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Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan Oak Ridge, Tennessee

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Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan Oak Ridge, Tennessee

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ACRONYMS

AR	Administrative Record
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
BV	Bethel Valley
BVBGs	Bethel Valley Burial Grounds
BVGWES	Bethel Valley Groundwater Engineering Study
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
CMP	comprehensive monitoring plan
CSA	Contaminated Soil Area
CSMA	Closed Scrap Metal Area
D&D	decontamination and decommissioning
DNAPL	dense non-aqueous phase liquid
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EPPP	Excavation/Penetration Permit Program
FFA	Federal Facility Agreement
FWPA	Former Waste Pile Area
FY	fiscal year
FYR	Five-Year Review
IP	integration point
LLLW	liquid low-level waste
LTS	long-term stewardship
LUC	land use control
Notice	Notice of Land Use Restrictions
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	National Research Council
NRWTP	Non-Radioactive Wastewater Treatment Plant
NSC	Non-Significant Change
NWT	Northwest Tributary
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCCR	Phased Construction Completion Report
PM	Project Manager
PWTP	Process Water Treatment Plant
QAPP	Quality Assurance Project Plan
RA	remedial action
RAO	Remedial Action Objective
RAR	Remedial Action Report
RCRA	Resource Conservation and Recovery Act of 1976
RER	Remediation Effectiveness Report
ROD	Record of Decision
SNS	Spallation Neutron Source
SWSA	Solid Waste Storage Area
TCA	*Tennessee Code Annotated*
TCE	trichloroethene
TDEC	Tennessee Department of Environment and Conservation
UU/UE	unlimited use/unrestricted exposure

VOC	volatile organic compound
WOC	White Oak Creek
WOD	White Oak Dam
WRRP	Water Resources Restoration Program

1. INTRODUCTION

1.1 PURPOSE

The purposes of this *Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee* (RAR CMP) are to:

- Assemble all performance and baseline environmental media monitoring and Land Use Controls (LUCs) and their verification requirements for completed Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) remedial actions (RAs) and media removal actions in the Bethel Valley (BV) watershed into a single document. Some completed actions may include ongoing operations.

- Assemble all remedial action objectives (RAOs) and performance goals for completed CERCLA RAs and media removal actions in BV into a single document.

- Describe performance and baseline environmental media monitoring for BV.

- Identify LUCs, their objectives, and their verification requirements.

- Serve as BV Land Use Control Implementation Plan.

For the purpose of this document, environmental media monitoring includes monitoring of groundwater, surface water, and biological media, e.g., fish, turtles, biota surveys, etc., for both performance and baseline data assessments of trends, regulatory compliance, future actions, or in support of the Five-Year Review (FYR) of remedy protectiveness. In addition, the verification of LUCs is identified to ensure the integrity of the remedy is maintained.

Since unlimited use/unrestricted exposure (UU/UE) seldom is achieved by these completed CERCLA RAs and media removal actions, attainment of RAOs and/or performance goals must be evaluated periodically to determine if the remedy is performing adequately. These RAOs and performance objectives are contained in the decision documents and/or the completion documents. In order to evaluate performance and effectiveness, environmental monitoring is required. Since all planned RAs, including groundwater, have not been completed for the watershed, baseline monitoring also is required so that RAOs and performance objectives of the subsequent CERCLA actions can be established.

Similarly, the decision documents and/or completion documents contain the LUCs required to achieve the remedy objective(s). The LUCs also need to be verified periodically to determine if the remedy remains protective. Therefore, this RAR CMP assembles all of the RAOs, performance objectives, LUCs, and monitoring and verification requirements into a single document for ease of implementation and tracking.

Table 1 indicates which decision and completion documents contain requirements for monitoring and LUCs, and Table 2 describes the environmental monitoring performance goals. While the completion documents demonstrate that the remedy was completed per requirements, the monitoring and verification requirements in this RAR CMP allow the periodic evaluation of the completed CERCLA actions.

The BV RAR CMP supersedes prior CERCLA decision and post-decision documents for environmental monitoring and verification requirements for identified LUCs. Once a requirement has been included and approved in the BV RAR CMP (see Table 1), any changes or revisions will be made through this document.

1.2 REMEDIATION STRATEGY

In Oak Ridge, the U.S. Department of Energy (DOE) and its predecessor agencies have had a mission since the 1940s of uranium enrichment, weapons production, and energy research. As a result of this mission, there is a legacy of hundreds of contaminated sites on the Oak Ridge Reservation (ORR). The OR Site was placed on the CERCLA National Priorities List (NPL) in 1989. The *Federal Facility Agreement for the Oak Ridge Reservation* (FFA; DOE/OR-1014), signed by DOE, the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) in 1991, and implemented on January 1, 1992, describes how remediation under CERCLA will be performed.

In the mid-1990s, DOE, EPA, and TDEC recognized that making numerous, individual remedial decisions on the ORR was an inefficient use of limited resources, that remediation dealing with comingled radioactive elements and research developed compound releases generally would not result in UU/UE, and that inconsistent remedial decisions would result without an overall strategy tied to the anticipated end use of the area being addressed. Therefore, they agreed to make remedial decisions at a watershed scale using consensus end uses developed by the citizen stakeholders for the watersheds to develop protective, risk-based remediation levels. DOE commissioned the End Use Working Group Stewardship Committee to recommend end uses, and they published the Stakeholder Report on Stewardship in 1998 that made such recommendations. When surface water is addressed in the watershed decisions, the stream classification, e.g., recreational, fish and aquatic life, drinking water, etc., is acknowledged. Groundwater has not been included in the watershed decisions, but when groundwater has been included in other decisions or when it is being considered for future decisions, restoration is acknowledged.

The watersheds were used as a basis for decision-making because the primary pathway for offsite contaminant transport is via surface water. The Clinch River bounds the ORR on three sides, and there are active creeks that flow down the valleys to the Clinch River (Figure 1). These surface water systems are fed by runoff from rainfall and by the groundwater that continually discharges to the surface streams. As much as 90% of the water entering the ground flows rapidly through highly porous, shallow soil, which contains most of the contaminated sites, before discharging to nearby surface water. Consequently, the primary pathway for contaminant migration is through shallow groundwater to surface water, which then has the potential to flow offsite. Because of abundant rainfall (an average of 54 in./yr.), contaminant transport by shallow subsurface flow to surface waters, and the presence of contaminated sites in defined watersheds, a watershed strategy became the basis for remedial decision-making. Watershed remedial decision-making is an integrated, holistic approach to restore and protect ecosystems and to protect human health by focusing on hydrologically defined drainage basins. Watershed remedial decision-making is applied to the environmental restoration of the ORR by grouping contaminated sites into the following five watersheds (Figure 1):

- BV
- Melton Valley
- Bear Creek Valley
- Upper East Fork Poplar Creek
- East Tennessee Technology Park

Additionally, decisions have been made and/or actions taken offsite (Lower East Fork Poplar Creek, Clinch River/Poplar Creek, Union Valley, and Lower Watts Bar Reservoir) and onsite, within Chestnut Ridge, White Wing Scrap Yard and Oak Ridge Associated Universities South Campus Facility.

The watershed Records of Decision (RODs) contain performance objectives to be met and a series of RAs designed to achieve them. Completed CERCLA actions in the watershed are gauged against their action-respective goals through performance monitoring. However, when CERCLA actions have yet to be fully implemented within a watershed, monitoring of baseline conditions are conducted, against which the effectiveness of the actions can be evaluated in the future.

Contaminants released from the contaminated sites accumulate in floodplain soils and aquatic sediments. Contaminants not retained, or those remobilized, are released to the surface waters and potentially offsite to the Clinch River. Therefore, the surface water acts as an integrator of contaminant flux, and integration points (IP; Figure 3) are identified in each watershed at which contaminant releases can be measured, assessed, tracked, and prioritized. Surface water contaminant IPs are points at which all upstream contaminant releases converge to exit the watershed. Once the baseline monitoring and characterization are completed and the cleanup objectives are defined, the contribution of each RA toward achieving the objectives can be estimated and assessed at the watershed integration point. Through surface water monitoring both the specific performance of each action and the cumulative progress toward achieving the cleanup objectives can be assessed.

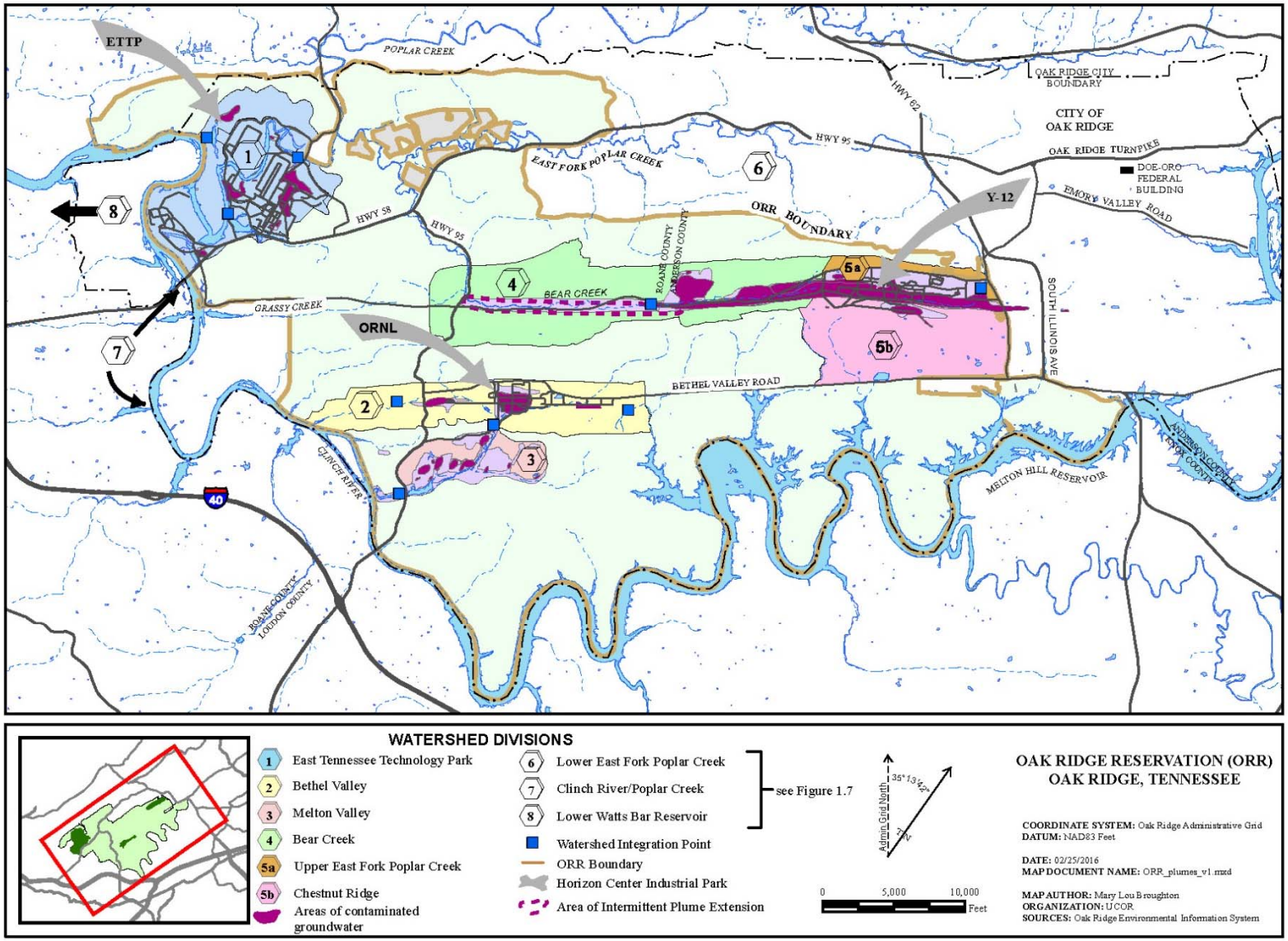

Figure 1. Watersheds on the ORR.

While waiting for the watershed decisions to be made with the associated series of RAs, single-project actions were performed primarily to mitigate immediate risks and to reduce further migration of contaminants offsite. In addition, interim RODs have been signed for sources and soil. This allowed decisions to be made and remediation performed on sources and soil and the more complex decisions on topics such as groundwater, surface water, sediment, ecological protection, and final LUCs to be deferred until the source terms are remediated and there is a better understanding is obtained on the contaminant pathways. These interim RODs also are interim for the sources and may be changed in the final RODs.

The CERCLA remedy evaluation process begins with the expectation that treatment will be used to address principal threat wastes and that groundwater will be returned to its beneficial use. Because most of the remediation decisions for ORR sites do not allow for UU/UE, LUCs are required at these sites. While UU/UE is commonly referred to as "residential" use, it is more accurately described as a condition that allows a property to be put to any use without the need for limitations or restrictions to prevent unacceptable human exposure or environmental impacts from occurring as a result of the presence of residual contamination. LUCs allow the realization of economically profitable and socially beneficial use or reuse of property while simultaneously ensuring protection of human health and the environment.

LUCs are any restriction or control, arising from the need to protect human health and the environment, that limits use of and/or exposure to any portion of that property, including water resources. LUCs encompass institutional controls (EPA 2000), such as property record restrictions, property record notices, zoning notices, excavation/penetration permit programs (EPPP), easements, covenants, well drilling prohibitions, land use restrictions, zoning, permits, advisories, and other legal restrictions (EPA 2000) and access restrictions achieved by engineered barriers such as a fence or by human means such as security guards.

The framework for remediation has been considered linear, progressing from identification of a potentially contaminated site through completion of remediation. However, because residual contamination on ORR will remain for long periods of time, a framework (NRC 2002) is needed that recognizes the iterative process of remediation (Figure 2). Table 1 lists all of the completed watershed-scale and single-project actions in BV that require monitoring and/or LUCs. A purpose of the RAR CMP is to assemble all of these requirements into a single primary document and then to make subsequent changes to these requirements through a revision to the RAR CMP and not to the plethora of completion documents. This consolidation will decrease the administrative burden of making and tracking changes, but, more importantly, will improve and simplify the understanding of the many requirements in each watershed. Thus, the RAR CMP will integrate the requirements currently in multiple documents into a single document. As additional response actions are completed, the RAR CMP will be revised to include them. If the annual Remediation Effectiveness Report (RER) or the FYR recommends changes, the changes will be made in the RAR CMP and not the underlying completion document. This approach recognizes that, if a prescriptive component of a ROD is recommended for change, the ROD will have to be revised prior to the RAR CMP being changed.

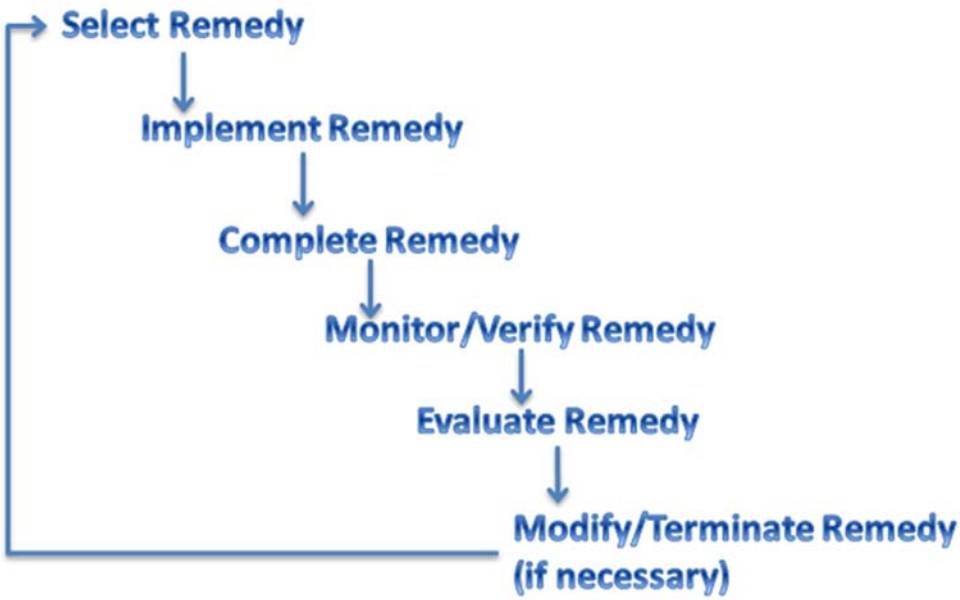

Figure 2. Framework for remediation.

Because most of the completed RAs and environmental media removal actions in BV do not allow UU/UE, these sites require performance monitoring (Table 2) and/or LUCs to protect human health and the environment from physical hazards, residual contamination, and wastes remaining following the completion of remediation.

Environmental monitoring and verification of LUCs are used to assess the performance of completed CERCLA actions in which residual contamination is left that does not allow for UU/UE. The ORR Water Resources Restoration Program (WRRP) was established by DOE in 1996 to implement a consistent approach to long-term environmental monitoring and verification of the completed CERCLA response actions. The WRRP provides a central administrative and reporting function that integrates and coordinates the numerous activities associated with this monitoring and verification, including the preparation of watershed-specific RAR CMP s and a single *Quality Assurance Project Plan for the Water Resources Restoration Program, U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (UCOR-4049).

This monitoring plan is developed to monitor effectiveness of existing CERCLA actions and to conduct trend monitoring in selected locations to observe changes in environmental conditions. Existing CERCLA decisions in BV are source control/removal actions that include goals for surface water and protection of groundwater from further contamination by source releases. A CERCLA decision for groundwater remediation has not been made for BV. The ORR Groundwater Strategy document and the ORR Groundwater Program are intended to conduct investigations to support watershed scale decision-making.

1.3 ORGANIZATION OF THE BV WATERSHED RAR CMP

This RAR CMP is organized as follows:

- Chapter 1 explains how CERCLA remediation is implemented on ORR and provides background on performance and baseline monitoring, and LUCs.

- Chapter 2 provides background information about BV, including a brief site history and watershed description. The watershed description provides an overview of the site hydrogeology, a conceptual model for contaminant transport in the subwatersheds, as well as the primary contaminants of concern in BV.

- Chapter 3 presents a summary of the status of each CERCLA action in the BV administrative watershed and indicates whether the completed actions require performance monitoring and/or verification of LUCs.

- Chapter 4 discusses CERCLA-derived environmental monitoring objectives and performance goals for completed actions and baseline monitoring for the watershed as a whole.

- Chapter 5 discusses the LUCs on both a watershed scale and a site-specific scale that are deemed necessary to protect human health and the environment from residual contamination that remains following remediation or have been put in place until a selected remedial alternative can be implemented.

- Chapter 6 outlines the overall plan for the environmental monitoring in BV administrative watershed, including sampling locations and monitored parameters.

- Chapter 7 describes the data management protocols, which are consistent with CERCLA and implemented by the WRRP.

- Chapter 8 lists the references.

- Appendix A contains the figures showing where environmental monitoring takes place.

- Appendix B summarizes relevant sampling and analysis information for each monitoring location.

- Appendix C contains the Administrative Sample Group Tables for each monitoring location. Technical details regarding specific sampling and analysis requirements are deferred to the WRRP Quality Assurance Project Plan (QAPP; UCOR-4049) that meets CERCLA requirements. This QAPP identifies the field sampling procedures, laboratory analytical methods, and detailed data management protocols that are followed to ensure that the environmental monitoring data used for the purposes of the WRRP achieve appropriate levels of quality assurance and quality control.

- Appendix D outlines the formal change request process for BV RAR CMP.

- Appendix E lists the LUCs and identifies the areas affected by each.

2. BACKGROUND

2.1 SITE HISTORY

BV, located in the southwestern portion of the ORR, is the site of the main plant of Oak Ridge National Laboratory (ORNL). ORNL was built in 1943 as a pilot plant for demonstrating production and separation of plutonium. Since then, ORNL has evolved from a laboratory almost wholly dedicated to nuclear technology, research, and development to one of the largest national laboratories in the United States. ORNL now includes extensive multidisciplinary efforts in nuclear and non-nuclear technologies and sciences.

2.2 WATERSHED DESCRIPTION

As specified in the *Record of Decision for Interim Actions in Bethel Valley Watershed, Oak Ridge, Tennessee* (DOE/OR/01-1862&D4), the BV administrative watershed includes approximately 1,700 acres generally bound by Chestnut Ridge to the north, Haw Ridge to the south, the Clinch River to the west, and Bearden Creek just east of the easternmost facilities at ORNL. The majority of BV CERCLA sites lie in the White Oak Creek (WOC) watershed. However, the adjacent Raccoon Creek and Bearden Creek watersheds also contain solid waste management units that are covered by the BV Interim ROD. BV is not comprised of a single watershed in which a single exit pathway for surface water and groundwater exists. However, rather than subdivide the site into several subwatersheds (i.e., component parts), it is convenient to refer to it as a single watershed, or a single 'administrative' watershed.

For the purposes of CERCLA environmental investigation and remediation at ORNL (DOE/OR/01-1748&D2), the BV administrative watershed has been divided into four regions (Figure 3):

- **East BV**—East BV is located approximately 1 mi. from the main ORNL plant complex and extends to Bearden Creek to the east of the WOC watershed. It contains support service facilities, such as the shipping and receiving depot, garage, plant maintenance area, and various shops and warehouses. The principal CERCLA contamination issue in East BV is the 7000 Area trichloroethene (TCE) Plume which is a bedrock TCE contaminated groundwater plume extending for at least 1500 feet from its source area and extending more than 150 ft below ground surface.

- **Central BV**—Central BV is located in the northern portion of the WOC watershed and includes the ORNL main plant area consisting of more than 150 sites identified for environmental restoration. Specifically, the Central BV includes the following (DOE/OR/01-1862&D4):

  — Four inactive nuclear reactors;

  — Inactive buildings and facilities that are designated for decontamination and decommissioning (D&D), some of which have highly radioactive materials from reactors or hot cells (used to remotely handle radioactive materials);

  — Buried tanks, many of which have been emptied, grouted in place, or removed;

  — Underground process and liquid low-level waste (LLLW) pipelines (including more than 56,000 linear ft of inactive pipelines) and related subsurface structures (e.g., valve boxes, dry wells, etc.);

— Contaminated surface and subsurface soils throughout Central BV, including ^{137}Cs-contaminated soil and sediment in the floodplain of WOC upstream of the 7500 Bridge; and

— Several groundwater plumes (e.g., Corehole 8 Plume) and shallow contamination areas, most of which discharge to surface water that exits Central BV at the 7500 Bridge location (WC7500) along WOC (Figure 3).

- **West BV**—West BV contains a remediated former waste burial ground along with associated contaminated soil and groundwater. Also, groundwater and surface water in West BV and Raccoon Creek to the west contain contaminant releases from Solid Waste Storage Area (SWSA) 3 and the adjacent Contractor's Landfill and Closed Scrap Metal Area (CSMA). The footprint of SWSA 3, which received radiological wastes generated between 1946 and 1951 at ORNL and other DOE facilities across the nation, covers approximately seven acres, and the adjacent landfills occupy an additional 11 acres. West BV also includes the westernmost portion of the ORNL main plant area.

- **Raccoon Creek**— Raccoon Creek is an undeveloped area west of TN Highway 95. Low levels of radiological contamination that originate from SWSA 3 are present in groundwater and surface water.

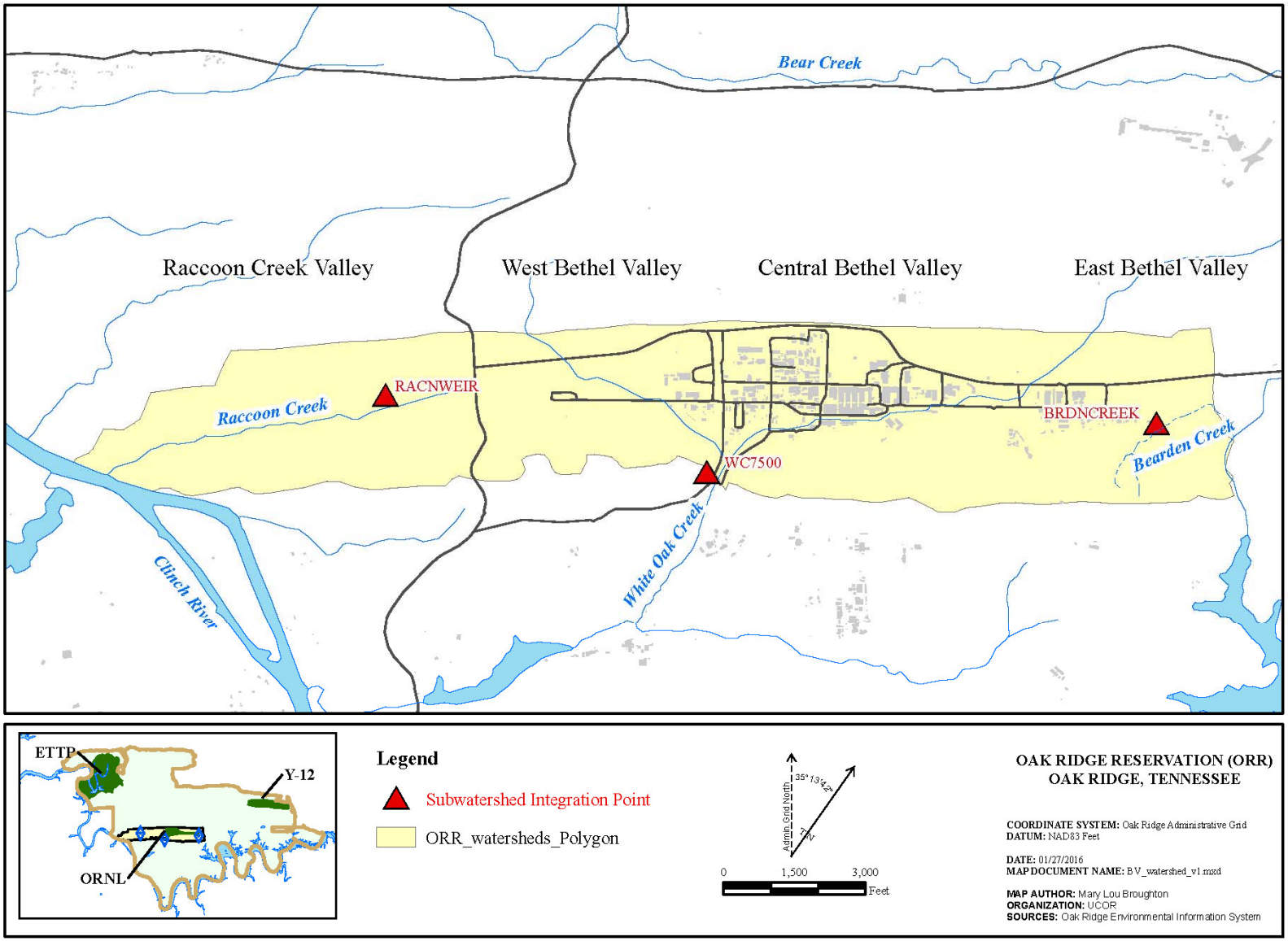

Figure 3. BV administrative watershed with surface water IPs.

2.2.1 Site Hydrogeology

BV is underlain by interbedded shale, siltstone, and limestone bedrock of the Chickamauga Group, with the Knox Group dolostone formations underlying Chestnut Ridge to the north and sandstones of the Rome Formation forming Haw Ridge to the south. The Chickamauga Group formations exhibit substantial variation in hydraulic conductivities, primarily because of varying degrees of fracturing and conduit flow in the carbonate (karst) units. In addition, the near-surface soils throughout much of ORNL main plant area has been altered by an extensive underground industrial support system of pipelines, tank farms, and building basements. Both the hydrogeologic characteristics (e.g., differing lithologies and variable fractures and karst conduits) and the man-made features (e.g., underground utilities and basement sumps) have resulted in some known and some unknown preferential flowpaths for contaminant transport.

The BV administrative watershed encompasses areas located within the hydrologic watersheds of Raccoon Creek, WOC, and Bearden Creek (Figure 3). Raccoon Creek drains the section of BV to the west of a hydrologic divide located near TN Highway 95, and flows west-southwest to the confluence with the Clinch River approximately 4 km (2.5 mi.) west of the ORNL main plant area. WOC drains BV throughout most of the ORNL main plant area, with major tributary inflows from Fifth Creek, First Creek, and the Northwest Tributary (NWT), which drain the western portion of Central BV and West BV, respectively. Surface water from almost all of the CERCLA action sites in the BV administrative watershed enters WOC, which traverses Central BV and flows south-southwest through a water gap in Haw Ridge, enters the Melton Valley watershed, where additional tributaries and groundwater influxes contribute flows before being impounded behind White Oak Dam (WOD). The easternmost portion of East BV is drained by unnamed western tributaries of Bearden Creek, which flows south-southeast to the confluence with the Clinch River (Melton Hill Lake) approximately 3 km (2 mi.) south-southeast of the ORNL main plant area.

A surface water IP, the point through which all surface water (and, therefore, any contamination) within a watershed passes, has been established for each hydrologic subwatershed in the BV administrative watershed (Figure 3). The IP along WOC is at the 7500 Bridge (WC7500) near the water gap at Haw Ridge. Upstream actions within the ORNL main plant area, including completed CERCLA actions and compliance abatement activities (i.e., changes to effluents, storm drain discharges, etc.), are major influences on water quality in WOC. In addition to the CERCLA actions, environmental compliance actions, especially in the early 1990s, have eliminated major effluent discharges, reduced chlorine in effluents, and eliminated sewage leaks that affected stream nutrient loading. Monitoring at the IP provides a watershed-scale measure for the RA effectiveness. Mobile contaminants from the BV administrative watershed ultimately discharge via WOC to the Melton Valley watershed (see Figure A.1 in Appendix A), where additional contaminants enter WOC before being discharged over WOD to the Clinch River (DOE/OR/01-2219&D2).

The IP for West BV is the weir at Raccoon Creek (see Figure A.1 in Appendix A) which collects ^{90}Sr that discharges from SWSA 3, and any other contaminants from the adjacent Contractor's Landfill and the CSMA. Because these areas straddle a groundwater divide, ^{90}Sr also discharges into the NWT and has been detected at the weir in NWT at relatively low levels over the years. Bearden Creek acts as the IP for surface water flow that drains East BV (DOE/OR/01-2219&D2).

2.2.2 Watershed Conceptual Model

Figure 4 illustrates some of the elements of a conceptual model for contaminant transport in the BV administrative watershed, providing a general framework of contaminant distribution and the principal contaminant source areas. The full delineation of the nature and extent of groundwater contamination is incomplete in many areas of the ORR, especially in defining deep flow pathways and contaminant

transport at depth. The three agencies of the FFA will continue to work together in the future to identify projects that improve the understanding of groundwater flow pathways and contaminant migration based on a continually refined groundwater strategy. The final groundwater decision will be made after source control actions are complete, their effectiveness is monitored, and additional characterization data is collected.

In West BV, the combination of leachate from buried waste trenches in SWSA 3 along with leachates from contaminated materials in the former CSMA, the Contractor's Landfill, and unprotected contaminated materials stored on the surface of SWSA 3 infiltrated to groundwater. Because of these contaminant sources lying on the watershed and groundwater divide between NWT and Raccoon Creek, contaminants that leached to groundwater have migrated through fracture/conduit flow both eastward and westward to discharge to NWT and Raccoon Creek. Multiple points of contaminant influx to both streams result from the relatively large contaminant source area. The depth and lateral extent of plume migration beneath west BV have not been fully defined. Groundwater discharging to these surface water bodies, therefore, contaminated the surface water, albeit at decreasing concentrations over time and since contaminant source area remediation. The human health and ecological risk assessments conducted in support of the BV Interim Actions ROD did not identify human health or ecological risk levels in groundwater, surface water, or sediment in West BV (the NWT area) or the Raccoon Creek area for future land use scenarios (DOE/OR/01-1862&D4). Ongoing monitoring of surface water and groundwater in the area are conducted to confirm conditions, monitor contaminant trends in the area, and to evaluate the effectiveness of RAs conducted at the solid waste management units.

Central BV contains a large number of groundwater contaminant sources and very complex contaminant migration pathways. Existing data indicate that, although most of the contaminant transport appears to occur in relatively shallow zones, some contamination is present at depths of 200 ft or more in bedrock. Future CERCLA investigations are required to fully characterize groundwater contamination in BV. In Central BV, ^{90}Sr from the Corehole 8 plume and Hot Bank Area (vicinity of Buildings 3019 and 3001) was found to enter bedrock and migrate along strike in fractures/conduits to discharge to buried utility lines and First Creek. Contaminated soil near the Surface Impoundments (Operable Unit) was in contact with shallow groundwater and contributed to discharges of radionuclides to WOC. Contaminated soils and buried sources within Central BV are known to leach contaminants to groundwater that discharges to First Creek, Fifth Creek, and WOC. Leaks from process lines, tanks, and buildings have been a primary source of groundwater contamination. Groundwater traveling in bedrock follows fractures and solutional conduits preferentially along strike toward the creeks or man-made features, such as pipelines or sumps. Recovery of contaminated groundwater by building sumps is an important mechanism that limits further spread of some contaminant plumes in Central BV (DOE/OR/01-1862&D4).

Contaminated soil accumulates in the WOC floodplain and may erode back into the creek and be transported downgradient (DOE/OR/01-1748&D2). Surface waters in BV serve as the integration mechanism for contaminant migration out of the watershed. Once contaminated groundwater enters the surface water, the material may react to the change in physicochemical properties of the receiving stream, be adsorbed to sediment, or be taken up by biota. Mobile contaminants remain as dissolved constituents of surface water and migrate downstream out of the BV area. Less mobile contaminants adsorb to sediment and periodically re-suspend during high flows to be either transported downstream or deposited along the floodplain. The point of integration for contaminants in the Central BV watershed is where WOC exits the watershed at the 7500 Bridge. Monitoring at this location provides a baseline for conditions against which RA effectiveness is measured (DOE/OR/01-1862&D4).

In East BV, volatile organic compounds (VOCs) in groundwater either naturally attenuate in the subsurface or are diffusely discharged to surface streams and volatilize. The distribution and character of the contamination indicate a surface or shallow subsurface release that has migrated below the water table

and into the bedrock aquifer, subsequently following discreet fracture and solutionally enhanced conduits to deeper intervals in the bedrock. An area of dense non-aqueous phase liquid (DNAPL) may reside in the bedrock and act as a secondary source of dissolved VOC contamination that travels downgradient with the groundwater (DOE/OR/01-1862&D4).

2.2.3 Contaminants of Concern

The annual RER for the ORR provides updated and detailed descriptions of the nature and extent of contamination throughout the BV administrative watershed, including maps illustrating the general extent of groundwater contaminant plumes and time-series graphs showing contaminant concentration trends for selected surface water and groundwater sampling locations. Figure 5 provides a map of the BV administrative watershed showing general areas of groundwater contamination. The following overview of environmental contamination in West BV, Central BV, and East BV, along with the watershed conceptual model for contaminant transport (Figure 4) described above, provides the general context for WRRP environmental monitoring in the BV administrative watershed.

During FY 2011-2012, the West BV Solid Waste Management Units were hydrologically isolated consistent with the BV ROD requirements. Post-remediation remedy performance demonstrates that, although a few wells have not yet attained remedy goals, the contaminant levels in groundwater and surface water (DOE/OR/01-2707&D2) have decreased significantly. In West BV, rainfall and seasonal surface water infiltration through buried wastes in SWSA 3 and adjacent landfills leached soluble contaminants into the shallow groundwater, which are transported toward both Raccoon Creek to the southwest and the NWT to the northeast (Figure 4). The major contaminant of concern in West BV is ^{90}Sr, although concentrations of ^{90}Sr in Raccoon Creek are below the target risk range. The distribution of contaminants indicates a long (>3000 ft), narrow (approximately 250 ft) plume (Figure 5), suggesting flow through a discrete bedrock pathway (DOE/OR/01-1862&D4).

Central BV encompasses the ORNL main plant and contains the largest number of contaminant source areas in the BV administrative watershed (DOE/OR/01-1862&D4). The primary contaminant of concern in Central BV is ^{90}Sr from the Corehole 8 Plume, and to a much lesser degree $^{233/234}$U. The Central BV South Area contains much less ^{90}Sr and some ^{3}H. In addition to contaminant plumes, groundwater in the Central BV area contains numerous radionuclides of varied concentrations not associated with a particular plume. Several metals are also present including arsenic, antimony, and vanadium. Tritium is present in groundwater throughout the area, and areas of elevated concentrations reveal probable release points and suggest migration pathways. In the ORNL main plant area, the surface impoundments in the Central BV 3000 South area were an apparent source of ^{3}H; a second ^{3}H source may be the Radioactive Waste Evaporator (Building 2531) in the Central BV 2000 area. The radionuclide migrates in the shallow subsurface and discharges to WOC. Concentrations of ^{3}H are diminishing because of radioactive decay (approximately 12 yr half-life for ^{3}H) and plume migration/dispersion. However, current sources of ^{3}H in BV surface water originate primarily from sources outside of BV (DOE/OR/01-1862&D4):

- Groundwater collected in Melton Valley and transferred to the Process Water Treatment Plant (PWTP) via the groundwater collection and treatment system.
- Wastewaters generated by the Office of Science operating facilities such as the High Flux Isotope Reactor and Spallation Neutron Source (SNS) that are discharged via the PWTP and sanitary sewage systems.

However, ^{3}H concentrations in surface water throughout WOC remain lower than the DOE-derived concentration standard (DOE-STD-1196-2011) and far below International Atomic Energy Agency-recommended aquatic exposure levels.

There are two known sources of mercury discharge to Fifth Creek—releases from Building 4501 where mercury lithium isotope process pilot operations occurred in the 1950s and an unknown source or sources that discharge from an outfall from the Isotopes Area into Fifth Creek. The ORNL Building 4501 basement sumps mercury actions were components of the BV Interim Actions ROD (see Section 4.2, BV Mercury Sumps Groundwater Action) which is listed in Table 1 as the Mercury Treatment System action performed and described in the *Phased Construction Completion Report for the Bethel Valley Mercury Sumps Groundwater Action Completion, Oak Ridge, Tennessee* (DOE/OR/01-2472&D1). The other source of mercury discharge to Fifth Creek that has the unknown source has not been remediated.

In Central/East BV, the primary contaminants of concern in soils include ^{137}Cs, as well as ^{60}Co, ^{228}Th, and ^{228}Ra. Contaminated soils and sediments throughout the main ORNL complex area and WOC floodplain in particular exhibit unacceptable risk levels (above 1 x 10^{-4}) by gamma emitters (i.e., ^{137}Cs).

Contaminant releases in East BV have resulted in a plume of dissolved VOCs in the groundwater that is dominated by TCE (Figure 5). Concentrations of TCE within the plume suggest the possible presence of DNAPL. Radioactive ^{3}H from the Tritium Target Facility also is detected in groundwater, but at levels below the concentration (20,000 pCi/L) determined by the EPA to produce an annual dose equivalent to the total body or any internal organ of 4 mrem/y, which is the maximum contaminant level for gross beta activity in drinking water. A report of the findings of the Bethel Valley Groundwater Engineering Study (BVGWES) presents detailed technical information regarding the groundwater contamination in this area, including maps illustrating the extent of contamination (DOE/OR/01-2219&D2).

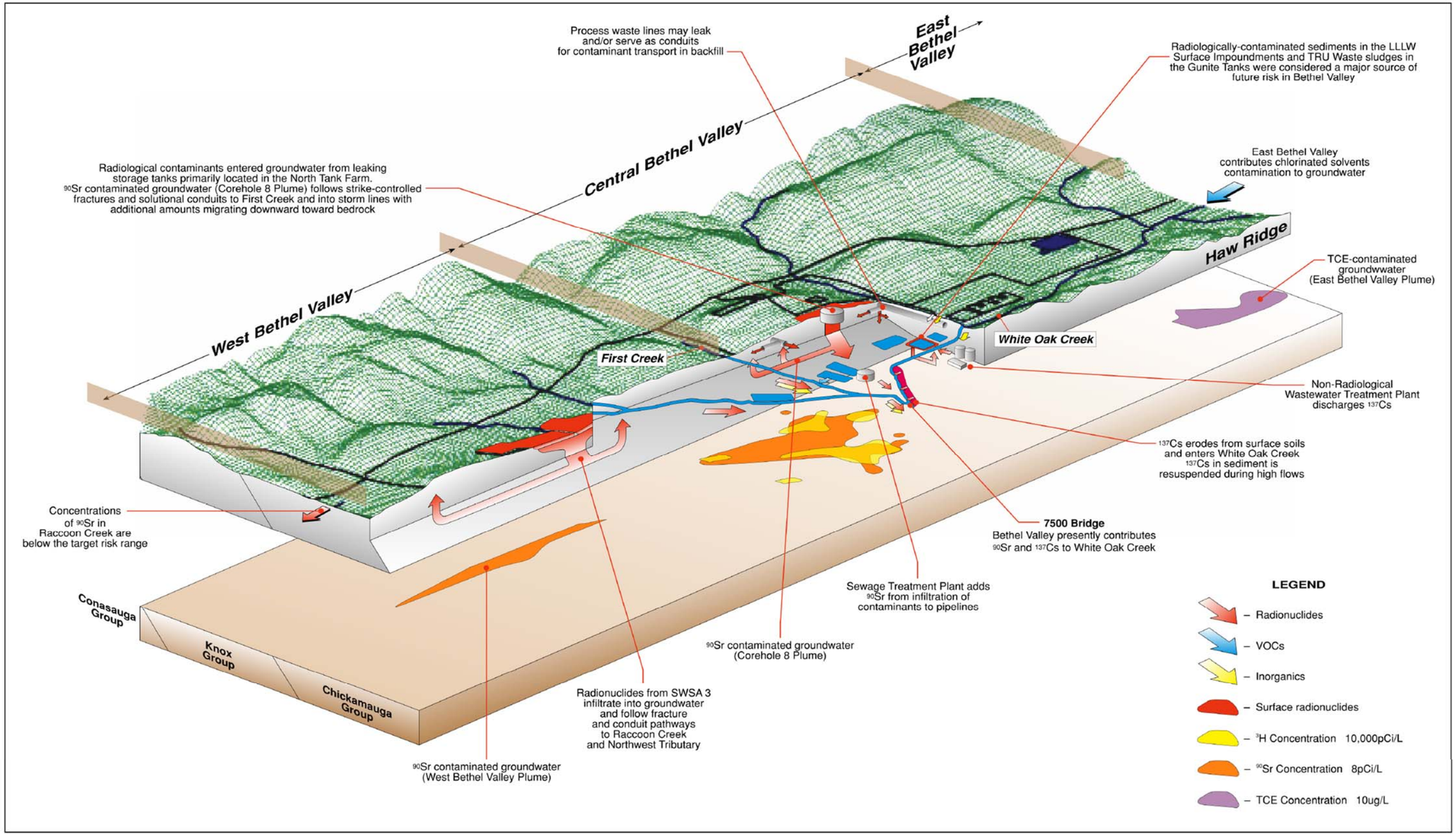

Figure 4. Conceptual model for shallow groundwater contaminant transport in the BV administrative watershed.

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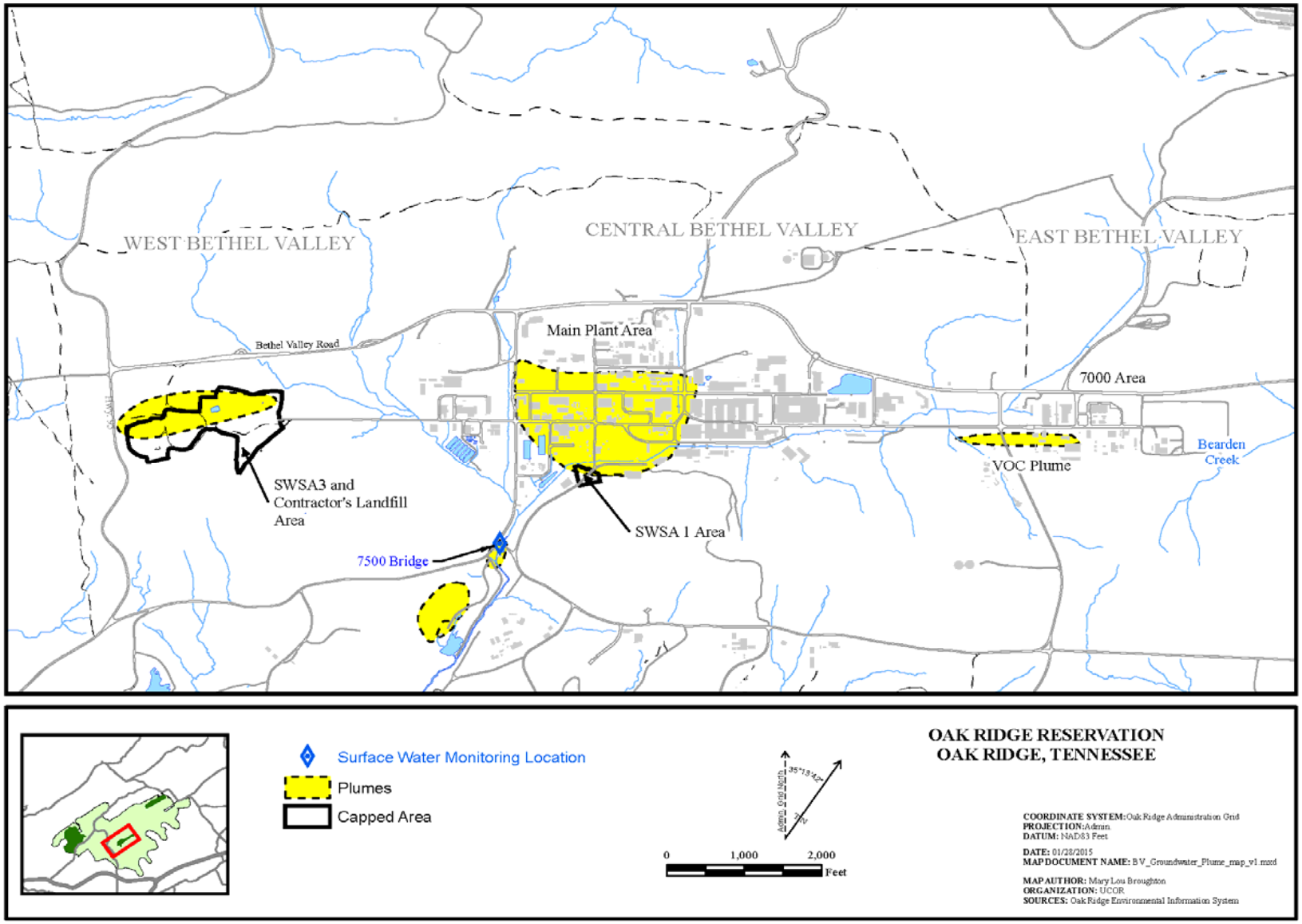

Figure 5. Areas of groundwater contamination in the BV administrative watershed.

3. CERCLA ACTIONS IN BV

Table 1 lists the completed CERCLA actions in the BV administrative watershed as of September 30, 2015 and identifies those that require continued monitoring or verification of LUCs. These actions are located in Figure 6. Performance monitoring requirements are discussed in Section 4 and verification requirements for LUCs are discussed in Section 5.

Until more recently, most of the completed remedies in BV were single-action projects to address primary sources of contamination or primary release mechanisms implemented in the mid-1990s to early 2000s. The *Record of Decision for Interim Actions in Bethel Valley Watershed, Oak Ridge, Tennessee* (DOE/OR/01-1862&D4) was approved in 2002 to address accessible sources of contamination and contaminated media to the extent practicable on a watershed scale. Since then, several subprojects under the BV Interim Actions ROD have been completed or are in progress.

Future CERCLA decisions are expected to address sitewide contaminated media and protection of ecological receptors in BV administrative watershed. The remainder of the BV administrative watershed, which includes areas outside of the Central and West portions of BV, is primarily uncontaminated, with the exceptions of the Raccoon Creek in the western portion of the watershed (west of Highway 95) and a small groundwater plume within the 7000 area of ORNL.

Since most of the surface water in BV flows into Melton Valley, the surface water within BV will be addressed in the final environmental media ROD for Melton Valley.

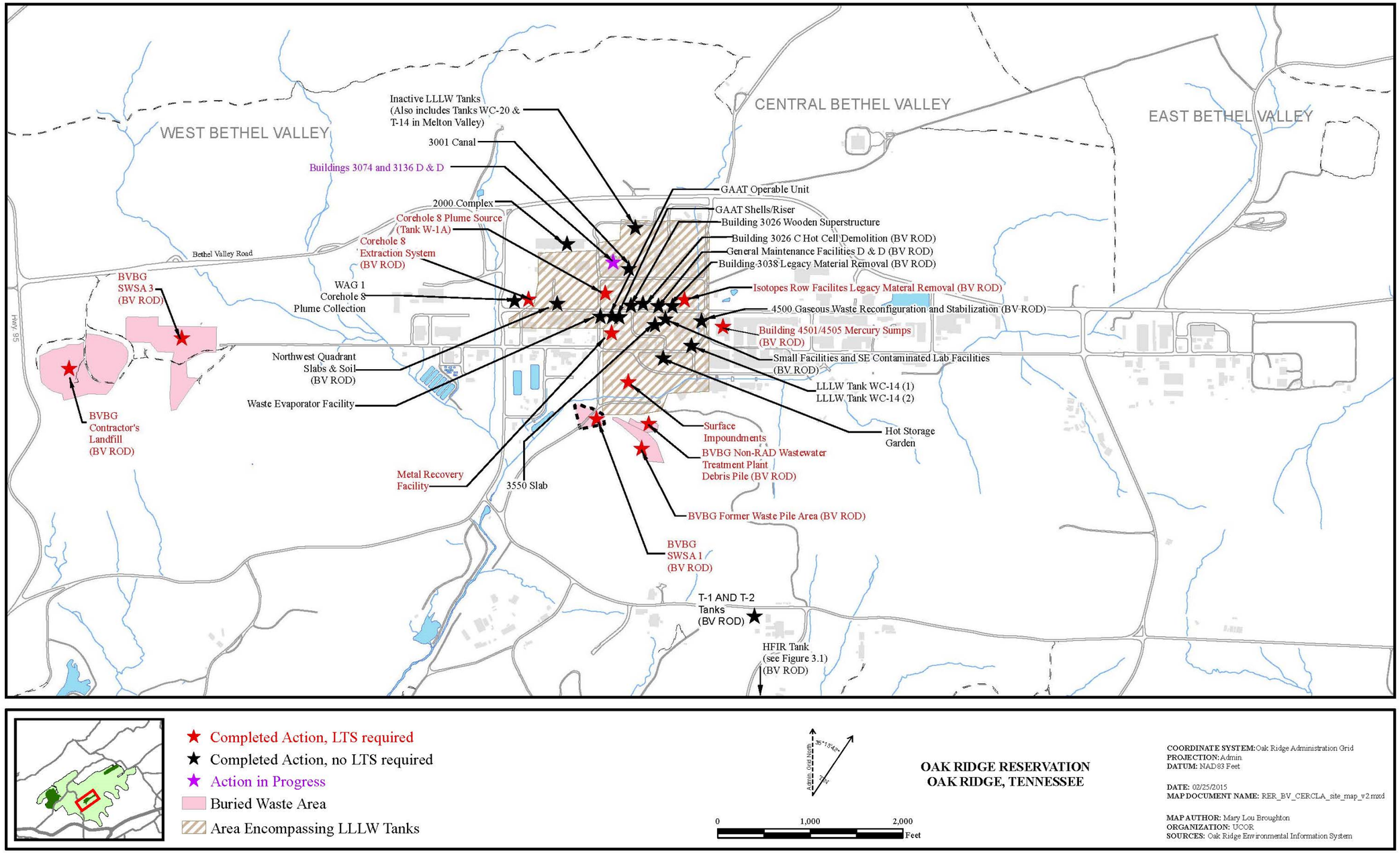

Figure 6. Location of CERCLA actions in the BV administrative watershed.

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Table 1. Completed CERCLA actions in the BV administrative watershed

CERCLA action location	Decision document, date signed (mm/dd/yy)	Completion document	Action performed	Performance monitoring/ LUC
		Watershed-scale actions		
BV Interim Actions	ROD (DOE/OR/01-1862&D4): 05/02/02	Watershed-scale requirements provided in ROD.	--	Yes/Yes
	NSC (DOE/OR/01-2152&D1), addition of Hot Storage Garden (3597): 06/25/04	PCCR for Hot Storage Garden (DOE/OR/01-2265&D1) approved 01/10/06	Stabilization of Facility due to contamination encountered	No/No
	NSC, delineates area of land transferred for multi-program research facility: 12/03/04	PCCR for the Tanks T-1, T-2, and HFIR (DOE/OR/01-2238&D1) approved 11/16/05	Remediation of inactive tanks	No/No[a]
	NSC, addition of IFDP facilities: 09/10/09	PCCR for the BV Mercury Sumps Groundwater Action (ORNL Bldg. 4501 sumps) (DOE/OR/01-2472&D1) approved 08/27/10	Mercury Treatment System	Yes/Yes
	NSC, errata to NSC submitted 09/10/09; no approval required: 10/26/09	PCCR for Corehole 8 Extraction System (DOE/OR/01-2534&D1/A1) approved 04/23/12	Groundwater Extraction System	Yes/Yes
	ESD (DOE/OR/01-2446&D2), changes to SWSA 3 remedy: 10/05/10	PCCR for Northwest Quadrant Slabs and Soils (DOE/OR/01-2579&D1) approved 11/05/12	Remediation of slabs and soil	No/No
	NSC, clarification of risk reduction goals at 7500 bridge: 11/16/13	PCCR for D&D of General Maintenance Facilities (DOE/OR/01-2552&D2) approved 10/09/12	Demolition	No/No
		PCCR for D&D of Small Facilities and Southeast Contaminated Lab Facilities (DOE/OR/01-2573&D2) approved 10/09/12	Demolition	No/No
		PCCR for Isotopes Row Facilities Legacy Material Removal (DOE/OR/01-2557&D2) approved 09/21/12	Waste Removal	No/No
		PCCR for BVBGs (DOE/OR/01-2533&D2) approved 05/11/12	Engineered Caps	Yes/Yes
		PCCR for 4500 Gaseous Waste Reconfiguration and Stabilization (DOE/OR/01-2614&D1) approved on 11/20/13	Demolition	No/No
		PCCR for Building 3026 C Hot Cell Demolition (DOE/OR/01-2629&D1) approved on 11/21/13	Demolition	No/No
		PCCR for Building 3038 Legacy Material Removal (DOE/OR/01-2617&D2) approved on 01/27/14	Demolition	No/No

Table 1. CERCLA actions in the BV administrative watershed (cont.)

CERCLA action location	Decision document, date signed (mm/dd/yy)	Completion document	Action performed	Performance monitoring/ LUC
		PCCR for 3550 Slab (DOE/OR/01-2627&D1) approved on 11/04/13	Demolition	No/No
		Single-project actions		
WAG 1 Corehole 8 (Plume Collection)	AM (DOE/OR/02-1317&D2): 11/10/94 Addendum AM (Letter): 04/22/98 Addendum AM (DOE/OR/01-1831&D2): 09/30/99	RmAR (DOE/OR/01-1380&D1) approved 09/11/95 Phase I Operations Report (DOE/OR/01-1832&D2) submitted on 11/02/99 Phase II Operations Report (DOE/OR/01-1882&D1) approved 06/21/00	Groundwater extraction System	Superseded by PCCR for Corehole 8 Extraction System (DOE/OR/01-2534&D1/A1)
Building 3001 Canal	AM (DOE/OR/02-1533&D2): 11/18/96	RmAR (DOE/OR/01-1599&D2) approved 08/22/97	Canal grouted	No/No[b]
Surface Impoundments Operable Unit	ROD (DOE/OR/02-1630&D2): 09/25/97	RAR for Impoundments A and B (DOE/OR/01-2086&D2) approved 05/17/04	Remediation of impoundments	No/Yes
		RAR for Impoundments C and D (DOE/OR/01-1784&D2) approved 04/19/99		No/No
Metal Recovery Facility	AM (DOE/OR/01-1843&D2): 03/3/00	RmAR ([DOE/OR/01-2000&D2/R1] approved with the acceptance of the Completion Letter [waste disposition] 06/18/08)	Demolition	No/Yes
WAG 1 Tank WC-14 (1) Liquid removal	AM (DOE/OR/02-1322&D2): 02/16/95	RmAR (DOE/OR/01-1397&D1) approved 08/21/95	Waste Removal	Discontinued/ No
WAG 1 Tank WC-14 (2) Sludge removal	AM (DOE/OR/02-1598&D2): 09/3/97	RmAR (DOE/OR/01-1738&D2) approved 12/15/98	Waste Removal	No/No
Waste Evaporator Facility	AM (DOE/OR/02-1381&D2): 07/28/95	RmAR (DOE/OR/01-1460&D1) approved 12/12/96	Demolition	No/No
GAAT Operable Unit	ROD (DOE/OR/02-1591&D3): 09/2/97	RAR (DOE/OR-01-1955&D1) approved 10/2/01	Waste Removal	No/No
Inactive LLLW Tanks	AM (DOE/OR/01-1813&D1): 05/26/99 AM Addendum (DOE/OR/01-1833&D2): 09/30/99	RmAR (DOE/OR/01-1953&D2) approved 10/2/01	Tank Removal	No/No
		RmAR II Addendum (DOE/OR/01-1953&D2/A2) submitted 09/26/01	Tank Removal	No/No
GAAT Shells/Risers	AM (DOE/OR/01-1957&D2): 07/13/01	RmAR (DOE/OR/01-2010&D1) approved 08/21/02	Tank Stabilization	No/No

Table 1. CERCLA actions in the BV administrative watershed (cont.)

CERCLA action location	Decision document, date signed (mm/dd/yy)	Completion document	Action performed	Performance monitoring/ LUC
Corehole 8 Plume Source (Tank W-1A)	AM (DOE/OR/01-1749&D1): 09/17/98 Amended in 1999	RmAR (DOE/OR/01-1969&D3) approved 08/30/12	Removal of Tank W-1A and surrounding soil	No/Yes
2000 Complex D&D	AM (DOE/OR/01-2412&D1): 09/03/09	RmAR for 2000 Complex (DOE/OR/01-2501&D1) approved 08/25/11	Demolition	No/No
3026 C&D D&D Wooden Superstructure	AM (DOE/OR/01-2402&D2) 03/24/09	RmAR (Wooden Superstructure) (DOE/OR/01-2470&D1) submitted 03/22/11 (approval not required)	Demolition	No/No

[a]The *Phased Construction Completion Report for the Remediation of Tanks T-1, T-2, and HFIR* (DOE/OR/01-2238&D1) states that the above-ground areas of these sites are subject to routine maintenance and radiological surveys. However, this requirement was superseded by the *Remedial Action Report for the Melton Valley Watershed* (DOE/OR/01-2343&D1/A1) which omits any LTS requirements for these sites. The LTS of these sites is no longer reported in the RER. The T-1 and T-2 Tanks are located on the BV watershed map (Figure 2.1) and HFIR Tank is located on the Melton Valley watershed map (Figure 3.1).

[b]The *Removal Action Report on the Building 3001 Canal* (DOE/OR/01-1599&D2) required monthly inspections of the grout and paint for one year only. The monthly checks were conducted through 2006 and are no longer reported in the annual RER.

AM = Action Memorandum
BV = Bethel Valley
BVBGs = Bethel Valley Burial Grounds
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
D&D = decontamination and decommissioning
ESD = Explanation of Significant Difference
GAAT = Gunite and Associated Tanks
HFIR = High Flux Isotope Reactor
IFDP = Integrated Facility Disposition Project
LLLW = liquid low-level waste
LTS = long-term stewardship
LUC = land use control
NSC = Non-Significant Change
PCCR = Phased Construction Completion Report
RAR = Remedial Action Report
RER = Remediation Effectiveness Report
RmAR = Removal Action Report
ROD = Record of Decision
SWSA = Solid Waste Storage Area
WAG = Waste Area Grouping

4. ENVIRONMENTAL MONITORING

4.1 INTRODUCTION

Environmental monitoring in the BV administrative watershed includes two components: (1) performance monitoring required by approved CERCLA decision or post-decision documents and (2) baseline monitoring conducted, as necessary, to track changes in contaminant concentrations at source areas in interior locations and at IPs and exit pathways to monitor for potential offsite transport/release.

4.2 PERFORMANCE MONITORING

As shown in Table 1, environmental monitoring is required by the applicable CERCLA decision documents or post-decision documents for the following completed actions in the BV administrative watershed.

- BV Interim Actions ROD and post-ROD BVGWES
- Corehole 8 Plume Extraction System
- Bethel Valley Burial Grounds (BVBGs) Action
- BV Mercury Sumps Groundwater Action (ORNL Building 4501 basement sumps – Mercury Treatment System)

Table 2 summarizes the environmental monitoring objectives and performance goals for these CERCLA actions in the BV administrative watershed as established by applicable CERCLA decision document(s) referenced in Table 1. The annual RER for the ORR describes the WRRP technical approach and rationale for surface water, groundwater, and biological monitoring in the BV administrative watershed.

Watershed—Scale ROD for BV

The remedy in the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) includes actions to address contaminated buildings and other facilities designated for demolition, buried waste, underground LLLW tanks, accessible underground process and LLLW transfer pipelines, accessible contaminated surface and subsurface soil, contaminated sediment and surface water, contaminated groundwater, and groundwater monitoring wells and piezometers no longer needed for monitoring. The scope does not include active facilities (e.g., Building 4500N) and infrastructure that have ongoing missions, contaminated media, and sources that are inaccessible due to the presence of the active facilities and infrastructure. The final groundwater decision will be made after source control actions are complete, their effectiveness is monitored, and additional characterization data is collected.

The BV Interim Actions ROD (DOE/OR/01-1862&D4) specifies RAOs, performance objectives and performance measures relevant to this RAR CMP. Specific performance objectives and performance measures form the basis of remediation effectiveness monitoring. These performance objectives provide part of a quantitative basis to evaluate the effectiveness of remedial activities including the attainment of ambient water quality criteria (AWQC) numeric and narrative goals related to contaminant discharges to surface water, risk-reduction for offsite releases, and the evaluation of hydrologic isolation at limiting contaminant releases from buried waste by monitoring groundwater fluctuation within hydrologic isolation areas.

Table 2. CERCLA action performance monitoring in the BV administrative watershed[a]

Media	Monitoring Location	Schedule and Type of Sample	Parameters	Performance Standard
PERFORMANCE MONITORING				
Surface water	7500 Bridge Weir	Continuous flow-proportionate monthly composite sample	^{90}Sr, gamma activity[b]	Achieve (BV Interim Actions ROD): • 45% risk reduction from 1994 levels at 7500 Bridge for ^{90}Sr and ^{137}Cs (i.e., 37 pCi/L of ^{90}Sr and 33 pCi/L of ^{137}Cs) • AWQC for all designated stream uses in all waters of the state (FYR)
	First Creek Weir	Continuous flow-proportionate monthly composite sample	COCs (^{90}Sr, gross alpha, gamma activity[b])	None specified (BV Interim Actions ROD)
	NWT Weir	Continuous flow-proportionate monthly composite sample	COCs (^{90}Sr)	
	Raccoon Creek Weir	Continuous flow-proportionate monthly composite sample	COCs (^{90}Sr)	
	7500 Bridge Weir	Monthly grab sample	Total mercury	51 ppt (ng/L) Hg (BV Mercury Sumps)
		Semiannual grab sample (Hg snapshot)	Total mercury	51 ppt (ng/L) Hg (BV Mercury Sumps)
		Annual grab sample (prior to FYR)	AWQC	AWQC (BV Mercury Sumps)
	WOC-105	Semiannual grab sample (Hg snapshot)	Total mercury	51 ppt (ng/L) Hg (BV Mercury Sumps)
	First Creek	Continuous flow-proportionate monthly composite monitoring	^{90}Sr	Document quantity of ^{90}Sr discharging from Corehole 8 plume to First Creek as it contributes to WOC (PCCR for Corehole 8 Extraction System)
	SWSA 3 Sediment Basin (BVBGs BASIN OUT)	Semiannual grab monitoring	Metals, VOCs, ^{90}Sr, and tritium	Basin will access upgradient trench as a potential source of contaminants and can be compared to the recreational goal of 1 x 10^{-4} risk for swimmers (BVBGs action)
Biota	WCK 6.8 WCK 3.9 FCK 0.1 FCK 0.8 FFK 0.2 FFK 1.0	Fish and benthic macroinvertebrate species surveys	Richness and density survey	Comparison to reference location to evaluate whether aquatic populations are being protected (BV Interim Actions ROD)

Table 2. CERCLA action performance monitoring in the BV administrative watershed (cont.)

Media	Monitoring Location	Schedule and Type of Sample	Parameters	Performance Standard
Groundwater	4579-01 4579-02 4579-03	Semiannual grab samples[c]	Gross alpha and gross beta activity, ^{90}Sr	Exit pathway (West BV/Raccoon Creek area) monitoring trend to determine if contaminants are leaving known contaminated areas (BVGWES)
	Well 4411	Quarterly grab sample	^{90}Sr	To monitor contaminant concentration trends (PCCR for Corehole 8 Extraction System)
	Well 4570	Semiannual grab sample	^{90}Sr	Sample groundwater down-dip to the southwest of the Corehole 8 Plume source (PCCR for Corehole 8 Extraction System)
	Wells 4571 and 4572	Semiannual grab sample	^{90}Sr	Installed west along geologic strike to detect potential underflow of First Creek (PCCR for Corehole 8 Extraction System)
	Wells:[d] **0482**, **0483**, **0484**, **0491**, **0492**, **0493**, 0692, 0693, **0694**, 0698, 0699, 0700, 0702, 0706, 0790, 0985, 0986, 0987, 0988, 0990, 0991, 0992, 0993, 0994, 0995, **0996**, **0997**, 0998, 1247, 1248, 4579-01, 4579-02, 4579-03, 4645, 4646, 4647, 4670, 4671, 4672, 4673, 4674, 4675	Quarterly synoptic monitoring	Water levels	Intent of the SWSA 3—CSMA cap is to limit the amount of water that encounters buried wastes by reducing or eliminating percolation of precipitation and through-flow of shallow groundwater. Therefore, water table elevations are expected to decline under the cap over time (See Table 7-2 of BVBGs PCCR [DOE/OR/01-2533&D2] for long-term water table elevation goals for SWSA 3).
	Wells 0706, 0995 Well 0985 Wells 4645, 4646, 4647 Wells 0992, 0993, 0994, 0997, 4579-01, 4579-02 , 4579-03	Semiannual grab samples	^{90}Sr, tritium VOCs, ^{90}Sr, tritium Metals, ^{90}Sr, tritium Metals, VOCs, ^{90}Sr, tritium, gross alpha, and gross beta	Downward trend in ^{90}Sr concentration towards 8 pCi/L (BVBGs PCCR)

[a]Table presents current requirements for monitoring included in the Interim Actions ROD for the BV, post-decision primary documents, or any subsequent errata that have received concurrence/approval from the EPA and TDEC. Additional monitoring requirements will be developed and approved during the remedial design process for actions yet to be implemented.

[b]Gamma scan provides ^{137}Cs, ^{60}Co, and ^{40}K activity.

[c]Per the BVGWES report (DOE/OR/01-2219&D2), semiannual grab samples in each monitoring zone were recommended for two years (starting in FY 2006), which provided a total of six baseline values. If analytical results are consistent, monitoring will be reduced to high- and low-base sampling every three years. If those results are consistent for a period of nine years (though FY 2016), monitoring will be reduced to high- and low-base sampling every five years. Monitoring at this frequency will continue until a statistically valid decreasing trend is clearly demonstrated. Note that monitoring has not been reduced due to the presence of contamination.

[d]**Bolded** values represent wells included in Table 7-2 of the PCCR for BVBGs (DOE/OR/01-2533&D2) which specifies long-term water table elevation goals for nine wells. The PCCR states, "*…the goal for SWSA 3 is a declining trend in the average water elevations to approximately the elevation of bedrock…Table 7-2* (of the PCCR) *provides a list of these elevations*."

Table 2. CERCLA action performance monitoring in the BV administrative watershed (cont.)

SWSA 3 Groundwater Target Elevations*

WELLS	ELEVATION GOAL (msl)
0482	823
0483	835
0484	824
0491	816
0492	818.5
0493	829
0694	838.33
0996	814.31
0997	818.64

*Source: *PCCR for BVBGs* (DOE/OR/01-2533&D2), Table 7-2.

AWQC = ambient water quality criteria
BV = Bethel Valley
BVBGs = Bethel Valley Burial Grounds
BVGWES = Bethel Valley Groundwater Engineering Study
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC = contaminant of concern
CSMA = Closed Scrap Metal Area
EPA = Environmental Protection Agency
FCK = First Creek kilometer
FFK = Fifth Creek kilometer
FY = fiscal year
FYR = Five-Year Review
msl = mean sea level
NWT = Northwest Tributary
PCCR = Phased Construction Completion Report
ROD = Record of Decision
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation
VOC = volatile organic compound
WCK = White Oak Creek kilometer
WOC = White Oak Creek

RAOs were developed separately for the Central/East BV and the Raccoon Creek/West BV areas. This was done because contamination in Raccoon Creek/West BV is limited to discrete areas (i.e., SWSA 3, Contractor's Landfill, and CSMA), while the Central/East BV area contains widespread contamination resulting from its use as a nuclear research laboratory. Thus, the ROD-stipulated RAOs for BV are based on future end-use, as well as environmental media, and are presented below in Table 3.

Table 3. RAOs for BV[a]

Issue	*Protection goals*
Future end 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 SWSA 3 and the Contractor's Landfill, and (4) unrestricted use in the undeveloped areas, all to a risk level of* 1×10^{-4}
Protection of surface water bodies	*Achieve AWQC for designated stream uses in all waters of the state*
	Achieve at least 45% risk reduction at the 7500 Bridge
	Maintain surface water and achieve sediment recreational risk-based limits to a goal of 1×10^{-4}
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*

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

AWQC = ambient water quality criteria
BV = Bethel Valley
ORNL = Oak Ridge National Laboratory
RAO = Remedial Action Objective
SWSA = Solid Waste Storage Area

In addition, the ROD for Interim Actions in BV (DOE/OR/01-1862&D4) specifies to maintain surface water and achieve sediment recreational risk-based limits to a goal of 1×10^{-4} Excess Lifetime Cancer Risk and the RAOs for groundwater are to minimize further impacts to groundwater and prevent groundwater from causing surface water exceedances in all waters of the state. The ROD did not specify applicable or relevant and appropriate requirement (ARAR)-based groundwater remediation levels and meeting such ARAR-based levels is not a performance objective of the ROD. The ROD also includes the requirements to monitor groundwater exit pathways and to monitor groundwater near contaminant source control areas to measure effectiveness of contaminant source control actions. Post-remediation monitoring requirements will be developed in the PCCR for each element of the remedy.

The BV Interim Actions ROD (DOE/OR/01-1862&D4) specified surface water monitoring locations to measure the effectiveness of the RAs implemented under decisions within the ROD at a few known release pathways. Continuous measurement of flow volume with flow-proportional sampling for contaminant measurement will occur at the four main stations in BV: 7500 Bridge Weir (WC7500), NWT Weir, First Creek Weir, and Raccoon Creek Weir. Other stations dictated by the design of the selected remedy may be sampled to document contaminant releases from tributary areas. Surface water monitoring will be used to verify compliance with AWQC and to verify reduction of offsite contaminant releases to acceptable levels.

The BV Interim Actions ROD (DOE/OR/01-1862&D4) notes that groundwater monitoring objectives in BV include two aspects: (1) groundwater exit pathway wells will be monitored to verify that

contaminants are not leaving the contaminated area, and (2) groundwater in the vicinity of contaminant source control areas will be monitored to measure effectiveness of contaminant source control actions.

The frequency of exit pathway groundwater monitoring will be based on rates of groundwater flow in shallow versus deep monitoring zones, and the contaminants to be monitored will vary depending on those known to occur and with periodic analysis for a broad spectrum of contaminants (DOE/OR/01-1862&D4). Examples provided of the types of groundwater monitoring include (1) groundwater and/or seep monitoring used to measure some aspects of RA effectiveness in areas where source control actions are implemented; (2) measurements of water level fluctuations inside and outside hydraulically isolated areas; (3) and sampling of monitoring wells to measure contaminant concentrations within and at the edges of existing plumes. As with surface water monitoring, the details of groundwater monitoring were left to be developed and approved during the remedial design process of RAs included in the BV Interim Actions ROD. For example, both groundwater level monitoring and contaminant concentration monitoring were specified for the BVBGs RA at the SWSA 3, CSMA, and Contractor's Landfill areas to determine cap performance and RA effectiveness for source control (discussion of *BVBGs Action* follows *Corehole 8 Plume* discussion).

The BV Interim Actions ROD (DOE/OR/01-1862&D4) requires that fish and benthic macroinvertebrate surveys are conducted in WOC, First Creek, and Fifth Creek to evaluate whether aquatic populations are being protected. The frequency of monitoring is not prescribed in the ROD, although results are to be reported in the annual RER.

BVGWES

Some remedial activities selected in the BV Interim Actions ROD are dependent on the collection of additional information. The ROD specified that a post-ROD groundwater engineering study (DOE/OR/01-2219&D2) be conducted to satisfy design data needs associated with the implementation of several RAs related to the management of contaminated soil and groundwater in BV. These actions include: (1) the exit pathway groundwater monitoring in West BV (completed: multizone well 4579); (2) the *in situ* biodegradation at the East BV VOC Plume (partially completed: treatability study and field-scale biostimulation pilot test); (3) the deep groundwater extraction at the Corehole 8 Plume (completed); and (4) the deep soil excavation at known leak sites to minimize impacts to groundwater (completed: source material for the Corehole 8 contaminant plume, Tank W1-A).

The BVGWES included installation of a multizone well (Well 4579) located in West BV to sample exit pathway groundwater between the SWSA 3 Area and the headwaters of Raccoon Creek (see Figure A.1 in Appendix A). Data indicate that the well is constructed in the proper bedrock intervals to determine that bedrock pathways discharge locally to Raccoon Creek and not to a more distant location. Extremely low levels of ^{90}Sr contamination in the monitoring well suggest that the principal pathway is in the uppermost portions of the groundwater system. Long-term monitoring to ensure that migration pathways do not develop in deeper bedrock is an appropriate exit pathway strategy for this area (DOE/OR/01-2219&D2).

7000 Area VOC Plume Treatability Study

The objective of the BVGWES regarding the elongated, westward-migrating, TCE plume in the 7000 Area was to identify the plume source(s), describe the plume in a three-dimensional manner, and assess the plume's suitability for enhanced bioremediation. Results of the investigation found that the VOC plume is stratabound in the sense that it appears to migrate via a discreet set of fractures within a thin limestone bed. Its source has been identified as the former Building 7055. The plume discharges to a

local spring, which then discharges to WOC, and this plume also extends to greater depths than anticipated downdip of the source area.

The BVGWES report recommended a treatability study for enhanced bioremediation as a potential component of an overall plume management strategy (DOE/OR/01-2219&D2). The report for the *Treatability Study for the Bethel Valley 7000 Area Groundwater Plume, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2566&D1) was issued in May 2012. The report presented the results of field and laboratory tests that were used to design a field scale biostimulation pilot test. The report also summarized monitoring results for a one year period following the injection of materials that allowed native dehalogenating microbes and other native microbes to increase their population numbers with resulting degradation of TCE and its transformation products. The microbial VOC degradation process requires chemically reducing conditions to exist in combination with the presence of sufficient electron donor compounds (compounds rich in carbon such as vegetable oils or carbohydrates are often used) for a sufficient time to allow the degradation to occur to completion. Laboratory tests confirmed that the native microbes at the 7000 Area are capable of fully degrading TCE of the innocuous ethane and ethylene compounds given sufficient time and carbon donor amendments. The project report concluded that biostimulation of native microbial communities within the plume is a viable remediation approach for the plume (DOE/OR/01-2566&D1).

The treatability study utilized four existing groundwater monitoring wells located near the center of the plume as injection locations for the chemical amendments. The required scope of work prescribed in the treatability study was completed, as reported in 2012, though post-project sampling and analysis continued through FY 2013 at selected wells in the study area to document the sustainability of the treatment and measure ongoing trends in VOC concentrations and microbial populations. Although monitoring of the biostimulant response was terminated during FY 2014, monitoring of the VOC compounds will be continued consistent with ongoing contaminant trend evaluation in the plume area. (This monitoring is included in Table 4 as baseline monitoring). In order to increase the scale of treatment to address the plume source area and other areas of the plume, additional characterization wells and injection wells will be needed. The next step in such a project would be preparation of a Remedial Design Work Plan that would delineate the depth extent of the plume and to determine if a DNAPL source exists in the plume source area. As the risk of the 7000 Area VOC plume determines funding priorities on the ORR, resources will be made available to continue with full-scale anaerobic reductive dechlorination treatment of the TCE groundwater plume in the 7000 Area and the associated performance monitoring will then be included in Table 2.

Corehole 8 Plume

In 1991, CERCLA characterization efforts identified a plume of ^{90}Sr contaminated groundwater in the western portion of the ORNL main plant area, referred to as the Corehole 8 Plume. The source area of the plume was later discovered to be LLLW Tank W-1A, the removal of which was addressed as a separate action. A removal site evaluation performed in 1994 concluded that contaminated groundwater seeping into the storm drain system was being discharged into First Creek at Outfalls 341 and 342. First Creek is a tributary to WOC and ultimately to the Clinch River. Further investigation showed that contaminated groundwater entered the storm water collection system by in-leakage to three catch basins in the western part of the ORNL.

Since the time that seepage into First Creek was discovered, the Corehole 8 Plume has been addressed through a series of actions beginning with the initial Corehole 8 (Plume Collection) Removal Action completed in 1994. Performance monitoring and other long-term stewardship (LTS) requirements for that removal action have been superseded by the *Phased Construction Completion Report for the Bethel Valley (Corehole 8) Extraction System at Oak Ridge National Laboratory, Oak Ridge, Tennessee*

(DOE/OR/01-2534&D1) approved in 2012. This action was completed under the BV Interim Actions ROD (DOE/OR/01-1862&D4).

Data summarized in the BVGWES regarding the Corehole 8 Plume suggest that the contamination appears to disperse within the uppermost water table near the soil/bedrock interface west of First Creek, and is not found in shallow bedrock west of the creek. The plume is also present at greater depths than anticipated downdip of the source area. In response, two more wells, in addition to existing extraction well 4411, were installed in the areas being targeted for plume extraction (DOE/OR/01-2534&D1): (1) a bedrock well, EW-1, beneath the area of plume upwelling for containment, and (2) another bedrock well near Corehole 8, EW-3, for mass removal from a location of known high concentrations. The action also included refurbishment of the existing shallow plume extraction system components because of their age and increasing operational problems. The refurbishment makes the existing system fully compatible and operationally integral with the new extraction system components, as well as insures that the ORNL PWTP can accept and treat the contaminated groundwater without resulting in filter cake strontium concentrations that exceed the disposal facility waste acceptance criteria.

As well as attainment of surface water goals of the BV Interim Actions ROD for ^{90}Sr and ^{137}Cs at the 7500 Bridge, performance monitoring of the Corehole 8 Extraction System includes the following (DOE/OR/01-2534&D1):

- Quarterly sampling of Well 4411 to monitor contaminant concentration trends (^{90}Sr)
- Semiannual sampling of Well 4570, which samples groundwater (^{90}Sr) down-dip to the southwest of the plume source
- Semiannual sampling of wells 4571 and 4572 (for ^{90}Sr), which were installed west of First Creek along geologic strike of the plume to detect potential underflow of First Creek
- Continuous flow-paced monitoring of surface water in First Creek at the First Creek flume to document the quantity of ^{90}Sr discharged from Corehole 8 plume as it contributes to WOC.

BVBGs Action

RAs at the BVBGs were conducted in accordance with requirements of the BV Interim Actions ROD (DOE/OR/01-1862&D4), as amended by the Explanation of Significant Differences (DOE/OR/01-2446&D2). Sites addressed by the action include two inactive land disposal areas, SWSA 1 and SWSA 3, that received low-level radioactive wastes between 1943 and 1951, as well as several adjacent disposal areas and/or contamination sites. Adjacent to SWSA 1 is the Former Waste Pile Area (FWPA) and the Non-Radioactive Wastewater Treatment Plant (NRWTP) Debris Pile. The CSMA, the Contractor's Landfill, and Contaminated Soil Areas (CSAs) 1 through 6 are adjacent to SWSA 3.

RAs performed at the BVBGs included the following major actions (DOE/OR/01-2533&D2):

- Installation of a Resource Conservation and Recovery Act of 1976 (RCRA)-type multi-layer cap and an isolation cap at SWSA 1. This action required removal and replacement of a portion of Third Street.
- Installation of a RCRA-type multi-layer cap, isolation cap, and upgradient surface water and shallow groundwater diversion system at SWSA 3 and the CSMA. CSAs 2 and 3 and the CSMA were also covered by the SWSA 3 multi-layer cap.
- Removal of contaminated soils from CSAs 4 and 6 and the CSMA, as needed. Removed soils were placed under the RCRA-type cap at SWSA 3.

- Some existing substandard or unneeded wells in the construction areas were plugged and abandoned to prevent the wells from continuing to act as pathways for contaminant migration.
- Soil covers at the FWPA, the NRWTP Debris Pile, and the Contractor's Landfill were installed or upgraded.

The caps and soil covers were designed to protect workers and hypothetical future recreational users from unacceptable exposure to contaminants and to minimize further impacts to groundwater. The upgradient surface water and shallow groundwater diversion system was designed to reduce the migration of water through the buried waste, resulting in a reduced flux of contaminants to groundwater and surface water. The effectiveness of these engineered features will be verified through a surface water and groundwater monitoring program. The monitoring program, as well as an inspection and maintenance program, will also ensure continued operational effectiveness of the engineered features.

The *Remedial Design Report/Remedial Action Work Plan for the Bethel Valley Burial Grounds at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2427&D2) indicated that wells 829 and 946 would be included in the SWSA 1 post-construction monitoring program. However, because these wells are close to WOC and their screened intervals are shallow, they are as likely to be influenced by contaminants in the creek as from groundwater. Therefore, SWSA 1 performance will be adequately characterized by the WOC monitoring at the 7500 Bridge Weir, and no additional site-specific performance goals are proposed (DOE/OR/01-2533&D2).

The PCCR for the BVBGs (DOE/OR/01-2533&D2) requires groundwater monitoring at SWSA 3 for five years (through 2016, the year of the CERCLA FYR). The PCCR stipulated one initial year of monitoring after completion of the RA, followed by slightly reduced monitoring that remains in place to date. The initial year of monitoring included a full year of quarterly synoptic groundwater levels, with a full year of continuous daily water levels collected from selected wells. After the first monitoring year, water levels would be collected quarterly from all wells, but the PCCR allowed that continuous monitoring may be discontinued.

There are currently 43 existing and new groundwater monitoring locations available in the SWSA 3, CSMA, and Contractor's Landfill area for groundwater level and contaminant monitoring. After the first monitoring year, water levels are collected at a minimum of quarterly from all but one location. Groundwater level data is mapped to determine groundwater flow directions and changes in level over time. Water levels are correlated with rainfall data to evaluate the effect of precipitation on groundwater under the SWSA 3/CSMA cap and in surrounding uncapped areas. If water levels are collected manually, they should not be collected within three days of a rain event equivalent to 0.5 in/24 hrs. In addition, during the first and third quarters of each fiscal year (FY) for five years (through 2016) samples are collected from selected wells and analyzed, at a minimum, for ^{90}Sr and tritium, and a subset of those wells are also monitored for gross alpha and beta activity. Certain wells that are known to contain non-radiological contaminants are also analyzed for VOCs and/or metals. General performance monitoring criteria and locations are provided in Table 2.

The primary contaminant of concern at SWSA 3 is ^{90}Sr and is, therefore, selected as the indicator parameter. The ^{90}Sr plume at SWSA 3 flows both eastward to the NWT and westward towards Raccoon Creek (see Figure A.1 in Appendix A). Surface water will continue to be monitored at the NWT and the Raccoon Creek Weir, but no additional surface water monitoring parameters other than what are specified in the BV Interim Actions ROD are proposed by this action.

Surface water in the SWSA 3 sediment basin will be sampled semiannually and analyzed for ^{90}Sr, tritium, VOCs, and metals. All data collected for the BVBGs Action are reported in the annual RER and used to trend contaminant levels. Monitoring requirements will be re-evaluated in the CERCLA FYR.

BV Mercury Sumps Groundwater Action (ORNL Building 4501 basement sumps – Mercury Treatment System)

In December 2007, the first RA specified in the BV Interim Actions ROD (DOE/OR/01-1862&D4) was partially completed by re-routing mercury-contaminated groundwater from one of the four basement sumps at Building 4501 to treatment at the PWTP (DOE/OR/01-2472&D1). Prior to the action, some mercury-contaminated groundwater collected in Building 4501 basement sumps was discharged to WOC via storm drain Outfall 211. In October 2009, this initial action was completed with the installation of an ion exchange system for the collected groundwater to remove particle-associated mercury and dissolved mercury from the wastewater stream prior to its final treatment and discharge at the PWTP. This system installation includes a pre-filter and ion exchange located in the basement of Building 4501 that serves to pre-treat the sump water which is then routed to the PWTP. The connection of the other three mercury-contaminated groundwater sumps within the basement of Building 4501 to the mercury pretreatment system remains to be completed.

Mercury monitoring is conducted at several surface water sampling locations in BV, and two locations are key to measuring the effectiveness of the Building 4501 sump water re-route. These locations include the watershed IP location at the 7500 Bridge and an in-stream sampling location, WOC-105, that is located approximately 250 ft downstream of the Outfall 211 storm drain. At the 7500 Bridge Weir, performance monitoring includes a monthly grab sample for total mercury, a semiannual grab sample for total mercury as part of a multi-point WOC mercury "snapshot" sampling program, and an annual grab sample during the CERCLA FYR for AWQC. At the WOC-105 in-stream location, performance monitoring includes a semiannual grab sample for total mercury, again as part of a multi-point WOC mercury "snapshot" sampling program.

All data are reported in the annual RER and the action is evaluated for protectiveness in the CERCLA FYR. The WRRP will collect system performance data, operational data, and the ORNL PWTP National Pollutant Discharge Elimination System (NPDES) compliance data to support the re-evaluation.

4.3 BASELINE MONITORING

In conjunction with the performance monitoring required by the above-referenced decision documents for CERCLA actions in the BV administrative watershed, the WRRP has implemented baseline (i.e., trend) monitoring. Baseline monitoring is conducted at exit pathways (other than those required by CERCLA primary documents noted above) where contaminants in groundwater or surface water have the potential to flow through and ultimately exit the BV subwatersheds to discharge offsite to the Clinch River or Melton Hill Lake. Baseline monitoring typically collects data near contaminant source control areas to assess trends to determine performance of future source control actions. Baseline monitoring data are also collected in support of the FYR assessment of remedy protectiveness.

Table 4 includes baseline monitoring in the BV administrative watershed that was not required by primary CERCLA decision or post-decision documents as performance monitoring to gauge the effectiveness of a particular remedy. Currently, baseline monitoring in BV includes continued monitoring for VOCs in groundwater wells and surface water location SP200 around the 7000 Area VOC Plume until resources are available to continue enhanced bioremediation. Wells 1198 and 1199 monitor for VOCs and tritium in East BV at the groundwater exit pathway to Melton Hill Lake; Bearden Creek is monitored for tritium as the East BV surface water exit pathway.

Interior baseline monitoring locations currently include a monthly grab sample for gross alpha, gamma, ^{90}Sr, and field parameters at instream location GS-5 and a semiannual (Q2, Q4) grab sample at Fifth Creek for metals, gross alpha and beta, gamma, ^{90}Sr, tritium, and field parameters (including

instantaneous flow to calculate flux). Another semiannual (Q1, Q3) grab sample at Fifth Creek for mercury and methylmercury are correlated with bioaccumulation data for WOC watershed.

As noted above, baseline data are collected to support trending information for DOE programs and the FYR assessment of remedy protectiveness. These monitoring locations may change each five-year cycle as results are evaluated and adjustments in monitoring are deemed necessary. Table 4 summarizes the baseline monitoring currently conducted in the BV administrative watershed and provides the monitoring objective for each group of monitoring locations.

Table 4. Baseline monitoring in the BV administrative watershed

Area of BV	Media	Monitoring location(s)	General schedule and monitoring parameters	Monitoring objective
BASELINE MONITORING				
BV 7000 Area VOC Plume	Groundwater	Well 0754	Semiannual grab sample for VOCs and field parameters	BV 7000 Area VOC groundwater plume monitoring
		Wells 0752, 1201, 1202, 4582, 4583, 4576, 4577, 4581	Quarterly grab sample for VOCs and field parameters	
	Surface water	SP200	Quarterly grab sample for VOCs and field parameters	
Exit Pathway – Eastern BV	Groundwater	Wells 1198 and 1199	Semiannual grab sample for VOCs, tritium, and field parameters	Watershed exit pathway monitoring for eastern BV
	Surface water	BRDNCREEK (Bearden Creek)	Semiannual grab sample for tritium and field parameters (including instantaneous flow)	Watershed exit pathway monitoring for eastern BV
Main Plant Area	Surface water	GS-5	Monthly grab sample for gross alpha, gamma, ^{90}Sr, and field parameters	BV surface water interior contaminant concentration monitoring
		Fifth Creek	Semiannual grab sample for metals, gross alpha, gross beta, gamma, ^{90}Sr, tritium, and field parameters (including instantaneous flow, when possible)	
			Semiannual grab sample for mercury and methylmercury (coordinate with bioaccumulation monitoring in watershed)	Assess occurrence of mercury and methylmercury in surface water and correlate with bioaccumulation data for WOC watershed
			Semiannual grab sample for field parameters (with instantaneous flow to calculate flux), metal (including mercury), gross alpha and beta, gamma, ^{90}Sr, and tritium	FYR monitoring for COCs (no exceedances of other AWQC constituents historically)
		BV1ST-13 (First Creek)	Semiannual grab sample for field parameters, metals (including mercury), gross alpha and beta, gamma, ^{90}Sr, tritium, and a reduced pesticide suite	FYR monitoring for COCs (no exceedances of other AWQC constituents historically)
		FIRST CREEK	Semiannual grab sample for field parameters, gross alpha and beta, gamma, ^{90}Sr, tritium, metals (including mercury), and AWQC (except VOCs)	FYR monitoring for all COCs (only VOCs have not been detected historically at this site)

Table 4. Baseline monitoring in the BV administrative watershed (cont.)

Area of BV	Media	Monitoring location(s)	General schedule and monitoring parameters	Monitoring objective
Exit Pathway - Western BV		3RDST_BRID (3rd Street Bridge)	Semiannual grab sample for mercury and methylmercury (coordinate with bioaccumulation monitoring in watershed)	Assess occurrence of mercury and methylmercury in surface water and correlate with bioaccumulation data for WOC watershed
			Semiannual grab sample for field parameters (including instantaneous flow measurement for flux), metals (including mercury), dioxins/furans, and a reduced pesticide suite	FYR monitoring for only the AWQC constituents detected historically at this site to determine compliance for the central and eastern portions of the main plant area
	Biota	WCK 3.9	Bioaccumulation of COCs (metals, including mercury, and PCBs) in invertebrates (e.g., caddisflies)	FYR monitoring to evaluate risk to insectivores
	Surface water	NWT Weir	Semiannual grab sample for field parameters, gamma, ^{90}Sr, and metals (including mercury)	FYR monitoring for Western BV for COC compliance (no historical exceedances of other AWQC constituents)
	Groundwater	Wells 4579-01, 4579-02, 4579-03	Semiannual grab sample for VOCs, metals (including mercury), gross alpha and beta, ^{90}Sr, and tritium	FYR monitoring at BV exit pathway Western BV

AWQC = ambient water quality criteria
BV = Bethel Valley
COC = contaminant of concern
FYR = Five Year Review
NWT = North West Tributary
PCB = polychlorinated biphenyl
VOC = volatile organic compound
WCK = White Oak Creek kilometer
WOC = White Oak Creek

5. LAND USE CONTROL IMPLEMENTATION PLAN

5.1 INTRODUCTION

As stated previously, because most of the remediation decisions in the BV watershed currently do not qualify for UU/UE, LUCs are required. This chapter addresses the LUCs necessary in the BV administrative watershed to ensure the remediated areas are protective of human health and the environment. This chapter describes the LUC objectives, the LUCs, transfer of property, and LUC verification and reporting for the BV administrative watershed.

A future, final ROD for the BV administrative watershed will select the remedies necessary to address the remaining environmental media, e.g., groundwater and ecological protection. BV surface water will be addressed in the final ROD for the environmental media in the Melton Valley watershed. The current schedule for these RODs are available in Appendix J of the FFA.

The federal government, currently through DOE, is responsible for implementing, maintaining, reporting on, and , if appropriate, enforcing LUCs. Although DOE may transfer these procedural responsibilities to another party, DOE shall retain ultimate responsibility for the integrity of remediation. DOE will seek the necessary funding for the implementation and maintenance of LUCs through the congressional appropriations process or other available mechanism. The process for DOE funding remediation projects, including any required LUCs, is described in the *Federal Facility Agreement for the Oak Ridge Reservation* Section XXXVIII (DOE/OR-1014).

DOE shall not modify or terminate LUCs and implementation actions per approved RODs or modify end use without approval by EPA and TDEC. DOE shall seek prior concurrence before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs.

5.2 LUC OBJECTIVES

During the CERCLA decision-making process assumptions are made about the anticipated future end uses of the areas to be remediated so that the need to maintain the LUCs for these uses can be evaluated. The *Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee* (DOE/OR/01-1862&D4) establishes the following four areas within the watershed with different remediation levels related to historical and current use of the area and the anticipated end uses (Figure 7):

- Controlled Industrial
- Unrestricted Industrial
- Recreational
- Unrestricted

The following LUC objectives have been identified as necessary to ensure the protectiveness of the selected remedy end use:

- Prevent access to or use of groundwater unless approved by DOE, EPA, and TDEC.
- Prohibit unauthorized excavation inconsistent with the LUCs described in Sect. 5.3.
- Prohibit the development and use of the area that is inconsistent with remediation levels, e.g., residential housing, elementary and secondary schools, playgrounds, and child care facilities.

- Maintain the integrity of any current or future RA where waste remains in place or required monitoring systems have been implemented.

DOE shall notify EPA and TDEC 45 days in advance of any proposed end use changes that are inconsistent with the LUC objectives or the selected remedy.

The LUC objectives are identified to prohibit uses of the post remediation areas within the watershed that will be harmful to the remediation activities performed, to the environment, and/or to humans that may be located at or visit the areas. LUC objectives are also used to ensure the integrity of the completed RA.

Because the BV ROD covers a large watershed and not a single remediation unit, some LUC objectives will be associated with the whole BV administrative watershed and some with individual affected areas (Table E.1).

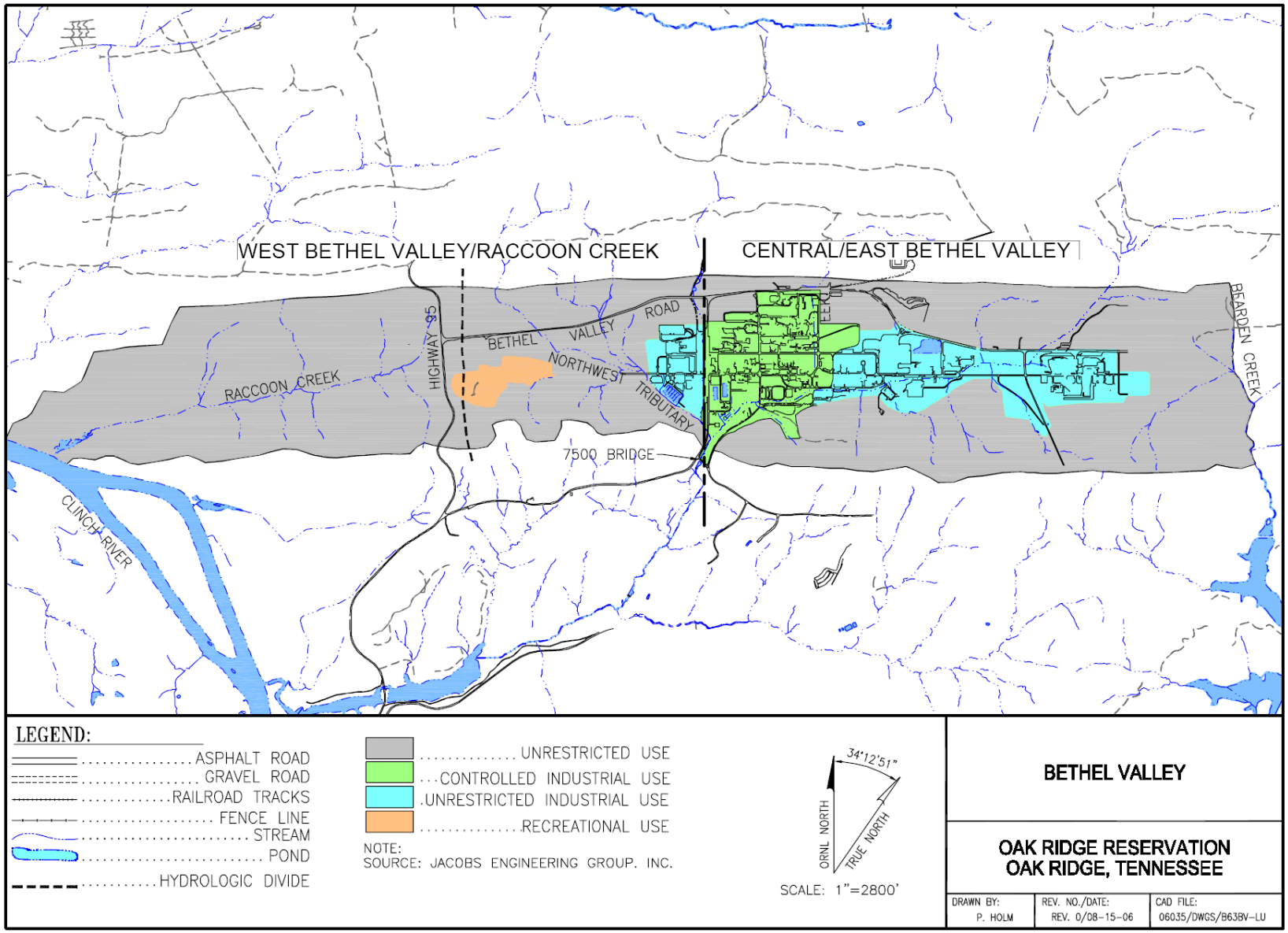

Figure 7. BV administrative watershed end uses.

5.3 LUCs

LUCs are used to achieve the LUC objectives. LUCs are to be maintained until the concentration of contamination in the soil and/or groundwater are at such levels to allow UU/UE.

The implemented LUCs are identified in Table E.1 in Appendix E. A description of each LUC follows:

- **Property Record Restrictions.** The purpose of a Property Record Restriction is to restrict the use of property and/or prohibit the use of groundwater by imposing limitations. DOE shall record property record restrictions in accordance with state law at the Roane County Register of Deeds office. Each transfer or fee title from the United States federal government will include a CERCLA 120(h) covenant that will have a description of the residual contamination on the property and the environmental use restrictions expressly prohibiting activities inconsistent with the LUC objectives to the degree practicable to ensure the clear delineation of the restriction.

- **Property Record Notices.** The purpose of a Property Record Notice is to provide notice to the public about the existence and location of regulated hazardous substance and the location of land that is not appropriate for UU/UE and limitations on the use. DOE acquired the land now within the ORR through various methods of acquisition, including condemnation through use of eminent domain; purchase; and transfer from other federal, state, and local government agencies. The acquisitions by eminent domain and purchase have been filed for record at the pertinent county offices of record.

  There are two types of Property Record Notices that will need to be filed by DOE. The first type, a general notice, is filed when regulated hazardous substances, e.g., radionuclides, hazardous chemicals, and asbestos) are left in place in an area at levels that may pose an unreasonable threat to public health, safety, or the environment. The second type, a more specific notice for individual areas, is filed after completion of remediation of the specific unit, e.g., landfill, when hazardous wastes or asbestos-containing materials are left in place in the unit. These two types of Property Record Notices are described below:

  1. Tennessee law requires that a Notice of Land Use Restrictions (Notice) be prepared and recorded by a property owner when hazardous substances, as defined under CERCLA §101, are left in place and land use restrictions are required as part of the RA on such property. This Notice with general locations identified will be filed by DOE as soon as practicable after signing the ROD, upon completion of all RAs, and upon transfer of affected areas, if that occurs. The Notice will be filed with Roane County Register of Deeds Office in a manner consistent with *Tennessee Code Annotated* (*TCA*) 68-212-225 and containing information similar to that required by CERCLA Section 120(h). If the property is transferred, the Notice also will be filed with the zoning commission. As required by *TCA* 68-212-225(b), the Notice that DOE files will include a legal description of the side; identify generally the type, location, and quantity of regulated hazardous substances and regulated substances known to exist on the site; and identify the location and dimensions of the areas of potential environmental concern with respect to surveyed, permanent benchmarks (where the site encompasses more than once parcel or tract of land, a composite map or plat showing all parcels or tracts may be recorded). The Notice will also list the LUCs used to protect workers and the public from risks associated with residual contamination and any other controls that may be implemented on the current or future use of the site. DOE will include statements, along with the Notice information, that the groundwater shall not be used without approval from DOE, EPA, and TDEC. DOE will also include statements that soil will only be used consistent with the anticipated end use assumptions in the [relevant] ROD.

2. An additional more specific Notice, with survey plat indicating the location and dimensions of the landfill cells or hazardous waste or asbestos disposal units with respect to permanently surveyed benchmarks, will also be filed by DOE with the Roane County Register of Deeds Office within 60 days of submitting the completion document for the RA of any landfill or hazardous waste or asbestos disposal unit where hazardous waste or asbestos is left in place within an affected area. The survey plat will be accomplished by a registered land surveyor under the direction and approval of a DOE official that depicts the relevant contamination/waste disposal areas. The plat must contain a note, prominently displayed, which states the owner/operator obligation to restrict disturbance of the landfill. The Notice must include a record of the type, location, and quantity of hazardous or asbestos wastes disposed of within each cell of the unit. DOE must also record, in accordance with state law, a notation on the deed to the facility property or on some other legal instrument which is normally examined during a title search that will in perpetuity notify any potential purchaser of the property that the land has been used to manage hazardous or asbestos wastes, its use is restricted under 40 *Code of Federal Regulations* (CFR) Part 264 Subpart G or 40 CFR Part 61 Subpart M regulations, respectively, and the survey plat and record of the type, location, and quantity of hazardous or asbestos wastes disposed within each cell or other waste disposal unit of the facility required by 40 CFR 264.116 and 264.119(a) or 40 CFR 61.151(e) have been filed with the local zoning authority and with the EPA Regional Administrator.

Once the Notices are filed and upon any further transfers of a parcel, any of the aforementioned land use restrictions may be enforced by any owner of the land, TDEC, or any unit of local government having jurisdiction over the property through issuance of an order by means of a civil action.

A copy of all Notices filed also will be mailed to the appropriate State and local governments having jurisdiction over any part of the property (including the zoning commission) within 30 days of being filed. These include, but are not limited to, the city of Oak Ridge and Roane County. Copies will also be provided to EPA Region IV and the TDEC Oversight Office. DOE will formally notify any initial property transferees of the existence of any Notices prior to final agreement on the property transfer.

- **Excavation Penetration Permit Program (EPPP)**. The purpose of the EPPP is to provide notice to the worker/developer (i.e., permit requestor) on the extent of contamination and prohibit or limit excavation/penetration activity to ensure that the excavation/penetration activity is conducted safely. An existing internal EPPP currently administered by DOE contractors requires workers/developers to obtain authorization before beginning subsurface excavation/penetration activities. This program, or equivalent, was selected as a CERCLA-imposed LUC in the BV ROD to ensure that planned excavation/penetration activities do not result in an uncontrolled release or unacceptable exposure to subsurface contamination. When an excavation/penetration is necessary, the requester will consult the internal DOE procedure to determine whether a permit is required.

  The goals of this program are to restrict subsurface construction and to protect the safety of the workers and the environment. Depending on the location of the excavation/penetration activity, such permits may contain necessary restrictions, waste disposal/handling requirements, or special work requirements.

  DOE and/or its agent will maintain responsibility for the EPPP for contamination handling and locations for on-going federal government activities at the site and for transferred land until the concentrations of hazardous substances are at levels to allow for UU/UE.

- **Access Controls.** The purpose of Access Controls (e.g., fences, gates, portals, signs, and surveillance patrols) is to control and restrict access to workers and the public to prevent unauthorized uses. Access Controls in and around BV that restrict/limit access to workers and/or the public to

contaminated units/areas will be evaluated by the remediation projects and, if necessary, selected in the corresponding design or construction completion report. DOE will erect and maintain signs across the BV administrative watershed at appropriate locations to achieve the LUC objectives. DOE will conduct surveillance patrols across the BV administrative watershed to determine that incompatible uses have not occurred for units/areas requiring land use restrictions. The patrols will be implemented, as needed, upon completion of RA. DOE and/or its agent will maintain responsibility for the access controls until the concentrations of hazardous substances are at levels to allow for UU/UE. In the event of property transfer, DOE will document access controls in the transfer documents and deed and will verify they are maintained.

The affected areas for LUCs are listed in Table E.1 and located in Figure A.2 in Appendix A. LUCs listed in Table E.1 will be evaluated annually and revised by DOE, as necessary as part of this primary document. DOE shall report in the annual RER any activity that may be inconsistent or may interfere with the effectiveness of the implemented LUCs. DOE will include in the RER what activity was performed or will be performed.

DOE shall address any activity that is inconsistent and/or may interfere with the protectiveness of the LUC objectives as soon as practicable but no longer than 10 days after discovery. DOE will notify EPA and TDEC of the activity that is inconsistent and/or may interfere with the LUC objectives or use restrictions as follows:

- DOE will address the activity as soon as practicable but no longer than 10 days after discovery.
- DOE will notify EPA and TDEC of the activity within 10 days after discovery.
- DOE will inform EPA and TDEC how the activity has been or will be addressed within 10 days of the notification.

5.4 TRANSFER OF PROPERTY

DOE will notify EPA and TDEC at least 90 days prior to any transfer or sale of the BV watershed property and will comply with the applicable requirements of Section 120(h) of CERCLA. In addition to the land transfer notice provisions above, DOE further agrees to provide EPA and TDEC with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE will provide a copy of the final executed transfer document to EPA and TDEC. The deed will include the following language, "Prior to seeking approval from EPA and TDEC, the owner of the property must notify and obtain approval from DOE of any proposals for an end use change at a site inconsistent with the use restrictions and assumptions in the [relevant] ROD."

Each transfer or fee title will include a CERCLA 120(h) covenant that will have a description of the residual contamination on the property and the environmental use restrictions expressly prohibiting activities inconsistent with the LUC objectives to the degree practicable to ensure the clear delineation of the restriction. The environmental restrictions are included in a section of the CERCLA 120(h) covenant that DOE is required to include in the deed for any property that has had hazardous substances (as defined and listed in CERCLA §101) stored for one year or more or known to have been released or disposed of on the property.

In the event of property transfer, DOE will ensure that DOE's property disposal agent incorporates the LUC objectives and LUCs into restrictive covenant languages in the deeds transferring the property. Each deed will also contain a reservation of access to the property for DOE, EPA, and TDEC, and their respective officials, agents, employees, contractors, and subcontractors for purposes consistent with the

FFA. The deed will contain appropriate provisions to ensure the restrictions continue to run with the land and are enforceable by DOE. The deeds shall also include a description of where the LUCs apply and may reference the interim Notice (see Property Record Notice) that will be recorded in the County Register of Deeds office and the zoning commission. Prior to final agreement on the property transfer and the transfer of fee title from DOE to the transferee, information regarding the environmental use restrictions and LUCs will be communicated in writing to the property owners and to appropriate state and local agencies to ensure such agencies can factor such conditions into their oversight and decision-making activities regarding the property.

5.5 LUC VERIFICATION AND REPORTING

The annual RER will evaluate the status of the LUCs and how any deficiencies or inconsistent uses have been addressed. The annual evaluation will address whether the use restriction and controls referenced above were communicated in the deed(s), whether the owners and state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed to such restrictions and controls.

6. MONITORING PLAN

6.1 INTRODUCTION

The principal goal of the WRRP monitoring plan for the BV administrative watershed is to meet the monitoring requirements specified by the CERCLA decision and primary post-decision documents for completed CERCLA actions in the watershed. Additional monitoring is conducted voluntarily by DOE to obtain baseline data that will be used to assess current trends and to determine performance of future actions, and to collect data in support of the FYR assessment of remedy protectiveness.

The following subsections briefly describe the organization of the RAR CMP appendices, which provide the monitoring specifics and details of surface water, groundwater, and biological sampling and analytical requirements and needs for the purposes of WRRP environmental monitoring in the BV administrative watershed. The monitoring data utilized by WRRP is stored in the Oak Ridge Environmental Information System.

6.2 ENVIRONMENTAL MONITORING LOCATIONS

Figure A.1 shows the surface water, groundwater, and biological sampling locations for WRRP environmental monitoring in the BV administrative watershed. Various symbols are used to indicate the different types of sampling media, e.g., a fish symbol indicates a biological monitoring location. Red-colored symbols are used for all monitoring conducted by the WRRP; blue-colored symbols are used for monitoring conducted by other programs on the ORR (e.g., Biological Monitoring and Abatement Program). Monitoring activities conducted by organizations other than the WRRP (e.g. Environmental Compliance Organization or the Biological Mapping and Abatement Program at ORNL) are ***not*** included in the Appendix C tables.

6.3 PLANNING TABLES—APPENDIX B TABLES

Table B in Appendix B provides a summary of WRRP environmental monitoring activities in the BV administrative watershed, including specific monitoring locations, media to be sampled (e.g., surface water, groundwater, biological), type of sample (e.g., grab), class of analytes (e.g., VOCs, metals, or radiological), sampling frequency, rationale for sampling (e.g., performance, baseline, FYR), and applicable performance standard, if available. To facilitate cross-referencing, the Appendix B Planning Table also shows the Appendix C Sample Group designation for the WRRP sampling locations in the BV administrative watershed.

Footnotes included in Table B define and explain table entries, and provide information to sampling personnel and data managers. An asterisk in the Primary Station Name column denotes a high-priority location for full data validation.

6.4 ADMINISTRATIVE SAMPLE GROUPS—APPENDIX C TABLES

Tables in Appendix C show the Administrative Sample Groups for the BV administrative watershed, which are subwatershed-level groups established for managing the sampling work conducted by the WRRP. Monitoring conducted by other programs in the BV administrative watershed is <u>not</u> included in the Appendix C tables. Table C.1 shows groundwater and surface water Administrative Sample Groups and Table C.2 provides Administrative Sample Groups for biological monitoring conducted in the watershed.

Table C.3 includes monitoring that is planned in support of the CERCLA FYR in the BV administrative watershed. Although this monitoring is conducted in the year prior to the FYR, the table serves as a holding place for information and planned monitoring captured on a real-time basis each year as data are evaluated. These monitoring locations may change each five-year cycle as results are evaluated and adjustments in monitoring are deemed necessary.

Administrative Sample Groups typically are based on the proximity of the sampling locations in the field, although other factors also may be used to group sampling locations, such as the necessity of obtaining contemporaneous data to measure remedial performance, or the timing of sampling conducted by other programs. Biological monitoring has been grouped together into a separate table to better track implementation by a specialized group of trained sampling personnel. The Appendix C tables also provide the specific analyte/parameter group for each sampling point in the BV administrative watershed. These analytes/parameters are grouped into Administrative Parameter Groups that are defined in Appendix D tables included in the WRRP QAPP (UCOR-4049) noted in Section 1. Analytical parameter group definitions have been included in a single QAPP (along with other quality assurance components of the program) because a change in a specified analytical method, detection limit, etc. would precipitate a change to every watershed-specific RAR CMP if these technical details were included in a combined RAR CMP/QAPP for each watershed.

Sampling personnel are typically grouped into teams that are dedicated to sampling specific media and follow sampling schedules that are planned at the beginning of the FY. However, there are occasions that sampling cannot be completed according to the schedule due to inclement weather (e.g., a long spell of rain when attempting to obtain base flow samples), site conditions or impediments (e.g., construction or security incidents), equipment malfunctions (e.g., multi-port well zones having equipment failures resulting in the necessity of accessing specialized personnel for repairs), and even the lack of cooperation of the target media (e.g., the target fish have migrated to a different part of the reservoir). When schedule slips such as these occur, the sampling team(s) will conduct other monitoring, as appropriate, and return to the postponed monitoring as conditions permit.

Each data summary table in Appendix C includes detailed footnotes that provide relevant information to sampling personnel and data managers.

7. DOCUMENT CONTROL

7.1 DATA MANAGEMENT

Monitoring data and meta-data generated by sampling activities in the BV administrative watershed, together with appropriate historical data required for data analysis and interpretations, are managed using the Project Environmental Measurements System (or equivalent system) and the Oak Ridge Environmental Information System. The Data Management Implementation Plan (UCOR-4160) serves as the project-level plan for managing all data collected by the WRRP. This plan outlines the data management requirements for the program. The plan outlines the program's data management activities, roles and responsibilities, and identifies data management interfaces among the various programs on the ORR involved in data acquisition, management, and reporting.

7.2 CHANGE REQUEST PROCESS

All modifications to the BV RAR CMP require an erratum. The instructions for initiating a change request to the RAR CMP and the necessary form is included in Appendix D. The RAR CMP Administrator (or authorized designee) will maintain the RAR CMP Addenda Log to track and document all changes to the watershed RAR CMP.

8. REFERENCES

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APPENDIX A
MONITORING FIGURES

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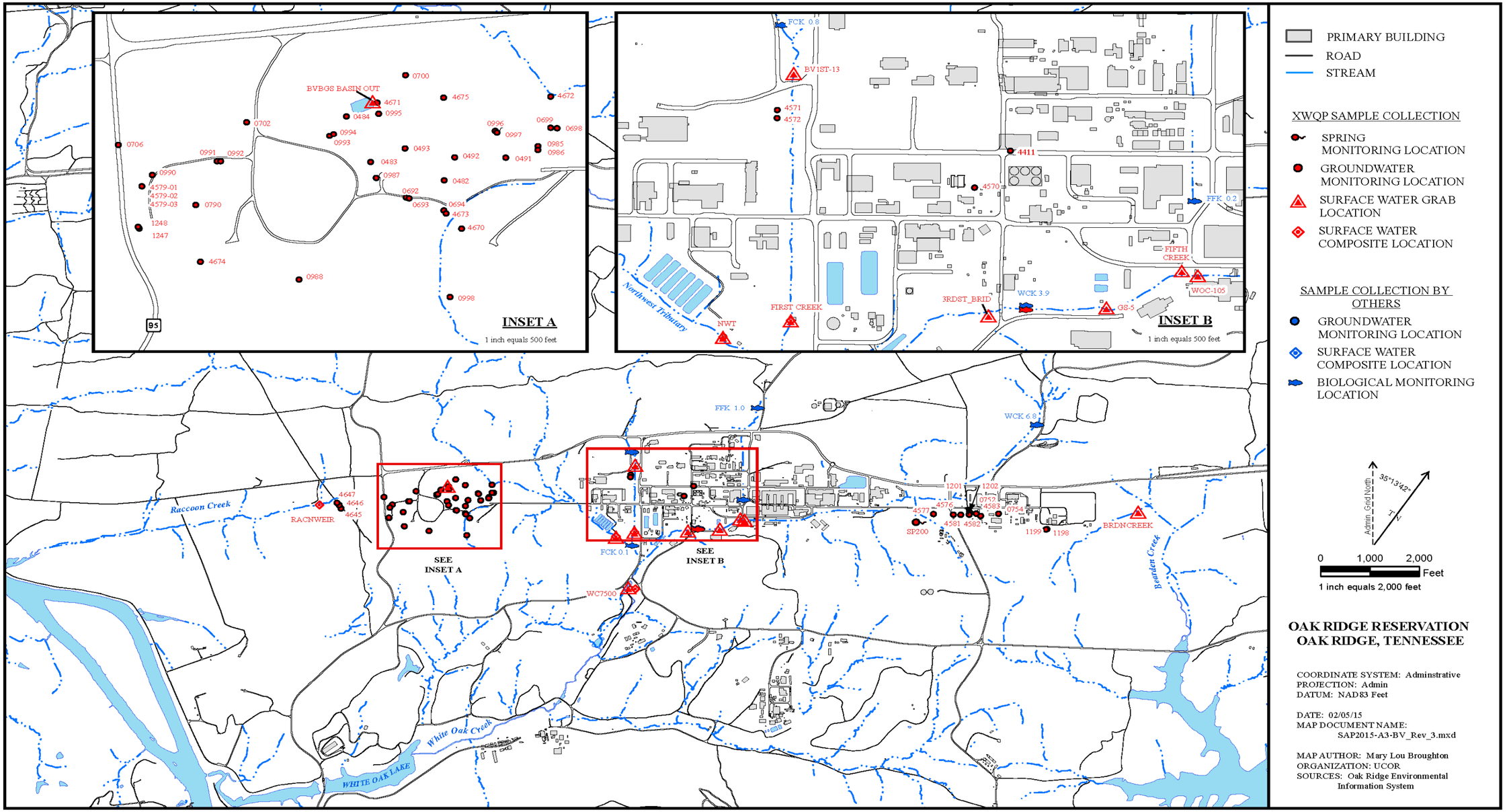

Figure A.1. Water Resources Restoration Program surface water, groundwater, and biological monitoring locations in the Bethel Valley (BV) administrative watershed.

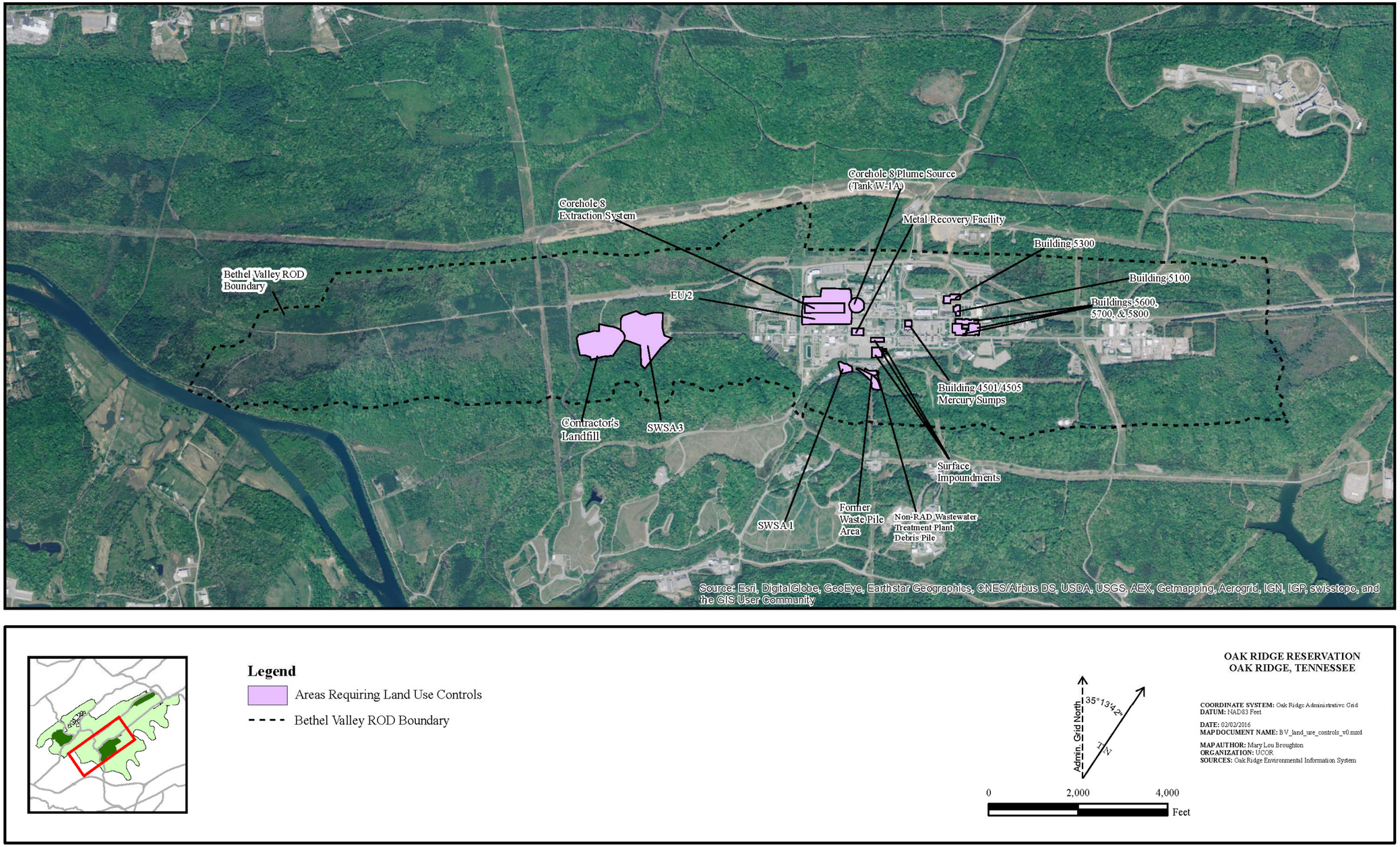

Figure A.2. BV administrative watershed areas affected by land use controls.

APPENDIX B
PLANNING TABLES

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Table B. Sample locations and parameters in Bethel Valley Watershed

Sample location	Primary station name*	Sample rationale[a]	Performance standard	Sample medium[b]	Sample Type[c]	Appendix C Sample Group[d]	VOCs	Metals	Radiological	AWQC[e]	Miscellaneous[f]	Biological monitoring	Flow/Precipitation[g]	Sampling program[h]	Sampling frequency[j]	Comments
Bethel Valley Watershed Exit Pathways																
BV 7000 Area	1198	BASE	Trend	G	G	BVW-6	2		2		2			XWQP	Q2, Q4	Watershed exit pathway monitoring for eastern BV groundwater (tritium plume determination)
BV 7000 Area	1199	BASE		G	G	BVW-6	2		2		2			XWQP	Q2, Q4	
Raccoon Creek	RACNWEIR*	PERF	Trend	S	C	BVW-1			12				C	XWQP	M	Bethel Valley Exit Pathway
SWSA 3	4579-01	PERF, BASE	Trend	G	G	BVW-6			2		2			XWQP	Q2, Q4*	
SWSA 3	4579-02			G	G	BVW-6			2		2			XWQP	Q2, Q4*	
SWSA 3	4579-03			G	G	BVW-6			2		2			XWQP	Q2, Q4*	
SWSA 3	4579-01	FYR	Trend	G	G	BVW-FYR1	2	2	2		2			XWQP	Q2, Q4 FYR	FYR - determine compliance with ROD requirement and 10^{-4} risk goal
SWSA 3	4579-02			G	G	BVW-FYR1	2	2	2		2			XWQP		
SWSA 3	4579-03			G	G	BVW-FYR1	2	2	2		2			XWQP		
7500 Bridge	WC7500	PERF, BASE	Hg ≤ 51 ppt (ng/L)	S	G	BVW-4		12						XWQP	M	Assess Hg concentration at 7500 Bridge
7500 Bridge	WC7500	FYR	AWQC	S	G	BVW-FYR2		1						XWQP	Q3 FYR	Annual assessment of AWQC compliance at exit pathway (BV mercury sump action)
7500 Bridge	WC7500*	PERF, BASE	$^{90}Sr \leq 37$ pCi/L $^{137}Cs \leq 33$ pCi/L	S	C	MV-3			12				C	XWQP	M	Assess 45% mass reduction goal from 1994 levels for ^{90}Sr and ^{137}Cs at the 7500 Bridge
BV 7000 Area	BRDNCREEK	BASE	Trend	S	G	BVW-2			2		2		I	XWQP	Q2, Q4	Watershed exit pathway monitoring for Eastern BV
Main Plant Area																
NWTRIB	NWT	PERF, BASE	Trend	S	C	BVW-1			12				C	XWQP	M	BV surface water contaminant flux and interior monitoring network (FYR - determine compliance with ROD requirement and 10^{-4} risk goal).
NWTRIB	NWT*	FYR	Trend	S	G	BVW-FYR1		2	2		2			XWQP	Q2, Q4 FYR	
WCK 3.9	WCK 3.9	PERF	Compare to reference location	B	SV	NA						1		BMAP	Q3	Benthic macroinvertebrate species richness and density
WCK 3.9	WCK 3.9			B	SV	NA						2		BMAP	Q1, Q3	Fish species richness and density

Table B. Sample locations and parameters in Bethel Valley Watershed (cont.)

Sample location	Primary station name*	Sample rationale[a]	Performance standard	Sample medium[b]	Sample Type[c]	Appendix C Sample Group[d]	VOCs	Metals	Radiological	AWQC[e]	Miscellaneous[f]	Biological monitoring	Flow/Precipitation[g]	Sampling program[h]	Sampling frequency[j]	Comments
WCK 3.9	WCK 3.9	FYR	Establish baseline trend to evaluate ecological risk	B	NA	BV-FYR3						1		XWQP	Q3 FYR	Bioaccumulation of COCs (metals, including Hg, and PCBs) in invertebrates (e.g., caddisflies) to evaluate risk to insectivores.
WCK 6.8	WCK 6.8	PERF	Compare to reference location	B	SV	NA						1		BMAP	Q3	Benthic macroinvertebrate species richness and density
WCK 6.8	WCK 6.8			B	SV	NA						2		BMAP	Q1, Q3	Fish species richness and density
Main Plant Area	FIFTH CREEK	BASE	Trend	S	G	BVW-2		2	2		2		I	XWQP	Q2, Q4*	BV surface water interior contaminant flux monitoring
Main Plant Area	FIFTH CREEK	FYR	Trend	S	G	BVW-FYR1		2	2		2		I	XWQP	FYR Q2, Q4	FYR - determine compliance with ROD requirement for historical COCs and 10^{-4} risk goal
Main Plant Area	GS-5	BASE	Trend	S	G	BVW-4			12		12			XWQP	M	BV surface water interior contaminant concentration monitoring
First Creek	FCK 0.1	PERF	Compare to reference location	B	SV	NA						4		BMAP	Q1, Q3	Fish and benthic macroinvertebrate species richness and density
First Creek	FCK 0.8			B	SV	NA						4		BMAP	Q1, Q3	Fish and benthic macroinvertebrate species richness and density
Fifth Creek	FFK 0.2	PERF	Compare to reference location	B	SV	NA						4		BMAP	Q1, Q3	Fish and benthic macroinvertebrate species richness and density
Fifth Creek	FFK 1.0			B	SV	NA						1		BMAP	Q1	Fish species richness and density
Performance Assessment																
Main Plant Area	FIRST CREEK	BASE	Trend	S	C	BVW-1			12				C	XWQP	M	BV surface water contaminant flux and interior monitoring network; Performance Assessment: Corehole 8 remedial effectiveness
Main Plant Area	FIRST CREEK*	FYR	Trend	S	G	BVW-FYR1		2	2	2	2			XWQP	FYR Q2, Q4	FYR - determine compliance with ROD AWQC (only VOCs have not been detected historically at this location) requirement and 10^{-4} risk goal

Table B. Sample locations and parameters in Bethel Valley Watershed (cont.)

Sample location	Primary station name*	Sample rationale[a]	Performance standard	Sample medium[b]	Sample Type[c]	Appendix C Sample Group[d]	VOCs	Metals	Radiological	AWQC[e]	Miscellaneous[f]	Biological monitoring	Flow/Precipitation[g]	Sampling program[h]	Sampling frequency[j]	Comments
Main Plant Area	BV1ST-13	FYR	Trend	S	G	BVW-FYR1		2	2	2	2			XWQP	FYR Q2, Q4	FYR - determine compliance with ROD AWQC (analyzing only for contaminants detected historically) requirements and 10^{-4} risk goal
Third Street Bridge	3RDST_BRID	FYR	Trend	S	G	BVW-FYR1		2		2	2		I	XWQP	FYR Q2, Q4	FYR - determine compliance with ROD AWQC (analyzing only for contaminants detected historically) requirement and 10^{-4} risk goal
CH-8 Plume	4411	PERF	Trend	G	G	BVW-5			4		4			XWQP	Q1-Q4	BV Performance Assessment: Corehole 8 plume remedial effectiveness
CH-8 Plume	4570			G	G	BVW-6			2		2			XWQP	Q2, Q4	
CH-8 Plume	4571			G	G	BVW-6			2		2			XWQP	Q2, Q4	
CH-8 Plume	4572			G	G	BVW-6			2		2			XWQP	Q2, Q4	
BV 7000 Area	SP200	BASE	Trend	S	G	BVW-5	4				4			XWQP	Q1-Q4	BV 7000 Area VOC groundwater plume monitoring
BV 7000 Area	0752			G	G	BVW-5	4				4			XWQP	Q1-Q4	
BV 7000 Area	1201			G	G	BVW-5	4				4			XWQP	Q1-Q4	
BV 7000 Area	1202			G	G	BVW-5	4				4			XWQP	Q1-Q4	
BV 7000 Area	4582			G	G	BVW-5	4				4			XWQP	Q1-Q4	
BV 7000 Area	4583			G	G	BVW-5	4				4			XWQP	Q1-Q4	
BV 7000 Area	4576			G	G	BVW-5	4				4			XWQP	Q1-Q4	
BV 7000 Area	4577			G	G	BVW-5	4				4			XWQP	Q1-Q4	
BV 7000 Area	4581			G	G	BVW-5	4				4			XWQP	Q1-Q4	
BV 7000 Area	0754			G	G	BVW-6	2				2			XWQP	Q2, Q4	
"Snapshot" of Hg Concentrations in Surface Water																
WOC-105	WOC-105	PERF	Trend (ultimately meet AWQC ≤51 ppt Hg at WC7500)	S	G	BVW-10		2						XWQP	Q1, Q3	Semi-annual assessment of Hg in surface waters in the White Oak Creek Watershed. Correlate with bioaccumulation data for biota in WOC watershed.[j]
Main Plant Area	FIFTH CREEK	BASE		S	G	BVW-10		2						XWQP	Q1, Q3	
Third Street Bridge	3RDST_BRID	BASE		S	G	BVW-10		2						XWQP	Q1, Q3	
7500 Bridge	WC7500	PERF		S	G	BVW-10		2						XWQP	Q1, Q3	

Table B. Sample locations and parameters in Bethel Valley Watershed (cont.)

Sample location	Primary station name*	Sample rationale[a]	Performance standard	Sample medium[b]	Sample Type[c]	Appendix C Sample Group[d]	VOCs	Metals	Radiological	AWQC[e]	Miscellaneous[f]	Biological monitoring	Flow/Precipitation[g]	Sampling program[h]	Sampling frequency[j]	Comments
BV Burial Grounds Performance Monitoring																
SWSA 3	BVBGS BASIN OUT	PERF	Compare to recreational goal of 1 x 10^{-4}	S	G	BVW-12	2	2	2					XWQP	Q1, Q3	SWSA 3 performance monitoring (for at least 5 years - through 2015)
SWSA 3	**0482**[k]	PERF	Reduce groundwater level fluctuations within isolated areas from pre-remediated conditions.[l]	G	WL	BVW-13					4			XWQP	Q1-Q4	Evaluate effectiveness of cap at controlling water table fluctuations and groundwater flow through SWSA 3 and Closed Scrap Metal Area (for at least 5 years - through 2015)
SWSA 3	**0483**[k]	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	**0484**[k]	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	**0491**[k]	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	**0492**[k]	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	**0493**[k]	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0692	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0693	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	**0694**[k]	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0698	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0699	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0700	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0702	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0706	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0790	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0985	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0986	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0987	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0988	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0990	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0991	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0992	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0993	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0994	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0995	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	**0996**[k]	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	**0997**[k]	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0998	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	

Table B. Sample locations and parameters in Bethel Valley Watershed (cont.)

Sample location	Primary station name*	Sample rationale[a]	Performance standard	Sample medium[b]	Sample Type[c]	Appendix C Sample Group[d]	VOCs	Metals	Radiological	AWQC[e]	Miscellaneous[f]	Biological monitoring	Flow/Precipitation[g]	Sampling program[h]	Sampling frequency[j]	Comments
SWSA 3	1247	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	1248	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4579-01	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4579-02	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4579-03	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4645	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4646	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4647	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4670	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4671	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4672	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4673	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4674	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	4675	PERF		G	WL	BVW-13					4			XWQP	Q1-Q4	
SWSA 3	0706	PERF	Trend to eventually reach goal of ≤ 8 pCi/L concentration of ^{90}Sr	G	G	BVW-12			2					XWQP	Q1, Q3	Performance monitoring for BV Burial Grounds (SWSA 3, Contractor's Landfill, Closed Scrap Metal Area) to determine a downward trend in ^{90}Sr concentration towards 8 pCi/L.
SWSA 3	0985	PERF		G	G	BVW-12	2		2					XWQP	Q1, Q3	
SWSA 3	0992	PERF		G	G	BVW-12	2	2	2					XWQP	Q1, Q3	
SWSA 3	0993	PERF		G	G	BVW-12	2	2	2					XWQP	Q1, Q3	
SWSA 3	0994	PERF		G	G	BVW-12	2	2	2					XWQP	Q1, Q3	
SWSA 3	0995	PERF		G	G	BVW-12			2					XWQP	Q1, Q3	
SWSA 3	0997	PERF		G	G	BVW-12	2	2	2					XWQP	Q1, Q3	
SWSA 3	4579-01	PERF		G	G	BVW-12	2	2	2					XWQP	Q1, Q3	
SWSA 3	4579-02	PERF		G	G	BVW-12	2	2	2					XWQP	Q1, Q3	
SWSA 3	4579-03	PERF		G	G	BVW-12	2	2	2					XWQP	Q1, Q3	
SWSA 3	4645	PERF		G	G	BVW-12		2	2					XWQP	Q1, Q3	
SWSA 3	4646	PERF		G	G	BVW-12		2	2					XWQP	Q1, Q3	
SWSA 3	4647	PERF		G	G	BVW-12		2	2					XWQP	Q1, Q3	

Table B. Sample locations and parameters in Bethel Valley Watershed (cont.)

Notes for Bethel Valley Watershed Table B:

[a] **Sample rationale:**

PERF = monitoring to evaluate remedial action(s) performance; BASE = baseline monitoring.
FYR = monitoring to support the five-year review of remedy effectiveness.

[b] **Sample medium:** G = groundwater, S = surface water, and B = biological.

[c] **Sample Type:** G = grab sample; C = composite (i.e., flow-proportional); SV = survey; WL = water level; NA = not applicable.

[d] **Sample Group:** Sample locations grouped together for collection within as short a time period as possible per Appendix C tables.

[e] **AWQC:**

Analysis of water for numeric ambient water quality criteria (AWQC) may require full suite analysis for constituents of the AWQC parameter group listed in the Quality Assurance Project Plan (UCOR-4049) or, depending on historical monitoring results, may include a subset of the AWQC parameter group [e.g., PEST(1) which includes some of the common pesticides; or DIOX, which represents the more common dioxins and furans].

[f] **Miscellaneous parameters:**

Miscellaneous may include general water quality parameters (e.g., total dissolved solids, total suspended solids, total organic carbon, temperature, dissolved oxygen, turbidity, pH, conductivity, oxidation-reduction potential) and water levels (in wells).

[g] **Flow/Precipitation:**

C = continuous flow measurements (usually accompanied by a flow-proportional composite sample)
I = instantaneous flow measurement (usually accompanied by a grab sample)

[n] **Program:** XWQP = X-10 Water Quality Program (implemented by EMEF); BMAP = Biological Monitoring and Abatement Program.

[i] **Sample Frequency:**

M = monthly
Q1.Q4 = lists sample schedule by FY quarters
FYR = Sampling conducted in the year prior to the CERCLA Five-Year Review
* = Sample in years other than year prior to Five-Year Review (i.e., alternate with Five-Year Review-specific monitoring)

[j] Monitoring locations within Sample Group BVW-10 fall within Bethel Valley in the White Oak Creek watershed, as shown on Figure A.1. Samples within this Sample Group shall be collected within as short a timeframe as possible to provide a "snapshot" of conditions with respect to Hg concentrations in surface water. Correlate with bioaccumulation data for biota in WOC watershed.

Table B. Sample locations and parameters in Bethel Valley Watershed (cont.)

[κ] **Bold** values represent wells included in Table 7-2 of the PCCR for BV Burial Grounds (DOE/OR/01-2533&D2) which specifies long-term water table elevation goals, as listed in the table below:

Wells	Elevation Goal (msl)
482	823
483	835
484	824
491	816
492	818.5
493	829
694	838.33
996	814.31
997	818.64

[*]In "Primary station name" column, denotes high-priority locations for full data validation.

AWQC = ambient water quality criteria
BV = Bethel Valley
CH = corehole
COC = contaminant of concern
EMEF = Environmental Management and Enrichment Facilities
FCK = First Creek kilometer
FFK = Fifth Creek kilometer
FY = fiscal year
FYR = Five-Year Review
msl = mean sea level
NWTRIB = Northwest Tributary
PCB = polychlorinated biphenyls
PCCR = Phased Construction Completion Report
ROD = Record of Decision
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation
VOC = volatile organic compound
WBK = Walker Branch kilometer
WCK = White Oak Creek kilometer
WOC = White Oak Creek

APPENDIX C
ADMINISTRATIVE SAMPLE GROUP TABLES

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Table C.1. Sample groups for the XWQP in the Bethel Valley Watershed

Sample group[a]	Location[b]	Sampling point[b]	Monitoring Frequency[c]	Matrix[d]	Sample Type[e]	Flow/ Precip[f]	Dup[g]	Analyte/parameter group[h]
BVW-1	EXP	RACNWEIR*	M	WS	C	C		SR(1)
	MPA	FIRST CREEK		WS	C	C	X	ALPHA(1), GAMMA(1), SR(1)
	SWSA3	NWTrib		WS	C	C		SR(1)
BVW-2	MPA	FIFTH CREEK	Q2, Q4	WS	G	I		FLD(1), MET(1,4,6), ALPHA(1), BETA, GAMMA(1), SR(1), T
	BV 7000 Area	BRDNCREEK		WS	G	I		FLD(1), T
BVW-4	MPA	GS-5	M	WS	G			FLD(1), ALPHA(1), GAMMA(1), SR(1)
	7500 Bridge	WC7500		WS	G			MET(4,6)
BVW-5	CH-8 Plume	4411	Q1 - Q4	WG	G			FLD(1), SR(1)
	BV 7000 Area	0752		WG	G			FLD(1), VOC(1)
	BV 7000 Area	1201		WG	G			FLD(1), VOC(1)
	BV 7000 Area	1202		WG	G			FLD(1), VOC(1)
	BV 7000 Area	4582		WG	G		X	FLD(1), VOC(1)
	BV 7000 Area	4583		WG	G			FLD(1), VOC(1)
	BV 7000 Area	4576		WG	G			FLD(1), VOC(1)
	BV 7000 Area	4577		WG	G			FLD(1), VOC(1)
	BV 7000 Area	4581		WG	G			FLD(1), VOC(1)
	BV 7000 Area	SP200		WS	G			FLD(1), VOC(1)
BVW-6	BV	4579-01	Q2, Q4	WG	G			FLD(4), ALPHA(1), BETA, SR(1)
	BV	4579-02		WG	G		X	FLD(4), ALPHA(1), BETA, SR(1)
	BV	4579-03		WG	G			FLD(4), ALPHA(1), BETA, SR(1)
	CH-8 Plume	4570		WG	G			FLD(1), SR(1)
	CH-8 Plume	4571		WG	G			FLD(1), SR(1)
	CH-8 Plume	4572		WG	G			FLD(1), SR(1)
	BV 7000 Area	0754		WG	G			FLD(1), VOC(1)
	BV 7000 Area	1198		WG	G			FLD(1), VOC(1), T
	BV 7000 Area	1199		WG	G			FLD(1), VOC(1), T
BVW-10 (Hg Snapshot)	MPA	WOC-105[i]	Q1, Q3	WS	G			MET(4,6)
	MPA	FIFTH CREEK		WS	G			MET(4,6)
	Third Street	3RDST_BRID		WS	G			MET(4,6)
	7500 Bridge	WC7500		WS	G		X	MET(4,6)

Table C.1. Sample groups for the XWQP in the Bethel Valley Watershed (cont.)

Sample group[a]	Location[b]	Sampling point[b]	Monitoring Frequency[c]	Matrix[d]	Sample Type[e]	Flow/ Precip[f]	Dup[g]	Analyte/parameter group[h]
BVW-12	SWSA 3	BVBGS BASIN OUT	Q1, Q3	WS	G			MET(1), VOC(1), SR(1), T
	SWSA 3	0706		WG	G			SR(1), T
	SWSA 3	0985		WG	G			VOC(1), SR(1), T
	SWSA 3	0992		WG	G			MET(1), VOC(1), ALPHA(1), BETA, SR(1), T
	SWSA 3	0993		WG	G			MET(1), VOC(1), ALPHA(1), BETA, SR(1), T
	SWSA 3	0994		WG	G			MET(1), VOC(1), ALPHA(1), BETA, SR(1), T
	SWSA 3	0995		WG	G			SR(1), T
	SWSA 3	0997		WG	G		X	MET(1), VOC(1), ALPHA(1), BETA, SR(1), T
	SWSA 3	4579-01		WG	G			MET(1), VOC(1), ALPHA(1), BETA, SR(1), T
	SWSA 3	4579-02		WG	G			MET(1), VOC(1), ALPHA(1), BETA, SR(1), T
	SWSA 3	4579-03		WG	G			MET(1), VOC(1), ALPHA(1), BETA, SR(1), T
	SWSA 3	4645		WG	G			MET(1), SR(1), T
	SWSA 3	4646		WG	G			MET(1), SR(1), T
	SWSA 3	4647		WG	G			MET(1), SR(1), T
BVW-13	SWSA 3	**0482**[j]	Q1 - Q4	WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	**0483**[j]		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	**0484**[j]		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	**0491**[j]		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	**0492**[j]		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	**0493**[j]		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0692		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0693		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	**0694**[j]		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0698		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0699		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0700		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0702		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0706		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0790		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0985		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0986		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0987		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0988		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0990		WG	WL			Quarterly Synoptic Water Levels

Table C.1. Sample groups for the XWQP in the Bethel Valley Watershed (cont.)

Sample group[a]	Location[b]	Sampling point[b]	Monitoring Frequency[c]	Matrix[d]	Sample Type[e]	Flow/ Precip[f]	Dup[g]	Analyte/parameter group[h]
BVW-13 (cont.)	SWSA 3	0991		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0992		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0993		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0994		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0995		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	**0996**[j]		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	**0997**[j]		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	0998		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	1247		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	1248		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4579-01		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4579-02		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4579-03		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4645		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4646		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4647		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4670		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4671		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4672		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4673		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4674		WG	WL			Quarterly Synoptic Water Levels
	SWSA 3	4675		WG	WL			Quarterly Synoptic Water Levels

Table C.1. Sample groups for the XWQP in the Bethel Valley Watershed (cont.)

Notes for Bethel Valley Watershed Table C.1:

[a] **Sample Group**

BVW = Bethel Valley Watershed sample group number

Samples will be collected in the sequence shown during as short a time period as possible following the schedule under Monitoring Frequency.

[b] **Location and Sampling Point**

BV = Bethel Valley
BVBGs = Bethel Valley Burial Grounds
CH = corehole
EXP = Exit Pathway
MPA = Main Plant Area (Oak Ridge National Laboratory)
MV = Melton Valley
NWTrib = Northwest Tributary
SWSA = Solid Waste Storage Area
WOC = White Oak Creek

[c] **Monitoring Frequency**

Q_ = Quarter of the fiscal year (e.g., Q1, Q2, Q3, Q4)
M = Monthly (Samples are typically collected on the last Wednesday of each month)

[d] **Matrix**

WG = Groundwater
WS = Surface water

[e] **Sample Type**

G = grab sample
C = composite
WL = water level

[f] **Flow/Precipitation**

C = continuous flow measurement (often accompanied by a flow-proportional composite sample)
I = instantaneous flow measurement (often accompanied by a grab sample)

[g] **Duplicate**

X = field duplicate sample collected

[h] **Analyte/Parameter group:**

See Table D.1 in the Quality Assurance Project Plan (UCOR-4049) for a list of parameter groups and analytes.

NOTE: Full suite analysis of water for numeric AWQC constituents requires analysis of AWQC parameter group, in addition to MET(1), MET(4), VOC(1), and SVOC, per methods and requested reporting limits contained therein.

[i] Collect sample above the mixing zone at the confluence of White Oak Creek and Fifth Creek.

Table C.1. Sample groups for the XWQP in the Bethel Valley Watershed (cont.)

[j] **Bold** values represent wells included in Table 7-2 of the PCCR for BV Burial Grounds (DOE/OR/01-2533&D2) which specifies long-term water table elevation goals, as listed in the table below:

Wells	Elevation Goal (msl)
482	823
483	835
484	824
491	816
492	818.5
493	829
694	838.33
996	814.31
997	818.64

***** Notation in "Sampling Point" column designates high-priority location for full data validation

AWQC = ambient water quality criteria

XWQP = X-10 Water Quality Project

Table C.2. Sample groups for biological monitoring conducted in Bethel Valley

Sample group[a]	Location[b]	Sampling point[b]	Monitoring Frequency[c]	Matrix[d]	Sample Type[e]	Flow/ Precip[f]	Dup[g]	Analyte/parameter group[h]
BIOLOGICAL MONITORING IN SUPPORT OF FIVE YEAR REVIEW (FYR)								
BVW-FYR3	BV	WCK 3.9	Q3 (year prior to FYR)	IN	C			B-MET(1,2,3), B-PCB, LIPIDS

Notes for Table C.2, Biological Monitoring:

[a] **Sample Group:**

BVW = Bethel Valley Watershed sample group number
FYR = sample in the year prior to the CERCLA FYR

Samples will be collected within each sample group during as short a time as possible, following the schedule indicated.

[b] **Location and Sampling Point:**

BV = Bethel Valley
WCK = White Oak Creek kilometer

[c] **Monitoring Frequency:**

Q_ = Quarter(s) of the fiscal year

[d] **Matrix:**

B = biological
IN = invertebrate

[e] **Sample Type:**

C = whole-body composite

[f] **Flow/Precipitation:** not applicable

[g] **Duplicate:** Field duplicate samples will be collected, as appropriate.

[h] **Analyte/parameter Group:**

See Table D.1 of the Quality Assurance Project Plan (UCOR-4049) for a list of parameter groups and analytes.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
FYR = Five-Year Review

Table C.3. Sample groups for monitoring conducted in support of the CERCLA Five-Year Review

Sample group[a]	Location[b]	Sampling point[b]	Monitoring Frequency[c]	Matrix[d]	Sample Type[e]	Flow/ Precip[f]	Dup[g]	Analyte/parameter group[h]
BVW-FYR1	EXP	4579	Q2, Q4	WS	NA			FLD(4)
	EXP	4579-01		WG	G		X	VOC(1), MET(1,4), ALPHA(1), BETA, SR(1), T
	EXP	4579-02		WG	G			VOC(1), MET(1,4), ALPHA(1), BETA, SR(1), T
	EXP	4579-03		WG	G			VOC(1), MET(1,4), ALPHA(1), BETA, SR(1), T
	MPA	FIRST CREEK*		WS	G			FLD(1), AWQC (except VOCs), MET(1,4,6), ALPHA(1), BETA, GAMMA(1), SR(1), T
	MPA	BV1ST-13		WS	G			FLD(1), MET(1,4,6), PEST(1), ALPHA(1), BETA, GAMMA(1), SR(1), T
	MPA	3RDST_BRID		WS	G	I		FLD(1), PEST(1), DIOX, MET(1,4,6)
	MPA	FIFTH CREEK		WS	G	I		FLD(1), MET(1,4,6), ALPHA(1), BETA, GAMMA(1), SR, T
	SWSA3	NWTrib*		WS	G		X	FLD(1), MET(1,4,6), SR(1)
BVW-FYR2	7500 Bridge	WC7500	Q3	WS	G			MET(4,6)

Notes for Table C.3, Monitoring in Support of the Five-Year Review:

[a] **Sample Group:**

BVW = Bethel Valley Watershed sample group
FYR= sample in the year prior to the CERCLA Five-Year Review

Samples will be collected within each sample group during as short a time as possible, following the schedule indicated.

[b] **Location and Sampling Point:**

BV = Bethel Valley
EXP = Exit pathway
MPA = Main Plant Area
NWTrib = Northwest Tributary
SWSA = Solid Waste Storage Area

[c] **Monitoring Frequency:**

Q_ = Quarter(s) of the fiscal year

[d] **Matrix:**

WS = Surface Water WG = Groundwater

[e] **Sample Type:**

G = grab sample NA = not applicable

[f] **Flow/Precipitation:**

I = instantaneous flow measurement (often accompanied by a grab sample)

[g] **Duplicate:**

X = field duplicate sample will be collected

[h] **Analyte/parameter Group:**

See Table D.1 of the Quality Assurance Project Plan (UCOR-4049) for a list of parameter groups and analytes.
NOTE: Full suite analysis of water for numeric AWQC constituents requires analysis of AWQC parameter group, in addition to MET(1), MET(4), VOC(1), and SVOC, per methods and requested reporting limits contained therein.

*In Sampling Point column, denotes high-priority locations for full data validation.

AWQC = Ambient Water Quality Criteria
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980

APPENDIX D
CHANGE REQUEST PROCESS FOR THE BETHEL VALLEY ADMINISTRATIVE WATERSHED COMPREHENSIVE MONITORING PLAN

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INSTRUCTIONS FOR INITIATING A CHANGE TO LONG-TERM STEWARDSHIP REQUIREMENTS INCLUDED IN THE WATER RESOURCES RESTORATION PROGRAM WATERSHED-SPECIFIC COMPREHENSIVE MONITORING PLAN

The following delineates the Federal Facility Agreement (FFA) process for the documentation and approval of changes to long-term stewardship (LTS) requirements of the completed Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) actions that have been prescribed in decision documents or primary post-decision documents (e.g., Remedial Action Reports [RARs] or Phased Construction Completion Reports [PCCRs]) and consolidated in watershed-specific comprehensive monitoring plans (CMPs). Because most of the remediation decisions do not allow unrestricted end use, these sites will require LTS, which is the set of activities necessary to protect human health and the environment from physical hazards, residual contamination, and wastes remaining following remediation. LTS maintains the protectiveness of and ensures the integrity of the remedy, consisting of engineering controls (e.g., caps, treatment facilities, etc.) and land use controls (LUCs; e.g., fences, signs, access controls, etc.) for an extended, or possibly indefinite, period of time until residual hazards are reduced sufficiently to permit unrestricted and unlimited access. The integrity of the remedy is ensured through operations, inspection, surveillance, monitoring, maintenance, and evaluation. Together, these controls are the set of activities that ensures that the remedy functions properly and remains protective.

The decision/post-decision document in which the LTS requirement was initiated will have a pointer to the watershed-specific RAR CMP where all LTS changes are henceforward made. These changes may be initiated in response to on-going, real-time data evaluations on and off the Oak Ridge Reservation (ORR) or in response to recommendations provided in the annual Remediation Effectiveness Report (RER) or CERCLA Five-Year Review (FYR). The process described herein follows the FFA protocol presented in Subsection XXI.J *Subsequent Modification of Final Reports* and results in an erratum to the watershed-specific RAR CMP that is approved by all parties to the FFA.

1.0 RAR CMP ERRATUM

When a change in a LTS requirement is identified, the watershed RAR CMP Administrator (Water Resources Restoration Program [WRRP] personnel) is notified to initiate an RAR CMP erratum (see Figure D.1). The RAR CMP Administrator prepares a summary of the change that adequately describes the change and includes a technical justification of sufficient detail that enables reviewers to make an informed decision. This summary is transmitted informally to the FFA Project Managers (PMs) and/or Project Team members via e-mail to determine whether the change will be openly and/or partially received before additional effort is expended to prepare a formal transmittal package with a detailed technical justification, red-lined RAR CMP change pages, etc.

The FFA PMs and/or Project Team members (i.e., regulatory agencies) review the summary and respond (i.e., approve, reject) within 30 days, sending comments or requesting a formal meeting to discuss the change. If there is interest in the proposed summary change request, an RAR CMP erratum is prepared (Figure D.2) providing the necessary technical justification, reviewed by the appropriate classification office for public release, and a formal request is transmitted to the FFA PMs for approval along with red-lined primary document and RAR CMP change-pages attached and a draft watershed-specific erratum log (Figure D.3). The erratum is assigned a number that reflects (1) the fiscal year (FY) in which the erratum is issued, (2) the applicable watershed, and (3) a sequential number.

The first time that a change affects a requirement of a particular CERCLA Record of Decision (ROD) or finalized post-decision remediation document, a pointer will be placed in the relevant document(s) to

direct the interested party to the watershed-specific RAR CMP for all watershed requirements and/or changes henceforth. In the case of a CERCLA ROD, this pointer to the watershed-specific RAR CMP will be treated as a Non-Significant Change (NSC) to the CERCLA decision document and any changed text will be shaded, as appropriate. The WRRP will prepare this documentation for the Administrative Record (AR) Coordinator to place in the appropriate records (see below). After this pointer has been placed in the CERCLA decision/post-decision document that initially identified the LTS requirements, it is not anticipated that additional changes will be required to the finalized primary document and all future revisions to the finalized primary document requirements will be implemented through the watershed-specific RAR CMP using the change process described herein.

2.0 RAR CMP ERRATA LOG

Once the formal RAR CMP erratum is approved by the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Tennessee Department of Environment and Conservation (TDEC), the RAR CMP Errata Log for the applicable watershed is updated by inserting the approval dates into the appropriate column next to the applicable RAR CMP erratum number. The Log serves to document the change, approval dates, and all relevant information associated with the change, including the identification of the primary documents that initially included the requirements for monitoring (which now have a pointer to the watershed-specific RAR CMP) that are part of the AR.

3.0 FINAL DISTRIBUTION OF ERRATUM AND LOG

After approval, the final RAR CMP change pages, with red-lines removed, are distributed to the appropriate watershed RAR CMP holders, along with the updated RAR CMP Errata Log. The erratum number is placed in the footer of each change page to document the change.

4.0 AR

The AR Coordinator is alerted that a change to a CERCLA AR is forthcoming when a letter request for approval of a LTS/LUC change is sent from the DOE to the EPA and TDEC, and both of the approval letters from these regulatory agencies are received by the DOE. The formal letter request for an RAR CMP revision will contain the RAR CMP Errata Log and the erratum, itself, both of which listing the relevant primary documents impacted by the approved erratum and, therefore, identifying the AR. The RAR CMP Administrator provides the AR Coordinator with the documentation for changing the AR: (1) the pointer for the primary document(s) that initially contained the LTS/LUC requirement, as outlined in Section 1.0 (third paragraph), (2) as well as the changed pages to the watershed RAR CMP and a copy of the updated RAR CMP Errata Log, itself. In the case of a closed ROD, the AR Coordinator will “open” the AR and the change will be treated as a NSC to the ROD. An updated final index will be submitted when this is completed.

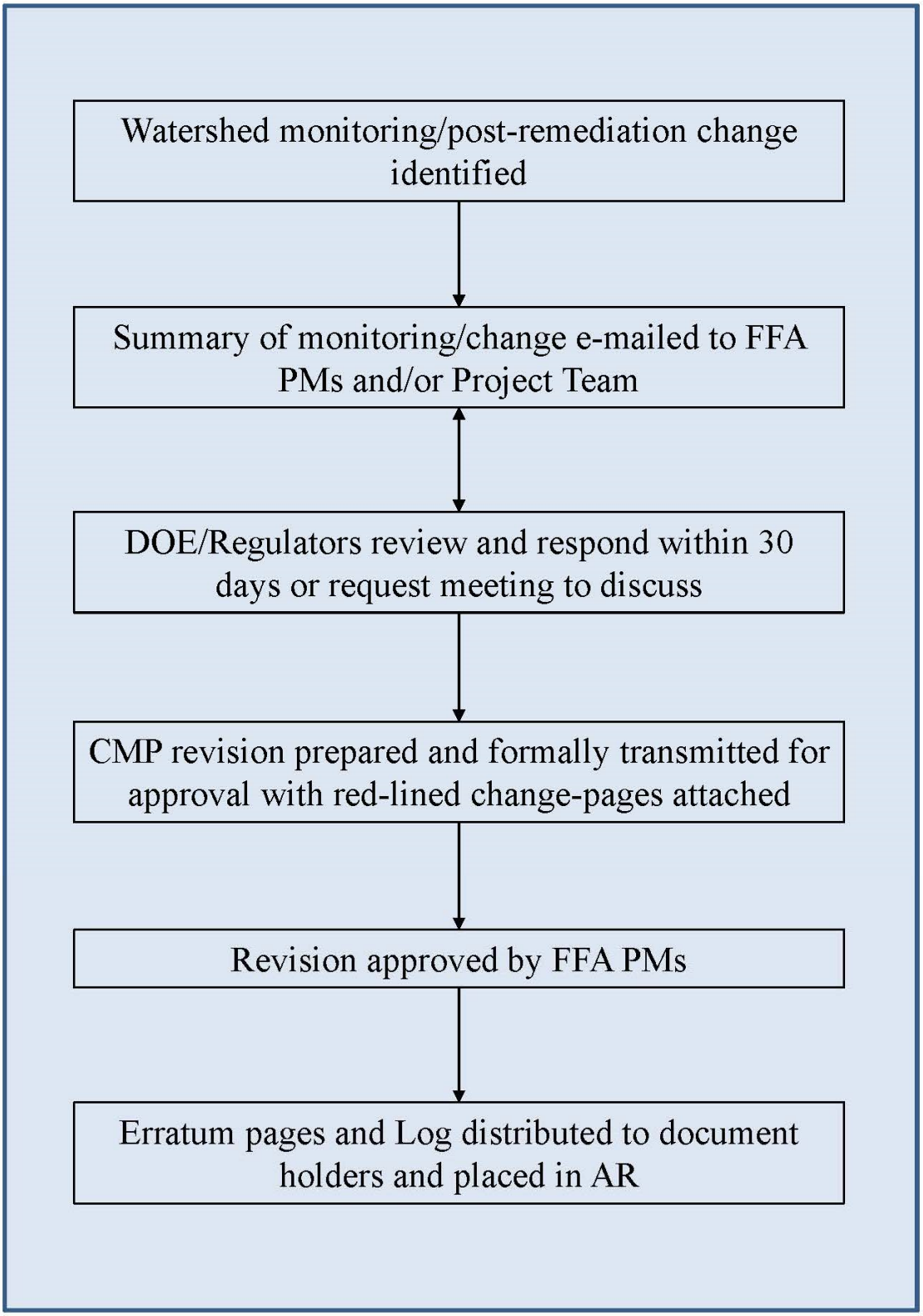

Figure D.1. Pathway to watershed RAR CMP changes.

WATERSHED COMPREHENSIVE MONITORING PLAN (CMP)

CHANGE FORM

CMP ERRATUM NUMBER: FY17-XXX-01 **EFFECTIVE DATE:** _____

Watershed affected by change:	☐ Melton Valley	☐ Bethel Valley
	☐ EFPC	☐ Bear Creek Valley
	☐ ETTP	☐ LWBR/CR/PC
	☐ N/A	☐ Chestnut Ridge

DOCUMENT NO. OF WATERSHED CMP AFFECTED BY CHANGE: _____

PRIMARY DOCUMENT(S) SUPERSEDED BY THIS WATERSHED CMP: _____

_____

_____

_____

Sampling Rationale:	☐ CERCLA performance	☐ Five-Year Review
	☐ CERCLA baseline	☐ Other _____
	☐ N/A	_____

Description of Change:

Reason for Change(s):

(Include rationale for change as *Attachment,* if necessary).

(Include red-lined change pages as *Attachment*).

Figure D.2. FFA Subsection XXI. J primary document erratum form.

RAR CMP Document Number	RAR CMP Erratum Number	Regulatory Approval Dates	Description of Change
DOE/OR/01-2466&D2	FY13-ChR-01	EPA: 09FEB13 TDEC: 20FEB13	Add ^{90}Sr to the analytical suite for spring monitoring location UNC SW-1 downgradient of the UNC Disposal Site. Also, footnote pages for Table B, Table C.1, and Table C.2 were updated to reference the revised WRRP QAPP (UCOR-4049). All monitoring requirements captured in the *Record of Decision United Nuclear Corporation Disposal Site* (July 28, 1991) and the *Postconstruction Report for the United Nuclear Corporation Disposal Site at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (DOE/OR/01-1128&D1) have been captured within this UEFPC/ChR watershed Comprehensive Monitoring Plan (RAR CMP), and from this point forward all changes to the ROD-stipulated monitoring will be captured within this RAR CMP, as well as in the Administrative Record for these primary documents.
DOE/OR/01-2466&D2	FY13-EFPC-01	EPA: 17OCT13 TDEC: 25SEP13	Align biological monitoring in East Fork Poplar Creek with the monitoring plan approved by the Division of Water Resources of TDEC and conducted by the Biological Monitoring and Abatement Program in support of the Y-12 Complex NPDES permit (see erratum for details). This biological monitoring represents baseline monitoring and, as such, is not required by any CERCLA primary document. Therefore, notification to the Administrative Record or post-decision file is not required for this change.
DOE/OR/01-2466&D2	FY13-EFPC-02	EPA: 17OCT13 TDEC: 25SEP13	Temporarily change the existing analytical detection limit for mercury (0.5 ng/L) at outfalls 150, 160, 163, and 169, as well as Station 8, in the UEFPC watershed to the more typical detection limit of 0.2 µg/L because current mercury concentrations do not warrant the lower detection limit. This change will continue until physical actions implemented under the Mercury Reduction Project to facilitate reduction and lessen mobility of mercury at the Y-12 Security Complex are seen in mercury concentrations at these monitoring stations. All monitoring requirements contained in the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3, p. 2-91) and the *Phased Construction Completion Report for the Big Spring Water Treatment System for Building 9201-2* (DOE/OR/01-2218&D1, p. 12) have been captured within and superseded by the UEFPC/ChR watershed RAR CMP (DOE/OR/01-2466&D2), and, from this point forward, all changes to the ROD-stipulated and PCCR-stipulated monitoring will be determined and implemented through this RAR CMP. The appropriate notations to this effect have been made in the Administrative Record(s) for these primary documents.
DOE/OR/01-2466&D3	N/A	(*b*)	Add monitoring location, LRBP-1, for measuring compliance with Tennessee ambient water quality criteria recreational (organisms only) with carbon tetrachloride (16 µg/L) to the EEVOC Plume monitoring network. Although the EEVOC Plume EE/CA (DOE/OR/01-1764&D4) clearly indicated that compliance with the CCl_4 water quality criteria would be attained instream downstream from the discharge point, this language was not carried through to the AM (DOE/OR/01-1819&D2). A Non-Significant Change to the EEVOC Plume AM and an Erratum to the RmAR (DOE/OR/01-2297&D1) to clarify that the point-of-compliance for monitoring is located downstream of the treatment system effluent discharge and beyond the edge of the mixing zone has been executed accordingly. From this point forward, all changes to the monitoring stipulated in the EEVOC Plume AM and RmAR will be captured in the watershed Comprehensive Monitoring Plan (DOE/OR/01-2466&D3 or latest version).
DOE/OR/01-2466&D3	N/A	EPA: TBD TDEC: TBD	Incorporate latest approved errata (FY13-EFPC-01 and FY13-EFPC-02), update figures and tables to reflect CERCLA activities completed since original issuance. Re-issue for 30-day finalization as primary document, per agreement.

Figure D.3. Example watershed-specific RAR CMP errata log.

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APPENDIX E
LAND USE CONTROLS FOR BETHEL VALLEY ADMINISTRATIVE WATERSHED

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Table E.1. LUCs for the BV watershed

Type of control	Duration	Implementation	Affected areas[a]	Verification frequency
1. Property Record Restrictions A. Land use B. Groundwater	Until the concentrations of hazardous substances are at such levels to allow for UU/UE CERCLA groundwater use prohibitions are in place until the final decision is made on groundwater	Drafted and implemented by DOE upon transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office.	All waste management areas and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions: A. 5100, 5300, 5600, 5700, and 5800 B. None	Five years
2. Property Record Notices	Until the concentrations of hazardous substances are at such levels to allow for UU/UE; CERCLA groundwater use prohibitions are in place until the final decision is made on groundwater	Notice recorded by DOE in accordance with state law at County Register of Deeds office and copied to the appropriate zoning office: A. As soon as practicable after signing of the ROD or B. Upon completion of RAs when appropriate	All waste management areas and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions: A. All BV (land use and groundwater) B. BVBGs (SWSA 1 and 3)	Five years
4. EPPP	Until the concentrations of hazardous substances are at such levels to allow for UU/UE; unauthorized groundwater use prohibitions are in place	• Implemented by DOE and its contractors • Initiated by permit request	Remediation systems, all waste management areas, and areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions: All BV (groundwater), BVBGs (no penetration), Corehole 8 Extraction System, Surface Impoundments, Metal Recovery Facility, Corehole 8 Plume Source (Tank W-1A), EU 2 (excluding 2026 complex and SW corner)	Monitor annually to ensure the permit program is functioning properly
5. Access Controls (e.g., fences, gates, portals, signs, surveillance patrols)	Until the concentrations of hazardous substances are at such levels to allow for UU/UE; CERCLA groundwater use prohibitions are in place until the final decision is made on groundwater	Controls maintained by DOE	Remediation systems, all waste management areas, and areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions: BVBGs, Corehole 8 Extraction System, Metal Recovery Facility	Verify annually that controls are being implemented

[a]Affected areas – The specific locations to which LUCs apply are documented in post-ROD documents.

BV = Bethel Valley
BVBGs = Bethel Valley Burial Grounds
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE = U.S. Department of Energy
EPPP = Excavation/Penetration Permit Program
EU = exposure unit
LUC = land use control
ORNL = Oak Ridge National Laboratory
RA = remedial action
ROD = Record of Decision
SWSA = Solid Waste Storage Area
UU/UE = unrestricted use/unlimited exposure

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Comment Resolution Form

Document Number:	Document Title:	
DOE/OR/01-2478&D2	Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee	
Name of Reviewer:	**Organization:**	**Date Comments Transmitted:**
Carl Froede	U.S. Environmental Protection Agency	

Comment No.	Sect/ Page	Comment	Response
General Comments			
1		This document does not convey all of the Data Quality Objectives (DQOs) specified in the Bethel Valley Interim Record of Decision. DQOs were developed for specific areas and that information should be presented along with an explanation how this document will be used to collectively meet the CERCLA goals.	Agree. As discussed at the comment response meeting on July 20, 2016, the RAR CMP does not establish Remedial Action Objectives (RAOs) or performance goals. The RAR CMP is the mechanism that provides the monitoring (environmental media) requirements and verification of LUCs to assess the performance of CERCLA activities against these RAOs and/or goals. Section 1.1 has been revised to describe the RAOs for the Bethel Valley ROD, define any performance objectives to meet the RAOs, explain how the monitoring and verification activities in the RAR CMP are used to demonstrate satisfaction of the RAOs, and list any future CERCLA actions to complete the watershed. The revised Section 1.1 follows: *The purposes of this* Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee *(RAR CMP) are to:* • *Assemble all performance and baseline environmental media monitoring and Land Use Controls (LUCs) and their verification requirements for completed Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) remedial actions and media removal actions in the Bethel Valley (BV) watershed into a single document. Some completed actions may include ongoing operations.* • *Assemble all Remedial Action Objectives (RAOs) and performance goals for completed CERCLA remedial actions and media removal actions in BV into a single document* • *Describe performance and baseline environmental media monitoring for BV* • *Identify LUCs, their objectives, and their verification requirements* • *Serve as BV Land Use Control Implementation Plan* *For the purpose of this document, environmental media monitoring includes monitoring of groundwater, surface water, and biological media, e.g., fish, turtles, biota surveys, etc., for both performance and baseline data assessments of trends, regulatory compliance, future actions, or in support of the Five-Year Review (FYR) of remedy protectiveness. In addition, the verification of LUCs is identified to ensure the integrity of the remedy is maintained.* *Since unlimited use/unrestricted exposure (UU/UE) seldom is achieved by these completed CERCLA remedial actions and media removal actions, attainment of RAOs and/or*

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			performance goals must be evaluated periodically to determine if the remedy is performing adequately. These RAOs and performance objectives are contained in the decision documents and/or the completion documents. In order to evaluate performance and effectiveness, environmental monitoring is required. Since all planned remedial actions, including groundwater, have not been completed for the watershed, baseline monitoring also is required so that RAOs and performance objectives of the subsequent CERCLA actions can be established. *Similarly, the decision documents and/or completion documents contain the LUCs required to achieve the remedy objective(s). The LUCs also need to be verified periodically to determine if the remedy remains protective. Therefore, this RAR CMP assembles all of the RAOs, performance objectives, LUCs, and monitoring and verification requirements into a single document for ease of implementation and tracking.* *Table 1 indicates which decision and completion documents contain requirements for monitoring and LUCs, and Table 2 describes the environmental monitoring performance goals. While the completion documents demonstrate that the remedy was completed per requirements, the monitoring and verification requirements in this RAR CMP allow the periodic evaluation of the completed CERCLA actions.* *The BV RAR CMP supersedes prior CERCLA decision and post-decision documents for environmental monitoring and verification requirements for identified LUCs. Once a requirement has been included and approved in the BV RAR CMP, any changes or revisions will be made through this document.*
2		The title and throughout the document, Bethel Valley is referred to as the "Bethel Valley Administrative Watershed." Please explain the distinction between "Bethel Valley Watershed" and "Bethel Valley Administrative Watershed."	Agree. The following text has been added to Section 2.2: *BV is not comprised of a single watershed in which a single exit pathway for surface water and groundwater exists. However, rather than subdivide the site into several subwatersheds (i.e., component parts), it is convenient to refer to it as a single watershed, or a single 'administrative' watershed.*
3		It should be clearly conveyed throughout the document that all WRRP-related sampling and analyses work is conducted in support of CERCLA monitoring and reporting requirements (e.g., Annual RER, the Five-Year Review, and site-specific CERCLA monitoring requirements). Otherwise, the WRRP work might be mistaken for DOE environmental work unrelated to CERCLA.	Agree. *Section 1.1* ***Purpose*** has been revised as follows: *For the purposes of this document, environmental media monitoring includes CERCLA monitoring of groundwater, surface water, and biological media, e.g., fish, turtles, biota surveys, etc., for both performance and baseline data assessments of trends, regulatory compliance, future actions, or in support of the Five-Year Review (FYR) of remedy protectiveness.*

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Specific Comments			
1	Section 1.1 Purpose, p. 1: Last paragraph	Last paragraph states: The BV CMP supersedes prior CERCLA decision and post-decision documents for monitoring and LUC requirements for the watershed. Once a requirement has been included in the BV CMP, any changes or revisions will be made through this document. COMMENT: This statement does not explain what the "prior CERCLA decision or post-decision documents" comprise. Please identify all such documents and their monitoring requirements so that this statement is clear.	Agree. ***Table 1. Completed actions at BV administrative watershed*** identifies the CERCLA action, the CERCLA decision and post-decision documents and status, the type of action taken, and whether there are media performance monitoring or land-use control requirements. The table also identifies these as watershed-scale actions or single-project actions. Within each of the listed documents, a standard format is followed which includes sections on Monitoring Schedule and Land Use Controls. A reference to Table 1 has been added to Section 1.1.
2	Section 1.2 Remediation Strategy, p. 1: Second paragraph	Second paragraph states: These surface water systems are fed by runoff from rainfall and by the groundwater that continually discharges to the surface streams. As much as 90% of the water entering the ground flows rapidly through highly porous, shallow soil, which contains most of the contaminated sites, before discharging to nearby surface water. Consequently, the primary pathway for contaminant migration is through shallow groundwater to surface water which then has the potential to flow off-site. Because of abundant rainfall (an average of 54 in/yr.), contaminant transport by shallow subsurface flow to surface waters, and the presence of contaminated sites in defined watersheds, a watershed strategy became the basis for environmental restoration. Comment: The DOE has not fully assessed groundwater migration pathways sufficiently to claim that "the primary pathway for contaminant migration is through shallow groundwater to surface	Clarification. The following text has been added to Section 1.2**:** *This monitoring plan is developed to monitor effectiveness of existing CERCLA actions and to conduct trend monitoring in selected locations to observe changes in environmental conditions. Existing CERCLA decisions in Bethel Valley are source control/removal actions that include goals for surface water and protection of groundwater from further contamination by source releases. A CERCLA decision for groundwater remediation has not been made for Bethel Valley. The ORR Groundwater Strategy document and the ORR Groundwater Program are intended to conduct investigations to support watershed scale decision-making.*" In Section 2.2, **East BV** description, the following text has been added: *The principal CERCLA contamination issue in East BV is the 7000 Area TCE Plume which is a bedrock TCE contaminated groundwater plume extending for at least 1500 feet from its source area and extending more than 150 feet below ground surface*.

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		water." While the basis of the "Watershed" groundwater decisions may have been based on this initial model, contaminant assessment across a watershed especially as it relates to long-term stewardship will need to consider all migration pathways and potential points of exposure. This section must be rewritten to address the potential for groundwater migration and possible long-term stewardship associated with understanding the dynamics of the entire system (i.e., shallow and deep flow). The issue is DNAPL which once fully characterized will have long-term stewardship implications. This issue is not captured in the second paragraph	
3	Section 1.2 Remediation Strategy, p. 2: Third paragraph	Third paragraph states: Therefore, the surface water acts as an integrator of contaminant flux, and integration points (IP; Figure 3) are identified in each watershed at which contaminant releases can be measured, assessed, tracked, and prioritized. Once the baseline monitoring and characterization are completed and the cleanup objectives are defined, the contribution of each remedial action (RA) toward achieving the objectives can be estimated and assessed at the watershed integration point. Through surface water monitoring both the specific performance of each action and the cumulative progress toward achieving the cleanup objectives can be assessed. Comment: The integration point (IP) locations presented in Figure 3 are far removed from any depositional settings that would more accurately reflect soil/sediment contamination possibly moving across and off the site.	Clarification. Surface water integration points (IPs) are points at which all upstream contaminant releases converge to exit the watershed (or subwatershed in the case of Bethel Valley). These locations within Bethel Valley have been established for decades and were chosen on the merits of the location's meeting the criteria of the definition. The definition of surface water IP is already provided in the text at the beginning of the 3rd paragraph of Section 2.2.1 Site Hydrogeology: *A surface water IP, the point through which all surface water (and, therefore, any contamination) within a watershed passes, has been established for each hydrologic subwatershed in the BV administrative watershed (Figure 3).*

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		Additionally, these IP locations have very limited utility in assessing the movement of subsurface DNAPL contamination and its probable daylighting along depressions, creeks, or streams. These IPs may need to be relocated or additional IPs added that can measure releases across the watershed as well as any required to address former site-specific actions. That process should occur with EPA participation.	
4	Section 1.2 Remediation Strategy, p. 2: Fourth paragraph	Fourth paragraph states: For the ORR the optimum solution needs to be determined at the watershed scale to ensure that the evaluation considers the cumulative resources needed for cleanup and the resource implications for alternate end uses. Also, the optimum decision for a single contaminated site may not be the same as when other contaminated sites in the same watershed are considered. The entire watershed must be considered as a whole. For this reason the optimum decision for each contaminated site is made in the context of the optimum solution for the entire watershed. The appropriate level of cleanup for a watershed can be established by focusing on future end use. Comment: Whether on a watershed scale or at the site-specific level the goal of CERCLA is to clean-up contamination and eliminate risk to humans and the environment. It is **not** focused on future end use. The "appropriate level of clean-up for all watersheds" is to address environmental risk and return contaminated groundwater to beneficial reuse. The goal of watershed restoration *is* the same goal as site-specific clean-	Clarification. The description of the remediation strategy is accurate and consistent with CERCLA, as evidenced by the approved watershed RODs. In the mid-1990s, DOE, EPA, and TDEC recognized that making numerous, individual remedial decisions was an inefficient use of limited resources, that remediation generally will not result in unlimited use/unrestricted exposure, and that inconsistent remedial decisions might be made without an overall strategy. Therefore, they agreed to make decisions at a watershed scale using consensus end uses for the watersheds to develop protective, risk-based remediation levels. The watersheds were used as a basis for decision-making because the primary pathway for offsite contaminant transport was via surface water. DOE commissioned the End Use Working Group Stewardship Committee to recommend end uses, and they published the *Stakeholder Report on Stewardship* in 1998 that made such recommendations. Subsequently, DOE, EPA, and TDEC collaboratively developed the first life-cycle baseline for the cleanup program in Oak Ridge based on making remedial decisions at the watershed scale. These watershed RODs do "eliminate risk to humans and the environment" by establishing risk-based remediation levels that are codified in the RODs and containing a series of actions to meet these remediation levels. When surface water is addressed in the watershed RODs, the stream classification (which is based on end use) is acknowledged. Groundwater has not been included in the watershed decisions, but when groundwater has been included in other decisions or when it is being considered for future decisions, restoration is acknowledged. Agree. The first five paragraphs of **Section 1.2** have been revised as follows: *In Oak Ridge, the U.S. Department of Energy (DOE) and its predecessor agencies have had a mission since the 1940s of uranium enrichment, weapons production, and energy research. As a result of this mission, there is a legacy of hundreds of contaminated sites on the Oak Ridge Reservation (ORR). The OR Site was placed on the CERCLA National Priorities List (NPL) in 1989. The Federal Facility Agreement for the Oak Ridge Reservation (FFA; DOE/OR-1014), signed by DOE, the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) in 1991, and*

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		up/restoration. This section must be rewritten to state the goals of watershed-scale remedial/removal actions, monitoring, and long-term stewardship are consistent with CERCLA.	*implemented on January 1, 1992, describes how remediation under CERCLA will be performed.* *In the mid-1990s, DOE, EPA, and TDEC recognized that making numerous, individual remedial decisions on the ORR was an inefficient use of limited resources, that remediation dealing with comingled radioactive elements and research developed compound releases generally would not result in UU/UE, and that inconsistent remedial decisions would result without an overall strategy tied to the anticipated end use of the area being addressed. Therefore, they agreed to make remedial decisions at a watershed scale using consensus end uses developed by the citizen stakeholders for the watersheds to develop protective, risk-based remediation levels. DOE commissioned the End Use Working Group Stewardship Committee to recommend end uses, and they published the Stakeholder Report on Stewardship in 1998 that made such recommendations. When surface water is addressed in the watershed decisions, the stream classification, e.g., recreational, fish and aquatic life, drinking water, etc., is acknowledged. Groundwater has not been included in the watershed decisions, but when groundwater has been included in other decisions or when it is being considered for future decisions, restoration is acknowledged.* *The watersheds were used as a basis for decision-making because the primary pathway for offsite contaminant transport is via surface water. The Clinch River bounds the ORR on three sides, and there are active creeks that flow down the valleys to the Clinch River (Figure 1). These surface water systems are fed by runoff from rainfall and by the groundwater that continually discharges to the surface streams. As much as 90% of the water entering the ground flows rapidly through highly porous, shallow soil, which contains most of the contaminated sites, before discharging to nearby surface water. Consequently, the primary pathway for contaminant migration is through shallow groundwater to surface water which then has the potential to flow off-site. Because of abundant rainfall (an average of 54 in./yr.), contaminant transport by shallow subsurface flow to surface waters, and the presence of contaminated sites in defined watersheds, a watershed strategy became the basis for remedial decision-making. Watershed remedial decision-making is an integrated, holistic approach to restore and protect ecosystems and to protect human health by focusing on hydrologically defined drainage basins. Watershed remedial decision-making is applied to the environmental restoration of the ORR by grouping contaminated sites into the following five watersheds (Figure 1):* • *Bethel Valley* • *Melton Valley* • *Bear Creek Valley* • *Upper East Fork Poplar Creek* • *ETTP*

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			Additionally, decisions have been made and/or actions taken off-site (Lower East Fork Poplar Creek, Clinch River/Poplar Creek, Union Valley, and Lower Watts Bar Reservoir) and on-site, within Chestnut Ridge, White Wing Scrap Yard and Oak Ridge Associated Universities South Campus Facility. *The watershed RODs contain performance objectives to be met and a series of RAs designed to achieve them. Completed CERCLA actions in the watershed are gauged against their action-respective goals through performance monitoring. However, when CERCLA actions have yet to be fully implemented within a watershed, monitoring of baseline conditions are conducted, against which the effectiveness of the actions can be evaluated in the future.*
5	Section 1.2 Remediation Strategy, p. 4, Last paragraph	The framework for remediation has been considered linear, progressing from identification of a potentially contaminated site through completion of remediation. However, because residual contamination on ORR will remain for long periods of time, a framework (NRC 2002) is needed that recognizes the iterative process of remediation (Figure 2). The RODs and environmental media action memoranda select and describe the remedy in terms of performance media monitoring requirements, ECs, LUCs, and their objectives. The remedy (performance media monitoring, ECs, and LUCs) is implemented with RA work plans, removal action work plans, or remedial design reports, and completion is documented in a Phased Construction Completion Report (PCCR), Remedial Action Report (RAR), or Removal Action Report (RmAR). The completion documents may further refine the performance media monitoring requirements, ECs, and LUCs. Comment: Please explain how this "Watershed" RAR will integrate with the individual site-specific RARs/RMARs/PCCRs in this watershed (i.e., Table 1). Focus on CERCLA	Agree. The reference to Figure 3 has been removed. The sentence following *Figure 2* has been deleted and the text has been revised as follows: *Table 1 lists all of the completed watershed-scale and single-project actions in BV that require monitoring and/or LUCs. A purpose of the RAR CMP is to assemble all of these requirements into a single primary document and then to make subsequent changes to these requirements through a revision to the RAR CMP and not to the plethora of completion documents. This consolidation will decrease the administrative burden of making and tracking changes, but, more importantly, will improve and simplify the understanding of the many requirements in each watershed. Thus, the RAR CMP will integrate the requirements currently in multiple documents into a single document. As additional response actions are completed, the RAR CMP will be revised to include them. If the annual Remediation Effectiveness Report or the Five Year Review recommends changes, the changes will be made in the RAR CMP and not the underlying completion document. This approach recognizes that, if a prescriptive component of a ROD is recommended for change, the ROD will have to be revised prior to the RAR CMP being changed.*

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		Remedial Action Objectives both individually and at the "watershed" scale.	
6	Section 1.2 Remediation Strategy, p. 5, First paragraph	Because most of the completed RAs and environmental media removal actions in BV do not allow UU/UE, **these sites require performance monitoring**, ECs, and/or LUCs to protect human health and the environment from physical hazards, residual contamination, and wastes remaining following the completion of remediation. Comment: This information is contained in Table 2 (pages 23 to 25) and should be cited in this paragraph.	Agree. The text has been revised as follows: *Because most of the completed RAs and environmental media removal actions in BV do not allow UU/UE, these sites require performance monitoring (Table 2) and/or LUCs to protect human health and the environment from physical hazards, residual contamination, and wastes remaining following the completion of remediation.*
7	Section 1.3 Organization of the BV Watershed CMP, p. 6	The text states: • Chapter 4 discusses environmental monitoring objectives and performance goals for completed **CERCLA** actions and baseline monitoring for the watershed as a whole. • Chapter 8 describes the data management protocols required under **CERCLA** and reported in the DOE WRRP. • Appendix C contains the Administrative Sample Group Tables for each monitoring location. Technical details regarding specific sampling and analysis requirements are deferred to the WRRP Quality Assurance Project Plan (QAPP; UCOR-4049), which identifies the field sampling procedures, laboratory analytical methods, and detailed data management protocols that are followed to ensure that the environmental monitoring data used for the purposes of the WRRP achieve appropriate levels of quality	Agree. The relevant text has been revised as follows: • *Chapter 4 discusses **CERCLA-derived** environmental monitoring objectives and performance goals for completed CERCLA actions and baseline monitoring for the watershed as a whole.* • *Chapter 7 describes the data management protocols which are **consistent with CERCLA** and implemented by the WRRP.* • *Appendix C contains the Administrative Sample Group Tables for each monitoring location. Technical details regarding specific sampling and analysis requirements are deferred to the WRRP Quality Assurance Project Plan (QAPP; UCOR-4099) **that meets CERCLA** requirements. This QAPP identifies the field sampling procedures, laboratory analytical methods, and detailed data management protocols that are followed to ensure that the environmental data used for the purposes of the WRRP achieve appropriate levels of quality assurance and quality control.*

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		assurance and quality control to meet CERCLA requirements. Comment: This is a CERCLA document and any/all environmental monitoring objectives and performance goals (Chapter 4) should be CERCLA-derived. Please state this in these bullets. Likewise, the data management protocols (Chapter 8) should meet CERCLA requirements. Appendix C presents a QAPP that meets CERCLA requirements and this should be conveyed.	
8	Section 2.2 Watershed Description, p. 8	The text states: Raccoon Creek—Raccoon Creek is an undeveloped area west of TN Highway 95 that contains slightly contaminated media resulting from transport of contaminants from sources located in West BV and in the uppermost portion of Raccoon Creek watershed. Comment: What are the "contaminated media?" Please list. Is the IP shown in Figure 3 at the Raccoon Creek weir designed to measure the "contaminated media" derived from West BV and Raccoon Creek?	Agree. Text has been revised as follows: ***Raccoon Creek****—Raccoon Creek is an undeveloped area west of TN Highway 95. Low levels of radiological contamination that originate from SWSA 3 are present in groundwater and surface water.*
9	Figure 3, p. 9	Please identify what media are collected at each of the three IPs shown. The reader should understand if these are groundwater, surface water, or sediments to understand the purpose of these IPs in identifying the migration of CERCLA contaminants across the watershed.	Agree. The figure has been revised to state that the IPs are surface water integration points. This is clearly stated in the third paragraph of Section 2.2.1 *Site Hydrogeology*.
10	Section 2.2.2 Watershed Conceptual Model, p. 10	The text states: Figure 4 illustrates some of the elements of a conceptual model for contaminant transport in the BV administrative watershed, providing a general framework of contaminant distribution and the	Agree. The following text has been added to the end of the first paragraph of *Section 2.2.2 Watershed Conceptual Model*: *The full delineation of the nature and extent of groundwater contamination is incomplete in many areas of the ORR, especially in defining deep flow pathways and contaminant transport at depth. The three agencies of the FFA will continue to work together in the future*

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		principal contaminant source areas. Comment: While the text states "some of the elements… for contaminant transport" what is not clear are the many data gaps. This section reads like the entire watershed and many areas of contamination are clearly understood. They are not. Text should be added that identifies data gaps and assumptions regarding contaminant migration. Something should be stated regarding possible DNAPL plume migration and the need for deeper monitoring wells both west and east along the valley. What is presented is a shallow-system conceptual model and there is much that remains unknown regarding the deeper groundwater flow system and the potential for contaminant migration along Bethel Valley.	*to identify projects that improve the understanding of groundwater flow pathways and contaminant migration based on a continually refined groundwater strategy. The final groundwater decision will be made after source control actions are complete, their effectiveness is monitored, and additional characterization data is collected.*
11	Section 2.2.3 Contaminants of Concern, p. 11-12	The text states: The following overview of environmental contamination in West BV, Central BV, and East BV, along with the watershed conceptual model for contaminant transport (Figure 4) described above, provides the general context for WRRP environmental monitoring in the BV administrative watershed. Comment: It should be noted that the environmental monitoring for groundwater contamination is only for shallow flow paths. Nothing has been done by the DOE to characterize the nature and extent of possible contaminant deep flow paths. That work remains to be conducted. It should also be noted that the WRRP environmental monitoring is in support of CERCLA reporting requirements (e.g.,	See response to Specific Comment #10 above.

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		RER, Five-Year Review, and site-specific CERCLA monitoring requirements. All of this needs to be conveyed in this paragraph.	
12	Section 2.2.3 Contaminants of Concern, p. 12	The text states: However, ^{3}H concentrations in surface water throughout WOC are still below the DOE-derived concentration standard (DOE-STD-1196-2011) and below remedy human health risk goals. Comment: What are "remedy human health risk goals?" Again, the program is CERCLA and it should be referenced throughout this document. While this section claims the levels of ^{3}H are not a risk to human health – does it pose a risk to ecological health? This sentence should be rewritten to clarify if there are CERCLA risks to human health and the environment.	Clarification. This sentence has been revised as follows: *However, ^{3}H concentrations in surface water throughout WOC remain lower than the DOE-derived concentration standard (DOE-STD-1196-2011) and far below IAEA-recommended aquatic exposure levels.*
13	Section 2.2.3 Contaminants of Concern, p. 12	The text states: There are two known sources of mercury discharge to Fifth Creek—releases from Building 4501 where mercury lithium isotope process pilot operations occurred in the 1950s, and an unknown source or sources that discharge from an outfall from the Isotopes Area into Fifth Creek. The first source, basement sump groundwater at Building 4501, is being treated by completed actions documented by DOE (DOE/OR/01-2472&D1). Comment: Was this a CERCLA action? The text only lists one area undergoing collection/treatment. Is the other mercury plume undergoing extraction and treatment? This is not reported in Table 1 – should it be? If this document is going to be "Watershed" scale and include actions	Clarification. The 2nd paragraph below the two bullets of *Section 2.2.3 Contaminants of Concern has been revised/replaced* as follows: There are two known sources of mercury discharge to Fifth Creek—releases from Building 4501 where mercury lithium isotope process pilot operations occurred in the 1950s, and an unknown source or sources that discharge from an outfall from the Isotopes Area into Fifth Creek. The ORNL Building 4501 basement sumps mercury actions were components of the BV Interim Actions ROD (see **Section 4.2 PERFORMANCE MONITORING**, *BV Mercury Sumps Groundwater Action*), which is listed in Table 1 as the **Mercury Treatment System** action performed and described in the *Phased Construction Completion Report for the Bethel Valley Mercury Sumps Groundwater Action Completion, Oak Ridge, Tennessee* (DOE/OR/01-2472). The other source of mercury discharge to Fifth Creek that has the unknown source has not been remediated.

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		taken to protect human health and the environment then it should clearly present everything in operation across the site and the regulatory driver(s) behind taking the action. Please clarify this section.	
14	Figure 4, p. 15	Text should be added to the caption that reflects this conceptual site model is for surficial and shallow groundwater flow paths. This cartoon does not capture the movement of contaminants through possible deep groundwater flow systems.	Clarification. The caption beneath Figure 4 has been revised to read: *Conceptual model for **shallow** contaminant transport in the BV administrative watershed.*
15	Section 4.2 Performance monitoring, p. 22, top paragraph and bullets	The text conveys environmental monitoring is required by CERCLA under "BV Mercury Sumps Groundwater Action." It is not clear in Table 1 which CERCLA documents correspond to this action. Please clarify the text and identify the appropriate CERCLA documents.	Clarification. The "BV Mercury Sumps Groundwater Action" refers to the action taken in Building 4501 as the first remedial action specified in the *BV Interim Actions ROD* and is described in detail within the last paragraphs immediately before Section 4.3 (under the italicized bolded heading ***BV Mercury Sumps Groundwater Action***). Also, it is listed in Table 1 under the *BV Interim Actions ROD* as the completion document, *PCCR for the **BV Mercury Sumps Groundwater Action*** (DOE/OR/01-2472&D1), and under Action Performed as the *Mercury Treatment System*. In order to clarify this information, the various sections of headers, tables, and text have been cross-referenced. The text in **Section 4.2 PERFORMANCE MONITORING** has been revised as follows: 1. To the fourth bullet, BV Mercury Sumps Groundwater Action, add the following parenthetical phrase after the name of the action: (ORNL Building 4501 basement sumps – Mercury Treatment System) 2. To the italicized header, *BV Mercury Sumps Groundwater Action*, provided just before the beginning of Section 4.3, add the parenthetical phrase: (ORNL Building 4501 basement sumps – Mercury Treatment System) 3. At the end of the first sentence under the italicized header, *BV Mercury Sumps Groundwater Action*, add the document number of the PCCR for the action: (DOE/OR/01-2472&D1). The text in **Section 3 CERCLA ACTIONS IN BV** has been revised as follows: 1. On the first page of Table 1, under the column titled *Completion document*, add (ORNL Bldg. 4501 sumps) after name, *PCCR for the BV Mercury Sumps Groundwater Action (DOE/OR/01-2472&D1) approved 08/27/10.*
16	Section 4.2 Performance monitoring,	Table 2 summarizes the environmental monitoring objectives and performance goals for these CERCLA actions in the BV	Clarification. The monitoring is to gage performance of the BV Mercury Sumps groundwater action, as is indicated in the Performance Standard column of Table 2 by the name of the action in parentheses. The CERCLA document number can then be determined in one of at

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	p. 22, bottom of first paragraph	administrative watershed as established by applicable CERCLA decision document(s) referenced in Table 1. In Table 2, p. 23, "Surface water" media, 7500 Bridge Weir, it documents the collection of mercury samples and lists the "Performance Standard" but it is not clear what CERCLA documentation is being used to conduct this work. Please identify the appropriate CERCLA documentation.	least two ways. The reader can look back to Table 1 to find the precise completed action listed under the Completion Document column that also requires monitoring (in this case, it would be the PCCR for the Bethel Valley Mercury Sumps Groundwater Action, DOE/OR/01-2472&D1, approved 08/27/10). Another way the reader can determine this information is to page through the Section 4.2 PERFORMANCE MONITORING to see which of the four bulleted actions listed best matches up with "Mercury Sumps." The action is discussed under the bold header BV Mercury Sumps Groundwater Action. The action itself, including the associated Interim ROD, is described in the first paragraph and the required monitoring is described in detail in the second paragraph.
16a		Please address all of the comments on the East Tennessee Technology Park RAR CMP where the same issues show up in the BV RAR CMP, including but not limited to Chapter 5 on LUCs (attached).	Agree. These comments have been included. When the comment requires a revision to text/table/figure, the equivalent change has been made to the BV RAR CMP, and the change has been shaded according to FFA protocol.
16b	Section 2.2, page 7, first paragraph, last sentence	Please add at the end of the sentence "that are covered by the BV IROD."	Agree. The text has been revised as follows: "However, the adjacent Raccoon Creek and Bearden Creek watershed also contain solid waste management units that are covered by the BV Interim ROD."
16c	Section 2.2.2, page 11, third paragraph	please confirm whether the first occurrence of the word "soil" should be "sediment".	Clarification. The first occurrence of the word "soil" in the third paragraph should not necessarily be "sediment." Soils quite readily form on floodplains from alluvium.
16d	Section 2.2.3, page 12	The text states: There are two known sources of mercury discharge to Fifth Creek—releases from Building 4501 where mercury lithium isotope process pilot operations occurred in the 1950s, and an unknown source or sources that discharge from an outfall from the Isotopes Area into Fifth Creek. The first source, basement sump groundwater at Building 4501, is being treated by completed actions documented by DOE (DOE/OR/01-2472&D1). Was this work initiated under CERCLA? Has it been captured in a CERCLA	Agree. See response to Specific Comment No. 13.

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		document? What makes this a CERCLA action? Please explain.	
16e	Section 4.2, page 22	Under *Watershed-scale ROD for BV,* in the first paragraph, last sentence, it states that "limited" additional groundwater characterization data will be collected. Please delete the word "limited" because data collection decisions will be made in the final RI.	Agree. The word "limited" has been deleted.
16f	Section 4.2, page 22	Under *Watershed-scale ROD for BV,* in the second paragraph, first sentence, please add "relevant to this report" at the end of the sentence.	Agree. The sentence has been revised as follows: The BV Interim Actions ROD (DOE/OR/01-1862&D4) specifies Remedial Action Objectives (RAOs), performance objectives and performance measures relevant to this RAR CMP.
16g	Section 4.2, page 22	Under *Watershed-scale ROD for BV,* in the second paragraph, last sentence, please add "part of" after "provide" since the final remedial investigation will form the foundation of the final ROD.	Agree. The text has been revised as requested.
16h	Section 4.2, page 26	In the last paragraph, second sentence, please clarify the phrase "that contribute to groundwater contamination above a 1 x 10-4 risk level for a hypothetical industrial use scenario." Groundwater does not distinguish industrial versus other uses. This phrase should reflect protection against leaching of contaminants from soil to groundwater, but not tied to use.	Agree. RAOs for groundwater in the text have been changed to be consistent with those in the ROD, as reflected in Table 3 of this RAR CMP. The revised text of final paragraph on page 26 follows: *In addition, the* Record of Decision for Interim Actions in Bethel Valley *(DOE/OR/01-1862&D4) specifies to maintain surface water and achieve sediment recreational risk-based limits to a goal of 1 x 10^{-4} Excess Lifetime Cancer Risk and the RAOs for groundwater are to minimize further impacts to groundwater and prevent groundwater from causing surface water exceedances in all waters of the state. The ROD did not specify applicable or relevant and appropriate requirement (ARAR)-based groundwater remediation levels and meeting such ARAR-based levels is not a performance objective of the ROD. The ROD also includes the requirements to monitor groundwater exit pathways and to monitor groundwater near contaminant source control areas to measure effectiveness of contaminant source control actions. Post-remediation monitoring requirements will be developed in the PCCR for each element of the remedy.*

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Comment Resolution Form

Document Number:	Document Title:	
DOE/OR/01-2478&D2	Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee	
Name of Reviewer: Randy Young	**Organization:** Tennessee Department of Environment and Conservation	**Date Comments Transmitted:** April 25, 2016; Received by DOE June 2, 2016

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1	Page 1, Section 1.2 Remediation Strategy 2nd paragraph	DOE should add some discussion of known and potential impacts from contaminant sources to both on-site and off-site groundwater.	Agree. The first five paragraphs of **Section 1.2** have been revised as follows: *In Oak Ridge, the U.S. Department of Energy (DOE) and its predecessor agencies have had a mission since the 1940s of uranium enrichment, weapons production, and energy research. As a result of this mission, there is a legacy of hundreds of contaminated sites on the Oak Ridge Reservation (ORR). The OR Site was placed on the CERCLA National Priorities List (NPL) in 1989. The Federal Facility Agreement for the Oak Ridge Reservation (FFA; DOE/OR-1014), signed by DOE, the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) in 1991, and implemented on January 1, 1992, describes how remediation under CERCLA will be performed.* *In the mid-1990s, DOE, EPA, and TDEC recognized that making numerous, individual remedial decisions on the ORR was an inefficient use of limited resources, that remediation dealing with comingled radioactive elements and research developed compound releases generally would not result in UU/UE, and that inconsistent remedial decisions would result without an overall strategy tied to the anticipated end use of the area being addressed. Therefore, they agreed to make remedial decisions at a watershed scale using consensus end uses developed by the citizen stakeholders for the watersheds to develop protective, risk-based remediation levels. DOE commissioned the End Use Working Group Stewardship Committee to recommend end uses, and they published the Stakeholder Report on Stewardship in 1998 that made such recommendations. When surface water is addressed in the watershed decisions, the stream classification, e.g., recreational, fish and aquatic life, drinking water, etc., is acknowledged. Groundwater has not been included in the watershed decisions, but when groundwater has been included*

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			in other decisions or when it is being considered for future decisions, restoration is acknowledged. *The watersheds were used as a basis for decision-making because the primary pathway for offsite contaminant transport is via surface water. The Clinch River bounds the ORR on three sides, and there are active creeks that flow down the valleys to the Clinch River (Figure 1). These surface water systems are fed by runoff from rainfall and by the groundwater that continually discharges to the surface streams. As much as 90% of the water entering the ground flows rapidly through highly porous, shallow soil, which contains most of the contaminated sites, before discharging to nearby surface water. Consequently, the primary pathway for contaminant migration is through shallow groundwater to surface water which then has the potential to flow off-site. Because of abundant rainfall (an average of 54 in./yr.), contaminant transport by shallow subsurface flow to surface waters, and the presence of contaminated sites in defined watersheds, a watershed strategy became the basis for remedial decision-making. Watershed remedial decision-making is an integrated, holistic approach to restore and protect ecosystems and to protect human health by focusing on hydrologically defined drainage basins. Watershed remedial decision-making is applied to the environmental restoration of the ORR by grouping contaminated sites into the following five watersheds (Figure 1):* • *Bethel Valley* • *Melton Valley* • *Bear Creek Valley* • *Upper East Fork Poplar Creek* • *ETTP* *Additionally, decisions have been made and/or actions taken off-site (Lower East Fork Poplar Creek, Clinch River/Poplar Creek, Union Valley, and Lower Watts Bar Reservoir) and on-site, within Chestnut Ridge, White Wing Scrap Yard and Oak Ridge Associated Universities South Campus Facility.* *The watershed RODs contain performance objectives to be met and a series of RAs designed to achieve them. Completed CERCLA actions in the watershed are gauged against their action-respective goals through performance monitoring. However, when CERCLA actions have yet to be fully implemented within a watershed, monitoring of baseline*

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			conditions are conducted, against which the effectiveness of the actions can be evaluated in the future.
2	Page 2, Section 1.2 Remediation Strategy, last paragraph, 3rd and 5th sentences	These sentences should be reworded. Although the watershed scale is used and considered with most actions on the Oak Ridge Reservation (ORR), the sentences are too absolute as they are worded. Individual decisions have been and will continue to be made in the watersheds.	Agree. See the response to Comment #1.
3	Page 7, Section 2.2, last bullet on page	Please modify the bullet to read: *"Several groundwater plumes…most of which partially discharge…along WOC (Figure 3). More information is needed to delineate the extent of contaminated groundwater plumes in Bethel Valley."*	Agree. However, because this section of the document is a high-level description of the four regions of the Bethel Valley watershed, details of required future investigations to support final CERCLA decisions and remedy decisions are not appropriate.
4	Page 8, Section 2.2, last bullet	If Raccoon Creek has potentially been impacted by contaminated groundwater, then the bullet should discuss that possibility.	Agree. The sentence has been revised to read, *Raccoon Creek is an undeveloped area west of TN Highway 95. Low levels of radiological contamination that originate from SWSA 3 are present in groundwater and surface water.*
5	Page 11, Section 2.2.2, 1st paragraph, 2nd sentence	The sentence should acknowledge the possibility of groundwater contaminants extending beyond the Northwest Tributary and Raccoon Creek.	Agree. Following the 2nd sentence, another sentence has been added stating: *Multiple points of contaminant influx to both streams result from the relatively large contaminant source area. The depth and lateral extent of plume migration beneath west BV have not been fully defined.*
6	Page 11, Section 2.2.2, 1st paragraph, 4th sentence	This sentence should be deleted or at least modified. The Interim Bethel Valley ROD did not make a decision on groundwater or ecological risk. The inclusion of that sentence in this report is unnecessary and confusing.	Agree. The sentence has been deleted.
7	Page 11, Section 2.2.2, 2nd and 4th paragraphs	Each of these paragraphs should also discuss the fact that there is not enough data to determine if all the contaminated groundwater discharges to creeks, pipelines, and sumps as the paragraphs suggest. There is not enough characterization data available to determine the extent of groundwater plumes in Bethel Valley.	Agree. The text has been revised as follows: *Central BV contains a large number of groundwater contaminant sources and very complex contaminant migration pathways. Existing data indicate that, although most of the contaminant transport appears to occur in relatively shallow zones, some contamination is present at depths of 200 feet or more in bedrock. Future CERCLA investigations are required to better characterize groundwater contamination in BV.*
8	Page 12, Section 2.2.3, 1st full paragraph	The first sentence should also mention the impact on contaminant migration from the rise and fall of groundwater into the SWSA 3 buried waste.	Agree. The paragraph has been modified to begin with the following sentences: *During FY 2011-12, the West BV Solid Waste Management Units were hydrologically isolated consistent with the BV ROD requirements. Post-remediation remedy performance demonstrates that, although a few wells*

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			have not yet attained remedy goals, the contaminant levels in groundwater and surface water (DOE/OR/01-2707&D2) have decreased significantly.
9	Page 15, Figure 4	The model completely ignores the possibility of contaminant migration over long distances by way of groundwater. Please revise the model accordingly.	Disagree. The figure is schematic in nature and depicts the approximate footprint of known groundwater plumes.
10	Page 30, 3rd full paragraph	The paragraph discusses monitoring that is being dropped per previous agreement of the FFA parties. A map and table would better provide the reader a clear picture of monitoring that has been dropped and monitoring that remains.	Clarification. No monitoring was "dropped" from the required program at the BVBGs per previous agreement of the FFA parties. The paragraph language has been revised to clarify the PCCR stipulated one year of initial monitoring, followed by slightly reduced monitoring that remains in place to date. The initial year of monitoring included a full year of quarterly synoptic groundwater levels, with a full year of continuous daily water levels collected from selected wells. After the first monitoring year, water levels would be collected quarterly from all wells, but the PCCR allowed that continuous monitoring may be discontinued.
11	Page 30, last paragraph, 5th sentence	The approach described in this sentence does not appear consistent with the goal of water level monitoring in wells to determine if groundwater elevations are reaching a level to infiltrate the waste trenches. Please explain.	Agree. The following language from the approved PCCR has been inserted into the paragraph: *If water levels are collected manually, they should not be collected within three days of a rain event equivalent to 0.5-in/24 hrs.*
12	Page 35, Section 5	This section attempts to draw a distinction between the approval processes for changing land use control (LUC) objectives versus changing land use controls. The distinction is unclear. For example, the details of how a LUC objective will be accomplished (e.g. the penetration permit program and access controls) are extremely important and ultimately decide if a LUC objective can be implemented. TDEC does not see the need for the distinction of the two processes when changes are being proposed by DOE.	Agree. Section 5 has been revised to reflect the definition of LUCs in EPA guidance. The revised text explains how changes can be made to LUCs and LUC objectives.
13	Page E-3, Table E-1	The FFA parties should discuss expanding the *Access Controls* to be more specific. TDEC understands one of the goals of developing this comprehensive plan is to consolidate requirements into one document. This section is very general and the table actually has a footnote directing the reader to previous documents.	Clarification. The specific areas to which access controls apply are listed in the "Affected areas" column of Table E.1. The footnote simply points to post-ROD documents as the source in which the specific areas are listed. Footnote "a" has been revised as follows: *The specific locations to which LUCs apply are documented in post-ROD documents.*