. Section A.5 – Develop the Analytic Approach,

6. Section A.6 Specify Performance or Acceptance Criteria, and

7. Section A.7 – Develop the Plan for Obtaining Data.

There are two main outputs of the DQO process – Decision Rules (Step 5) and the framework for a characterization plan (Step 7). The following sections outline general DQOs for obtaining Decision Rules and a characterization plan to address Bethel Valley soils and sediments. The general DQOs presented here are the basis for development of specific DQOs during the systematic planning sessions conducted by the Core Team under the DCS.

A.1 STATE THE PROBLEM

The first step in the DQO process is to state the problem clearly and concisely so that the focus of the project is unambiguous.

The remedial action objective (RAO) of the selected remedy for Bethel Valley soils and sediments is presented in *Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee* (DOE 2002) (BV ROD). The RAO identifies four issues, each of which has a unique protection goal. In order to address the protection goals and support the RAO, it is necessary to know the concentrations of chemicals

and radionuclides in Bethel Valley soils and sediments. A remedial investigation/feasibility study for Bethel Valley (BV RI/FS) (DOE 1999) summarizes existing Bethel Valley soil and sediment data. On the basis of the BV RI/FS data, the BV ROD identifies several locations requiring soil and sediment remedial actions and several locations of accessible soil and sediment requiring further characterization. The BV ROD concludes that Bethel Valley soils sediments will meet the RAO and its protection goals following completion of the actions dictated in the ROD and any actions resulting from the further characterization. Subsequent to issuance of the BV ROD a groundwater engineering study was conducted and soils data from the study are presented in the associated report (GW Report) (DOE 2005). The net result of the combined BV RI/FS and GW Report data is that there are sufficient data to support all of the remedial action decisions in the BV ROD, there are sufficient data to make an action/no further action (NFA) decision for some of the locations identified in the BV ROD for further characterization, and several data gaps exist which pertain to soils and sediments meeting the BV ROD RAO. These data gaps include:

- As described in the BV ROD, several accessible soil locations require further characterization. In addition, soils underlying facilities that are scheduled for decommissioning and decontamination (D&D) will require characterization when those soils become accessible.
- As described in the BV ROD, the areas of Bethel Valley lying outside of the remedial action locations and the locations for further characterization must be verified as "clean".
- Other than vertical dimensions, which are defined by BV ROD land use scenarios, remedial action boundaries (RABs) for the remedial actions identified in the BV ROD and any remedial actions determined to be necessary by further characterization are not defined.

Inspection of the identified data gaps shows that there are essentially two types of data gaps – nature of contamination and extent of contamination. Combining the data gaps and data requirements results in the following Problem Statement:

In order to make the action NFA decision for Bethel Valley soils and sediments, the types and concentrations of chemicals and radionuclides in Bethel Valley soils and sediments must be determined. Further, when an action is determined to be necessary, the distributions of the chemicals and radionuclides driving the action must be delineated in order to determine the RABs.

The general terminology of this Problem Statement is expanded in the next three steps of the DQO process to arrive at the Decision Rules in DQO Step 5 (Sect. A.5).

A.2 IDENTIFY THE GOALS OF THE STUDY

The objective of this second step in the DQO process is to develop one or more Decision Statements that, when fully defined during DQO Steps 3 and 4, result in the Decision Rules of Step 5. The process of developing Decision Statements in this step is one of defining the principal study questions (PSQs) which are embedded in the general text of the Problem Statement in Step 1 (Sect. A.1) and assigning alternative actions (AAs) to each PSQ. For Bethel Valley soils, the PSQs must address the data gaps identified in Step 1 (Sect. A.1) in terms of the criteria presented in the BV ROD for evaluating soils. To this end, the three identified data gaps can be compressed into two PSQs – one which addresses soil compositions and the other which addresses the extent of soil contamination. The two PSQs and their AAs for Bethel Valley soils and sediments are presented in Table A.1.

Table A.1 Principal study questions (PSQs) and alternative actions (AAs) for Bethel Valley soils.

PSQ no.	PSQ	AA no.	AA
1	Do the concentrations of chemicals or radionuclides in Bethel Valley soils and sediments exceed the evaluation criteria of the BV ROD?	1	Yes conduct a remedial action
		2	No - NFA
2	If chemicals or radionuclides exceed the evaluation criteria of the BV ROD, are their horizontal and vertical extents defined?	1	Yes conduct a remedial action
		2	No define the extents

Combining each PSQ with its AA results in the following Decision Statements:

1. *If chemicals or radionuclides in Bethel Valley soils and sediments exceed the evaluation criteria of the BV ROD, then conduct a remedial action; otherwise NFA.*

2. *If the horizontal and vertical extents of chemicals and radionuclides in excess of their BV ROD evaluation criteria are known, then conduct a remedial action; otherwise define the extent of the exceedances.*

The term "evaluation criteria" which is used in the Decision Statements will be defined in the next step of the DQO process along with other types of information that will be necessary in order to make the action/NFA decision.

A.3 IDENTIFY INFORMATION INPUTS

The objective of this third step in the DQO process is to identify the information inputs required to resolve the decision statements in Step 2 (Sect. A.2). A critical component of the DCS, the data gap assessment, is described below in Sect. A.3.2. For Bethel Valley soils and sediments there are three types of information inputs:

1. Evaluation criteria (Section A.3.1) – these are the criteria from the BV ROD that are referenced in the Decision Statements of DQO step 2 (Sect. A.2) against which soil and sediment compositions are to be compared in order to make the action/NFA decision.

2. Evaluation criteria values (Section A.3.1) – these are the quantitative values of the evaluation criteria in #1.

3. Evaluation data (Section A.3.2) – these are the types of data and the data sources which will be used to evaluate Bethel Valley soils and sediments against the BV ROD evaluation criteria.

A.3.1 Evaluation Criteria and Values

The BV ROD presents four sets of evaluation criteria for Bethel Valley soils and sediments which are based on anticipated future land use and groundwater protection. There are three anticipated future land uses which result in three different sets of evaluation criteria: industrial (controlled and unrestricted), recreational, and unrestricted. The controlled and unrestricted industrial land uses differ only in the depths to which the evaluation criteria are applied. The boundaries of the different land uses, including

depth boundaries, are defined in Sect. A.4. The soils and sediments within the land areas encompassed by each of the three land use scenarios will be evaluated against the human health risk limits in the BV ROD. The primary contaminants of concern (COCs) for each land use scenario are identified in the BV ROD and clean up guidelines have been calculated for these COCs. The cleanup guidelines, known as maximum and average remediation levels (RLs), are defined as follows:

- Average RL – a risk (or equivalent) limit not to be exceeded by the residual risk for the exposure unit (EU) (the EU will be defined in Sect. A.4).
- Maximum RL – a risk (or equivalent) limit not to be exceeded by the risk determined for any particular location or hot spot (the hot spot will be defined in Sect. A.4).

While it is assumed that the identified land use-specific COCs are characteristic of the land areas encompassed by each land use, it also assumed that additional contaminants may be present which contribute to an unacceptable risk. To account for these contaminants, the BV ROD also requires that the aggregate risk from all chemicals and radionuclides be within the EPA's target risk range (calculated without radium and thorium and their daughter products) over the EU (the EU will be defined in Sect. A.4).

Table A.2 Evaluation criteria for Bethel Valley soils and sediments

Land Use or Other Scenarios	Evaluation Criteria	Evaluation Criteria Values
Industrial land use (controlled and unrestricted) – 2000 hours/year for the industrial worker	Human health risk	ELCR = 1×10^{-4}, HI = 1
	Average RLs	BV ROD Table 2.40
	Maximum RLs	10 times average RLs
Recreational land use – 75 hours/year for the recreational user; also ecological benchmarks	Human health risk	ELCR = 1×10^{-4}, HI = 1
	Average RLs	BV ROD Table 2.41 for human health COCs; BV ROD Table 2.39 for ecological COCs
	Maximum RLs	10 times average RLs
Unrestricted land use – 8760 hours/year for the residential user	Human health risk	ELCR = 1×10^{-4}, HI = 1
	Average RLs	BV ROD Table 2.42
	Maximum RLs	10 times average RLs
Accessible soils cannot contribute significantly to groundwater contamination	Human health risk for groundwater (industrial use)	ELCR = 1×10^{-4}, HI = 1; BV ROD Appendix C presents trigger levels and describes the process for determining if soil concentrations exceed the risk threshold
	Soil RLs for 12 primary groundwater COCs (^{14}C, ^{137}Cs, ^{64}Cu, ^{3}H, ^{226}Ra, ^{90}Sr, ^{234}U, ^{238}U, 1,2-dichloroethene, trichloroethene, vinyl chloride)	BV ROD Appendix C Table C.2

In addition to human health risk limits on soil and sediment compositions, the BV ROD also limits the human health risk resulting from industrial groundwater usage. A method for calculating the human health risk impacts of soil compositions on groundwater is presented in the BV ROD and soil RLs for the 12 primary groundwater COCs have been calculated and are presented in the BV ROD.

Soil and sediment compositions within land areas whose boundaries are defined in Sect. A.4 will be evaluated against the aggregate soil, sediment, and groundwater risk limits and the maximum and average RI.s. Table A.2 presents the evaluation criteria and their values, or references to their values, for the three land use scenarios and for protection of groundwater.

A.3.2 Evaluation Data

Bethel Valley soils and sediments will be evaluated against the evaluation criteria presented in Table A.2 using the types of data and the data sources presented in Table A.3.

Table A.3 Types of data and data sources for evaluating Bethel Valley soils and sediments

Data Type/Source	Description/Explanation
Historical information	Historical information includes reports, data from previous characterization studies, process knowledge, personnel interviews, and aerial photographs. The purpose for using historical information is to make use of information acquired during previous investigations for decision making. A key component of the DCS is to focus characterization efforts on areas where historical information does not exist or is insufficient for decision making.
Effective data from field quantitative and non-quantitative analytical instruments	Effective data are data of sufficient quality for decision-making. Direct-reading field instrumentation will be used to the extent possible for characterization of soil and sediment. Because the principal radiological COCs for Bethel Valley soils and sediments are gamma emitters, direct reading gamma scanning instrumentation such as sodium iodide (NaI) detectors and count rate meters will be relied on for field characterization data. In addition, other field analytical instruments will be considered on an as-needed basis.
Quantitative data from fixed-based laboratory quantitative analytical instrumentation	Data from this class of instruments will be used for characterization and verification purposes when field detection approaches are not feasible. Data from this class of instruments will also be used to confirm the conclusions obtained from direct-reading field instruments.

Historical information deserves elaboration because it is an important component of the DCS. As described in Table A.3, the DCS focuses characterization activities on areas where historical information either does not exist or it exists but is insufficient for decision making, i.e., focuses characterization activities on the data gaps. In order to understand where historical information exists and where it does not exist, a data gap assessment must be conducted. A data gap assessment is a thorough compilation of existing records and analytical data. Existing information identified during the data gap assessment is then evaluated against the Decision Rules in DQO step 5 (Sect. A.5) for decision-making sufficiency. Based on the data gap assessment and sufficiency evaluation, land areas can be classified as described in DQO step 4 (Sect. A.4) and a classification-based characterization program can be developed in DQO step 7 (Sect. A.7).

A.4 DEFINE THE BOUNDARIES OF THE STUDY

The DCS for Bethel Valley addresses soils and sediments encompassed by several boundaries. All of the boundaries except one, the soil unit (SU), have been referred to in previous steps of the DQO process. In Table A.4, the DCS boundaries are described and each boundary is cross referenced to the preceding DQO steps in which it is referenced. The SU boundary concept is explained below.

Table A.4 Horizontal and vertical spatial boundaries in Bethel Valley addressed by the DCS

Boundary name	Description	Cross reference to preceding DQO steps
Bethel Valley	All soil and sediment in Bethel Valley are addressed by the DCS. Approximately 1734 acres (see BV ROD Fig. 2.2).	By default, included in all preceding DQO steps.
Controlled industrial land use areas	The central section of the ORNL main plant area made up of the 2000 North, 2000 South, 3000 North, and 3000 South Areas, also designated as EUs 2 through 5, respectively (see BV ROD Fig. 2.38). The goal is to have soil clean to 0.6 m (2 ft) below grade.	References to land use scenarios are made in Sect. A.3.1 (Step 3).
Unrestricted industrial land use areas	Sections of the ORNL main plant area on the east and west of the controlled industrial areas. Made up of the 1000, 4000, 5000, 6000, and 7000 Areas, also designated as EUs 1 and 6 through 9, respectively (see BV ROD Fig. 2.38). The goal is to have soil clean to 3 m (10 ft) below grade.	References to land use scenarios are made in Sect. A.3.1 (Step 3).
Recreational land use areas	The area to be covered by the SWSA 3 and Contractor's Landfill caps and seven EUs which equate to the following stream reaches: Raccoon Creek, Northwest Tributary, First Creek, Fifth Creek, White Oak Creek between 7500 Bridge and First Creek, White Oak Creek between First Creek and Fifth Creek, and White Oak Creek above Fifth Creek. The goal is to have sediment clean to the depth of deposited sediment. Following the remedial actions, SWSA 3 and the Contractor's Landfill will be assumed to be clean owing to the installed cap.	References to land use scenarios are made in Sect. A.3.1 (Step 3).
Unrestricted land use areas	The remaining land area of Bethel Valley outside of controlled and unrestricted industrial land use areas recreational land use areas, SWSA 3, and the Contractor's Landfill (see BV ROD Fig. 2.38). The goal is to have soil clean to bedrock or the groundwater table, whichever is nearer the surface.	References to land use scenarios are made in Sect. A.3.1 (Step 3).

Table A.4 (cont.)

Boundary name	Description	Cross reference to preceding DQO steps
Exposure units	The geographical areas over which an anticipated receptor may move about and be exposed to a contaminated medium during the period of the exposure duration. These are the land areas over which human health risk, ecological risk, and average RLs are applied. Sixteen EUs are defined in the BV ROD (see controlled and unrestricted industrial, and recreational land use areas above). Additional EUs may be defined if contamination is found during characterization activities but the BV ROD limits the size of new EUs to a maximum of 1 acre. In the industrial and unrestricted land use areas, the average RL will be assessed against the residual EU risk (or equivalent) for both (1) the uppermost 15 cm (6 in) layer of soil and (2) all soil to the prescribed cleanup depth for the applicable land use. In the recreational land use areas, the average RL will be assessed against the residual EU risk to the depth of deposition.	References to EUs are made in Sect. A.3.1 (Step 3).
Hot spot	This is the land area and depth over which the maximum RL is evaluated. For all land uses, the maximum remediation level will be assessed against the residual risk (or equivalent) for contaminated surface soil having an area greater than 1 m^2 (11 ft^2). For the industrial and recreational land use areas, the depth of maximum RL assessment is both (1) 0 to 15 cm (0 to 6 in) and (2) all soil to the prescribed cleanup depth for the applicable land use. In the recreational land use areas, the depth of the maximum RL assessment is the depth of deposition.	The hot spot is referenced in Sect. A.3.1 (Step 3) for application of maximum RLs.
Soil unit	Areas over which characterization is conducted. The SU allows characterization activities to be focused where data are needed.	Soil units are described below in this section (Step 4).
Remedial action boundaries	RABs are the horizontal and vertical boundaries for remedial actions identified in the BV ROD and any new remedial actions identified during characterization activities.	RABs are referred to in the problem statement in Section A.1 (Step 1).

The SU concept is a system of classification which focuses characterization activities on filling the data gaps identified during the data gap assessment (Sect. A.3). As such, SUs are an integral part of the DCS classification-based characterization program for obtaining data (Step 7). Because of its importance to the development of a characterization program, each classification of a land area as an SU must be agreed to by the decision makers. Soil unit classifications are initially based on historical information but classifications can be changed in response to new information acquired by means of any or all of the data types and data sources presented in Table A.3. Soil unit boundaries may be contained within, or may cross, EU boundaries. There are four SU classifications in Bethel Valley which are defined in Table A.5.

Table A.5 Bethel Valley soil unit classifications

Soil Unit	Definition
Class 1	The area has been impacted and there is a high degree of certainty that it will require a remedial action.
Class 2	The area has been impacted and there is high degree of uncertainty regarding the need for a remedial action in the area.
Class 3	The area has been impacted and there is a high degree of certainty that it will not require a remedial action.
Class 4	The area has not been impacted therefore a remedial action will not be necessary.

It is clear from Table A.5 that areas with data gaps are classified as Class 2 SUs and that, based on the data gap assessment, Class 1, Class 3, and Class 4 SUs will require little, if any, additional characterization. Examples of SUs in Bethel Valley are: the areas designated for remedial action in the BV ROD would be classified as Class 1 SUs, the areas designated for further characterization in the BV ROD would be classified as Class 2 SUs, the impacted land areas outside of these proposed Class 1 and Class 2 SUs would be classified as Class 3 SUs, and the land areas surrounding the ORNL campus which have been designated for unrestricted use and have not been impacted by activities at ORNL or its predecessor organizations would be classified as Class 4 SUs. The types of characterization activities to be conducted in each class of SU are described in DQO step 7 (Sect. A.7). Based on the results of these characterization activities, land areas may be reclassified and the appropriate SU-specific characterization activities will be applied to the reclassified areas.

5.5 DEVELOP THE ANALYTIC APPROACH

The goal of DQO step 5 is to develop an analytic approach that will guide how the study results are to be analyzed and how conclusions are to be drawn from the data. The goal of step 5 will be attained by combining DQO steps 1 through 4 to produce the following elements to form Decision Rules:

1. Parameters of interest – the evaluation criteria for the different land use and other scenarios in Table A.2.

2. Unit of decision-making – an area or volume of space described in Table A.4 over which the parameters of interest are evaluated.

3. Action levels – the quantitative values of the evaluation criteria for the different land use scenarios in Table A.2.

4. Alternative actions – originally defined in Table A.1, these are the responses to both meeting and not meeting the action levels.

The four Decision Rule elements are presented in Table A.6.

Table A.6 Decision Rule elements for Bethel Valley soils and sediments

Parameter of interest	Unit of decision-making	Action level	Alternative actions
Average RL for COCs	EU – depth is land use-specific, see BV ROD Table 2.39	Land use-specific: see BV ROD Tables 2.39, 2.40, 2.41, and 2.42	1. Conduct remedial action until average COC concentrations are below action level. 2. NFA if action level is not exceeded.
Maximum RL for COCs	Hot spot - depth is land use-specific, see BV ROD Table 2.39	Land use-specific: 10 times the average RL	1. Conduct remedial action until COC concentrations are below action level. 2. NFA if action level is not exceeded.
Risk limits on chemical and radionuclide concentrations in soils and sediments	EU – depth is land use-specific, see BV ROD Table 2.39	Land use-specific: see BV ROD Table 2.39	1. Conduct remedial action if action level is exceeded. 2. NFA if action level is not exceeded.
Protection of groundwater	EU	Trigger levels and modeling methodology are presented in BV ROD Appendix C	1. Conduct remedial action if modeling results show a threat to groundwater. 2. NFA if no threat to groundwater.
Spatial extent of chemicals and radionuclides exceeding an action level	RAB depth is land use-specific, see BV ROD Table 2.39	Level of confidence that the spatial extent of action level exceedances is well-defined	1. Conduct remedial action if extent of action level exceedance is known. 2. Conduct additional characterization to determine extent of action level exceedance.

Combining the decision rule elements in Table A.6 for each parameter of interest, results in five Decision Rules. Four of the Decision Rules (Decision Rules 1 through 4) address the action/NFA decision which is the first part of the Problem Statement in DQO step 1 (Section A.1) and the fifth Decision Rule addresses RABs which is the second part of the Problem Statement. It is important to keep in mind that many of the decision rule elements are land use-specific so that, when applying the Decision Rules, it is necessary to know which land use area is being addressed. Following are the five Decision Rules for Bethel Valley soils and sediments:

Decision Rule 1

If the average concentration of any Bethel Valley COC within soils or sediments of an EU exceeds its average RL, then conduct a remedial action until the average concentration is less than the average RL, otherwise take NFA with respect to average RLs.

Decision Rule 2

If the concentration of any Bethel Valley COC within soils or sediments exceeds its maximum RL over the area defined for a hot spot, then conduct a remedial action until the concentration is less than the maximum RL, otherwise take NFA with respect to maximum RLs.

Decision Rule 3

If the calculated risk for soils or sediments in a Bethel Valley EU exceeds the BV ROD risk limits, then conduct a remedial action until the EU risk is less than the risk limits, otherwise take NFA with respect to EU risk.

Decision Rule 4

If Bethel Valley EU soil compositions create an unacceptable risk in groundwater compositions as determined by the BV ROD groundwater modeling methodology, then conduct a remedial action until EU soil compositions no longer create an unacceptable risk in groundwater, otherwise take NFA with respect to protection of groundwater

Decision Rule 5

If the horizontal and vertical extents of a RAB are known with confidence then conduct the remedial action, otherwise perform additional characterization to better define the RAB.

Although the SU is the boundary area over which characterization is conducted (Table A.4), the BV ROD states that it is the EU and the hot spot boundary areas (Table A.4) over which the action/NFA decision will be made. Therefore, the action/NFA Decision Rules (Decision Rules 1 through 4) refer to either the EU or the hot spot. The RAB Decision Rule (Decision Rule 5) refers to only the RAB boundary area. Thus, the SU is not referenced in any of the Decision Rules because no decision is made at the SU level. Instead, the SU designation is used in DQO steps 6 and 7 for development of classification-based characterization program to address the Decision Rules.

A.6 SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA

The sixth step in the DQO process is to develop a process that addresses the tolerable limits on decision errors to aid in the design of a sampling program that limits uncertainty when making decisions based on the Decision Rules in DQO step 5. Decision uncertainty is addressed under the DCS by classification and characterization.

Classification is described in DQO step 4 (Sect. A.4). Classification addresses Decision Rules 1 through 4. Land areas are classified into SUs based on an evaluation of historical information that a remedial action will be required or not required, or that there is insufficient information to make a determination about a remedial action. Classification of a land area as a particular SU is justified to the decision makers based on the results of a data gap assessment. Because the decision makers must agree to each classification of a land area as a SU, considerable decision uncertainty is addressed directly in a decision maker forum and the bulk of the decision uncertainty, i.e., the bulk of the data gaps, are incorporated into Class 2 SUs.

In addition to classification information, the data gap assessment also provides the basis for deciding whether sufficient information exists to delineate RABs in Class 1 SUs (Decision Rule 5). The decision makers must also agree on whether existing information is sufficient for RAB delineation. Just as with classification, decision uncertainty with respect to RABs is addressed in a decision maker forum.

Characterization is the means by which the DCS addresses data gaps. As described above, data gaps exist either because there is insufficient information to make the action/NFA decision (Decision Rules 1 through 4) or RABs have not been sufficiently delineated to conduct a remedial action (Decision Rule 5). The BV ROD prescribes a method for minimizing uncertainty where data gaps exist in terms of risk (Decision Rules 1 through 3). The BV ROD states that in the industrial and unrestricted areas,

"The number and grid spacing of samples to verify that the average remediation level has been met in disturbed areas will be determined using the approach by Gilbert (1987) with $\beta = 0.1$ and L = 30 m (100 ft), or other appropriate statistical method approved by the three FFA parties. Sample results used for verification of the average remediation level will also be assessed against the maximum remediation level. However, verification of the maximum remediation level will be based primarily on risk-to-exposure correlations with the walkover or other radiological surveys, to the extent practicable."

In terms of the DCS and these DQOs, the statement from the BV ROD is referring to the filling of data gaps and thus, is referring to Class 2 SUs, i.e., land areas for which data gaps do not allow an action/NFA decision. Although the BV ROD statement addresses the risk-based Decision Rules (Decision Rules 1 through 3), the statistical sampling approach prescribed by the BV ROD for addressing average RLs will be applied to addressing the groundwater Decision Rule (Decision Rule 4) when data gaps exist.

A separate approach will be used to address data gaps as they pertain to RABs (Decision Rule 5). The statistical sampling approach for the action/NFA decision, described above, is one in which sample locations are distributed over a suspect area to identify the presence of contamination. RABs, by definition, are the boundaries of areas for which the action decision has been made already. RABs are not areal by nature so an areal approach to characterization would be ineffective. Instead of the action/NFA decision approach, a practical approach to hypothesis testing, described in Sect. A.7, will be employed for delineation of RABs.

Characterization under the DCS also mitigates residual uncertainty in SU classifications. Residual uncertainty in SU classifications is an important consideration under the DCS for Class 3 SUs which are known to have been impacted but for which there is no indication of contamination. Under the DCS, characterization activities will be conducted in Class 3 SUs to verify the presumption of absence of contamination. Class 3 SU characterization activities also address a requirement of the BV ROD. In addressing the unrestricted use area of Bethel Valley, which will, in part, be classified as a Class 3 SU, the BV ROD states "the lack or presence of contamination in the unrestricted area will be verified in post-ROD activities."

Characterization activities to address data gaps and residual uncertainty in classification are discussed in DQO step 7 (Sect. A.7).

A.7 DEVELOP THE PLAN FOR OBTAINING DATA

The goal of DQO step 7 is to develop a resource-effective design for collecting and measuring environmental samples, or for generating other types of information needed to address the problem. Resource effectiveness is a core concept of the DCS classification-based approach to characterization. By directing resources toward filling data gaps, the DCS focuses resources where they are needed most.

Class 1 SUs. Class 1 SUs are areas for which a remedial action is certain. The purpose for characterization in Class 1 SUs is to define the extent of contamination when the extent is not known in order to delineate the RABs. As described in Sect. A.6, a practical approach to hypothesis testing is employed for delineation of RABs.

The first step in the approach to delineating RABs is to formulate a hypothesis by making the best possible estimation of the RAB based on existing information. The next step is to test the hypothesis by conducting characterization activities over and around the estimated RAB. The particular characterization activities will depend on the nature of the contaminants driving the remedial action and the types of information the decision makers are willing to accept for sufficient RAB delineation. The characterization activities for RAB hypothesis testing will be conducted according to the following plan:

1. Conduct a radiation walkover survey if the drivers for the remedial action are radiological contaminants. The extent of the radiation walkover survey should be determined, initially, by the estimate of the RAB. Monitoring the response of the radiation detection equipment during the survey will determine if the extent of the survey should be broader. With decision maker concurrence, the radiation walkover survey may be sufficient to define the surface expression of the RAB. At this point, if the decision makers are also willing to accept the land use-specific depths in Table A.4 as the depth of remediation, then the RAB has been defined.

2. Conduct sampling and analysis as needed. Analytical data will be needed if the radiation walkover surveys do not adequately define the RABs, or the contaminants driving the action are non-radiological, or if the depth of the remedial action must be defined. One set of sample locations should be distributed along the estimated RAB and another set should be located 3 m (10 ft) from the first set in a direction away from the center of the estimated RAB. Samples will be composited from the land use-specific depths specified in the BV ROD. Samples will be analyzed for the contaminants driving the remedial action, at a minimum. With concurrence from the decision makers, field screening of sample cores may be used in place of analyses or to determine the suite of analytes.

Upon completion of characterization activities and receipt of analytical data, if any, the characterization results will be evaluated and a decision made, with decision maker concurrence, as to whether the RAB has been adequately defined. If the characterization activities do not adequately define the RAB, the data gaps will be evaluated and subsequent characterization will be proposed to the decision makers.

Class 2 SUs. Class 2 SUs are areas for which there exists insufficient information to make the action/NFA decision. The goal of Class 2 SU characterization is to fill the data gaps in order to have sufficient data to make the decision. A systematic approach to Class 2 SU characterization will be conducted as follows:

1. Conduct a radiation walkover survey over the entire extent of the Class 2 SU. Monitoring the response of the radiation detection equipment during the survey will determine if the boundaries of the Class 2 SU need to be expanded.

2. Using the approach by Gilbert (1987) with $\beta = 0.1$ and L = 30 m (100 ft), or other appropriate statistical method approved by the three FFA parties, create a systematic grid of sample locations over the Class 2 SU.

3. Conduct sampling at each systematic grid sample location. Samples will be composited from the land-use specific depths specified in the BV ROD. Samples will be analyzed, at a minimum, for the suites of analytes defined by the BV ROD COCs of the land use area being investigated. For the industrial land use areas (controlled and unrestricted), the suites of analytes include metals, radionuclides, and SVOCs; for recreational land use areas, the suites of analytes include PCBs, radionuclides, and SVOCs; and for unrestricted land use areas, the suites of analytes include radionuclides and SVOCs. With concurrence from the decision makers, field screening of sample cores may be used in place of analyses or to determine the suite of analytes.

Class 3 SUs. Based on process knowledge and existing data, soils in Class 3 SUs do not require remedial action. The project team will develop a protocol for Class 3 SU walkover assessments that will involve visual inspection and spot check radiation surveys. The intent of the walkover assessments will be to verify the Class 3 SU classification. Biased sampling will be conducted when observation indicates that the presumption of no contamination may not be valid.

Class 4 SUs. Class 4 SUs are land areas which have not been impacted by activities at ORNL, its support facilities, or its predecessor organization(s). Because these land areas have not been impacted, no characterization is required.

REFERENCES

DOE (1999) *Remedial Investigation/Feasibility Study for Bethel Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee.* DOE/OR/01-1748/V1&D2. Oak Ridge, TN.

DOE (2002) *Record of Decision for Interim Remedial Actions in Bethel Valley, Oak Ridge, Tennessee.* DOE/OR/01-1862&D4. Oak Ridge, TN.

DOE (2005) *Engineering Study Report for Groundwater Actions in Bethel Valley, Oak Ridge, Tennessee.* DOE/OR/01-2219&D2.

EPA (2006) *Guidance on Systematic Planning Using the Data Quality Objective Process* EPA/240/B-06 /001, February 2006.

APPENDIX B - DATA GAP SUMMARY TABLE

Site Name	Type of Action	Description	Class
SWSA 1	Install Simple Cap	Entire area of buried waste covered by cap. Infiltration limited by the cap	1
SWSA 3	Install Multilayer Cap	Entire area of buried waste covered by cap designed to meet relevant RCRA landfill cover requirements, stable of decreasing surface water concentrations, and stable groundwater conditions.	1
FWPA	Install and maintain 2 ft cover	All debris and contamination above remediation levels covered.	1
NRWTP Debris Pile	Install and maintain 2 ft cover	All debris and contamination above remediation levels covered.	1
Contractor's Landfill	Maintain Cap	All contamination above remediation levels covered.	1
Contaminated Surfaces and Soil from 1959 Explosion in Bldg. 3019 Cell	Soil Excavation and off-site disposal	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil. Determine Volume and WAC	1
Contaminated soil detected through radiological walkover	Soil Excavation and off-site disposal	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil. Determine Volume and WAC	1
SWSA 3 Soil No. 1	Soil Excavation and consolidation	Consolidate beneath SWSA 3 Cap Determine Volume	1
SWSA 3 Soil No. 2	Soil Excavation and consolidation	Consolidate beneath SWSA 3 Cap Determine Volume	1
SWSA 3 Soil No. 3	Soil Excavation and consolidation	Consolidate beneath SWSA 3 Cap Determine Volume	1
Closed Scrap Metal Area (1562)	Soil Excavation and off-site disposal	Excavate contaminated soil above RLs 3 m (10 ft). Determine Volume and WAC	1
3517 Filter Pit Contaminated Soil (Fission Product Development Laboratory)	Soil Excavation and off-site disposal	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil. Determine Volume and WAC	1
Fission Product Development Laboratory LLLW Transfer Line (3517)	Soil Excavation and off-site disposal	Excavate contaminated soils above RLs to 3 m (10 ft) depth, backfill with clean soil. Determine Volume and WAC	1
Contamination at Base of 3019 Stack	Soil Excavation and off-site disposal	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil. Determine Volume and WAC	1
Fission Product Pilot Plant Contaminated Soil	Soil Excavation and off-site disposal	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil. Determine Volume and WAC	1
LLLW Lines and Leak Sites - Under Bldg. 3515	Soil Excavation and off-site disposal	Excavate contaminated soils above RLs to 3 m (10 ft) depth, backfill with clean soil. Determine Volume and WAC	1

Site Name	Type of Action	Description	Class
North and South Tank Farm Contaminated Soil (includes Tank W-1A Contaminated Soil)	Soil Excavation and off-site disposal	Excavate contaminated soils above RLs to 0.6 m (2 ft) depth, backfill with clean soil. Determine Volume and WAC	1
7078 Area Former Construction Dump Site	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
Abandoned Burn Pit	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
C-14 Allocation in Woody Biomass Plantation Species	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
West End Dump Site	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required 3 m (10 ft).	2
ORRR Decay Tank Rupture Site (3087)	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to .6 m (2.0 ft).	2
Decommissioned Waste Holding Basin (soil) (3512)	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to .6 m (2.0 ft).	2
LLLW Lines and Leak Sites - Northwest of SWSA 1	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required 3 m (10 ft).	2
LLLW Lines and Leak Sites - East of Bldg. 2531	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required 3 m (10 ft).	2
LLLW Lines and Leak Sites - Southwest Corner of Bldg. 3019	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required 3 m (10 ft)	2
LLLW Lines and Leak Sites - Bldg. 3518, West	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required 3 m (10 ft).	2
LLLW Lines and Leak Sites - North of Bldg. 3019	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
WC-10 LLLW Line Leak Site	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - West of Bldg. 3082	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - South of Bldg. 3020	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - East of Bldg. 3020 Stack	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - Bldg. 3525 to a Sump	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - Between W-5 and WC-19	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2

Site Name	Type of Action	Description	Class
LLLW Lines and Leak Sites - Bldg. 3503 Ground Contamination	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - Sewer Near Bldg. 3500	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - Between WC-1 and W-5	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - ORRR Water Line (3085)	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - Under Bldg. 3047	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
LLLW Lines and Leak Sites - General Isotopes Area (3034, 3037, 3038)	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
Low Intensity Test Reactor Ponds (3085W)	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
Abandoned Underground Waste Oil Storage Tank 7002A (soils)	Conduct DCS investigation	Conduct DCS investigation to determine if excavation is required to 3 m (10 ft).	2
Class 3 Acreage East and West of Central Bethel Valley	Conduct DCS investigation	Conduct DCS Class 3/4 assessments	3 and 4

APPENDIX C – ARARS

Table B.1. Chemical-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee

Action/medium	Requirements	Citation(s)
Restoration of surface water(s) classified for *Fish and Aquatic Life* use	Waters shall not contain toxic substances or a combination of substances including disease-causing agents that, by way of either direct or indirect exposure through food chains, may cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, physical deformations, or restrict or impair growth in fish or aquatic life or their offspring—**applicable or relevant and appropriate**	Rules of the TDEC Chap. 1200-4-3-.03(3)(g)
	May not exceed numeric AWQC in surface water(s)—**applicable or relevant and appropriate**	Rules of the TDEC Chap. 1200-4-3-.03(3)(g)
	Waters shall not contain other pollutants that will be detrimental to fish or aquatic life—**applicable or relevant and appropriate**	Rules of the TDEC Chap. 1200-4-3-.03(3)(h)
Restoration of surface water(s) classified for *Recreation* use	Waters shall not contain toxic substances, whether alone or in combination with other substances, that will render the water unsafe or unsuitable for water contact activities including the capture and subsequent consumption of fish and shellfish, or will propose toxic conditions that will adversely affect man, animal, aquatic life, or wildlife—**applicable or relevant and appropriate**	Rules of the TDEC Chap. 1200-4-3-.03(4)(b)
	May not exceed numeric AWQC in surface water(s)—**applicable or relevant and appropriate**	Rules of the TDEC Chap. 1200-4-3-.03(4)(b)
	Waters shall not contain other pollutants in quantities that may have a detrimental effect on recreation—**applicable or relevant and appropriate**	Rules of the TDEC Chap. 1200-4-3-.03(4)(i)
Restoration of surface water(s) classified for *Irrigation* and/or *Livestock Watering and Wildlife* uses	Waters shall not contain toxic substances, whether alone or in combination with other substances, that will produce toxic conditions that adversely affect the quality of the waters for irrigation and/or livestock watering and wildlife—**applicable or relevant and appropriate**	Rules of the TDEC Chap. 1200-4-3-.03(5)(f) and (6)(f)
	Waters shall not contain other pollutants in quantities that may be detrimental to the waters used for irrigation and/or for livestock watering and wildlife—**applicable or relevant and appropriate**	Rules of the TDEC Chap. 1200-4-3-.03(5)(g) and (6)(g)

Table C.1. Chemical-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action/medium	Requirements	Citation(s)
Release of radionuclides into the environment	Exposure to individual members of the public from radiation shall not exceed a total EDE of 0.1 rem/year (100 mrem/year), exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical/research programs **relevant and appropriate**	10 *CFR* 20.1301(a)(1)
	Shall use, to the extent practicable, procedures and engineering controls based on sound radiation protection principles to achieve doses to members of the public that are ALARA **relevant and appropriate**	10 *CFR* 20.1101(b)

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
AWQC = ambient water quality criteria
CFR = *Code of Federal Regulations*
EDE = effective dose equivalent
ORNL = Oak Ridge National Laboratory
TBC = to be considered
TDEC = Tennessee Department of Environment and Conservation

Table B.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
	Wetlands		
Presence of wetlands as defined in 10 *CFR* 1022.4(v)	Avoid, to the extent possible, the long- and short-term adverse effects associated with destruction, occupancy, and modification of wetlands. Measures to mitigate adverse effects of actions in a wetlands include, but are not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecology-sensitive areas as provided in 10 *CFR* 1022.12(a)(3)	Federal actions that involve potential impacts to, or take place within, wetlands—**applicable**	10 *CFR* 1022.3(a)
	Take action, to the extent practicable, to minimize destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands		10 *CFR* 1022.3(b)(5) and (6)
	Potential effects of any new construction in wetlands shall be evaluated. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse impacts on wetlands		10 *CFR* 1022.3(c) and (d)
	Floodplains		
Presence of floodplain as defined in 10 *CFR* 1022.4(i)	Avoid, to the extent possible, the long- and short-term adverse effects associated with occupancy and modification of floodplains. Measures to mitigate adverse effects of actions in a floodplain include, but are not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecology-sensitive areas as provided in 10 *CFR* 1022.12(a)(3)	Federal actions that involve potential impacts to, or take place within, floodplains—**applicable**	10 *CFR* 1022.3(a)
	Potential effects of any action taken in a floodplain shall be evaluated. Identify, evaluate, and implement alternative actions that may avoid or mitigate adverse impacts on floodplains		10 *CFR* 1022.3(c) and (d)
	Design or modify selected alternatives to minimize harm to or within floodplains and restore and preserve floodplain values		10 *CFR* 1022.5(b)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
	Aquatic resources		
Within an area potentially impacting waters of the state as defined in *TCA* 69-3-103(43)	Must comply with the substantive requirements of the ARAP for erosion and sediment control to prevent pollution	Action potentially altering the properties of any waters of the state – **applicable**	*TCA* 69-3-108(b)(1)(i)
	Erosion and sediment control requirements include, but are not limited to: • Limit clearing, grubbing, and other disturbances in areas in or immediately adjacent to waters of the state to the minimum necessary to accomplish the proposed activity; • Unnecessary vegetation removal is prohibited, and all disturbed areas must be properly stabilized and revegetated as soon as practicable; • Limit excavation, dredging, bank reshaping, or grading to the minimum necessary to install authorized structures, accommodate stabilization, or prepare banks for revegetation; • Maintain the erosion and sedimentation control measures throughout construction period; and • Upon achievement of a final grade, stabilize and revegetate, within 30 days, all disturbed areas by sodding, seeding, or mulching, or using appropriate native riparian species	Action potentially altering the properties of any waters of the state – **TBC**	TDEC ARAP Program General Requirements
Location encompassing aquatic ecosystem as defined in 40 *CFR* 230.3(c)	No discharge of dredged or fill material into an aquatic ecosystem is permitted if there is a practicable alternative that would have less adverse impact No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps in accordance with 40 *CFR* 230.70 *et seq.* have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **applicable**	40 *CFR* 230.10(a) 40 *CFR* 230.10(d)
	Endangered, threatened, or rare species		
Presence of federally endangered or threatened species, as designated in 50 *CFR* 17.11 and 17.12, or critical habitat of such species	Actions that jeopardize the existence of a listed species or results in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken	Action that is likely to jeopardize fish, wildlife, or plant species or destroy or adversely modify critical habitat – **applicable**	16 *USC* 1531 *et seq.*, Sect. 7(a)(2)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
Presence of Tennessee non-game species as defined in *TCA* 70-8-103	May not take (e.g., harass, hunt, capture, kill or attempt to kill), possess, transport, export, or process such wildlife species	Action impacting Tennessee non-game species, including wildlife species that are threatened and endangered or "in need of management" (as listed in TWRCP 94-16 and 94-17) —**applicable**	*TCA* 70-8-106(c)
	May not knowingly destroy the habitat of such wildlife species		TWRCP 94-16(I)(1)(a) and TWRCP 94-17(I)
	Upon good cause shown and where necessary to protect human health or safety, endangered or threatened species may be removed, captured, or destroyed		*TCA* 70-8-106(e) TWRCP 94-16(II)(1)(e)
Presence of Tennessee-listed endangered or rare plant species as listed in Rules of the TDEC Chap. 0400-6-2.04	May not knowingly uproot, dig, take, remove, damage or destroy, possess, or otherwise disturb for any purpose any endangered species	Action impacting rare plant species including but not limited to federally listed endangered species—**applicable**	*TCA* 70-8-309
	Cultural resources		
Presence of historic properties (including artifacts, records, or remains located within such properties)	Must take into account the adverse effects on historic properties per Sect. 106 of the NHPA	Undertaking [as defined in 36 *CFR* 800.16(y)] that has the potential to cause effects on historic property on or eligible for inclusion on the National Register of Historic Places—**applicable**	36 *CFR* 800.1(a) 36 *CFR* 800.3
	Determine adverse effects per 36 *CFR* 800.5(a)(1) and, if found, evaluate alternatives or modifications to the undertaking to avoid, minimize, or mitigate the adverse effects on the property		36 *CFR* 800.5(a) and (d) 36 *CFR* 800.6

ARAP	Aquatic Resource Alteration Permit	TBC	to be considered
ARAR	applicable or relevant and appropriate requirement	*TCA*	*Tennessee Code Annotated*
CFR	*Code of Federal Regulations*	TDEC	Tennessee Department of Environment and Conservation
NHPA	National Historic Preservation Act	TWRCP	Tennessee Wildlife Resources Commission Proclamation
ORNL	Oak Ridge National Laboratory	*USC*	*United States Code*

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Table B.3. Action-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee

Action	Requirements	Prerequisite	Citation(s)
	General construction standards—site preparation, excavation, drilling, trenching, etc., activities		
Activities causing fugitive dust emissions	Shall take reasonable precautions to prevent particulate matter from becoming airborne; reasonable precautions shall include, but are not limited to, the following:	Fugitive emissions from demolition of existing buildings or structures, construction operations, grading of roads, or the clearing of land—**applicable**	Rules of the TDEC Chap. 1200-3-8-.01(1)
	• use, where possible, of water or chemicals for control of dust, and • application of asphalt, oil, water, or suitable chemicals on dirt roads, materials stock piles, and other surfaces which can create airborne dusts.		Rules of the TDEC Chap. 1200-3-8-.01(1)(a) Rules of the TDEC Chap. 1200-3-8-.01(1)(b)
	Shall not cause or allow fugitive dust to be emitted in such a manner as to exceed 5 min/hr > 20 mm/d beyond property boundary lines on which emission originates		Rules of the TDEC Chap. 1200-3-8-.01(3)
Activities causing radionuclide emissions	Shall not exceed those amounts that would cause any member of the public to receive an EDE of 10 mrem per year	Radionuclide emissions from point sources, as well as diffuse or fugitive emissions, at a DOE facility—**applicable**	40 *CFR* 61.92 Rules of the TDEC Chap. 1200-3-11-.08(6)
Activities causing storm water runoff (e.g., clearing, grading, excavation)	Implement good construction management techniques (including sediment and erosion controls, vegetative controls, and structural controls) in accordance with the substantive requirements of *General Permit No. TNR10-0000 Appendix F*, to ensure that storm water discharge • does not violate water quality criteria as stated in TDEC 1200-4-3-.03 including but not limited to prevention of discharges that cause a condition in which visible solids, bottom deposits, or turbidity impair the usefulness of waters of the state for any of the designated uses for that water body by TDEC 1200-4-4	Dewatering or storm water runoff discharges from land disturbed by construction activity—disturbance of >5 acres total—**applicable**; > 5 acres—**relevant and appropriate**	*TCA* 69-3-108(j) Rules of the TDEC Chap. 1200-4-10-.03(7)
		Storm water discharges from construction activities—TBC	*General Permit No. TNR10-0000* Part III.D.2.a

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	• does not contain distinctly visible floating scum, oil, or other matter;		*General Permit No. TNR10-0000* Part III D.2.b
	• does not cause an objectionable color contrast in the receiving stream; and		*General Permit No. TNR10-0000* Part III D.2.c
	• results in no materials in concentrations sufficient to be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream		*General Permit No. TNR10-0000* Part III D.2.d
	Capping—SWSA 1, SWSA 3, FWPA, NRWTP Pile, and Contractors Landfill		
Closure of SWSA 3	Must close the unit in a manner that:	Closure of a RCRA hazardous waste management facility—**relevant and appropriate**	40 *CFR* 265.111(a) Rules of the TDEC Chap. 1200-1-11-.05(7)(b)(1)
	• minimizes the need for further maintenance;		
	• controls, minimizes, or eliminates to the extent necessary to protect human health and the environment, postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to ground or surface waters or to the atmosphere; and		40 *CFR* 265.111(b) Rules of the TDEC Chap. 1200-1-11-.05(7)(b)(2)
	• complies with the relevant closure requirements of 40 *CFR* 265.310		40 *CFR* 265.111(c) Rules of the TDEC Chap. 1200-1-11-.05(7)(b)(3)
Capping of SWSA 3	Must cover the landfill or cell with a final cover designed and constructed to	Closure of a RCRA hazardous waste management facility—**relevant and appropriate**	40 *CFR* 265.310(a) Rules of the TDEC Chap. 1200-1-11-.05(14)(k)(1)
	• provide long-term minimization of migration of liquids through the closed landfill;		40 *CFR* 265.310(a)(1) Rules of the TDEC Chap. 1200-1-11-.05(14)(k)(1)(i)
	• function with minimum maintenance;		40 *CFR* 265.310(a)(2) Rules of the TDEC Chap. 1200-1-11-.05(14)(k)(1)(ii)
	• promote drainage and minimize erosion or abrasion of the cover;		40 *CFR* 265.310(a)(3) Rules of the TDEC Chap. 1200-1-11-.05(14)(k)(1)(iii)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite		Citation(s)
	• accommodate settling and subsidence so that the cover's integrity is maintained; and • have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present			40 *CFR* 265.310(a)(4) Rules of the TDEC Chap. 1200-1-11-.05(14)(k)(1)(iv) 40 *CFR* 265.310(a)(5) Rules of the TDEC Chap. 1200-1-11-.05(k)(1)(v)
Protection of capped SWSA 3	Postclosure use of property must never be allowed to disturb the integrity of the final cover, liners, or any other components of the containment system or the facility's monitoring system unless necessary to reduce a threat to human health or the environment.	Closure of a RCRA landfill	**relevant and appropriate**	40 *CFR* 265.117(c) Rules of the TDEC Chap. 1200-1-11-.05(17)(b)(3)
General postclosure care of capped SWSA 3	Owner or operator must • maintain the effectiveness and integrity of the final cover, including making repairs to the cap as necessary to correct effects of settling, subsidence, erosion, and other events; and • prevent run-on and runoff from eroding or otherwise damaging final cover	Closure of a RCRA landfill	**relevant and appropriate**	40 *CFR* 265.310(b) 40 *CFR* 265.310(b)(1) Rules of the TDEC Chap. 1200-1-11-.06(14)(k)(2) Rules of the TDEC Chap. 1200-1-11-.06(14)(k)(2)(i) 40 *CFR* 265.310(b)(4) Rules of the TDEC Chap. 1200-1-11-.05(14)(k)(2)(iv)
Closure of LLW burial grounds (SWSA 1 and SWSA 3)	Covers must be designed to minimize, to the extent practicable, water infiltration, to direct percolating or surface water away from the disposed waste, and to resist degradation by surface geologic processes and biotic activity	Land disposal of LLW	**relevant and appropriate**	Rules of the TDEC Chap.1200-2-11-.17(2)(d)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	Concentrations of radioactive material which may be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ; a reasonable effort shall be made to maintain releases of radioactivity in effluents to the general environment to ALARA		Rules of the TDEC Chap. 1200-2-11-.16(2)
Corrective Measures for SWSA 1 and SWSA 3	Must have plans for taking corrective measures if migration of radionuclides would indicate that the performance objectives of Rules of the TDEC Chap. 1200-2-11-.16 may not be met	Closure of a LLW disposal facility— **relevant and appropriate**	Rules of the TDEC Chap. 1200-2-11-.17(4)(b)
Closure of solid waste disposal units (EWPA, NRWTP Plc, Contractors Landfill)	Must be closed in a manner that minimizes the need for further maintenance and controls, and minimizes, or eliminates, to the extent necessary to protect human health and the environment, postclosure escape of solid waste, solid waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere	Closure of a Class I-IV solid waste landfill **relevant and appropriate**	Rules of the TDEC Chap. 1200-1-7-.04(8)(a)
	Sludge removal—TRU waste from tanks (S-424, T1, T2, and HFIR)		
Characterization of TRU waste	Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the WAC of the receiving facility	Generation TRU waste for management and storage at a DOE facility—**TBC**	DOE M 435.1-1(III)(1)
	Characterization data shall, at a minimum, include the following information relevant to the management of the waste:		DOE M 435.1-1(III)(1)(2)
	• physical and chemical;		DOE M 435.1-1 (III)(1)(2)(a)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	• volume, including the waste and any stabilization or absorbent media;		DOE M 435.1-1(III)(O)(2)(b)
	• weight of the container and contents;		DOE M 435.1-1(III)(O)(2)(c)
	• identities, activities, and concentrations of major radionuclides;		DOE M 435.1-1(III)(O)(2)(d)
	• characterization date;		DOE M 435.1-1(III)(O)(2)(e)
	• generating source;		DOE M 435.1-1(III)(O)(2)(f)
	• packaging date; and		DOE M 435.1-1(III)(O)(2)(g)
	• any other information that may be needed to prepare and maintain the disposal facility performance assessment or demonstrate compliance with the applicable performance objectives		DOE M 435.1-1(III)(O)(2)(h)
Packaging of TRU waste	Shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste is removed from the container	Generation of TRU waste for management and storage at a DOE facility — **TBC**	DOE M 435.1-1(III)(L)(1)(a)
	Vents or other mechanisms to prevent pressurization of containers or generation of flammable or explosive concentration of gases shall be installed on containers of newly generated waste at the time the waste is packaged		DOE M 435.1-1(III)(L)(1)(b)
	Containers of TRU waste shall be marked such that their contents can be identified		DOE M 435.1-1(III)(L)(1)(d)
Temporary storage of TRU waste	Shall be conducted in a manner as to provide reasonable assurance that the combined annual dose equivalent to any member of the general public in the general environment resulting from discharges of radioactive material and direct radiation shall not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other critical organ	Management and storage of TRU waste at a DOE facility — **relevant and appropriate**	40 *CFR* 191.03(a)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	Shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water	Management and storage of TRU waste at a DOE facility—**TBC**	DOE M 435.1-1(III)(N)(1)
	Shall be stored in a location and manner that protects the integrity of waste for the expected time of storage and minimizes worker exposure		DOE M 435.1-1(III)(N)(2)
	Shall be monitored, as prescribed by the appropriate facility safety analysis, to ensure the wastes are maintained in a safe condition		DOE M 435.1-1(III)(Q)(2)
Treatment of TRU waste	Shall be treated as necessary to meet the WAC of the facility receiving the waste for storage or disposal	Generation of TRU waste for storage at a DOE facility and disposal at WIPP—**TBC**	DOE M 435.1-1(III)(O)
	Shall be treated, prepared and packaged to be nonflammable	Generation of pyrophoric TRU waste at a DOE facility—**TBC**	DOE M 435.1-1(III)(N)(1)
Disposal of TRU waste at WIPP	Shall be disposed in accordance with the requirements of 40 *CFR* Part 191	Generation of TRU waste at a DOE facility for disposal at WIPP—**TBC**	DOE M 435.1-1(III)(P)
Removal of contaminated media—White Oak Creek and tributary sediment and floodplain soils; contaminated soil hotspots			
Risk-based disposal of PCB remediation waste	May be disposed of in a manner other than prescribed in 40 *CFR* 761.61(a) or (b) if approved in writing by EPA and method will not pose an unreasonable risk of injury to human health or the environment	Disposal of PCB remediation waste—**applicable**	40 *CFR* 761.61(c)
Remediation of radionuclide-contaminated soil	Guidelines for residual concentrations of radionuclides in soil shall be derived from the basic dose limit using an environmental pathway analysis	Residual radioactive material in soil—**TBC**	DOE Order 5400.5(IV)(4)(a)
D&D activities—inactive facilities in the main plant area			

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Decontamination of radioactively contaminated equipment and building structure	Most meet surface contamination guidelines for residual activity provided in Fig. IV-1 of the Order for specified radionuclides	Residual radioactive material on equipment and building structures for unrestricted use — **TBC**	DOE Order 5400.5(IV)(4)(d) and Fig. IV-1
Removal of refrigeration equipment	Disposal of any such appliances, which may vent or otherwise release to the environment any Class I or II substances as a refrigerant is prohibited	Appliances that contain Class I or II substances used as a refrigerant — **applicable**	40 *CFR* 82.154(a)
	No person may dispose of such appliances, with certain exceptions, without • observing the required practices set forth in 40 *CFR* 82.156, and • using equipment that is certified for that type of appliance pursuant to 40 *CFR* 82.155		40 *CFR* 82.154(b)
Removal of RACM from a facility	Procedures for asbestos emission control per 40 *CFR* 61.145(c)(1)-(6) shall be followed, as appropriate	Demolition of a facility containing RACM exceeding the volume requirements of 40 *CFR* 61.145(a)(1) — **applicable**	40 *CFR* 61.145(c) Rules of the TDEC Chap. 1200-3-11-.02(2)(d)(3)
Water treatment — on-site treatment and discharge of groundwater, transfer of collected dewatering, decontamination, etc. water			
Transport to ORNL NPDES wastewater treatment facility	All tank systems, conveyance systems, and ancillary equipment used to store or transport waste to an on-site NPDES-permitted wastewater treatment facility are exempt from the requirements of RCRA Subtitle C standards	On-site wastewater treatment units that are subject to regulation under Sect. 402 or Sect. 307(b) of CWA (NPDES permitted) — **applicable**	40 *CFR* 270.1(c)(2)(v) Rules of the TDEC Chap. 1200-1-11-.07(1)(b)1.(i)(v)
Discharge of treated groundwater	Shall receive the degree of treatment or effluent reduction necessary to comply with water quality standards and, where appropriate, will comply with the standard of performance as required by the Tennessee Water Quality Control Act of 1977 at *TCA* 69-3-103(30)	Point source discharge(s) of pollutants into surface water — **applicable**	Rules of the TDEC Chap. 1200-4-3-.05(6)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	Are not prohibited from land disposal if such wastes are managed in a treatment system that subsequently discharges to waters of the United States pursuant to a permit issued under Sect. 402 of the CWA, unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* 268.40 or are D003 reactive cyanide	Restricted RCRA characteristically hazardous waste intended for disposal– **applicable**	40 *CFR* 268.1(e)(4)(i) Rules of the TDEC Chap. 1200-1-11-.10(1)(a)(3)(iv)(I)
	Absorbed dose to native animal aquatic organisms must not exceed 1 rad/day	Discharge of radioactive materials in liquid waste to surface water at a DOE facility– **TBC**	DOE Order 5400.5(11)(3)(a)(5)
	In situ grouting —empty tank shells and inactive pipelines		
Emissions from air filter system	Discharge of air contaminants must be in accordance with the appropriate provisions of Rules of the TDEC 1200-3 et seq., any applicable measures of control strategy, and all provisions of the Tennessee Pollution Control Act	Emissions of air pollutants from new air contaminant sources **applicable**	Rules of the TDEC Chap. 1200-3-9-.01(1)(d)
	Emission measurements in conformance with 40 *CFR* 61.93(b) shall be made	Release points that have the potential to discharge radionuclides into the air in quantities that could cause an EDE in excess of 1% of	40 *CFR* 61.93(b)(4)(i)
	Shall measure all radionuclides that could contribute greater than 10% of the potential EDE for a release point	10 mrem/year to any member of the public —**applicable**	Rules of the TDEC Chap. 1200-3-11-.08(6)
	Periodic confirmatory measurements shall be made to verify low emissions	Other release points that have the potential to release radionuclides into the air—**applicable**	
	Well P&A— all inactive monitoring wells		

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Closure of groundwater monitoring well(s)	Well shall be completely filled and sealed in such a manner that vertical movement of fluid either into or between formation(s) containing groundwater classified pursuant to Rules of the TDEC Chap. 1200-4-6-.05(1) through the borehole is not allowed. Shall be performed in accordance with the provisions for Seals at Rules of the TDEC 1200-4-6-.09(6)(e), (f), and (g); for Fill Materials at Rules of the TDEC 1200-4-6-.09(6)(h) and (i); for Temporary Bridges at Rules of the TDEC 1200-4-6-.09(6)(j); for Placement of Sealing Materials at Rules of the TDEC 1200-4-6-.09(7)(a) and (b); and for Special Conditions at Rules of the TDEC 1200-4-6-.09(8)(a) and (b), as appropriate	Permanent plugging and abandonment of a well **relevant and appropriate**	Rules of the TDEC Chap. 1200-4-6-.09(6)(d)
Well construction – all new groundwater monitoring wells and extraction wells			
Construction of extraction wells for groundwater treatment	Shall construct, reconstruct, or repair wells in accordance with provisions at Rules of the TDEC Chaps. 1200-4-9-.10(4) through (11), as appropriate	Construction, reconstruction, or repair of any water well constructed for the production of water from underground sources **relevant and appropriate**	Rules of the TDEC Chap. 1200-4-9-.10(1)(a)
	When strict compliance with these standards is impractical, may obtain TDEC approval of equivalent standards (a variance) prior to work being performed		Rules of the TDEC Chap. 1200-4-9-.10(1)(d)
	Shall install any pump, filter, and water treatment units in accordance with provisions at Rules of the TDEC Chap. 1200-4-9-.11		Rules of the TDEC Chap. 1200-4-9-.10(1)(a)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Construction of groundwater monitoring well(s)	All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole; this casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples; the annular space above the sampling depth must be sealed to prevent contamination of groundwater and samples	Construction of RCRA groundwater monitoring well—**relevant and appropriate**	40 *CFR* 264.97(c) Rules of the TDEC Chap. 1200-1-11-.06(6)(h)(3)
	Underground Injection Well Construction and Operation		
Injection of nutrients (or other treatments) into groundwater	Wells shall be designed, constructed, and operated in such a manner that does not present a hazard to existing or future use of groundwater and may not cause a violation of water quality standards	Class V injection well for innovative or experimental technologies—**relevant and appropriate**	TDEC 1200-4-6-.14(1)(b) TDEC 1200-4-6-.14(7)(b) and (8)(a)
	Institutional control—all waste left in place (SWSAs), pipelines, D&D facilities, contaminated soil or sediment		
Waste left in place	Institutional controls are required and shall include, at a minimum, deed restrictions for sale and use of property and securing area to prevent human contact with hazardous substances	Hazardous substances left in place that may pose an unreasonable threat to public health, safety, or the environment—**relevant and appropriate**	Rules of the TDEC Chap. 1200-1-13-.08(10)
Radioactive material left in place	A property may be maintained under interim management provided administrative controls are established to protect members of the public	Residual radioactive material above guidelines in inaccessible locations that would be unreasonably costly to remove—**TBC**	DOE Order 5400.5(IV)(6)(c)(1)
	Controls include, but are not limited to, periodic monitoring as appropriate, appropriate shielding, physical barriers (i.e., fences, warning signs) to prevent access, appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate		DOE Order 5400.5(IV)(6)(c)(2)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Waste generation, characterization, segregation, and storage *excavated soils, sludge, sediments, building debris, secondary wastes*			
Characterization of solid waste ***(all primary and secondary wastes)***	Must determine if solid waste is hazardous waste or if waste is excluded under 40 *CFR* 261.4(b); and	Generation of solid waste as defined in 40 *CFR* 261.2 and that is not excluded under 40 *CFR* 261.4(a) – **applicable**	40 *CFR* 262.11(a) Rules of the TDEC Chap. 1200-1-11-.03(1)(b)1)
	Must determine if waste is listed under 40 *CFR* Part 261; or		40 *CFR* 262.11(b) Rules of the TDEC Chap. 1200-1-11-.03(1)(b)(2)
	Must characterize waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used		40 *CFR* 262.11(c) Rules of the TDEC Chap. 1200-1-11-.03(1)(b)(3)
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chap. 40 for possible exclusions or restrictions pertaining to management of the specific waste	Generation of solid waste that is determined to be hazardous – **applicable**	40 *CFR* 262.11(d); Rules of the TDEC Chap. 1200-1-11-.03(1)(b)1)(i)
Characterization of hazardous waste ***(all primary and secondary wastes)***	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 *CFR* 264 and 268	Generation of RCRA-hazardous waste for storage, treatment, or disposal – **applicable**	40 *CFR* 264.13(a)(1) Rules of the TDEC Chap. 1200-1-11-.06(2)(d)(1)
	Must determine the underlying hazardous constituents [as defined in 40 *CFR* 268.2(i)] in the waste	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Sect. 268.42 Table 1) for storage, treatment or disposal – **applicable**	40 *CFR* 268.9(a) Rules of the TDEC Chap. 1200-1-11-.10(1)(i)(1)
	Must determine if the waste is restricted from land disposal under 40 *CFR* 268 *et seq.* by testing in accordance with prescribed methods or use of generator knowledge of waste		40 *CFR* 268.7 Rules of the TDEC Chap. 1200-1-11-.10(1)(g)(1)(i)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 *CFR* 268.40 et seq.		40 *CFR* 268.9(a) Rules of the TDEC Chap. 1200-1-11-.10(1)(a)(1)
Temporary storage of hazardous waste in containers *(e.g., PPE, D&D demolition debris)*	A generator may accumulate hazardous waste at the facility provided that:	Accumulation of RCRA hazardous waste on site as defined in 40 *CFR* 260.10—**applicable**	40 *CFR* 262.34(a) TDEC 1200-1-11-.03(4)(e)
	• waste is placed in containers that comply with 40 *CFR* 265.171-173; and		40 *CFR* 262.34(a)(1)(i) Rules of the TDEC Chap. 1200-1-11-.03(4)(e)(2)(i)(I)
	• the date upon which accumulation begins is clearly marked and visible for inspection on each container.		40 *CFR* 262.34(a)(2) Rules of the TDEC Chap. 1200-1-11-.03(4)(e)(2)(ii)
	• container is marked with the words "hazardous waste." or		40 *CFR* 262.34(a)(3) Rules of the TDEC Chap. 1200-1-11-.03(4)(e)(2)(iv)
	• container may be marked with other words that identify the contents	Accumulation of 208 L (55 gal) or less of RCRA hazardous waste at or near any point of generation **applicable**	40 *CFR* 262.34(c)(1) Rules of the TDEC Chap. 1200-1-11-.03(4)(e)(5)(i)(II)
Use and management of hazardous waste in containers	If container is not in good condition (e.g., severe rusting, structural defects), or if it begins to leak, must transfer waste into container in good condition	Storage of RCRA hazardous waste in containers—**applicable**	40 *CFR* 265.171 Rules of the TDEC Chap. 1200-1-11-.05(9)(b)
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired		40 *CFR* 265.172 Rules of the TDEC Chap. 1200-1-11-.05(9)(c)
	Keep containers closed during storage, except to add/remove waste		40 *CFR* 265.173(a) Rules of the TDEC Chap. 1200-1-11-.05(9)(d)(1)
	Open, handle, and store containers in a manner that will not cause containers to rupture or leak		40 *CFR* 265.173(b) Rules of the TDEC Chap. 1200-1-11-.05(9)(d)(2)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 *CFR* 264.175(b)	Storage of RCRA-hazardous waste in containers with free liquids — **applicable**	40 *CFR* 264.175(a) Rules of the TDEC Chap. 1200-1-11-.06(9)(d)(1)
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid	Storage of RCRA-hazardous waste in containers that do not contain free liquids — **applicable**	40 *CFR* 264.175(c) Rules of the TDEC Chap. 1200-1-11-.06(9)(d)(3)
Characterization of LLW (e.g., *contaminated PPE, equipment, D&D demolition debris*)	Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the WAC of the receiving facility	Generation of LLW for storage or disposal at a DOE facility — **TBC**	DOE M 435.1-1(IV)(I)
	Characterization data shall, at a minimum, include the following information relevant to the management of the waste:		DOE M 435.1-1(IV)(I)(2)(a)
	• physical and chemical characteristics;		DOE M 435.1-1(IV)(I)(2)(a)
	• volume, including the waste and any stabilization or absorbent media;		DOE M 435.1-1(IV)(I)(2)(b)
	• weight of the container and contents,		DOE M 435.1-1(IV)(I)(2)(c)
	• identities, activities, and concentration of major radionuclides;		DOE M 435.1-1(IV)(I)(2)(d)
	• characterization date;		DOE M 435.1-1(IV)(I)(2)(e)
	• generating source, and		DOE M 435.1-1(IV)(I)(2)(f)
	• any other information that may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with performance objectives		DOE M 435.1-1(IV)(I)(2)(g)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Temporary storage of LLW *(e.g., contaminated PPE, D&D demolition debris)*	Shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water	Management of LLW at a DOE facility—**TBC**	DOE M 435.1-1 (IV)(N)(1)
	Shall be stored in a location and manner that protects the integrity of waste for the expected time of storage		DOE M 435.1-1 (IV)(N)(3)
	Shall be managed to identify and segregate LLW from mixed waste		DOE M 435.1-1 (IV)(N)(6)
Packaging of solid LLW *(e.g., contaminated PPE, equipment, D&D demolition debris)*	Shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste has been removed from the container	Storage of LLW in containers at a DOE facility—**TBC**	DOE M 435.1-1(IV)(L)(1)(a)
	Vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container		DOE M 435.1-1(IV)(L)(1)(b)
	Containers shall be marked such that their contents can be identified		DOE M 435.1-1(IV)(L)(1)(c)
Segregation of scrap metal for recycle	Material is not subject to RCRA requirements for generators, transporters, and storage facilities under 40 *CFR* Parts 262 through 266, 268, 270, or 124	Scrap metal, as defined in 40 *CFR* 261.1(c)(6) intended for recycle—**applicable**	40 *CFR* 261.6(a)(3)(ii) Rules of the TDEC Chap. 1200-1-11-.02(1)(f)(1)(iii)(II)
Release of scrap metal *(lead bricks, lead shielding, etc.)*	Before being released, items shall be surveyed to determine whether both removable and total surface contamination (including contamination present on or under any coating) is greater than the levels given in Fig. IV-1 of the Order and that the contamination has been subjected to the ALARA process	Radionuclide-contaminated scrap materials and equipment intended for recycle or reuse—**TBC**	DOE Order 5400.5(II)(5)(c)(1)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Management of asbestos-containing waste prior to disposal (*e.g., D&D demolition debris*)	Discharge no visible emissions to the outside air, or use one of the emission control and waste treatment methods specified in paragraphs (a)(1) through (a)(4) of 40 *CFR* 61.150	Collection, processing, packaging or transporting of any asbestos-containing waste material generated by demolition activities – **applicable**	40 *CFR* 61.150(a) Rules of the TDEC Chap. 1200-3-11-.02(2)(i)(1)
Management of PCB waste (*e.g., contaminated PPE, demolition debris, sludges*)	Any person storing or disposing of PCB waste must do so in accordance with 40 *CFR* 761, Subpart D	Generation of waste containing PCBs at concentrations ≥ 50 ppm – **applicable**	40 *CFR* 761.50(a)
	Any person cleaning up and disposing of PCBs shall do so based on the concentration at which the PCBs are found	Generation of PCB remediation waste as defined in 40 *CFR* 761.3—**applicable**	40 *CFR* 761.61
Management of PCB/radioactive waste (*e.g., oils drained from pumps, equipment, D&D demolition debris, etc.*)	Any person storing such waste must do so taking into account both its PCB concentration and radioactive properties, except as provided in 40 *CFR* 761.65(a)(1), (b)(1)(ii) and (c)(6)(i)	Generation for disposal of PCB/radioactive waste with ≥ 50 ppm PCBs – **applicable**	40 *CFR* 761.50(b)(7)(i)
	Any person disposing of such waste must do so taking into account both its PCB concentration and its radioactive properties If, after taking into account only the PCB properties in the waste, the waste meets the requirements for disposal in a facility permitted, licensed, or registered by a state as a municipal or nonmunicipal nonhazardous waste landfill (e.g., PCB bulk product waste under 40 *CFR* 761.62(b)(1)), the person may dispose of such waste without regard to the PCBs, based on its radioactive properties alone in accordance with applicable requirements		40 *CFR* 761.50(b)(7)(ii)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Temporary storage of PCB waste *(e.g., contaminated PPE, D&D demolition debris, sludges)*	Container(s) shall be marked as illustrated in 40 *CFR* 761.45(a)	Storage of PCBs and PCB items at concentrations of 50 ppm for disposal — **applicable**	40 *CFR* 761.65(a)(1)
	Storage area must be properly marked as required by 40 *CFR* 761.40(a)(10)		40 *CFR* 761.65(c)(3)
	Any leaking PCB items and their contents shall be transferred immediately to a properly marked nonleaking container(s).		40 *CFR* 761.65(c)(5)
	Container(s) shall be in accordance with requirements set forth in DOT HMR at 49 *CFR* 171-180		40 *CFR* 761.65(c)(6)
	The date shall be recorded when PCB items are removed from service, and the storage shall be managed such that PCB items can be located by this date. (Note: Date should be marked on the container.)	PCB items (includes PCB wastes) removed from service for disposal– **applicable**	40 *CFR* 761.65(c)(8)
Storage of PCB/radioactive waste in containers *(e.g., contaminated PPE demolition debris, sludges)*	For liquid wastes, containers must be nonleaking.	Storage of PCB/radioactive waste in containers other than those meeting DOT HMR performance standards— **applicable**	40 *CFR* 761.65(c)(6)(i)(A)
	For nonliquid wastes, containers must be designed to prevent buildup of liquids if such containers are stored in an area meeting the containment requirements of 40 *CFR* 761.65(b)(1)(ii)		40 *CFR* 761.65(c)(6)(i)(B)
	For both liquid and nonliquid wastes, containers must meet all regulations and requirements pertaining to nuclear criticality safety		40 *CFR* 761.65(c)(6)(i)(C)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Storage of PCB waste and/or PCB/radioactive waste in a RCRA-regulated container storage area	Does not have to meet storage unit requirements in 40 *CFR* 761.65(b)(1) provided unit	Storage of PCBs and PCB items designated for disposal—**applicable**	40 *CFR* 761.65(b)(2)
	• is permitted by EPA under RCRA Sect. 3004, or		40 *CFR* 761.65(b)(2)(i)
	• qualifies for interim status under RCRA Sect. 3005, or		40 *CFR* 761.65(b)(2)(ii)
	• is permitted by an authorized state under RCRA Sect. 3006, and		40 *CFR* 761.65(b)(2)(iii)
	• PCB spills cleaned up in accordance with Subpart G of 40 *CFR* 761		40 *CFR* 761.65(c)(1)(iv)
	Treatment/disposal of waste—excavated sediment/soils, sludge, building debris, secondary wastes		
Disposal of RCRA-hazardous waste in a land-based unit (*debris with lead paint, lead shielding, sludge, etc.*)	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *CFR* 268.40 before land disposal	Land disposal, as defined in 40 *CFR* 268.2, of restricted RCRA waste—**applicable**	40 *CFR* 268.40(a) Rules of the TDEC Chap. 1200-1-11-.10(3)(a)
	May be land disposed if it meets the requirements in the table "Alternative Treatment Standards for Hazardous Debris" at 40 *CFR* 268.45 before land disposal or the debris is treated to the waste-specific treatment standard provided in 40 *CFR* 268.40 for the waste contaminating the debris	Land disposal, as defined in 40 *CFR* 268.2, of restricted RCRA-hazardous debris—**applicable**	40 *CFR* 268.45(a) Rules of the TDEC Chap. 1200-1-11-.10(3).(f)(1)
	Must be treated according to the alternative treatment standards of 40 *CFR* 268.49(c) or according to the UTSs specified in 40 *CFR* 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal	Land disposal, as defined in 40 *CFR* 268.2, of restricted hazardous soils—**applicable**	40 *CFR* 268.49(b) Rules of the TDEC Chap. 1200-1-11-.10(3)(f)(2)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	Are not prohibited if the wastes no longer exhibit a characteristic at the point of land disposal, unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* 268.40, or are D003 reactive cyanide	Land disposal of restricted RCRA characteristically hazardous wastes—**applicable**	40 *CFR* 268.1(c)(4)(iv) Rules of the TDEC Chap. 1200-1-11-.10(1)(a)(3)(iv)(IV)
Packaging of LLW for disposal *(e.g., contaminated PPE, D&D demolition debris)*	Must have structural stability either by processing the waste or placing the waste in a container or structure that provides stability after disposal	Generation of LLW for disposal at a LLW disposal facility— **relevant and appropriate**	Rules of the TDEC Chap. 1200-2-11-.17(7)(b)(1)
	Void spaces within the waste and between the waste, and its package must be reduced to the extent practicable		Rules of the TDEC Chap. 1200-2-11-.17(7)(b)(3)
Treatment of LLW	Treatment to provide more stable waste forms and to improve the long-term performance of a LLW disposal facility shall be implemented as necessary to meet the performance objectives of the disposal facility	Generation of LLW for disposal at a LLW disposal facility— **TBC**	DOE M 435.1-1(IV)(O)
Disposal of solid LLW *(D&D demolition debris, pipelines, equipment, soil, sediment)*	LLW shall be certified as meeting waste acceptance requirements before it is transferred to the receiving facility	Generation of LLW for disposal at a DOE facility— **TBC**	DOE M 435.1-1(IV)(J)(2)
Disposal of asbestos-containing waste material *(D&D demolition debris)*	Shall be deposited as soon as practicable at • an approved waste disposal site operated in accordance with Sect. 61.154 or • an EPA-approved site that converts RACM and asbestos-containing waste material into nonasbestos (asbestos-free) material according to the provisions of 40 *CFR* 61.155	Asbestos-containing waste material or RACM (except Category I nonfriable asbestos-containing material) from demolition activities—**applicable**	40 *CFR* 61.150(b) Rules of the TDEC Chap. 1200-3-11-.02(2)(j)(2) 40 *CFR* 61.150(b)(1) Rules of the TDEC Chap. 1200-3-11-.02(2)(j)(2)(i) 40 *CFR* 61.150(b)(2) Rules of the TDEC Chap. 1200-3-11-.02(2)(j)(2)(ii)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Disposal of fluorescent light ballasts (e.g., *from D&D activities*)	Must be disposed of in a TSCA-approved disposal facility, as bulk product waste under 40 *CFR* 761.62, or in accordance with the decontamination provisions of 40 *CFR* 761.79	Generation for disposal of fluorescent light ballasts containing PCBs in the potting material **applicable**	40 *CFR* 761.60(b)(6)(iii)
	May dispose of in a nonmunicipal solid waste landfill	Generation for disposal of intact, nonleaking PCB Small Capacitors (as defined in 40 *CFR* 761.3) **applicable**	40 *CFR* 761.60(b)(2)(ii)
Disposal of PCB-contaminated articles (e.g., *hydraulic machines, pumps, electrical equipment, etc.*)	Must remove all free-flowing liquid from the article, disposing of the liquid in compliance with the requirements of 40 *CFR* 761.60(a)(2) or (a)(3); and	Generation for disposal of PCB-Contaminated Articles (as defined in 40 *CFR* 761.3) **applicable**	40 *CFR* 761.60(b)(6)(i)
	Dispose by one of the following methods:	Disposal of PCB-Contaminated Articles with no free-flowing liquid **applicable**	40 *CFR* 761.60(b)(6)(i)
	• in accordance with the decontamination provisions at 40 *CFR* 761.79;		40 *CFR* 761.60(b)(6)(i)(A)
	• in a facility permitted, licensed, or registered by a state to manage municipal solid waste or nonmunicipal nonhazardous waste;		40 *CFR* 761.60(b)(6)(i)(B)
	• in an industrial furnace operating in compliance with 40 *CFR* 761.72; or		40 *CFR* 761.60(b)(6)(ii)(C)
	• in a disposal facility approved under this part		40 *CFR* 761.60(b)(6)(ii)(D)
Disposal of PCB liquids (e.g., *from drained electrical equipment*)	Must be disposed of in an incinerator that complies with 40 *CFR* 761.70, except	PCB liquids at concentrations ≥ 50 ppm **applicable**	40 *CFR* 761.60(a)
	• for mineral oil dielectric fluid, may be disposed of in a high-efficiency boiler according to 40 *CFR* 761.71(a), and	PCB liquids at concentrations ≥ 50 ppm and < 500 ppm **applicable**	40 *CFR* 761.60(a)(1)
	• for liquids other than mineral oil dielectric fluid, may be disposed of in a high-efficiency boiler according to 40 *CFR* 761.71(b)		40 *CFR* 761.60(a)(2)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Disposal of PCB cleanup wastes *(e.g., contaminated PPE, nonliquid cleaning materials)*	Shall be disposed of either • in a facility permitted, licensed, or registered by a state to manage municipal solid waste under 40 *CFR* 258 or nonmunicipal, nonhazardous waste subject to 40 *CFR* 257.5 thru 257.30; or • in a RCRA Subtitle C landfill permitted by a state to accept PCB waste; or • in an approved PCB disposal facility; or • through decontamination under 40 *CFR* 761.79(b) or (c).	Generation of nonliquid PCBs at any concentration during and from the cleanup of PCB remediation waste—**applicable**	40 *CFR* 761.61(a)(5)(v)(A)
Disposal of PCB cleaning solvents, abrasives, and equipment	May be reused after decontamination in accordance with 40 *CFR* 761.79	Generation of PCB wastes from the cleanup of PCB remediation waste— **applicable**	40 *CFR* 761.61(a)(5)(v)(B)
Performance-based disposal of PCB remediation waste *(e.g., soils, sediments, sludges)*	May dispose by one of the following methods: • in a high-temperature incinerator approved under 40 *CFR* 761.70(b). • by an alternate disposal method approved under 40 *CFR* 761.60(e). • in a chemical waste landfill approved under 40 *CFR* 761.75, • in a facility with a coordinated approval issued under 40 *CFR* 761.77, or • through decontamination in accordance with under 40 *CFR* 761.79	Disposal of nonliquid PCB remediation waste as defined in 40 *CFR* 761.3—**applicable**	40 *CFR* 761.61(b)(2) 40 *CFR* 761.61(b)(2)(i) 40 *CFR* 761.61(b)(2)(ii)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Performance-based disposal of PCB bulk product waste *(e.g., D&D demolition debris with PCB painted surfaces)*	May dispose of by one of the following: • in an incinerator approved under 40 *CFR* 761.70, • in a chemical waste landfill approved under 40 *CFR* 761.75, • in a hazardous waste landfill permitted by EPA under Sect. 3004 of RCRA or by authorized state under Sect. 3006 of RCRA, • under alternate disposal approved under 40 *CFR* 761.60(e), • in accordance with decontamination provisions of 40 *CFR* 761.79, or • in accordance with thermal decontamination provisions of 40 *CFR* 761.79(c)(6) for metal surfaces in contact with PCBs	Disposal of PCB bulk product waste as defined in 40 *CFR* 761.3—**applicable**	40 *CFR* 761.62(a) 40 *CFR* 761.62(a)(1) 40 *CFR* 761.62(a)(2) 40 *CFR* 761.62(a)(3) 40 *CFR* 761.62(a)(4) 40 *CFR* 761.62(a)(5) 40 *CFR* 761.62(a)(6)
Risk-based disposal of PCB bulk product waste	May dispose of in a manner other than prescribed in 40 CFR 761.62(a) or (b) if receive approval in writing from EPA and the method based on technical, environmental or waste-specific characteristics will not pose an unreasonable risk of injury to human health or the environment.	Disposal of PCB bulk product waste—**applicable**	40 *CFR* 761.62(c)
		Transportation	
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at 49 *CFR* 171-180	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material—**applicable**	49 *CFR* 171.1(c)
Transportation of radioactive waste	Shall be packaged and transported in accordance with DOE Order 460.1A and DOE Order 460.2	Shipment of LLW and/or TRU waste off-site—**TBC**	DOE M 435.1-1(I)(1)(L)(1)
Transportation of LLW and/or TRU waste	To the extent practical, the volume of the waste and the number of the shipments shall be minimized	Shipment of LLW and/or TRU waste off-site—**TBC**	DOE M 435.1-1(IV)(L)(2) DOE M 435.1-1(III)(L)(2)

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Transportation of PCB wastes	Must comply with the manifesting provisions at 40 *CFR* 761.207 through 40 *CFR* 761.218	Relinquishment of control over PCB wastes by transporting, or offering for transport—**applicable**	40 *CFR* 761.207 (a)
Transportation of hazardous waste off-site	Must comply with the generator requirements of 40 *CFR* 262.20–23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 262.12 to obtain EPA ID number	Off-site transportation of RCRA hazardous waste—**applicable**	40 *CFR* 262.10(h) Rules of the TDEC Chap. 1200-1-11-.03(1)(a)(8)
	Must comply with the requirements of 40 *CFR* 263.11–263.31	Transportation of hazardous waste within the United States requiring a manifest—**applicable**	40 *CFR* 263.10(a) Rules of the TDEC Chap. 1200-1-11-.04(1)(a)(1)
	A transporter who meets all applicable requirements of 49 *CFR* 171–179 and the requirements of 40 *CFR* 263.11 and 263.31 will be deemed in compliance with 40 *CFR* 263		
Transportation of hazardous waste on-site	The generator manifesting requirements of 40 *CFR* 262.20–262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 *CFR* 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way—**applicable**	40 *CFR* 262.20(f) Rules of the TDEC Chap. 1200-1-11-.03(3)(a)(6)

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
CWA = Clean Water Act of 1972
D&D = decontamination and decommissioning
DEACT = deactivation
DOE = U.S. Department of Energy
DOE M = *Radioactive Waste Management Manual*
DOT = U.S. Department of Transportation
EDE = effective dose equivalent
EPA = U.S. Environmental Protection Agency
FWPA = Former Waste Pile Area
HMR = Hazardous Materials Regulations
HMTA = Hazardous Materials Transportation Act
ID = identification
LLW = low-level (radioactive) waste
NPDES = National Pollutant Discharge Elimination System
NRWTP = Nonradiological Wastewater Treatment Plant
ORNL = Oak Ridge National Laboratory
P&A = plugging and abandonment
PCB = polychlorinated biphenyl
PPE = personal protective equipment
RACM = regulated asbestos-containing material
RCRA = Resource Conservation and Recovery Act of 1976
SWSA = solid waste storage area
TBC = to be considered
TCA = *Tennessee Code Annotated*
TDEC = Tennessee Department of Environment and Conservation
TRU = transuranic
TSCA = Toxic Substances Control Act of 1976
UTS = universal treatment standard
WAC = waste acceptance criteria
WIPP = Waste Isolation Pilot Plant

Table C.2. Location-specific ARARs and TBC guidance for the selected remedy, Bethel Valley area, ORNL, Oak Ridge, Tennessee (continued)