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Melton Valley Monitoring Plan, Oak Ridge, Tennessee

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March 13, 2002

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Dear Ms. Berry and Mr Young:

FINAL MELTON VALLEY MONITORING PLAN, OAK RIDGE, TENNESSEE (DOE/OR/01-1982&D1/R1) AND COMMENT RESPONSE FORM

Enclosed for your information are two copies each of the above referenced documents. This will satisfy the Federal Facility Agreement delivery date of March 15, 2002. If you have any questions, please contact John Julius at (865)-241-6676.

Sincerely,

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Melton Valley Monitoring Plan, Oak Ridge, Tennessee

Date Issued—March 2002

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ACRONYMS

ARAR	applicable or relevant and appropriate
AWQC	ambient water quality criteria
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	contaminant of concern
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EDE	effective dose equivalent
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
ETTP	East Tennessee Technology Park
FFA	Federal Facility Agreement
FY	fiscal year
HFIR	High Flux Isotope Reactor
HRE	Homogeneous Reactor Experiment
IHP	Intermediate Holding Pond
LLW	low-level (radioactive) waste
NPDES	National Pollutant Discharge Elimination System
OHF	old hydrofracture facility
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
P&A	plugging and abandonment
RAO	remedial action objective
RAWP	remedial action work plan
RCRA	Resource Conservation and Recovery Act of 1976
RDL	required detection limit
RDR	remedial design report
RDWP	remedial design work plan
RER	Remediation Effectiveness Report
RGO	remedial goal option
RI	remedial investigation
ROD	record of decision
SAP	sampling and analysis plan
SWSA	Solid Waste Storage Area
TDEC	Tennessee Department of Environment and Conservation
TRU	transuranic
VOC	volatile organic compound
WAG	Waste Area Grouping
WOD	White Oak Dam
WRRP	Water Resources and Recovery Program
XWQP	X-10 Water Quality Program

EXECUTIVE SUMMARY

This document presents the strategy and rationale for a surface and groundwater monitoring program in Melton Valley to support the requirements of the Melton Valley record of decision (ROD) for interim actions (DOE 2000a). The goal of the monitoring program is to collect data necessary to determine the extent to which the selected remedy is effective in meeting the remedial action objective (RAO), the performance measures, and other requirements of the ROD.

Because implementation of the full remedy will take place over many years, with different activities occurring at different stages, ROD monitoring will have two primary components: long-term, watershed-scale monitoring to show progress toward meeting the RAO; and shorter-term, action-specific monitoring geared toward showing compliance with action-specific applicable or relevant and appropriate requirements and performance measures.

The strategy for monitoring in Melton Valley to document long-term changes in environmental quality and to evaluate effectiveness of remedy component actions uses three types of data. For long-term watershed-wide contaminant discharge trend measurement, flow proportional surface water samples from the four mainstem weirs (White Oak Dam, Melton Branch Weir, White Oak Creek Weir, and the 7500 Bridge Weir) will continue to be collected and analyzed monthly to document the major radionuclide concentrations and fluxes. Supplemental grab samples will be taken for analysis of ambient water quality criteria parameters. To obtain data that measure performance of remedy actions as remediation projects are implemented, preconstruction surface water sampling will be implemented at appropriate tributary weirs (e.g., SWSA 4 Tributary, HRE Tributary, West Seep) and preconstruction groundwater samples will be collected from appropriate existing wells. Preconstruction monitoring for specific remediation projects (e.g., individual burial ground capping actions) will be specified in the annual Water Resources Restoration Program Sampling and Analysis Plan. Postconstruction surface water and groundwater monitoring will be determined in the remediation project remedial design report (RDR)/remedial action work plan (RDWP). A set of six multi-port exit pathway groundwater monitoring wells must be installed, according to the ROD. Monitoring of these wells, after installation, will identify groundwater contamination seeping toward the Clinch River at the western end of Melton Valley.

This monitoring plan is intended to serve as the framework for ROD monitoring in the valley. It includes detailed monitoring requirements for the next 1 to 2 years and the framework for monitoring requirements that will be implemented throughout the remedy. Details of monitoring locations, frequencies, and parameters are expected to vary throughout the implementation of remedial actions in Melton Valley. This monitoring plan outlines the long-term, watershed-scale monitoring requirements that will be fulfilled and identifies necessary integration of the watershed-scale and remediation project-specific monitoring. Monitoring data will be integrated and reported through the Water Resources Restoration Program Remediation Effectiveness Report. Pre-remediation baseline monitoring will be implemented through the WRRP and will be identified in the annual revisions of the WRRP SAP. Postremediation monitoring to measure remedy component effectiveness will be specified in project RDR/RAWPs and will be reported in the Remediation Effectiveness Reports.

1. INTRODUCTION

The purpose of this document is to present the strategy and rationale for a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) surface and groundwater monitoring program in the Melton Valley portion of Oak Ridge National Laboratory (ORNL). The Melton Valley record of decision (ROD) for interim actions (DOE 2000a) describes the remedial action objectives (RAO) for protecting workers and the public from contaminated media in the Melton Valley waste units and the selected remedial actions to attain the RAOs. The primary goal of the monitoring program is to collect the data necessary to determine the effectiveness of the remedial actions. Other goals are described in Sects. 3.1 and 3.2.

The monitoring program will be divided into two components—watershed-scale monitoring and action-specific monitoring. The watershed-scale monitoring program will include key surface water and groundwater monitoring locations and will determine and document the general environmental conditions in Melton Valley through time. The action-specific monitoring program will include the monitoring specified for preconstruction baseline and postconstruction monitoring [to be specified in the remedial design report (RDR)/remedial action work plan (RAWP)] to measure the effectiveness of remedial actions. It is expected that when the effectiveness of remedial actions has been adequately documented, some of the action-specific monitoring will become part of the watershed-scale monitoring program and the remainder will no longer be necessary. This report discusses details of near-term, action-specific monitoring only.

2. MELTON VALLEY CONCEPTUAL MODEL AND OVERVIEW OF THE MELTON VALLEY ROD

2.1 MELTON VALLEY CONCEPTUAL MODEL

2.1.1 Site Description and History

The 34,516-acre Oak Ridge Reservation (ORR) is located within and adjacent to the city limits of Oak Ridge, Tennessee, in Roane and Anderson counties (Fig. 2.1). Oak Ridge is located approximately 20.1 km (12.5 miles) west-northwest of Knoxville, 19.3 km (12 miles) southwest of Clinton, and 16.1 km (10 miles) northeast of Kingston. The ORR is bounded to the east, south, and west by the Clinch River (Melton Hill and Watts Bar lakes) and on the north by the developed portion of the City of Oak Ridge. The ORR hosts three major industrial research and production facilities originally constructed as part of the World War II-era Manhattan Project: East Tennessee Technology Park (ETTP, formerly the Oak Ridge K-25 Site), ORNL (formerly X-10), and the Y-12 National Security Complex.

Melton Valley lies within the southeastern portion of the ORR, 16 km (10 miles) southwest of the residential area of Oak Ridge, and encompasses approximately 1062 acres. Melton Valley is one of two valleys that comprise the ORNL land area and the White Oak Creek Watershed (Bethel Valley is the other) (Fig. 2.2). As shown in Fig. 2.2, the White Oak Creek Watershed contains four topographically distinct subwatersheds.

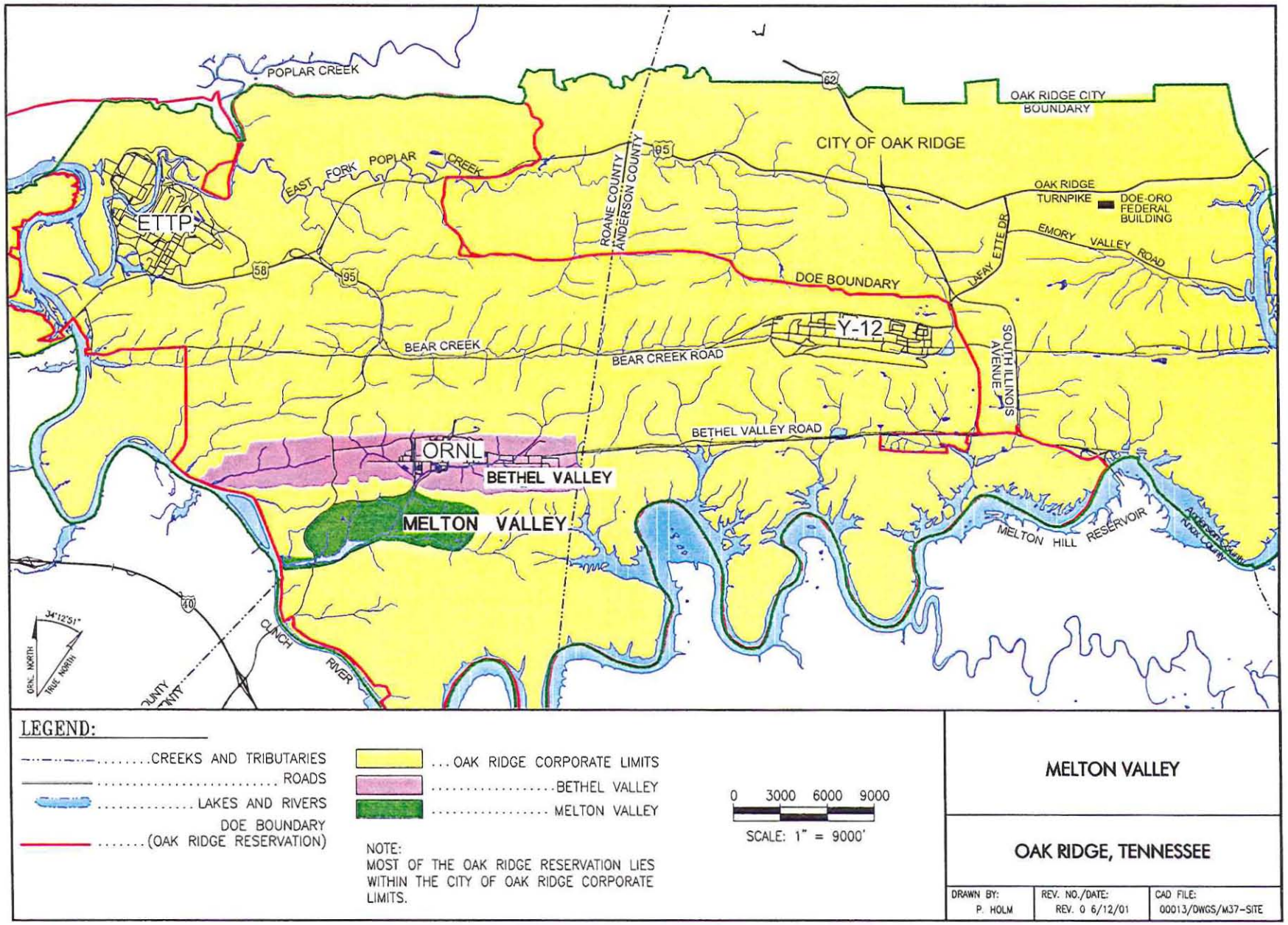


Fig. 2.1. Location of Melton Valley Watershed on the Oak Ridge Reservation.

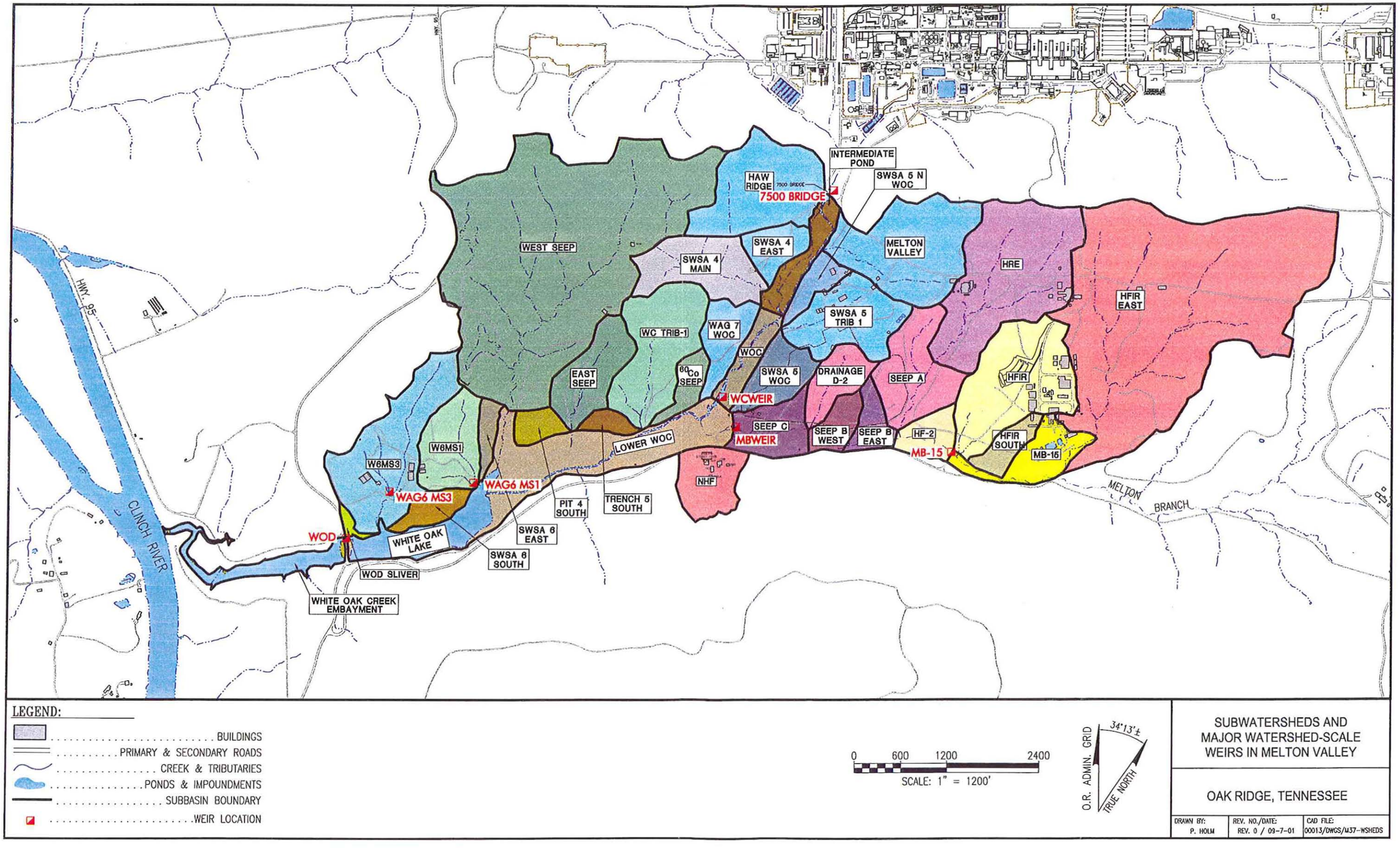


Fig. 2.2. White Oak Creek Watershed and subwatersheds.

Melton Valley is of primary importance on the ORR because, along with Bear Creek Valley, it is one of the major waste disposal areas. Most of the waste disposal areas in Melton Valley are in the Middle White Oak Creek and Melton Branch subwatersheds.

ORNL historical missions—plutonium production development during World War II and nuclear technology development during the postwar era—produced a diverse legacy of contaminated facilities, research areas, and waste disposal areas in Melton Valley. From 1955 to 1963, the U.S. Atomic Energy Commission designated ORNL's solid waste areas as the Southern Regional Burial Ground. During this period, ORNL served as a major disposal site for wastes from more than 50 off-site government-sponsored installations, research institutions, and other isotope users. As its role in the development of nuclear weapons decreased over time, ORNL's scope of work expanded to include production of radioactive isotopes, fundamental research in a variety of sciences, research involving hazardous and radioactive materials, environmental research, and radioactive waste disposal. These activities, as well as activities at Y-12 and ETTP, have resulted in the release of contaminants to the environment. Because of the contaminant releases, the ORR was placed on the U.S. Environmental Protection Agency (EPA) National Priorities List established under CERCLA (54 *Federal Register* 48184, November 21, 1989).

2.1.2 Waste Units in Melton Valley

Melton Valley contains several types of waste unit. The Melton Valley remedial investigation [RI (DOE 1997b)] grouped the sources of potential contamination, including facilities and infrastructure, on the basis of their physical characteristics:

- buried waste,
- landfills,
- tanks,
- impoundments,
- seepage pits and trenches,
- hydrofracture wells and associated grout sheets,
- buried liquid waste transfer pipelines,
- leak/spill sites,
- surface structures, and
- contaminated soil and sediment.

Figure 2.3 shows the locations of the principal contaminated areas in Melton Valley.

The principal waste units in Melton Valley are Solid Waste Storage Areas (SWSAs) 4, 5 and 6, the liquid waste seepage pits and trenches, and hydrofracture grout sheets. The Melton Valley RI (DOE 1997b) estimates that about 1 million (M) ft^3 of solid waste from off-site installations was buried at the three SWSAs between 1955 and 1963. Burial was typically done in unlined auger holes and trenches. Beginning in 1986, ORNL began placing solid low-level (radioactive) waste (LLW) in concrete-lined silos below grade at SWSA 6. Since 1988, waste has been placed in SWSA 6 in aboveground concrete storage pads, some of which have been covered with a multilayered cap pending final closure. Besides the SWSAs in Melton Valley, other contaminated areas include the new hydrofracture and old hydrofracture (OHF) sites, the wastewater ponds and pipeline leak sites associated with the High Flux Isotope Reactor (HFIR) area, the Homogeneous Reactor Experiment (HRE) facility, the Molten Salt Reactor Experiment facility, and the White Oak Creek and Melton Branch floodplain.

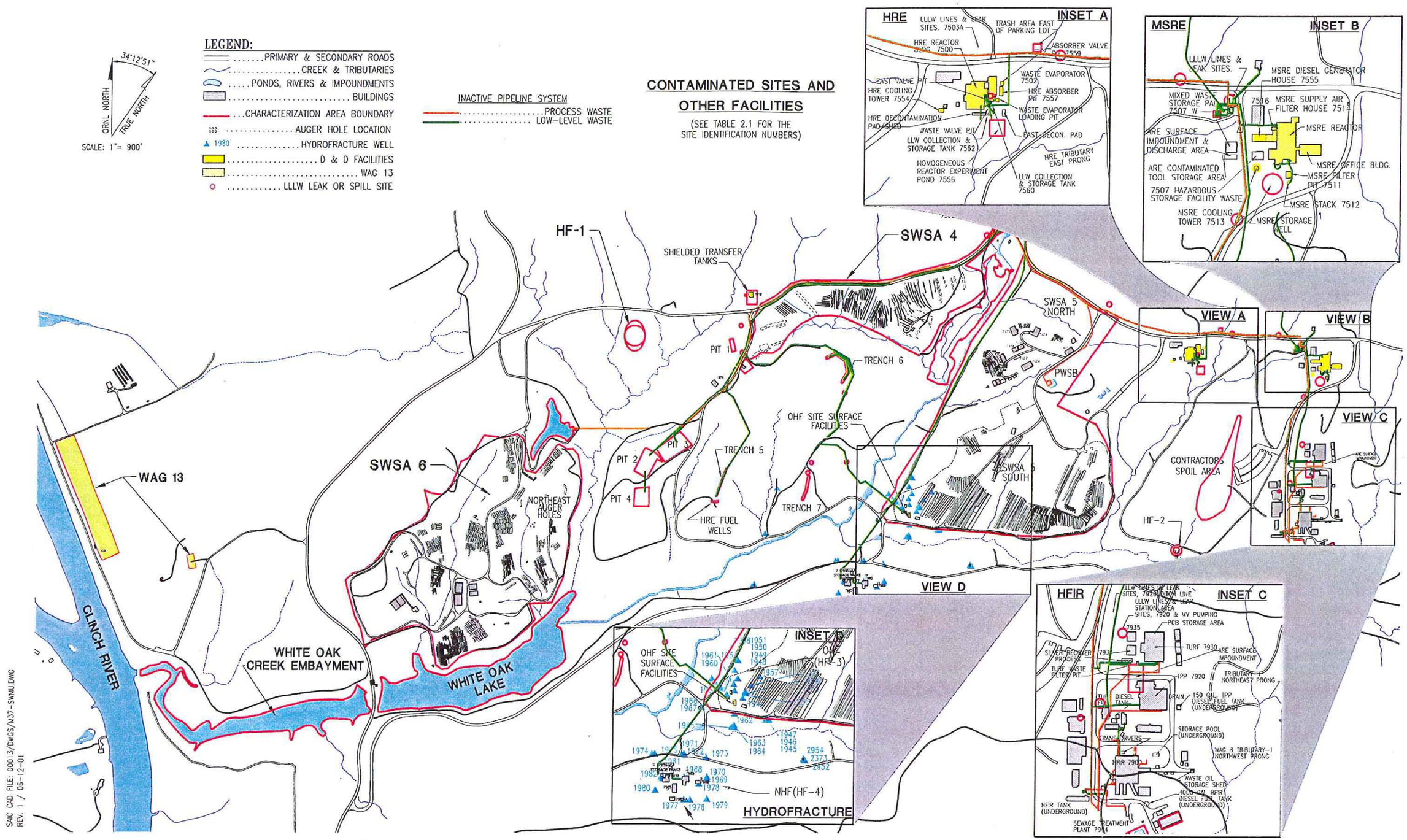


Fig. 2.3. Contamination sites and other facilities in the Melton Valley Watershed.

2.1.3 Melton Valley Contaminant Transport Pathways

Figure 2.4 summarizes the conceptual model of contaminant release and transport in Melton Valley; a complete discussion of this topic can be found in the Melton Valley RI (DOE 1997b). The shallow waste units in Melton Valley lie within the Nolichucky Shale and Maryville Limestone geologic formations, which are both aquitard formations within the Conasauga Group. As a result, shallow groundwater and surface water are tightly coupled. Precipitation near ORNL averages 132 cm/yr. About 76 cm/yr of water is consumed by evapotranspiration. The natural streamflow, which averages 56 cm/yr of water, consists of overland flow (about 21 cm/yr) from water bodies, wetlands, and impervious areas and of groundwater discharge (about 35 cm/yr of water)(Moore 1989). Essentially all the groundwater discharge component flows through the stormflow zone during and shortly after storm events or seeps through the shallow groundwater to the nearest stream channel. Although local geologic conditions such as bedrock type and geologic structure determine precise groundwater seepage pathways, no discrepancies between topographic basins and groundwater basins are known to exist in the shallow groundwater zone in Melton Valley. Deep groundwater seepage pathways are dominated by bedrock stratigraphy and structural features (Moore 1989). In its short journey through the groundwater system, stormflow and shallow groundwater leach contaminants from the buried waste and discharge to the surface water system.

Groundwater level and surface water discharge data show strong seasonal relationships (DOE 1995, Sect. 3.7). Well hydrograph analysis combined with stream flow and contaminant discharge flux show that through typical water years the discharge of contaminants is higher in the wet season than during the growing season. This is attributed to the increased evapotranspiration of soil moisture during the growing season, which reduces water table recharge and shallow groundwater discharge to streams. Winter rainfall events are more effective at groundwater recharge than those during the growing season, and groundwater recharge from early winter storms tend to displace contaminated pore water from fractures and stagnation zones. The early winter storm discharge pulses that occur after the growing season soil moisture deficit is replenished tend to discharge greater contaminant fluxes than those of any other season. Groundwater contaminant concentrations in some wells also tend to show seasonal variations indicative of winter season vs. growing season dilution of groundwater during the winter season. The importance of this seasonality in hydrology at the ORR is that contaminant release conditions may be categorized by season. For this reason, semi-annual groundwater sampling and analysis is recognized at the ORNL site for most ongoing groundwater monitoring activities.

Groundwater plays a small role in contaminant transport in Melton Valley. As described above, shallow waste burial and the presence of aquitard bedrock in the shallow subsurface result in the bulk of leached contaminants entering the surface water system. The Melton Valley RI (DOE 1997b) suggests that a small percentage of rainwater may remain in the subsurface by intersecting fractures in the bedrock and moving along strike. Additionally, radionuclides mixed in grout have been injected in deep [~300 m (~1000 ft) below ground surface] hydrofracture wells in Melton Valley with the intent of fixing the radionuclides in place. The Melton Valley RI reports that there are indications that a very small proportion of the injected radionuclides were not isolated in the grout and are present in deep natural brines in the injection zone.

With the foregoing contaminant transport model in mind, it is clear that contaminant releases in Melton Valley can be gauged using an integrated surface water monitoring system, supplemented by a few key groundwater monitoring wells located to assure that no contaminants are exiting the valley and to monitor releases from the hydrofracture grout sheets.

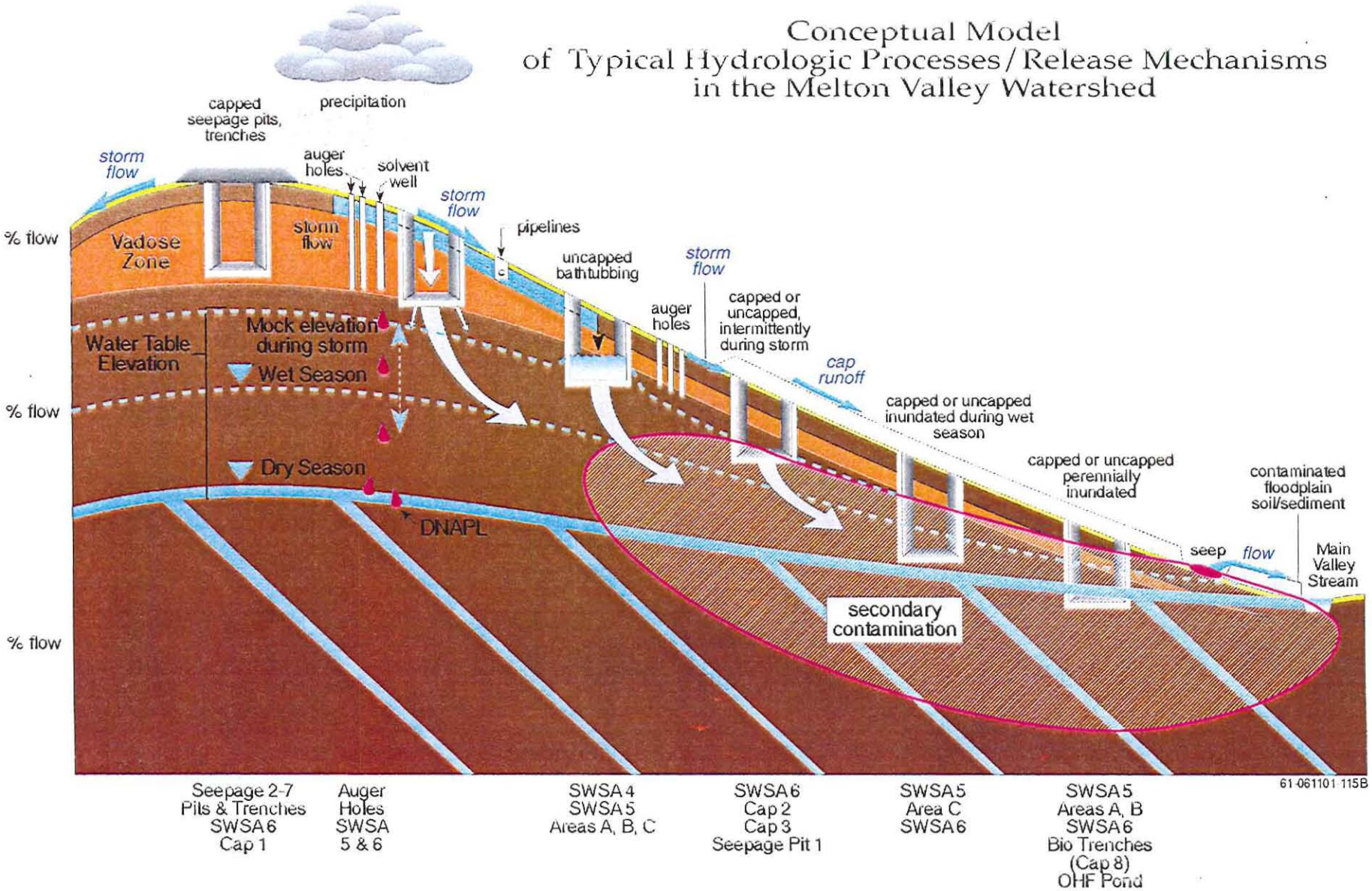


Fig. 2.4. Conceptualized contaminant release mechanisms recognized in the Melton Valley Watershed.

2.1.4 Melton Valley Contaminants of Concern

Table 2.1 lists the contaminants of concern (COCs) identified in the Melton Valley ROD (DOE 2000a) for surface water and soils, and in the RI (DOE 1997b) for groundwater. Of primary importance to the monitoring programs are the surface water COCs, because surface water is the primary migration pathway for chemical releases in Melton Valley and is the focus of long-term monitoring. The COCs in the additional media are important because they are additional drivers for action-specific remediation and because they represent chemicals "in the pipeline" that could become issues in the future.

Table 2.1. Contaminants of concern in Melton Valley

Project Area	Soil COCs	Sediment COCs	Groundwater COCs	Surface water COCs
SWSA 4	^{137}Cs, Be, ^{90}Sr		^{234}U, ^{90}Sr, ^{137}Cs, As, ^{241}Am, ^{14}C	
SWSA 5	^{60}Co, ^{137}Cs, ^{226}Ra, ^{228}Ra, ^{208}Tl, ^{228}Ac, ^{214}Bi, ^{90}Sr, Be	^{137}Cs, ^{60}Co, ^{226}Ra, ^{90}Sr, ^{244}Cm, ^{228}Th, ^{241}Am, ^{238}Pu, $^{239/240}$Pu, PCB-1260	^{90}Sr, ^{3}H, ^{137}Cs, ^{14}C, ^{238}Pu, ^{230}Th, $^{233/234}$U, ^{234m}Pa, CCl_4, As, PCE, 1,1-DCE, VC	^{90}Sr, ^{137}Cs, ^{3}H, ^{14}C, $^{233/234}$U, ^{45}Ca, Be, CCl_4, PCE, 1,1-DCE
SWSA 6	^{60}Co, ^{228}Ra		DNO, PCB-1254, PCE	
Seepage Pits and Trenches	^{137}Cs, ^{60}Co, ^{208}Tl, ^{228}Th	^{60}Co		
HRE	^{137}Cs, ^{226}Ra, ^{154}Eu, ^{208}Tl			
HFIR Area	^{60}Co, ^{137}Cs			
WOC Floodplain	^{137}Cs, ^{60}Co	^{137}Cs, ^{60}Co, Be, PCB-1260	^{90}Sr, ^{3}H, As, 1,1-DCE, PCE	^{90}Sr, ^{3}H, Be, PCE

COC = contaminant of concern
DCE = dichloroethene
DNO = di-n-octylphthalate
HFIR = High Flux Isotope Reactor
HRE = Homogeneous Reactor Experiment
PCB = polychlorinated biphenyl
PCE = tetrachloroethene
VC = vinyl chloride

The Melton Valley RI (DOE 1997b) found that the majority of potential human health risk associated with surface water discharged from the watershed at White Oak Dam is attributed to ^{90}Sr and tritium. PCBs, ^{137}Cs, metals, and volatile organic compounds (VOCs) are subordinate contributers to the total risk depending on the stream flow stage. The PCBs, cesium, and metals are probably associated with suspended sediment that is included in the bulk water samples submitted for analysis. Since ^{90}Sr and tritium are the major contributors to human health risk in discharging waters, they are used as the indicators of seasonal and annual variations in contaminant discharge fluxes from the watershed.

Tritium and ^{90}Sr were placed in most of the shallow burial areas. Volatile organic compounds are prevalent in shallow groundwater in the SWSAs, but they volatilize rapidly upon resurfacing to surface water. Cesium-137 is present primarily in the sediments and floodplain soils of White Oak Creek, having been deposited in the creek bed through years of process releases from ORNL. The major hazard associated with ^{137}Cs is the potential for direct gamma radiation exposure and sediment-bound migration

to the Clinch River. Alpha emitters, primarily uranium and transuranics, are present in some locations of the valley, one major area being the northern portion of SWSA 5.

2.1.5 Melton Valley Surface Water Monitoring Stations

Environmental monitoring in the Melton Valley Watershed has a long history, much of which has focused on contaminant releases across WOD and on major sites within the watershed that contribute contamination at the dam. In recent years, monitoring has focused heavily on the effectiveness of several actions that were implemented to decrease releases across the dam, primarily at SWSA 5 Seeps C and D and SWSA 4 trenches. As a consequence of this historical monitoring, an integrated surface water monitoring system already exists in Melton Valley. This system is designed to measure influx to and efflux from the valley and the contribution to contaminant loading in White Oak Creek from major waste units in the valley.

Melton Valley was subdivided in the Melton Valley RI (DOE 1997b) into subbasins for the purpose of better defining monitoring locations for individual waste units (Fig. 2.5). Subbasin boundaries encompass surface water and groundwater basins that contribute flow and contamination to specific surface water measurement points. By defining the downstream ends of subbasins at measurement locations, the RI was able to relate contaminant releases to upstream contributing areas. For the purpose of postremedial action monitoring, this relationship between monitoring locations and subbasins allows a determination of how well individual remedial actions are meeting the RAO for Melton Valley (see RAO discussion below). The relationship between source areas and subbasins is shown in Fig. 2.5. Also indicated in the figure is the estimated contribution of contamination at WOD from each primary source area in the watershed, based on data presented in the Melton Valley RI.

2.2 ACTIONS IN MELTON VALLEY

2.2.1 Planned Remedial Actions

In order to address the RAO and performance measures stated in the Melton Valley ROD (DOE 2000a), a remedy containing a number of actions is planned for Melton Valley. The remedy is discussed in the RDWP for interim actions in the Melton Valley Watershed (DOE 2001a). The major actions include hydraulic isolation of most wastes disposed by shallow land burial, removal of contaminated soils and/or pond sediments in some areas, demolition of unneeded facilities, plugging and abandonment of unneeded wells, grouting of the HRE Fuel Wells, and in situ vitrification of two liquid waste seepage trenches (Fig. 2.6).

Hydraulic isolation of SWSAs 4, 5, and 6 and four of the Liquid Waste Seepage Pits and Trenches will be accomplished using multi-layer caps in combination with upgradient stormflow diversion trenches and downgradient groundwater interceptor trenches where needed. These actions are expected to provide the greatest benefit in reducing surface water and groundwater contaminant concentrations and releases. Monitoring of surface water and groundwater will be required to measure the performance of hydraulic isolation systems.

Pond sediments in the HFIR Ponds and the closed HRE Pond and contaminated soils at numerous locations throughout Melton Valley, including floodplain soils and soils affected by liquid low-level (radioactive) waste pipeline leak and spill sites, will be excavated to meet cleanup levels specified in the ROD (DOE 2000a). These actions will reduce releases to surface water and groundwater and will reduce the potential for human or ecological exposure to contaminated soils. Monitoring of surface water and groundwater will be required in some areas to measure the benefit of contaminated soil and sediment removal.

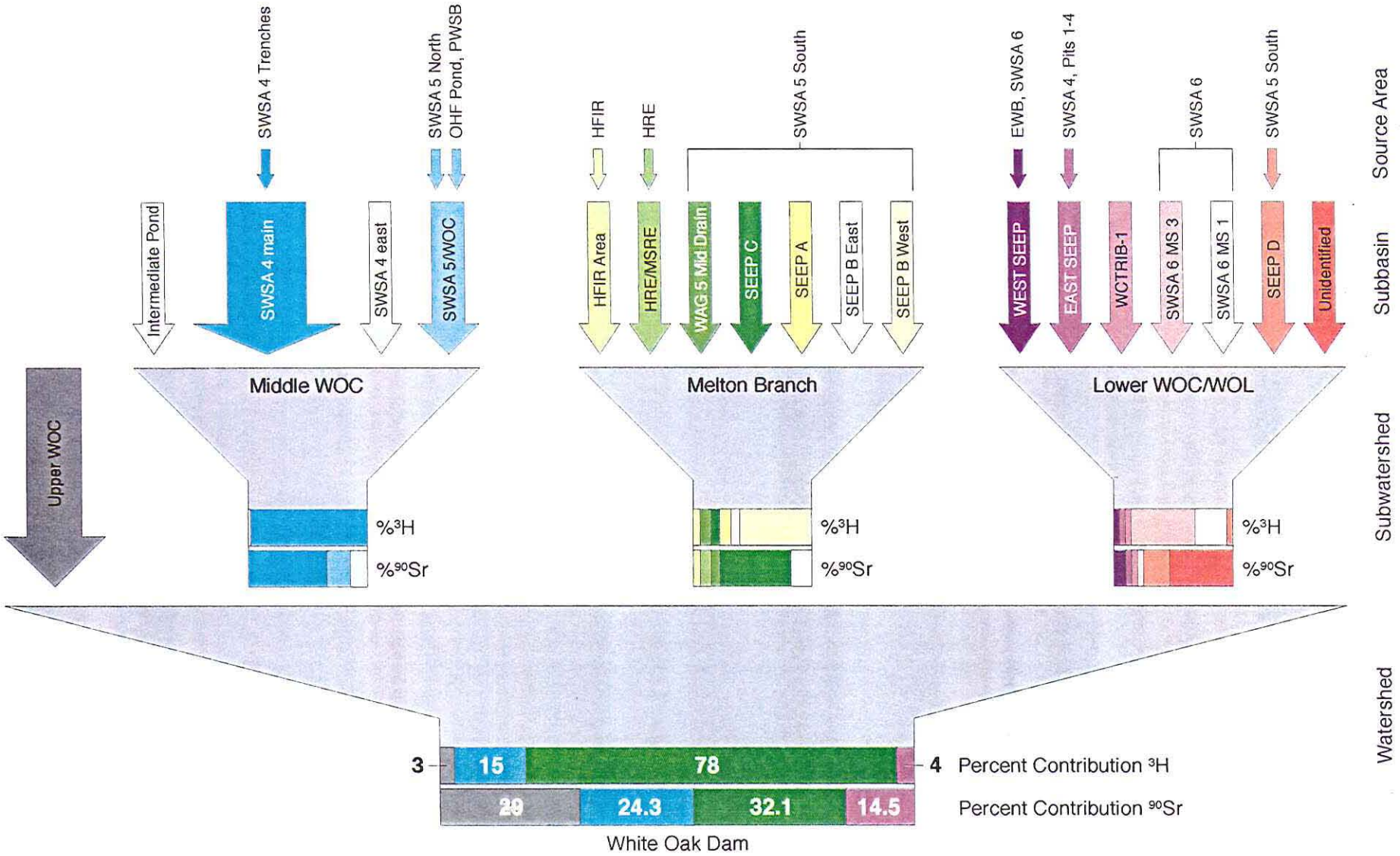


Fig. 2.5. Average 1993-1994 contaminant discharge to White Oak Dam.

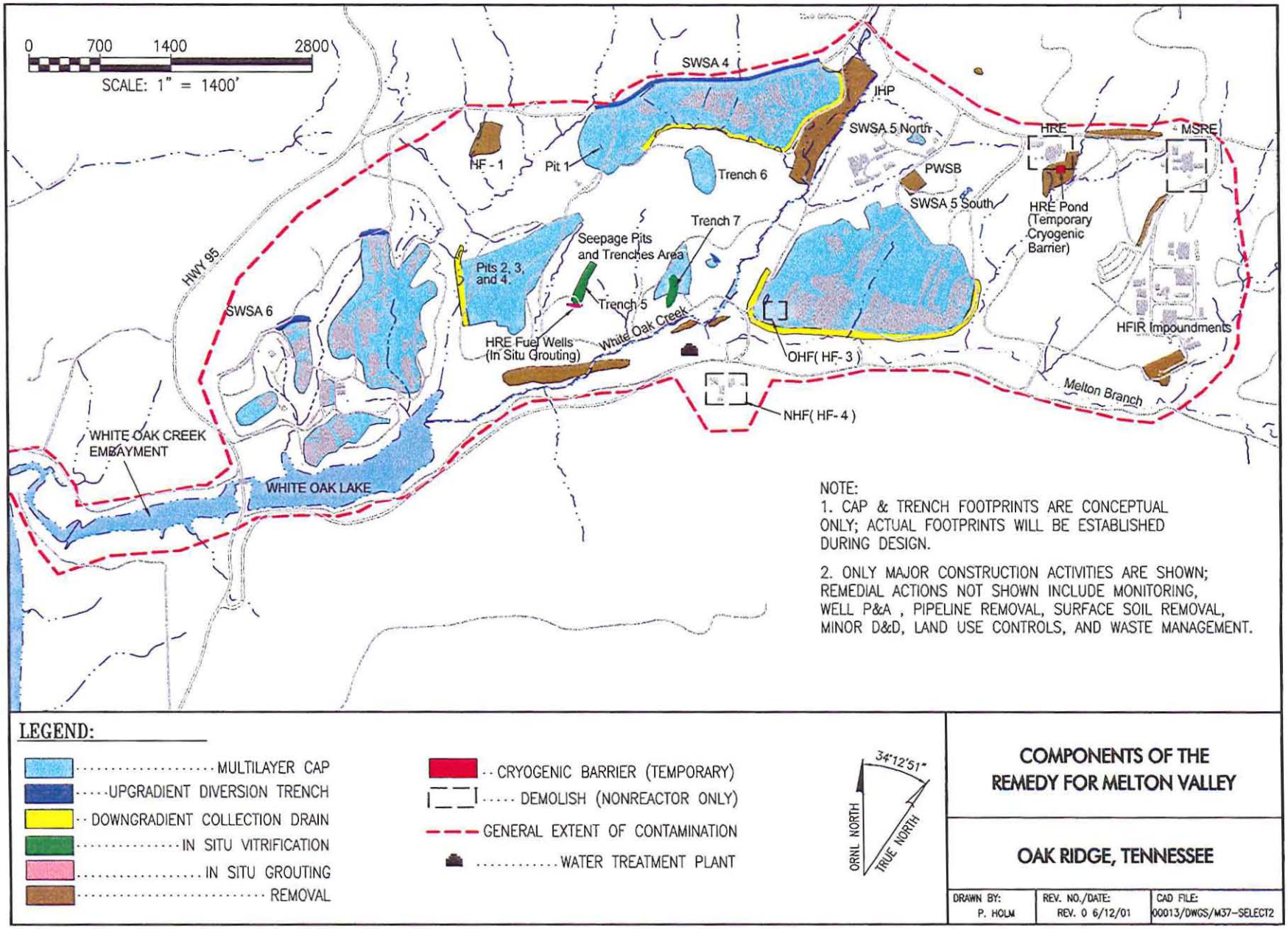


Fig. 2.6. Components of the remedy for the Melton Valley Watershed.

Unneeded facilities, such as buildings associated with the hydrofracture process and other buildings at various sites throughout Melton Valley, will be demolished and the debris will be disposed at appropriate waste disposal sites. In some cases, building D&D is required to allow later construction of other remedial measures, such as caps required to hydraulically isolate contaminated areas. The D&D actions will reduce potential future human exposures and contaminant release to the environment through removal of the buildings and disposal of contaminated materials. However, since the buildings have generally not been significant sources of release to the environment, there is no ongoing monitoring required in relation to these actions.

Plugging and abandonment of unneeded wells retards the migration of contaminants by groundwater seepage through well bores. All unneeded wells in Melton Valley, including wells related to the hydrofracture waste injection research and disposal sites, will be permanently plugged and abandoned. Wells that are required for long-term monitoring of groundwater, including some wells that may be used to monitor the continued isolation of deeply injected wastes, will be retained for use by DOE.

In situ vitrification of Liquid Waste Seepage Trenches 5 and 7 and grouting of the HRE Fuel Wells will stabilize small-volume, high-activity wastes in place in a nonleachable form. These waste disposal units are not know to be significant sources of contaminant release and are expected to require a minimal amount of long-term monitoring.

In addition to the actions described, the ROD requires performance of an ecological study to determine if chemicals of potential ecological concern identified in the Baseline Ecological Risk Assessment (DOE 1997b) are accumulating in biota at levels that may cause actual risk.

Land use controls are required in Melton Valley because waste is left in place. The Melton Valley Land Use Control Implementation Plan was prepared and published with the RDWP (DOE 2001a). LUC monitoring will be implemented separate from the environmental monitoring outlined in this monitoring plan.

2.2.2 Sequencing of Remedial Actions in Melton Valley

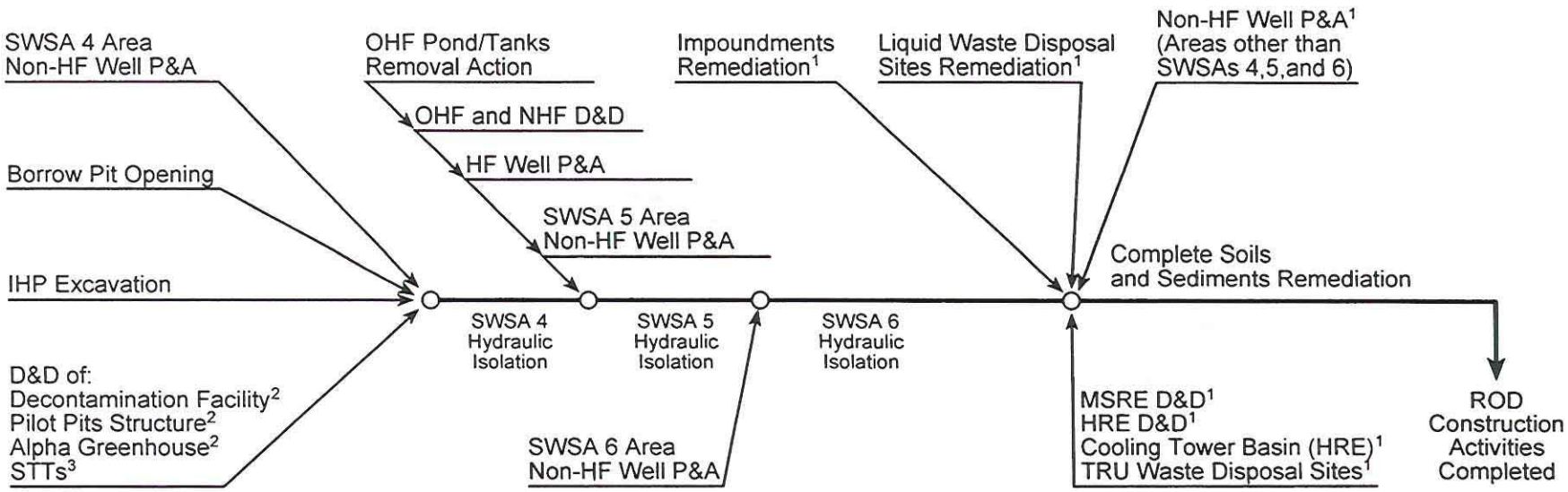
Remedial actions in Melton Valley will be conducted in a general sequence that is shown in Fig. 2.7. The sequence is determined by a number of factors, including risk reduction, hazardous inventories, the source unit contributions to off-site releases, logistics, constructability, construction sequencing, and resource availability. It is estimated in the Melton Valley ROD (DOE 2000a) that these actions will be sequenced over a period of about 14 years, provided that sufficient funding is available. The relevance of this sequencing to the monitoring approach is twofold:

1) One to two years prior to the startup of a specific action, baseline monitoring will begin for that project. Details of baseline monitoring are presented in this plan only for projects planned through fiscal year (FY) 2003. For projects beginning after FY 2003, baseline monitoring will be specified in the Melton Valley ROD section of the annual Remediation Effectiveness Report (RER).

2) Once an RDWP has been approved for a specific action, action-specific performance assessment monitoring will begin. This plan presents the details of action-specific monitoring for only one action, based on the RDWP for SWSA 4 (DOE 2001b). Figure 2.7 provides the expected sequencing for future action-specific monitoring.

2.2.3 Schedule for Remedial Actions in Melton Valley

Figure 2.8 shows the approximate schedule for remedial design and remedial action construction activities for the major subprojects and associated tasks in Melton Valley as presented in the RDWP



Related Actions
(not MV ROD remedy components)

- Construct EMWMF (prior to IHP excavation)
- Retrieve KEMA fuel (prior to SWSA 6 cap)[2]
- Relocate roads and power lines (as required)
- Remove six above-grade waste storage units (prior to SWSA 6 cap)
- Close Tumuli & IWMF (coincident with SWSA 6 cap)
- Retrieve TRU Waste in SWSA 5 North
- Construct the TRU Waste Treatment Facility

[1] These subprojects have no logical precedence relationship with other components of the remedy and are sequenced based on risk reduction, projected funding availability, or external constraints (e.g., related actions).

[2] Completed in FY01.

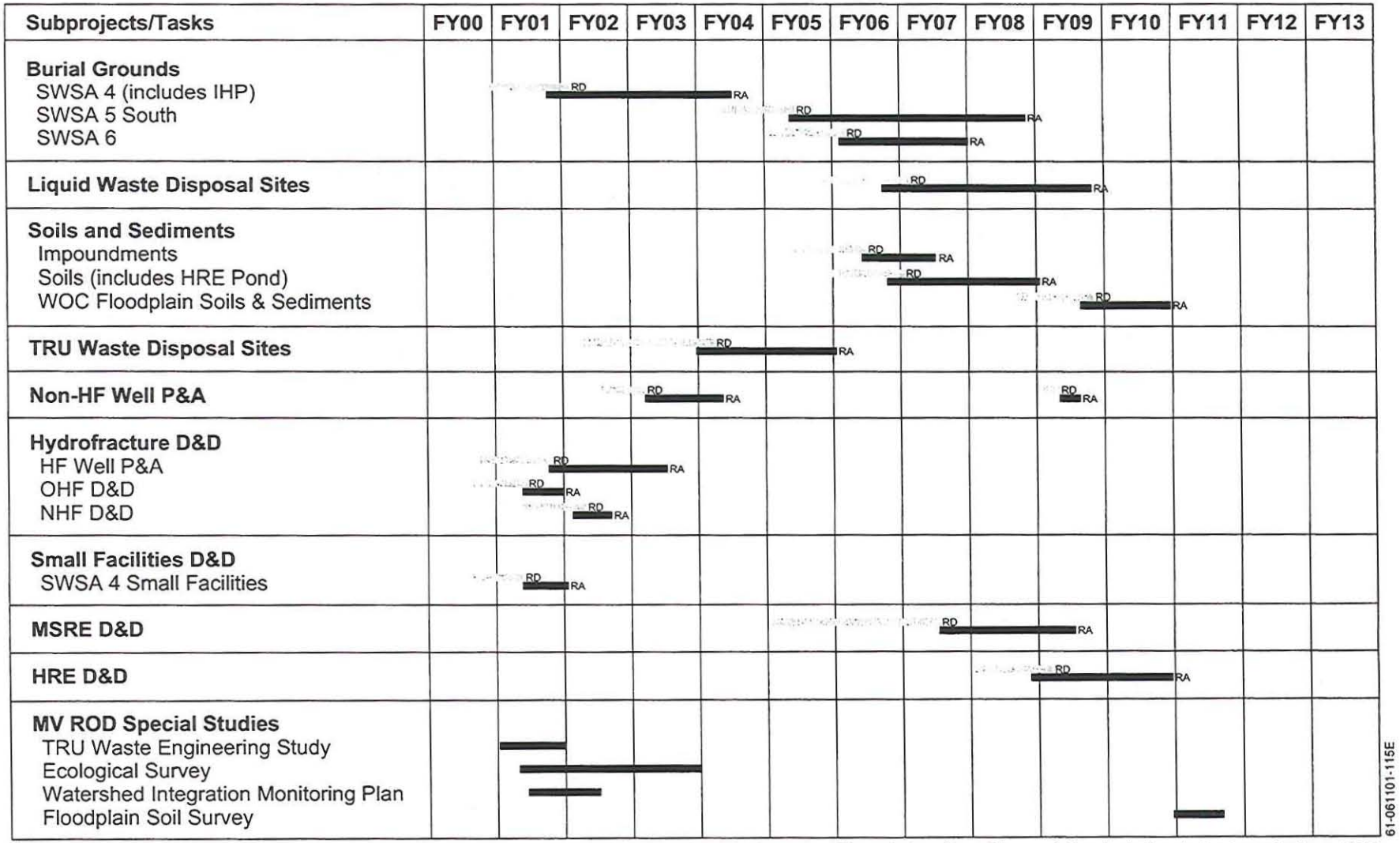
[3] Relocated for future disposal.

ACRONYMS

D&D	Decontamination & Decommissioning
EMWMF	Environmental Management Waste Management Facility
HF	Hydrofracture
HFIR	High Flux Isotope Reactor
HRE	Homogeneous Reactor Experiment
IHP	Intermediate Holding Pond
IWMF	Interim Waste Management Facility
KEMA	Keuring van Electrotechnische Materialen
MV	Melton Valley
MSRE	Molten Salt Reactor Experiment
NHF	New Hydrofracture Facility
OHF	Old Hydrofracture Facility
P&A	Plugging and Abandonment
ROD	Record of Decision
STT	Shielded Transfer Tank
SWSA	Solid Waste Storage Area
TRU	Transuranic

61-061101-115D

Fig. 2.7. Sequence of major construction activities in Melton Valley.



[1] Schedule shown includes remedial design and remedial action construction activities as shown in the current life cycle baseline. Other activities, including design investigations, RFP preparation and award, and Phased Construction Completion Report preparation, are not reflected in this schedule. Actual start and end dates reflecting FFA milestones are subject to modification through the FFA scheduling process.

D&D: Decontamination & Decommissioning
FFA: Federal Facility Agreement
FY: Fiscal Year
HF: hydrofracture
HRE: Homogeneous Reactor Experiment
IHP: Intermediate Holding Pond
MSRE: Molten Salt Reactor Experiment
MV: Melton Valley
NHF: New Hydrofracture Facility
OHF: Old Hydrofracture Facility
P&A: Plugging and Abandonment
RA: Remedial Action
RD: Remedial Design
RFP: Request for Proposal
ROD: Record of Decision
SWSA: Solid Waste Storage Area
TRU: transuranic
WOC: White Oak Creek

Fig. 2.8. Melton Valley project remedial design/remedial action schedule[1].

(DOE 2001a). Other activities, including procurement, design investigations before the request for proposals, and phased construction completion report preparation, are not reflected in the schedule. This anticipated schedule is based on FY 2000 planning and is consistent with the ORNL project life cycle baseline, which in turn is influenced by current prioritizations and resource allocations across the ORR. The schedule generally provides optimistic construction completion dates that are more aggressive (or occur sooner) than the completion dates referenced in the ROD (DOE 2000a).

The schedule shown in Fig. 2.8 is provided for informational purposes only and is not considered to be an enforceable element of this monitoring plan. The enforceable milestones and nonenforceable FY +3 milestones for performance of remedial design and remedial action for sites included in the Melton Valley ROD (DOE 2000a) are set forth in Appendix E and Appendix J of the FFA, respectively (DOE 1992). Any additional milestones, timetables, or deadlines for sites included in the Melton Valley project will be identified and established independently of this monitoring plan, in accordance with the existing FFA protocols.

3. MONITORING STRATEGY

The monitoring strategy for Melton Valley is designed to help track progress in meeting the RAO of the ROD for interim actions (DOE 2000a) and to help prepare for the final ROD for Melton Valley.

All of the actions specified in the ROD are governed by the watershed-scale RAO. As stated in the ROD, these are long-term objectives that should be met approximately 10 years after the full remedy is operational. The ROD also specifies numerous additional remediation requirements, including compliance with additional applicable or relevant and appropriate requirements (ARARs), monitoring needs and action-specific performance measures.

Because implementation of the full remedy will take place over many years, with different activities occurring at different stages, ROD monitoring will have two primary components: long-term, low frequency watershed-scale monitoring to show progress toward meeting the RAOs, and shorter-term, action-specific monitoring geared toward showing compliance with ARARs and performance measures.

This section provides a summary of the ROD goals and requirements that affect the monitoring strategy, and then discusses the approach to implementing the monitoring program.

3.1 REMEDIATION GOALS

3.1.1 Remedial Action Objective

Section 1.4 of the ROD (DOE 2000a) specifies the RAO for the Melton Valley remedy (Table 3.1 below). The goals are a combination of chemical-specific ARARs [e.g., the numeric and narrative ambient water quality criteria (AWQC) for the state], and risk-based goals (e.g., protect workers to a 10^{-4}-to-10^{-6} risk level). As indicated by the table, there are various points of compliance (or points of measuring exposure) for the goals. These various locations relate to the use of land use restrictions as part of the remedy:

1. The eastern portion of Melton Valley is designated as industrial use with limited restrictions.

2. The western portion of the valley, which contains the waste disposal sites, is designated as restricted waste management areas.

Table 3.1. Remedial action objective for Melton Valley

Area/receptor	Goal
Waste management area (includes SWSAs 4, 5, and 6 and Seepage Pits and Trenches)	• Manage waste disposal sites as a restricted waste management area • Protect maintenance workers • Meet AWQC in surface water in a reasonable amount of time • Mitigate further impact to groundwater
Industrial use area (generally the area east of SWSA 5)	• Manage areas generally east of SWSA 5 as an industrial area • Protect industrial workers • Meet AWQC in surface water in a reasonable amount of time • Mitigate further impact to groundwater
Surface water and floodplain area	• Achieve numeric and narrative AWQC for waters of the state in a reasonable amount of time • Remediate contaminated floodplain soils to 2500 μR/h[a] • Protect an off-site resident user of surface water at the confluence of White Oak Creek and the Clinch River from contaminant sources in Melton Valley • Make progress toward meeting the Clinch River's stream use classification as a drinking water source at its confluence with White Oak Creek
Human receptors	• Protect maintenance workers, industrial workers, and off-site resident users of surface water (at the confluence of White Oak Creek and the Clinch River) to a 10^{-4}-to-10^{-6} excess lifetime cancer risk and an HI of 1 • Protect hypothetical recreational users of waters of the state[b]
Ecological receptors	• Protect ecological populations[c]

[a]A future CERCLA decision will be prepared to determine whether additional actions are required for floodplain soil <2500 μR/h.

[b]This remedy addresses water quality but does not fully address fish consumption or sediment/floodplain soil contact or exposure under the recreational scenario. A future CERCLA decision will be prepared to assess whether any additional actions are required.

[c]Additional actions and monitoring to address the goal will be included in a future CERCLA decision.

AWQC = ambient water quality criteria

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980

HI = hazard index

SWSA = Solid Waste Storage Area

3. Surface waters are designated as waters of the state and addressed under the recreational and fish and aquatic life stream use classifications.

Land use controls are not addressed by this plan; however, since RAO compliance points allow for some areas to remain above federal and state ARAR-based levels, an evaluation of land use control effectiveness will have to be included in the evaluation of remedy performance. Figure 3.1 presents a schematic showing monitoring for measurement of remedy effectiveness and progress toward meeting the RAO.

The ROD (DOE 2000a) also identifies the COCs for Melton Valley. These COCs were identified through an ARAR screen and from the baseline human health risk assessment. COCs are listed in Table 3.2.

3.1.2 Additional ARARS

Appendix B of the ROD (DOE 2000a) identifies chemical-specific ARARs and to-be-considered guidance for the selected remedy. These include the following:

- AWQC numerical and narrative criteria identified in the RAO, including the statement that "waters shall not contain other pollutants that will be detrimental," indicating the requirement to monitor contaminants other then the COCs identified by the RI (DOE 1997b).

- 10 *CFR* 20.1301(a)(1) 100 mrem/year effective dose equivalent (EDE) limit to members of the public.

- 10 *CFR* 20.1402(a) and (b), EDE > 25 mrem/year.

In addition, there are location- and action-specific ARARs that will need to be addressed during implementation of the action.

3.1.3 Other ROD Considerations

3.1.3.1 Action-specific performance measures

In addition to the watershed-scale RAO presented in Sect. 3.1, the ROD (DOE 2000a) specifies action-specific performance measures that have been designed to 1) ensure that the cumulative impact of the various actions results in meeting the watershed RAOs, and 2) provide quantitative measures for evaluating the effectiveness of a given remedy. These performance goals are provided in Sect. 3.2.2.

3.1.3.2 Monitoring requirements

Section 2.11.2 of the ROD (DOE 2000a) provides general requirements for monitoring the effectiveness of the remedial actions. The following are included in the requirements:

- Surface water and groundwater will be monitored to measure remediation effectiveness.

- Measurement stations on the main stem of White Oak Creek and Melton Branch will be maintained. [They are currently maintained for National Pollutant Discharge Elimination System (NPDES) permit requirements, but would have to be maintained under CERCLA in the event the NPDES permit eliminated the need for these stations.]

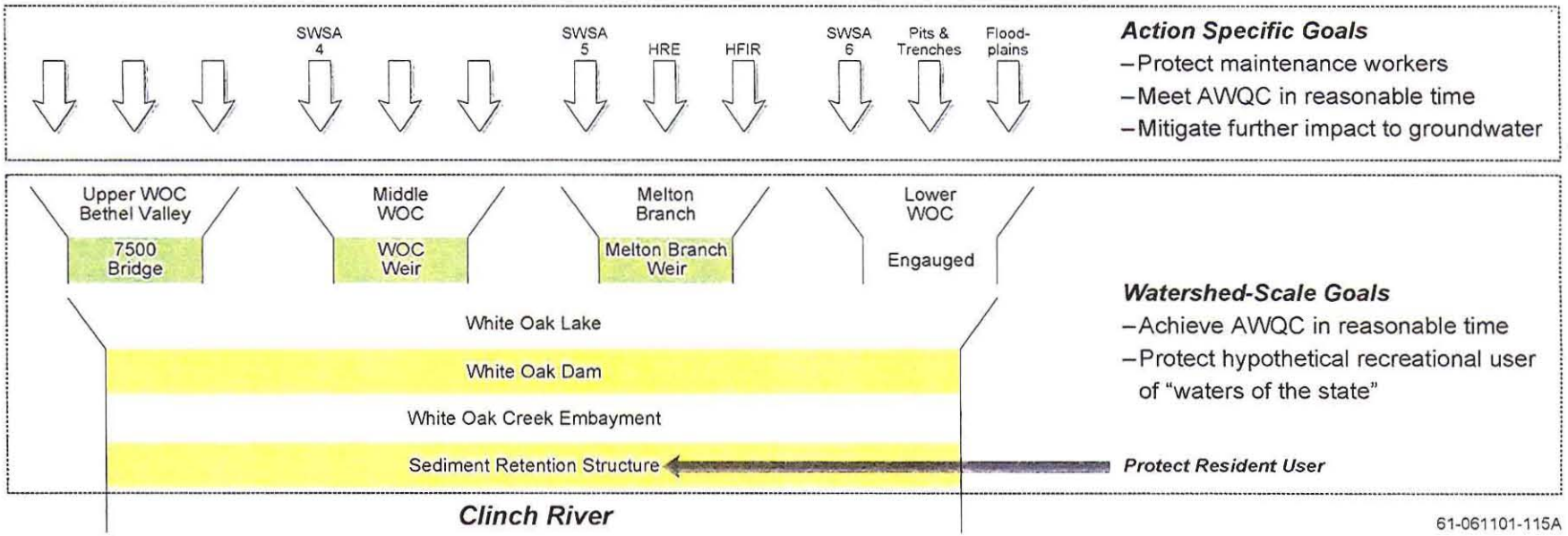


Fig. 3.1. Locations for measuring remedy effectiveness and progress toward meeting the remedial action objective.

Table 3.2. Remediation levels for surface water contaminants in Melton Valley

Contaminant of concern	Ambient water quality criteria[a]		Recreational remedial goals[d] (µg/L or pCi/L)
	Human health[b] (µg/L)	Fish and aquatic[c] (µg/L)	
Arsenic	0.14		0.14[a]
Cadmium		2.2	
Copper		9.0	
Lead		2.5	
Mercury	0.051	0.77	
Selenium		5.0	
^{137}Cs			$2.37 \times 10^{+5}$
^{60}Co			$3.92 \times 10^{+5}$
^{228}Ra			$2.99 \times 10^{+4}$
^{90}Sr			$1.33 \times 10^{+5}$
^{3}H			$1.04 \times 10^{+8}$
^{234}U			$1.67 \times 10^{+5}$
Vinyl chloride			525[a]
Tetrachloroethene			81[a]

[a]Values were taken from *National Recommended Water Quality Criteria—Correction*, EPA 822-Z-99-001, U.S. Environmental Protection Agency, Office of Water, April 1999.

[b]Values are based on a carcinogenicity of 10^{-6} risk to human health from the consumption of recreationally caught fish.

[c]Values are for fresh water organism criterion continuous concentration (CCC), or the highest concentration to which an aquatic community can be exposed indefinitely without unacceptable effects.

[d]Recreational wading scenario from Table 2.19 of the record of decision (DOE 2000a) unless footnoted.

- Additional monitoring stations will be used as needed to measure the effectiveness of individual remedial actions.

- Surface water monitoring will be used to verify compliance with ARARs.

- Flow-proportional (described in Sect. 4.1.2) sampling will take place at WOD, Melton Branch Weir, White Oak Creek Weir and 7500 Bridge.

- The groundwater exit pathway wells will be used to verify contaminants are not leaving the area.

- Deep wells in the area of the hydrofracture waste disposal area will monitor the stability of the hydrofracture waste disposal zone.

- Groundwater monitoring will be used as needed to monitor the effectiveness of individual actions.

- SWSA 6 Resource Conservation and Recovery Act of 1976 (RCRA) Subpart F monitoring will take place.

3.2 MONITORING STRATEGY

Two primary types of monitoring stem from the objectives spelled out in the ROD (DOE 2000a):

- Core watershed-scale monitoring used to measure the cumulative effectiveness of several actions implemented over a longer period of time. This monitoring will be designed to measure progress over time toward meeting watershed-scale RAO.

- Action-specific monitoring to measure the effectiveness of specific remedial actions. This monitoring is designed to show compliance with ARARs and performance measures.

3.2.1 Watershed-Scale Goals and Strategy

Watershed-scale monitoring includes the monitoring required to assess the overall effectiveness of multiple actions to meet the watershed-scale goals specified in the ROD (DOE 2000a) (Table 3.1). The following requirements apply to watershed-scale monitoring:

- It must measure effectiveness at achieving AWQC criteria in waters of the state.

- It must evaluate the effort in meeting residential surface water use criteria at the confluence of White Oak Creek and the Clinch River.

- It should be designed to identify—at least on a large scale—the approximate reasons/locations associated with increases or decreases in contamination at the mouth of White Oak Creek (as measured at WOD), and at watershed-scale AWQC "compliance" locations.

- It must address environmental issues, for which specific actions were deferred under the ROD, that will eventually need to be addressed under CERCLA and currently must be addressed in response to other regulatory drivers (e.g., RCRA groundwater monitoring at SWSA 6 and exit pathway boundary monitoring in groundwater).

3.2.2 Action-Specific Goals and Strategy

The second set of monitoring that will occur over time in Melton Valley will coincide with the initiation and completion of the individual remedial actions specified in the ROD (DOE 2000a). Many remedial actions will require preconstruction monitoring to establish baseline environmental quality conditions and postconstruction monitoring to measure the remedy effectiveness. The overall goals of the action-specific monitoring are as follows:

- ensure maintenance workers and industrial workers are not exposed to contaminant levels that could results in exposure above target risk goals;
- identify progress toward meeting AWQC in surface water; and
- mitigate further releases to groundwater (which, as indicated in Chap. 2, eventually flows to nearby surface water).

The design of the action-specific monitoring will be based on the action-specific performance measures identified in the ROD (DOE 2000a) (Table 3.3), the site-specific hydrologic model, and the COCs at the specific waste unit. Specification of baseline groundwater monitoring requirements will be based on review of existing groundwater data for each remediation project area to determine historical contaminant concentration behavior and prior concentration trends and data required to establish current average concentrations. Action-specific post construction monitoring details generally will be determined in the RDR/RAWP. As shown schematically in Fig. 3.1, the details of action-specific monitoring will be planned and sequenced on a project-by-project basis and will be implemented in parallel with the watershed-scale monitoring.

Several CERCLA removal actions have been performed in Melton Valley that require ongoing monitoring to evaluate their effectiveness. Removal action effectiveness monitoring will continue and will be used as a part of preconstruction monitoring for remedial actions; it may also be continued as postconstruction monitoring after remedial action when appropriate. Table 3.4 lists previous removal actions, required monitoring, and monitoring locations in Melton Valley.

The SWSA 4 remedial action project is the first major project requiring a monitoring strategy to be implemented since the Melton Valley ROD was signed in September 2000 (DOE 2000a). The type of monitoring identified for that project will be used as a prototype for action-specific monitoring planning and implementation. This project serves as a good example because it includes effectiveness monitoring for a previous removal action as well as preconstruction monitoring prior to initiation of remedial design. Chapter 4 of this plan includes a description of the SWSA 4 action-specific monitoring plan.

3.3 IMPLEMENTATION ISSUES

3.3.1 Schedule

Implementation of remedial actions in Melton Valley will take years to complete. During the remediation period, some monitoring activities will occur continuously to monitor valleywide conditions while some action-specific monitoring will occur in shorter time intervals.

The Melton Valley Post-ROD monitoring concept indicates watershed-scale monitoring activities will be implemented continuously with action-specific monitoring before and after construction of specific remedial actions. The concept for action-specific monitoring includes preconstruction, and

Table 3.3. Unit-specific performance measures, Melton Valley ROD

Unit type/unit name project scope	Performance measure
SWSA 4 • SWSA 4 • Liquid Seepage Pit 1 & secondary media • Inactive waste transfer lines at Lagoon Rd • Pilot Pits Area shallow well P&A	• Prevent releases from SWSA 4 from causing AWQC exceedances in waters of the state within 2 years after SWSA 4 remediation is complete • Reduce SWSA 4 contaminant releases to surface water by approximately 80% to meet computed 10^{-4} total residential risk at the confluence of White Oak Creek and Clinch River in ~10 years after all ROD actions are complete • Reduce groundwater throughflow in buried waste units by >75% as measured by >75% decrease in water level fluctuations in selected monitoring locations inside the contained area
SWSA 5 South • SWSA 5 South • Stabilized OHF pond and tanks • Stabilized subsurface OHF facilities • Contaminated soils at OHF site • Shallow well P&A	• Prevent releases from SWSA 5 South from causing AWQC exceedances in waters of the state in Melton Branch, Lower HRE Tributary, and SWSA 5 D1 within 2 years after SWSA 5 South remediation is complete • Reduce SWSA 5 contaminant releases to surface water by approximately 80% to meet computed 10^{-4} total residential risk at the confluence of White Oak Creek and Clinch river in ~10 years after all ROD actions are complete • Reduce groundwater throughflow in buried waste units by >75% as measured by >75% decrease in water level fluctuations in selected monitoring locations inside the contained area
SWSA 6 • SWSA 6 • Shallow well P&A	• Prevent releases from SWSA 6 from causing AWQC exceedances in waters of the state within 2 years after SWSA 6 remediation is complete • Reduce groundwater throughflow in buried waste units by >75% as measured by >75% decrease in water level fluctuations in selected monitoring locations inside the contained area
TRU waste sites • SWSA 5 North 4 trenches	• Verify that groundwater does not contact the buried waste through water level monitoring in and adjacent to the trenches after cappin •
HRE Pond (7556) • Filled pond • Shallow well P&A	• Prevent releases from HRE site from causing AWQC exceedances in the HRE tributary within 2 years after remediation is complete • Reduce HRE area contaminant releases to surface water by approximately 80% to achieve hypothetical residential water use risk goal of 10^{-4} at the confluence with Clinch River in ~10 years after ROD actions are complete
HFIR waste collection basins • Ponds	• Prevent releases from the HFIR ponds from causing AWQC exceedances in Melton Branch within 2 years after remediation is complete
Pits 2,3, and 4 and Trench 6 • Liquid seepage pits • Inactive waste pipelines • Shallow well P&A	• Prevent releases from Liquid Waste Seepage Pits 2, 3, and 4 and Trench 6 from causing AWQC exceedances in waters of the state within 2 years after construction is complete • Reduce groundwater throughflow in the contained area by >75% as measured by >75% decrease in water level fluctuations in selected monitoring locations inside the contained area
Trenches 5 and 7 • Liquid seepage trenches • Inactive waste pipelines • Shallow well P&A	• Prevent releases from Seepage Trenches 5 and 7 from causing AWQC exceedances in waters of the state within 2 years after ISV is complete

Table 3.3. Unit-specific performance measures, Melton Valley ROD (continued)

Unit type/unit name project scope	Performance measure
Inactive waste transfer pipelines • Inactive pipelines outside hydraulically isolated areas •	• Prevent contaminants associated with inactive waste transfer pipelines from causing AWQC exceedances in waters of the state
Wastewater treatment facility	• Monitoring of the facility effluent to ensure compliance with numeric AWQC and narrative criteria in-stream will be used to determine the effectiveness of treatment • Discharge water will be treated to achieve 10^{-4} risk for ^{90}Sr (residential scenario =~85 pCi/L)

AWQC = ambient water quality criteria
HFIR = High Flux Isotope Reactor
HRE = Homogeneous Reactor Experiment
ISV = in situ vitrification
OHF = old hydrofracture facility
P&A = plugging and abandonment
ROD = record of decision
SWSA = Solid Waste Storage Area

Table 3.4. Current removal action effectiveness monitoring in Melton Valley

Removal action	Required monitoring	Locations monitored	Status
WAG 4 Seeps 4 and 6	Monitor ^{90}Sr and ^{3}H at two seeps and the SWSA 4 tributary for reduction in ^{90}Sr concentrations following grouting of contaminant burial trenches.	• Monthly grab sampling @ W4T4, SCS4, S4T6, and SCS6 with analysis for ^{90}Sr and ^{3}H • Monthly flow composite sampling at WAG4-MS1 with analysis for ^{90}Sr and ^{3}H	Ongoing. To be permanently discontinued when SWSA 4 RA construction begins
WAG 5 Seep C	• Monitor treatment system effectiveness • Monitor flux from Seep C reach into Melton Branch	• Monitor ^{90}Sr in influent and effluent at Seep C treatment system • Monitor ^{90}Sr in Melton Branch upstream and downstream of Seep C	Ongoing
WAG 5 Seep D	• Monitor treatment system effectiveness • Monitor flux from Seep D reach into Melton Branch	• Monitor ^{90}Sr in influent and effluent at Seep D treatment system • Monitor ^{90}Sr in Melton Branch upstream and downstream of Seep D	Ongoing
White Oak Creek Embayment	• Water level at sediment retention structure • Sediment profile	• Sediment retention structure • Embayment sediment	Five-Year Review recommended discontinuing water level monitoring

RA = remedial action
SWSA = Solid Waste Storage Area
WAG = Waste Area Grouping

postconstruction monitoring for each remedial action project. The duration of postconstruction monitoring for each remedial action project will be specified in the RDR/RAWP monitoring scope. The duration of monitoring outlined in this plan is expected to continue until a final ROD is prepared for Melton Valley.

3.3.2 Planning

The Melton Valley monitoring program will be managed under the X-10 Water Quality Program (XWQP) and the ORR-wide Water Resources and Recovery Program (WRRP). These activities are planned, scoped and budgeted on an annual basis through the annual WRRP sampling and analysis plan (SAP), which is produced each summer during planning for the upcoming fiscal year. Any changes to the previous year's plan stem from two primary drivers: 1) the addition of new monitoring due to completion of a new remedial action, and 2) monitoring changes identified and agreed to by all parties in the process of reviewing the annual RER.

Melton Valley monitoring will be evaluated annually during this process. Any changes to the monitoring will be documented in the annual WRRP SAP. As indicated in Sect. 3.2, the monitoring approach for new actions will be detailed and approved through RDRs/RAWPs and carried over into the WRRP SAP.

3.3.3 Reporting and Change Control

As indicated in Sect. 3.3.2, Melton Valley monitoring will be implemented as part of the XWQP and WRRP activities. The primary reporting mechanism is the annual RER. The RER provides an annual update of the monitoring results for each watershed, including a watershed-scale introductory analysis and a separate section for each discrete remedial action within the watershed. Proposed changes to the monitoring approach, including proposed new locations for action-specific baseline monitoring, will be presented in the annual RER. These recommendations will be followed by a formal letter from DOE requesting specific changes. Regulator signature of this letter will signify approval of the changes.

3.3.4 Five-Year Reviews

In 2001 the first reservationwide Five-Year Review was completed to satisfy the mandated CERCLA Five-Year Reviews at National Priorities List sites. Actions specified by the Melton Valley ROD (2000a) will be managed under the new Five-Year Review schedule: 2006, 2011, etc. This requirement will have to be considered in the design of the action-specific monitoring approach.

As indicated in the ROD (DOE 2000a), it is projected that the selected remedy should be successful at meeting surface water remediation goals approximately 10 years after the full remedy becomes operational. Based on early schedule projections, the full remedy will not be completed until 2010–2011 at the earliest, indicating that surface water goals may not be met until approximately 2020–2021. Because waste is being left in place as part of the remedy, Melton Valley will be subject to Five-Year Reviews, during which a formal evaluation of the protectiveness of the response will be conducted. At least four Five-Year Review cycles will take place on the valley prior to the time goals are met. During the year prior to each Five-Year Review, monitoring will increase to prepare for the review. Additional monitoring will be designed to measure the protectiveness of any completed actions and to provide a comprehensive update of progress toward meeting the long-term watershed-scale RAOs. This monitoring will be designed to address all ARARs-based and risk-based RAOs, both numeric and narrative, as presented in Sect. 2.11.7.2 of the ROD (DOE 2000a).

4. MONITORING DESIGN

This section discusses the design for monitoring in the valley, including identified locations, monitoring frequency and chemical analyses required to address goals of the ROD (DOE 2000a).

4.1 WATERSHED-SCALE MONITORING

Watershed-scale monitoring is designed to measure the overall effectiveness of individual actions on the recovery of the White Oak Creek Watershed. The approach to measuring overall remedial effectiveness in Melton Valley/Lower White Oak Creek is dictated primarily by three considerations:

1. The quantitative "cleanup levels" for COCs identified in the ROD (DOE 2000a), as discussed in Chap. 3,
2. The location of contaminant sources in relation to monitoring locations, and
3. The hydrologic flow model for the watershed, as discussed in Chap. 2.

4.1.1 Sample Locations

Table 4.1 summarizes the proposed watershed-scale monitoring locations for Melton Valley as they relate to cleanup levels. Figure 4.1 shows the proposed monitoring locations.

Although several comprehensive surface water characterization efforts have occurred over the years in Melton Valley, routine monitoring has occurred historically at the major weirs that were built to help measure the mass of contaminants coming from the different reaches of the watershed. These weirs are identified in Table 4.1. In the early stage of ROD monitoring, these weirs will be used routinely to check the progress of meeting AWQC and recreational cleanup remedial goal options (RGOs), as well as continuing to track contaminant fluxes.

RCRA monitoring at Waste Area Grouping (WAG) 6 has occurred since the 1994 memorandum of agreement for WAG 6 was signed by DOE, TDEC, and EPA (DOE, EPA, and TDEC 1994). This monitoring is required under 40 *CFR* 265 Part F and is described in the annual SWSA 6 Groundwater Quality Monitoring Reports. A re-evaluation of groundwater monitoring requirements at SWSA 6 will occur during preparation of RDRs/RAWPs for the SWSA 6 remedy, and the postconstruction groundwater monitoring regimen may be modified with approval by TDEC.

In addition to routine watershed-scale monitoring, it will be necessary to perform periodic exit pathway and deep groundwater monitoring at the Hydrofracture 3 and 4 sites to determine if contaminants are being discharged from the Melton Valley area of contamination via groundwater and to determine the stability of deep contamination associated with hydrofracture waste disposal sites. This deep groundwater monitoring is stipulated in the ROD (DOE 2000a). After construction, exit pathway picket wells will be sampled quarterly in the first year and semiannually in the second year to establish the contaminant baseline in the wells. The analytical suite will initially include general water chemistry (anions and cations), metals by ICP analysis, tritium, gross alpha, gross beta, gamma scan, and VOCs. After the baseline period, the list of COCs for the exit pathway wells will be developed from the six baseline analyses. Following COC identification, the wells will be sampled once every 3 years for COC analyses. The analyte suites will be referenced to the appendix tables, which include parameters, analytical methods, and detection limits.

Table 4.1. Watershed-scale water quality monitoring

Monitoring goal	Monitoring locations/types	Contaminants of concern	Rationale
Achieve numeric and narrative AWQC for waters of the state in a reasonable amount of time	Major watershed reach weirs: WC Weir, MB Weir, 7500 Bridge, Melton Branch (MB-15, HRT-3, MB-Headwaters), Lower WOC locations (WAG 6 MS1 and MS3, West Seep Weir), WOD	Metals and organic COCs; all AWQC analytes	During early years of ROD implementation this goal should be evaluated on a large scale
Protect off-site resident user of surface water at the confluence of White Oak Creek with the Clinch River	WOD, SRS	Radionuclides	SRS is ROD-required location; WOD location provides ongoing record of releases at the dam, and allows for a buffer between the monitoring point and compliance point
Track contaminant distribution within watershed	Major watershed reach weirs: 7500 Bridge, WC Weir, MB Weir, Melton Branch (MB-15, HRT-3, MB-Headwaters), Lower WOC locations (WAG 6 MS1 and MS3, West Seep Weir), WOD	Radionuclides	Develop mass balance evaluation of contaminant fluxes; track changes in watershed over time
Meet other ROD requirements	WAG 6 RCRA wells	RCRA analytes	Required by WAG 6 letter of agreement
	Exit point groundwater wells, 1189, 1190, 1191, 1192, 1193, 1194, 1195; additional planned wells	Radionuclides	Required by DOE Order 5400 to evaluate contaminant conditions at the DOE property boundary

AWQC = ambient water quality criteria
DOE = U.S. Department of Energy
MB = Melton Branch
RCRA = Resource Conservation and Recovery Act of 1976
ROD = record of decision
SRS = sediment retention structure
WAG = Waste Area Grouping
WOC = White Oak Creek
WOD = White Oak Dam

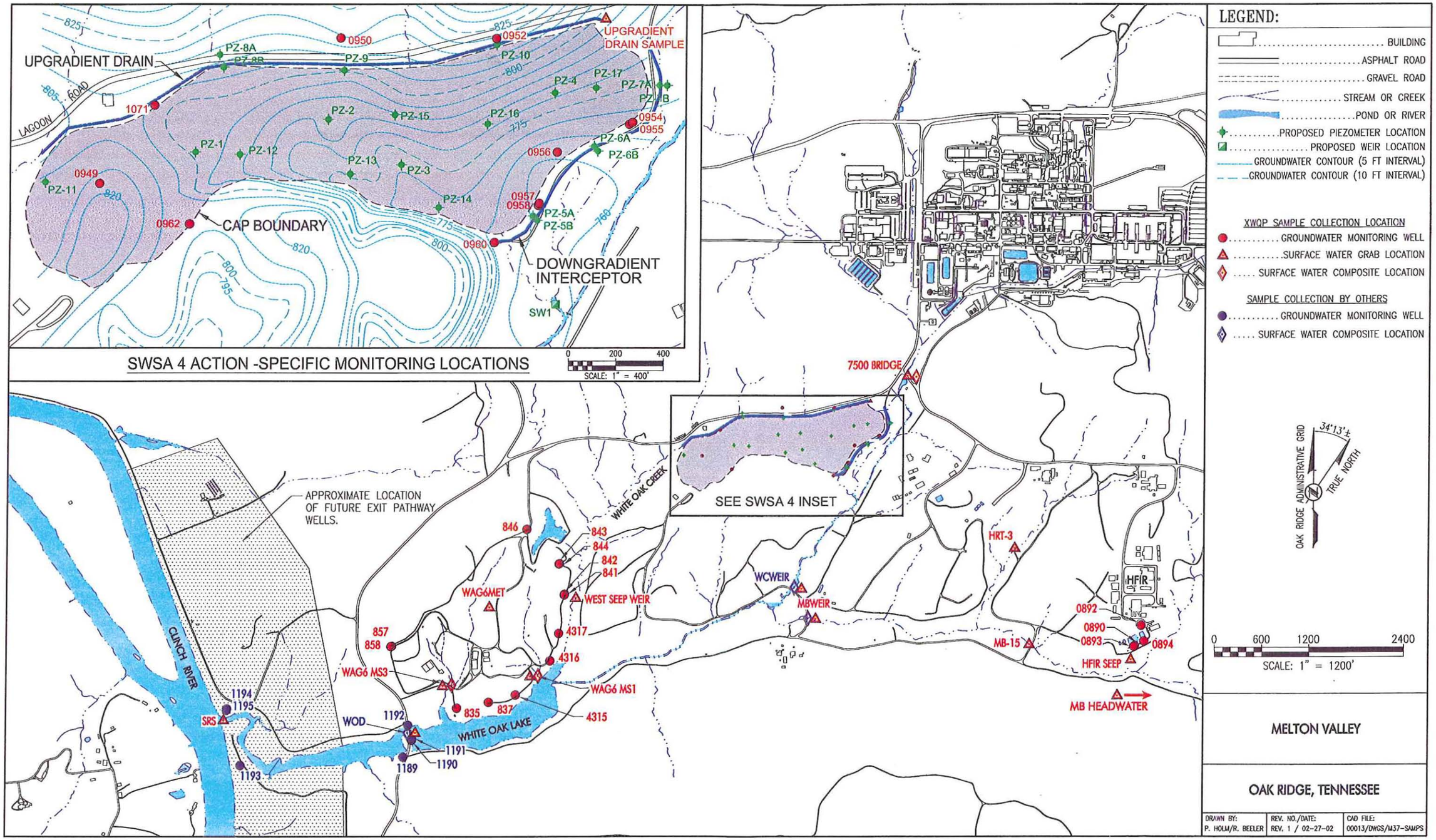


Fig. 4.1. Proposed monitoring locations in Melton Valley.

4.1.2 Sample Types

One key aspect of the conceptual flow model for Melton Valley that is critical for designing a monitoring approach is the overall water balance model for the watershed. The watershed water balance model indicates that at least 95% of rainfall (and thus dissolved contamination) that infiltrates the ground surface resurfaces prior to the watershed exit point, at the mouth of White Oak Creek; much of it resurfaces at the nearest downstream surface drainage. For this reason, surface water is the most valid and cost-effective environmental medium to monitor for measuring changes in contaminant releases.

There are two primary surface water monitoring sample types: flow-proportional sampling and grab sampling.

Flow-Proportional Sampling. Flow-proportional sampling, or flow-composite sampling, is performed using automated samplers, generally placed at weirs. These samplers are preset to collect a water sample automatically every time a preset volume of water has passed the weir. When flow is low, the sampler collects a sample infrequently. When flow is high, the sampler collects a sample more frequently. These "subsamples" are composited to make a single sample. This sample reflects the flow-averaged surface water contaminant concentration across all flow conditions that occur over the composite period. When combined with flow volumes, this sample can be used to measure the contaminant mass that has moved across the weir during the sample period using the following equation:

Concentration (mg or pCi/L) × water flow rate (L/time) = contaminant mass (mg or pCi/time)

Flow-proportional sampling has been used effectively in the White Oak Creek Watershed for many years to measure changes in the contaminant mass leaving the watershed and entering the Clinch River. Flow proportional samples include total suspended particulate load as well as the water. Water samples are not filtered before analysis, so the water analysis results include the total dissolved and particle-bound contaminant flux. As indicated in the recent RER for the ORR (DOE 2001c), strontium mass leaving the watershed has decreased from 2.4 Ci in 1993 to 1.1 Ci in 2000.

Flow-proportional sampling is very effective, but also very costly, and thus is proposed only for long-term monitoring at key sample locations.

Grab Sampling. Grab sampling measures the contaminant concentration in surface water at the time and flow condition under which the sample was collected. In general in Melton Valley, concentrations collected during baseflow or low-flow conditions are higher than concentrations collected during high flow, or diluted, conditions. In general, surface water grabs are used because they are inexpensive to collect and, if samples are collected throughout the watershed within a short period of time under similar flow conditions, they can be used to compare contaminant concentrations and mass release across the watershed. They can also be used to compare to RGO concentrations to measure the effectiveness of achieving AWQC. Grab samples are arguably better for comparison to AWQC, since they represent baseflow conditions, which are present most of the time.

Grab sampling is also used for groundwater monitoring (e.g., at the WAG 6 RCRA wells). Groundwater sampling performed by the XWQP will utilize a low-flow purge sampling method.

Proposed grab samples at the sediment retention structure at the mouth of White Oak Creek, where the White Oak Creek Embayment meets the Clinch River, has not been a part of past sampling programs and will be a new requirement.

4.1.3 Sample Frequency

As indicated above, flow-proportional samples are collected "continuously" and composited monthly, along with continuous flow data. This allows for a monthly and annual evaluation of the changes in mass flux of contaminants.

Biannual grab samples are proposed for the major weir locations and will be collected for a dry season baseflow (August/September) and a wet season baseflow (February/March).

All groundwater samples will be collected using low-flow purge methods. Groundwater sampling frequencies for baseline and postconstruction monitoring are generally semiannual, with sample collection to occur once during the wet season (January through April) and once during the dry season (August through November). The basis for the seasonality in groundwater sampling is the annual hydrologic cycle behavior described in Sect. 2.1.3, which demonstrates increased groundwater recharge and seepage during the winter and early spring and decreased recharge and general groundwater stagnation during late summer and autumn.

4.1.4 Decision Analysis and Decision Error

Data will be analyzed and presented in the annual RER and as part of the Five-Year Reviews. As a part of this effort, attempts will be made to quantitatively show progress toward achieving goals

Quantitative efforts to show actual compliance with watershed goals will not begin until the first Five-Year Review in 2006. At that time, it is expected that data will be analyzed and presented to show statistically significant trends. An attempt will be made to address both analytical uncertainties and sampling uncertainties. Analytical uncertainty is controlled using routine split, duplicate, and replicate sampling and routine data screening and validation processes under the WRRP sampling protocol. As surface water contaminant levels become even lower and get closer to AWQC and other remediation levels, additional effort may needed to ensure a high degree of certainty with laboratory measurements.

Sampling uncertainties are controlled by collecting flow-proportional samples for surface water, and grab samples during both wet and dry seasons for both surface water and groundwater.

Individual actions will develop project plans for ensuring a desired degree of confidence that the performance measurement goals have been attained. As indicated in the ROD (DOE 2000a), "documentation of remediation level attainment must provide an acceptable level of confidence that this has occurred." For example, it is expected that Multi-Agency Radiation Survey and Site Investigation Manual (DOD, DOE, EPA, and NRC 2000) geostatistical principals will be used to show compliance with the 2500 μR/hour goals for the IHP. For evaluating surface water and groundwater monitoring results, statistical approaches used in the RCRA program to show both trend analysis and compliance have been and will be used as part of the RER.

4.1.5 Watershed-Scale Sample Design

Table 4.2 and Fig. 4.1 show the proposed core monitoring locations for the Melton Valley ROD (DOE 2000a). Section 4.3 below provides additional information on analytical requirements for both watershed-scale and action-specific monitoring.

Table 4.2. Proposed monitoring activities for the Melton Valley Watershed

Sample location	Sample medium[a]	VOCs	Metals	Radiological	Anions	AWQC[b]	Miscellaneous[c]	Flow/precipitation[d]	Sampling program[e]	Sampling frequency[f]	Meet RAOs	Measure spatial, temporal contaminant distribution	Meet other ROD requirements	Meet action-specific goals	Comments
		Samples per year							*Watershed –scale*						
Sediment Retention Structure (SRS)	S	2	2	2					XWQP	Q2,Q4	X				MV ROD residential use measure point
WOD	S	2	2	2		2	2		XWQP	Q2,Q4	X				MV ROD residential, recreational use measure point; baseline for meeting AWQC
MBWEIR	S			2		2	2		XWQP	Q2,Q4	X				
WCWEIR	S			2		2	2		XWQP	Q2,Q4	X				
WAG 6 MS1	S			2		1	2		XWQP	Q2,Q4	X				
WAG 6 MS3	S			2		1	2		XWQP	Q2,Q4	X				
West Seep Weir	S			2		1	2		XWQP	Q2,Q4	X				
MB-15	S			12		1			XWQP	Q4	X				
7500 Bridge	S			2			2		XWQP	Q2,Q4	X				
MB-Headwaters	S					1			XWQP	Q4	X				
HRT-3	S					1			XWQP	Q4	X				
WOD (flow composite)	S			12				C	UT-B	M		X			MV long-term tracking of temporal/spatial contaminant distribution
WCWEIR (flow composite)	S			12				C	UT-B	M		X			
MBWEIR (flow composite)	S			12				C	UT-B	M		X			
7500 Bridge (flow composite)	S			12		2		C	XWQP	M		X			
WAG 6 MS1 (flow composite)	S			12				C	XWQP	M	X	X			MV long-term tracking of temporal/spatial contaminant distribution; WAG 6 EMP
WAG 6 MS3 (flow composite)	S			12				C	XWQP	M		X			
WAG 6 MET								X	XWQP	C					Monitor hydrological system in support of evaluating contaminant flux

Table 4.2. Proposed monitoring activities for the Melton Valley Watershed (continued)

Sample location	Sample medium[a]	VOCs	Metals	Radiological	Anions	AWQC[b]	Miscellaneous[c]	Flow/precipitation[d]	Sampling program[e]	Sampling frequency[f]	Meet RAOs	Measure spatial, temporal contaminant distribution	Meet other ROD requirements	Meet action-specific goals	Comments
TBD deep GW	G	X	X	X	X		X			Varies[g]			X		MV deep groundwater exit pathway picket well-sampling frequency described in text
TBD deep GW	G	X	X	X	X		X			Varies[g]			X		
TBD deep GW	G	X	X	X	X		X			Varies[g]			X		
TBD deep GW	G	X	X	X	X		X			Varies[g]			X		
TBD deep GW	G	X	X	X	X		X			Varies[g]			X		
TBD deep GW	G	X	X	X	X		X			Varies[g]			X		
1189	G	1	1	1	1		1		UT-B	Q2			X		MV exit pathway-sampling frequency is determined by UT-B groundwater program
1190	G	1	1	1	1		1		UT-B	Q2			X		
1191	G	1	1	1	1		1		UT-B	Q2			X		
1192	G	1	1	1	1		1		UT-B	Q2			X		
1193	G	1	1	1	1		1		UT-B	Q2			X		
1194	G	1	1	1	1		1		UT-B	Q2			X		
1195	G	1	1	1	1		1		UT-B	Q2			X		
835	G	2		2			2		XWQP	Q1,Q3			X		WAG 6 RCRA groundwater assessment wells. Sampling frequency is specified by RCRA monitoring requirements
837	G	2	2	2			2		XWQP	Q1,Q3			X		
841	G	2		2			2		XWQP	Q1,Q3			X		
842	G	2		2			2		XWQP	Q1,Q3			X		
843	G	2		2			2		XWQP	Q1,Q3			X		
844	G	2		2			2		XWQP	Q1,Q3			X		
846	G	2		2			2		XWQP	Q1,Q3			X		
857	G	2		2			2		XWQP	Q1,Q3			X		
858	G	2		2			2		XWQP	Q1,Q3			X		
4315	G	2	2	2			2		XWQP	Q1,Q3			X		
4316	G	2		2			2		XWQP	Q1,Q3			X		
4317	G	2		2			2		XWQP	Q1,Q3			X		

Table 4.2. Proposed monitoring activities for the Melton Valley Watershed (continued)

Sample location	Sample medium[a]	VOCs	Metals	Radiological	Anions	AWQC[b]	Miscellaneous[c]	Flow/precipitation[d]	Sampling program[e]	Sampling frequency[f]	Meet RAOs	Measure spatial, temporal contaminant distribution	Meet other ROD requirements	Meet action-specific goals	Comments
		Samples per year							*Action-specific monitoring***						
949	G							C	XWQP	C				X	Evaluate effectiveness of cap at controlling water table fluctuations and groundwater flow through SWSA 4
950	G							C	XWQP	C				X	
952	G							12	XWQP	M				X	
954	G	2	2	2	2		2	4	XWQP	Q1-Q4				X	
955	G	2	2	2	2		2	4	XWQP	Q1-Q4				X	
956	G							4	XWQP	Q1-Q4				X	
957	G	2	2	2	2		2	4	XWQP	Q1-Q4				X	
958	G	2	2	2	2		2	4	XWQP	Q1-Q4				X	
960	G							4	XWQP	Q1-Q4				X	
962	G							C	XWQP	C				X	
1071	G							4	XWQP	Q1-Q4				X	
PZ-8A,B	G							12	XWQP	Q1-Q4				X	
PZ-9	G							C	XWQP	C				X	
PZ-10	G							C	XWQP	C				X	
PZ-5A,B	G							12	XWQP	Q1-Q4				X	
PZ-6A,B	G							12	XWQP	Q1-Q4				X	
PZ-7A,B	G							12	XWQP	Q1-Q4				X	
PZ-1	G							12	XWQP	Q1-Q4				X	
PZ-2	G							12	XWQP	Q1-Q4				X	
PZ-3	G							12	XWQP	Q1-Q4				X	
PZ-4	G							12	XWQP	Q1-Q4				X	
PZ-11	G							12	XWQP	Q1-Q4				X	
PZ-12	G							12	XWQP	Q1-Q4				X	
PZ-13	G							12	XWQP	Q1-Q4				X	
PZ-14	G							12	XWQP	Q1-Q4				X	

Table 4.2. Proposed monitoring activities for the Melton Valley Watershed (continued)

Sample location	Sample medium[a]	VOCs	Metals	Radiological	Anions	AWQC[b]	Miscellaneous[c]	Flow/precipitation[d]	Sampling program[e]	Sampling frequency[f]	Meet RAOs	Measure spatial, temporal contaminant distribution	Meet other ROD requirements	Meet action-specific goals	Comments
PZ-15	G							12	XWQP	Q1-Q4				X	
PZ-16	G							12	XWQP	Q1-Q4				X	
PZ-17	G							12	XWQP	Q1-Q4				X	
Upgradient Drain (flow composite)	S			12				C	XWQP	C				X	
SW-1	S		12	12					XWQP	M				X	Measure releases of Sr flux; meet AWQC goals
HFIR Well 0890	G	2	2	2	2		2		XWQP	Q2, Q4				X	
HFIR Well 0892	G	2	2	2	2		2		XWQP	Q2, Q4				X	
HFIR Well 0893	G	2	2	2	2		2		XWQP	Q2, Q4				X	HFIR CERCLA action baseline
HFIR Well 0894	G	2	2	2	2		2		XWQP	Q2, Q4				X	
HFIR Seep	G			12				I	XWQP	M				X	

[a] Sample medium: S = surface water, G = groundwater.

[b] Ambient Water Quality Criteria parameters. AWQC parameters will be analyzed only during the Q4 dry season sampling event.

[c] Miscellaneous includes, but is not limited to, general water quality parameters such as total dissolved solids, total suspended solids, total organic carbon, temperature, dissolved oxygen, turbidity, pH, conductivity, oxidation-reduction potential, and water levels (in wells).

[d] C = continuous flow measurements, X = precipitation (hourly)/temperature/wind speed/wind direction/solar radiation/relative humidity, I = instantaneous flow measurement.

[e] XWQP = X-10 Water Quality Program implemented by EMEF, UT-B = UT-Battelle Environmental Protection Department.

[f] Q1…Q4 = lists sample schedule by FY quarters, M= monthly, C = continuous.

[g] Wells will be sampled quarterly in the first year and semiannually in the second year to establish the contaminant baseline in the wells. After this baseline period, the wells will be sampled once every 3 years.

AWQC = ambient water quality criteria
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
EMEF = Environmental Management and Enrichment Facilities
EMP = environmental monitoring plan
FY = fiscal year
GW = groundwater
HFIR = High Flux Isotope Reactor
MV = Melton Valley
RAO = remedial action objective
RCRA = Resource Conservation and Recovery Act of 1976
ROD = record of decision
SWSA = solid waste storage area
TBD = to be determined
VOC = volatile organic compound
WAG = Waste Area Grouping
WOD = White Oak Dam

4.2 ACTION-SPECIFIC MONITORING

As indicated in Chap. 3, most action-specific monitoring will be identified in one of two places.

- Baseline monitoring prior to an action will be identified in the annual WRRP SAP.
- Performance assessment monitoring that occurs after the action has been completed will be identified in action-specific RDRs/RAWPs and other project-specific documents.

At this time, monitoring for two actions identified in the ROD (DOE 2000a) has been identified and is discussed below. The baseline monitoring was first specified in the WRRP SAP (BJC 2000), and the post-action monitoring for SWSA 4 has been specified in Appendix L of the RDR/RAWP (DOE 2001b).

4.2.1 SWSA 4

The first major remedial action to be performed in Melton Valley will be capping of SWSA 4, including installation of an upgradient groundwater diversion trench and a downgradient groundwater interceptor trench and excavation of contaminated soil in the Intermediate Holding Pond area adjacent to SWSA 4. The goal of the project is to hydraulically isolate the buried waste in SWSA 4 from continuing groundwater throughflow and to collect and treat contaminated groundwater seepage along the eastern edge of the burial ground. Figure 4.1 shows key features of the SWSA 4 remedy along with the groundwater elevation contours and principal groundwater seepage direction.

Baseline monitoring at SWSA 4 is ongoing and is described in Sect. 4.2.1.1, and post-construction monitoring is described in Sect. 4.2.1.2

4.2.1.1 SWSA 4 Baseline Monitoring

Pre-construction baseline monitoring for SWSA 4 includes flow-proportional surface water monitoring at SWSA 4 MS1, monthly grab samples at the West Seep Weir, and semiannual groundwater sampling and analysis at wells 0954, 0955, 0957, and 0958. Analytical parameters for the baseline monitoring are listed in Table 4.3.

Table 4.3. Pre-Construction baseline monitoring at SWSA 4

Sample site	Sample frequency	Analytes
SWSA 4 MS1	Continuous flow-paced	$^{89/90}$Sr, Tritium
West Seep Weir	Monthly grabs	Gross alpha, gross beta, $^{89/90}$Sr, Tritium, ^{137}Cs, ^{60}Co
Groundwater (Wells 0954, 0955, 0957, 0958)	Wet season/dry season	Gross alpha, $^{89/90}$Sr, ^{234}U, ^{137}Cs, As, ^{241}Am, ^{14}C, Tritium, VOCs

SWSA = Solid Waste Storage Area

4.2.1.2 SWSA 4 Post-construction performance monitoring

There will be two types of monitoring to determine the effectiveness of these actions: groundwater-level monitoring in and around SWSA 4, and surface water sample collection associated with the treatment and discharge of captured groundwater at the downgradient interceptor trench.

Groundwater-level monitoring will be accomplished using a system of shallow piezometers and existing groundwater wells. A full round of water levels will be collected as a baseline as soon as all wells and piezometers have been installed. Surface water sample collection will occur at a weir to be constructed following the remedial actions for SWSA 4. This new weir will be designated SW-1, and its location is shown on Fig. 4.1.

Groundwater-Level Monitoring at SWSA 4. A goal of the cap and groundwater diversion structures that are to be installed as part of the remedial actions at SWSA 4 will be to create a general decline in the groundwater levels within the cap footprint. In order to test if this goal is being met, new piezometers and existing 900 series monitoring wells will be used to monitor groundwater levels in and around SWSA 4. The groundwater-level monitoring network is described in the following text, and the frequency of monitoring at each location is presented in Table 4.4. Four new piezometers (PZ 8 A, -B, PZ 9, and PZ 10) will be used to monitor upgradient diversion trench effectiveness. With existing wells 950 and 952, these form three monitoring pairs, each with one point each north and south of the diversion trench location and spaced along its length. Monthly water level measurements are proposed for the first two years as new average groundwater conditions are established and seasonal variations are observed. When sufficient data have been gathered to establish patterns, measurement frequency can be relaxed to quarterly. PZ 9 and PZ 10 have been selected for continuous water level monitoring.

Three new piezometer pairs (PZ 5 A, -B, PZ 6 A, -B, and PZ 7 A, -B) will be used to monitor the operation of each of the three sections of the downgradient collection trench. Measurements will be taken weekly to ensure that an inward hydraulic gradient exists from south of the trench into the trench. The "A" piezometer of each pair will be located within the trench section. The "B" piezometer of each pair will be positioned as closely as possible to the south edge of the trench. The results of these measurements will be used to establish an average pumping rate needed to maintain the required inward gradient. None of these piezometers will be used to measure storm-related fluctuations.

Eleven new piezometers (PZ 1 through PZ 4, and PZ 11 through PZ 17) will be placed within the capped area. Water levels will be measured monthly for two years, and then the frequency will be relaxed to quarterly. Five of these (PZ 1 through PZ 4 and PZ 14) will be used to collect continuous water levels during the low-to-high groundwater cycle for evaluation of water level fluctuation.

All other 900 series monitoring wells and Well 1071 will be measured quarterly. Two of the wells, 949 and 962, have been selected for continuous wet season water level monitoring for groundwater fluctuation evaluation within the capped area, while 950 will be similarly monitored as an upgradient (background) location for comparison.

Surface Water Monitoring at SWSA 4. Achievement of the SWSA 4 remedial action performance goals (Table 3.3) will be determined by collecting and analyzing surface water samples at a new weir, SW 1, located at the confluence of the SWSA 4 tributary and White Oak Creek (Fig. 4.2). Sampling will be flow proportional and samples will be analyzed for gross alpha, gross beta, gamma scan, metals, tritium, ^{90}Sr, and ^{137}Cs. Water discharged from the upgradient drain will be sampled and analyzed for radiological contamination monthly.

4.2.2 HFIR Ponds

In preparation for the planned action at the HFIR Ponds, preaction baseline sampling is being performed as part of the XWQP/WRRP sampling program. Baseline monitoring includes the following:

- Surface water sampling at the "Cobalt Seep" just downgradient of the HFIR Ponds. Samples are being collected monthly and analyzed for alpha and beta/gamma radionuclides;

Table 4.4. SWSA 4 postremediation groundwater level monitoring points and frequency

Well ID	Proposed frequency			Performance wells	Screen elevation
	Weekly	Monthly	Quarterly		
949			*a*	*d*	813-794
950		*b*	*c*	*d*	813-788
952		*b*	*c*		814-787
955			*a*		758-746
956			*a*		765-752
958			*a*		756-740
960			*a*		756-739
962			*a*	*d*	811-799
1071			*a*		802-786
PZ 1		*b*	*c*	*d*	798-793
PZ 2		*b*	*c*	*d*	783-778
PZ 3		*b*	*c*	*d*	778-773
PZ 4		*b*	*c*	*d*	771-766
PZ 5 A, B	*a*				755-750
PZ 6 A, B	*a*				760-755
PZ 7 A, B	*a*				761-756
PZ 8 A, B		*b*	*c*		815-810, 807-802
PZ 9		*b*	*c*	*d*	799-794
PZ 10		*b*	*c*	*d*	790-785
PZ 11		*b*	*c*		802-797
PZ 12		*b*	*c*		788-783
PZ 13		*b*	*c*		771-766
PZ 14		*b*	*c*	*d*	767-762
PZ 15		*b*	*c*		782-777
PZ 16		*b*	*c*		775-770
PZ 17		*b*	*c*		764-759

Note: Program subject to change at Five-Year Review period or upon interim request to modify program as needed to verify performance.

a Recommended frequency of measurement.

b, c Monthly for first two years, quarterly thereafter.

d Automated measurement for October-May dry-to-wet season fluctuation measurements for years 1 through 3 will be modified as necessary at 3-year and 4-year review periods.

- Groundwater sampling in four monitoring wells surrounding the ponds.

This sampling protocol will continue through the year until the action is implemented.

4.3 DATA QUALITY REQUIREMENTS

4.3.1 Analytical Methods

Since 1996, the then Integrated Water Quality Program, which is now referred to as the WRRP, has studied and identified analytical methods required to meet ORO data quality objectives. For ease in tracking and administering these requirements, WRRP has developed "administrative parameter groups" (BJC 2000). A complete listing of the parameter groups and associated detection limits is provided in Appendix A.

4.3.2 AWQC Required Detection Limits

A requirement of the Melton Valley ROD (DOE 2000a) is the need to meet AWQC. Although implicit in past monitoring requirements, the ROD has made explicit the need to meet AWQC detection limit requirements. Required detection limits (RDLs) have been proposed by TDEC (General Water Quality Criteria, Chap. 1200-4-3). Table 4.5 summarizes the RDLs for the chemicals that will be screened against AWQC. These detection limits may require that one or two new parameter groups be developed by the XWQP/WRRP.

4.3.3 Data Management

All data collected under this plan will be managed according to the Data Management Implementation Plan for the WRRP, including verification, validation, and Oak Ridge Environmental Information System storage requirements specified in the plan.

Table 4.5. Required detection limits for contaminants of concern

Contaminant of concern	Required detection limit (μg/L)
Arsenic	1.0
Cadmium	1.0
Copper	1.0
Lead	1.0
Mercury	0.2
Selenium	2.0
Vinyl chloride	2.0
Tetrachloroethene	0.5

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APPENDIX A

WRRP SAMPLE GROUP AND ADMINISTRATIVE PARAMETER GROUP TABLES

Table A.1. Parameter groups and analyte groups for WRRP monitoring during FY 2001

Parameter group	Analytes
ATTN	FLD, ION(1,2,3,4), MET(6), TOC, VOC(1,2)
BC-SW	FLD, ION(1,2,3), SLD, MET(1,3,4), VOC(1), BETA, TC, U
BIO-1	B-MET(2), B-GAMMA, B-PEST, B-PCB, LIPIDS
BVA	FLD, MET(1), RAD(1), GAMMA
DCELL	FLD, ION(1,2,3), SLD, MET(1,3,4), VOC(1,2), SVOC, PCB, RAD(4), Dioxin/Furan
EXP-1	FLD, ION(1,2,3), SLD, MET(1,3), VOC(1), RAD(1)
EXP-2	EXP-1, MET(6), VOC(2)
EXP-3	FLD, ION(1,2), SLD, MET(1,3), VOC(1), RAD(1)
FCAP-PA	FLD, ION(1,2), SLD, MET(1,3), RAD(1)
KHQ-PA	FLD, ION(1,2,3), SLD, MET(2,3,4), RAD(1)
MVA	FLD, VOC(1), ALPHA, GAMMA, SR, T
RCRA-1	FLD, ION(1,2,3), SLD, MET(1,3,4),VOC(1), RAD(2)
RCRA-2	FLD, ION(1,2,3), SLD, MET(1,3,4),VOC(1), RAD(1), TC
RCRA-3	FLD, SLD, MET(1,3,4),VOC(1), RAD(1)
RCRA-4	FLD, SLD, MET(1,3,4)
S3PATH	FLD, VOC(1), MET(1,3,6), ION (1,2,3), U
STORM-1	FLD, ION(1,2,3), SLD, MET(1,3),VOC(1), PCB
STORM-2	STORM-1, RAD(1), U
UNC-ROD	FLD, ION(1,2,3), SLD, MET(1,3), RAD(1), SR
UV-IROD	FLD, ION(1,2,3), SLD, MET(6), VOC(1), RAD(1)

Parameter group	Analytes	Appendix A table
	Water	
ION(1)	Chloride, fluoride, sulfate	Table A.2
ION(2)	Alkalinity – carbonate and bicarbonate	Table A.2
ION(3)	Nitrate (as N)	Table A.2
ION(4)	Sulfide (In-field analysis)	Table A.2
MET(1)	ICP trace metals suite	Table A.3
MET(2)	Outfall 301 metals suite	Table A.4
MET(3)	Uranium (RCRA PCP), detection limit = 0.004 mg/L	Table A.5
MET(4)	Mercury (RCRA PCP), detection limit = 0.0002 mg/L	Table A.5
MET(5)	Mercury, detection limit = 0.5 ng/L	Table A.5
MET(6)	Iron $^{(2+)}$, manganese $^{(2+)}$ (In-field analyses)	Table A.5
MET(7)	Lead	Table A.5
MET(8)	Methyl Mercury	Table A.5
VOC(1)	IWQP suite of volatile organic compounds	Table A.6
VOC(2)	Methane, ethane, ethene	Table A.7
PCB	Polychlorinated biphenyls	Table A.8
SLD	Total dissolved solids, total suspended solids	Table A.9

Table A.1 Parameter groups and analyte groups for WRRP monitoring during FY 2001 (continued)

Parameter group	Analytes	Appendix A table
TOC	Total organic carbon	Table A.9
FLD	Temperature, dissolved oxygen, turbidity, pH, conductivity, oxidation-reduction potential, water level (in wells)	Table A.9
I	Instantaneous flow	Table A.9
PRES	Pressure Profile	Table A.9
RAD(1)	ALPHA, BETA	Table A.10
RAD(2)	RAD(1), AM, NP, RA, SR, TC, U	Table A.10
RAD(3)	RAD(2), T, TH	Table A.10
RAD(4)	GAMMA, PU, SR, TC, U, U(2), C, CM, EU, I	Table A.10
RAD(5)	RAD(1), SR, T	Table A.10
RAD(6)	RAD(5), GAMMA, U	Table A.10
RAD(7)	RAD(1), GAMMA, SR, U, TC, TH	Table A.10
ALPHA	Gross alpha activity	Table A.10
BETA	Gross beta activity	Table A.10
GAMMA	^{137}Cs (Cesium), ^{60}Co (Cobalt)	Table A.10
AM	^{241}Am (Americium)	Table A.10
NP	^{237}Np (Neptunium)	Table A.10
C	^{14}C (Carbon)	Table A.10
CM	^{244} Cm (Curium)	Table A.10
EU	$^{152, 154, 155}$Eu (Europium)	Table A.10
I	^{129}I (Iodine)	Table A.10
PU	^{238,239,240}Pu (Plutonium)	Table A.10
RA	Total radium	Table A.10
SR	$^{89/90}$Sr (Strontium)	Table A.10
T	^{3}H (Tritium)	Table A.10
TC	^{99}Tc (Technetium)	Table A.10
TH	^{228,230,232}Th (Thorium)	Table A.10
U	^{234,235,238}U (Uranium)	Table A.10
U(2)	$^{232, 233, 236}$U	Table A.10
SVOC	Semivolatile organic compounds	Table A.18
Dioxin/furan	Dioxins/Furans	Table A.19
	Sediment	
S-MET	ICP trace metals suite for sediment	Table A.11
S-VOC	IWQP suite of volatile organic compounds for sediment	Table A.12
S-PCB	Polychlorinated biphenyls for sediment	Table A.13
S-PEST	Pesticides for sediment	Table A.14
S-SVOC	Semi-volatile organic compounds for sediment	Table A.15
S-ALPHA	Gross alpha activity for sediment	Table A.16
S-BETA	Gross beta activity for sediment	Table A.16

Table A.1 Parameter groups and analyte groups for WRRP monitoring during FY 2001 (continued)

Parameter group	Analytes	Appendix A table
S-GAMMA	^{137}Cs (Cesium), ^{60}Co (Cobalt) for sediment	Table A.16
S-AM	^{241}Am (Americium) for sediment	Table A.16
S-NP	^{237}Np (Neptunium) for sediment	Table A.16
S-PU	$^{238,239,240}Pu$ (Plutonium) for sediment	Table A.16
S-SR	$^{89/90}Sr$ (Strontium) for sediment	Table A.16
S-TC	^{99}Tc (Technetium) for sediment	Table A.16
S-U	$^{234,235,238}U$ (Uranium) for sediment	Table A.16
	Biota	
B-MET(1)	ICP trace metals suite for fish/turtle tissue	Table A.17
B-MET(2)	Total mercury for fish/turtle tissue	Table A.17
B-MET(3)	Methyl mercury in fish tissue	Table A.17
B-PCB	Polychlorinated biphenyls for fish/turtle tissue	Table A.17
B-PEST	Pesticides for fish/turtle tissue	Table A.17
B-GAMMA	^{137}Cs (Cesium) for fish/turtle tissue	Table A.17
FISH	Fish community species and diversity determination in creeks with field identification and enumeration, per sampling locality	Table A.17
BENTHIC	Benthic macroinvertebrate community species and diversity determination in creeks with laboratory identification and enumeration, per sampling locality	Table A.17
LIPIDS	Total lipids in fish and turtle tissue measured gravimetrically and reported as weight percent	Table A.17

Table A.2. Anion parameter groups

Parameter group	Analyte	Analytical method	Project quantitation level (mg/L)
ION (1)	Chloride	EPA-300.0	0.1
	Fluoride	EPA-340.2	0.05
	Sulfate	EPA-300.0	0.1
ION (2)	Alkalinity – HCO_3	EPA-310.1	NA
	Alkalinity – CO_3	EPA-310.1	NA
ION (3)	Nitrate (as nitrogen)	EPA-353.2	0. 1
ION (4)	Sulfide	SM4500-S-D (in field analysis)	0.1

Table A.3. MET(1) parameter group

Analyte	Analytical method	Project quantitation level (mg/L)
Aluminum	SW846-6010B or SW846-6020	0.05
Antimony	SW846-6010B or SW846-6020	0.006**
Arsenic	SW846-6010B or SW846-6020	0.005**
Barium	SW846-6010B or SW846-6020	0.005
Beryllium	SW846-6010B or SW846-6020	0.001
Boron	SW846-6010B or SW846-6020	0.01
Cadmium	SW846-6010B or SW846-6020	0.001**
Calcium	SW846-6010B or SW846-6020	0.25**
Chromium	SW846-6010B or SW846-6020	0.005**
Cobalt	SW846-6010B or SW846-6020	0.005**
Copper	SW846-6010B or SW846-6020	0.005
Iron	SW846-6010B or SW846-6020	0.01
Lead	SW846-6010B or SW846-6020	0.003**
Lithium	SW846-6010B or SW846-6020	0.01
Magnesium	SW846-6010B or SW846-6020	0.05
Manganese	SW846-6010B or SW846-6020	0.005
Nickel	SW846-6010B or SW846-6020	0.01
Potassium	SW846-6010B or SW846-6020	0.25
Selenium	SW846-6010B or SW846-6020	0.005
Silver	SW846-6010B or SW846-6020	0.005
Sodium	SW846-6010B or SW846-6020	0.25
Strontium*	SW846-6010B or SW846-6020	0.005
Thallium	SW846-6010B or SW846-6020	0.002**
Tin***	SW846-6010B or SW846-6020	0.0026
Vanadium	SW846-6010B or SW846-6020	0.01
Zinc	SW846-6010B or SW846-6020	0.01
Zirconium***	SW846-6010B or SW846-6020	0.0212

*For ETTP sample groups (Table C.1) omit Strontium.
**For ETTP sample groups the project quantitation level (mg/L) is:

Antimony – 0.041	Cadmium – 0.002	Chromium – 0.012	Lead – 0.03
Arsenic – 0.03	Calcium – 0.002	Cobalt – 0.02	Thallium – 0.4

***Reported for sample group BCW-2 (EMWMF wells) only.

Table A.4. MET(2) parameter group

Analyte	Analytical method	Project quantitation level (mg/L)
Aluminum	SW846-6010B or SW846-6020	0.08
Arsenic	SW846-6010B or SW846-6020	0.05
Barium	SW846-6010B or SW846-6020	0.003
Beryllium	SW846-6010B or SW846-6020	0.004
Boron	SW846-6010B or SW846-6020	0.5
Cadmium	SW846-6010B or SW846-6020	0.001
Chromium	SW846-6010B or SW846-6020	0.1
Cobalt	SW846-6010B or SW846-6020	0.003
Copper	SW846-6010B or SW846-6020	0.01
Iron	SW846-6010B or SW846-6020	0.3
Lead	SW846-6010B or SW846-6020	0.15
Magnesium	SW846-6010B or SW846-6020	0.05
Manganese	SW846-6010B or SW846-6020	0.05
Molybdenum	SW846-6010B or SW846-6020	0.1
Nickel	SW846-6010B or SW846-6020	0.1
Selenium	SW846-6010B or SW846-6020	0.03
Silver	SW846-6010B or SW846-6020	0.004
Strontium	SW846-6010B or SW846-6020	0.6
Thallium	SW846-6010B or SW846-6020	0.002
Vanadium	SW846-6010B or SW846-6020	0.01
Zinc	SW846-6010B or SW846-6020	0.1

Table A.5. MET(3, 4, 5, 6, 7, and 8) parameter groups

Parameter group	Analyte	Analytical method	Project quantitation level	Units
MET (3)	Uranium (RCRA PCP)	ASTM D5174M	0.004	mg/L
MET (4)	Mercury (RCRA PCP)	SW846-7470	0.0002	mg/L
MET (5)	Mercury	EPA 1631 (RMPE)	0.5	ng/L
MET (6)	Iron (Fe^{2+}) Manganese (Mn^{2+})	SM* 3500-Fe-D (in-field analysis) SM* 3500-Mn-D (in-field analysis)	100 5	µg/L µg/L
MET (7)	Lead	SW846-6010B or SW846-6020	0.003	mg/L
MET (8)	Methyl mercury	EPA 1630M (Draft)	0.02	ng/L

* SM = Standard Methods for the Examination of Water and Wastewater

Table A.6. VOC(1) parameter group

Analyte	Analytical method*	Project quantitation level (µg/L)
1,1,1-Trichloroethane	OLM03.1VOA	5
1,1,2,2-Tetrachloroethane	OLM03.1VOA	5
1,1,2-Trichloroethane	OLM03.1VOA	5
1,1,2-Trichloro-1,2,2-trifluoroethane****	OLM03.1VOA	10
1,1-Dichloroethane	OLM03.1VOA	5
1,1-Dichloroethene	OLM03.1VOA	5
1,2-Dichloroethane	OLM03.1VOA	5
1,2-Dichloroethene	OLM03.1VOA	5
1,2-Dichloropropane	OLM03.1VOA	5
2-Butanone	OLM03.1VOA	10**
2-Hexanone***	OLM03.1VOA	10
4-Methyl-2-pentanone	OLM03.1VOA	10**
Acetone	OLM03.1VOA	10**
Benzene	OLM03.1VOA	5
Bromodichloromethane	OLM03.1VOA	5
Bromoform	OLM03.1VOA	5
Bromomethane	OLM03.1VOA	10
Carbon disulfide	OLM03.1VOA	5
Carbon tetrachloride	OLM03.1VOA	5
Chlorobenzene	OLM03.1VOA	5
Chloroethane	OLM03.1VOA	10
Chloroform	OLM03.1VOA	5
Chloromethane	OLM03.1VOA	10
cis-1,2-Dichloroethene	OLM03.1VOA	5
cis-1,3-Dichloropropene	OLM03.1VOA	5
Dibromochloromethane	OLM03.1VOA	5
Ethylbenzene	OLM03.1VOA	5
Methylene chloride	OLM03.1VOA	5
Styrene	OLM03.1VOA	5
Tetrachloroethene	OLM03.1VOA	5
Toluene	OLM03.1VOA	5
trans-1,2-Dichloroethene	OLM03.1VOA	5
trans-1,3-Dichloropropene	OLM03.1VOA	5
Trichloroethene	OLM03.1VOA	5
Vinyl chloride	OLM03.1VOA	2
Xylenes (total)	OLM03.1VOA	5

*For ETTP sample groups (Table C.1), the analytical method is SW846-8260A.
**For ETTP sample groups the project quantitation level for these analytes is 50 µg/L.
***For ETTP sample groups omit 2-Hexanone.
****Reported for sample group BCW-2 (EMWMF wells) only.

Table A.7. VOC(2) parameter group

Analyte	Analytical methods	Project quantitation level (µg/L)
Methane	SW846-3810/8015	10
Ethane	SW846-3810/8015	10
Ethene	SW846-3810/8015	10

Table A.8. PCB parameter group

Analyte	Analytical method	Project quantitation level* (µg/L)
Aroclor-1016	SW846-8082	0.5
Aroclor-1221	SW846-8082	0.5
Aroclor-1232	SW846-8082	0.5
Aroclor-1242	SW846-8082	0.5
Aroclor-1248	SW846-8082	0.5
Aroclor-1254	SW846-8082	0.5
Aroclor-1260	SW846-8082	0.5

*For ETTP sample groups (Table C.1) the project quantitation level for all analytes in this parameter group is 1.0 µg/L.

Table A.9. Miscellaneous parameter groups

Parameter group	Parameter	Analytical method	Project quantitation level	Units
SLD	Total dissolved solids	EPA-160.1	2.5	mg/L
	Total suspended solids	EPA-160.2	2.5	mg/L
TOC	Total organic carbon	EPA 415.2	1.0	mg/L
FLD (In-field measurements)	Temperature		NA	°C
	Dissolved oxygen		NA	ppm
	Turbidity		NA	NTU
	pH		NA	pH units
	Conductivity		NA	µmhos/cm
	Oxidation-reduction potential		NA	mV
	Water level (in wells)		NA	ft
I	Instantaneous Flow		NA	cfs
PRES (Westbay® Wells)	Pressure profile of all sampling ports within Westbay® well obtained prior to sampling		NA	ft

Table A.10. Radiological analytes

Parameter group	Analyte	Analytical method	Project quantitation level (MDA) (pCi/L)
ALPHA	Gross Alpha	EPA 900.0	5
BETA	Gross Beta	EPS 900.0	5
GAMMA	Gamma scan (^{137}Cs, ^{60}Co)	EPA 901.1	10 ea.
AM	^{241}Am	EPA 907.0*	0.4
C	^{14}C	Liquid scint.*	0.05
CM	^{244}Cm	EPA 907.0*	0.3
EU	$^{152,154,155}Eu$	EPA 907.0*	1
I	^{129}I	Liquid scint.*	0.25
NP	^{237}Np	EPA 907.0*	0.4
PU	$^{238,239,240}Pu$	EPA 907.0*	1
RA	Total Radium	EPA 903.0	0.5
SR	$^{89/90}Sr$	EPA 905.0	4
T	Tritium	EPA 906.0	300
TC	^{99}Tc	Liquid scint.*	10**
TH	$^{228,230,232}Th$	EPA 907.0*	1
U	$^{234,235,238}U$	EPA 908.0*	1
U(2)	$^{232,233,236}U$	EPA 908.0*	1

*Public drinking water approved radiochemistry EPA Methods. Non-EPA methods that meet or exceed the intent of the applicable methods may be substituted.

**For ETTP sample groups (Table C.1) the project quantitation level for this analyte is 12 pCi/L.

Table A.11. S-MET parameter group

Analyte	Analytical method	Project quantitation level (mg/Kg)
Antimony	SW846-3050A/6010B	0.5
Arsenic	SW846-3050A/6010B	0.5
Barium	SW846-3050A/6010B	0.5
Beryllium	SW846-3050A/6010B	0.1
Cadmium	SW846-3050A/6010B	0.1
Calcium	SW846-3050A/6010B	5
Chromium	SW846-3050A/6010B	0.5
Cobalt	SW846-3050A/6010B	0.5
Copper	SW846-3050A/6010B	0.5
Iron	SW846-3050A/6010B	1
Lead	SW846-3050A/6010B	0.3
Magnesium	SW846-3050A/6010B	5
Mercury	SW846-7471	0.1
Manganese	SW846-3050A/6010B	0.5
Nickel	SW846-3050A/6010B	1
Potassium	SW846-3050A/6010B	5
Selenium	SW846-3050A/6010B	0.5
Silver	SW846-3050A/6010B	0.5
Sodium	SW846-3050A/6010B	5
Thallium	SW846-3050A/6010B	0.2
Vanadium	SW846-3050A/6010B	1
Zinc	SW846-3050A/6010B	0.5
Boron	SW846-3050A/6010B	1
Lithium	SW846-3050A/6010B	1
Molybdenum	SW846-3050A/6010B	1
Uranium	SW846-3050A/6010B	5

Table A.12. S-VOC parameter group

Analyte	Analytical method	Project quantitation level (µg/kg)
1,1,1-Trichloroethane	SW846-8260B	5
1,1,2,2-Tetrachloroethane	SW846-8260B	5
1,1,2-Trichloroethane	SW846-8260B	5
1,1-Dichloroethane	SW846-8260B	5
1,1-Dichloroethene	SW846-8260B	5
1,2-Dichloroethane	SW846-8260B	5
1,2-Dichloropropane	SW846-8260B	5
2-Butanone	SW846-8260B	10*
2-Hexanone	SW846-8260B	10
4-Methyl-2-pentanone	SW846-8260B	10*
Acetone	SW846-8260B	10*
Benzene	SW846-8260B	5
Bromodichloromethane	SW846-8260B	5
Bromomethane	SW846-8260B	10
Carbon disulfide	SW846-8260B	5
Carbon tetrachloride	SW846-8260B	5
Chlorobenzene	SW846-8260B	5
Chloroethane	SW846-8260B	10
Chloroform	SW846-8260B	5
Chloromethane	SW846-8260B	10
cis-1,3-Dichloropropene	SW846-8260B	5
cis-1,2-Dichloroethene	SW846-8260B	5
Dibromochloromethane	SW846-8260B	5
Ethylbenzene	SW846-8260B	5
Methylene chloride	SW846-8260B	5
Styrene	SW846-8260B	5
Tetrachloroethene	SW846-8260B	5
Toluene	SW846-8260B	2
trans-1,3-Dichloropropene	SW846-8260B	5
trans-1,2-Dichloroethene	SW846-8260B	5
Tribromomethane	SW846-8260B	5
Trichloroethene	SW846-8260B	5
Vinyl chloride	SW846-8260B	2
Xylenes (total)	SW846-8260B	5

*For ETTP sample groups (Table C.1) the project quantitation level for these analytes is 50 µg/kg.

Table A.13. S-PCB parameter group

Analyte	Analytical method	Project quantitation level (µg/kg)
Aroclor-1016	SW846-8082	33
Aroclor-1221	SW846-8082	67
Aroclor-1232	SW846-8082	33
Aroclor-1242	SW846-8082	33
Aroclor-1248	SW846-8082	33
Aroclor-1254	SW846-8082	33
Aroclor-1260	SW846-8082	33

Table A.14. S-PEST parameter group

Analyte	Analytical method	Project quantitation level (µg/kg)
Aldrin	SW846-8081	1.7
alpha-BHC	SW846-8081	1.7
beta-BHC	SW846-8081	1.7
gamma-BHC	SW846-8081	1.7
delta-BHC	SW846-8081	1.7
alpha-Chlordane	SW846-8081	1.7
gamma-Chlordane	SW846-8081	1.7
Chlordane, not otherwise specified	SW846-8081	100.0
DBCP	SW846-8081	3.3
4,4'-DDD	SW846-8081	3.3
4,4'-DDE	SW846-8081	3.3
4,4'-DDT	SW846-8081	3.3
Dieldrin	SW846-8081	3.3
Endosulfan I	SW846-8081	1.7
Endosulfan II	SW846-8081	3.3
Endosulfan sulfate	SW846-8081	3.3
Endrin	SW846-8081	3.3
Endrin aldehyde	SW846-8081	3.3
Endrin ketone	SW846-8081	3.3
Heptachlor	SW846-8081	1.7
Heptachlor epoxide	SW846-8081	1.7
Methoxychlor	SW846-8081	17.0
Toxaphene	SW846-8081	170.0

Table A.15. S-SVOC parameter group

Analyte	Analytical method	Project quantitation level (µg/kg)
Phenol	SW846-3550/8270C	330
bis(2-Chloroethyl) ether	SW846-3550/8270C	330
2-Chlorophenol	SW846-3550/8270C	330
1,3-Dichlorobenzene	SW846-3550/8270C	330
1,4-Dichlorobenzene	SW846-3550/8270C	330
1,2-Dichlorobenzene	SW846-3550/8270C	330
2-Methylphenol	SW846-3550/8270C	330
2,2'- oxybis(1-Chloropropane)	SW846-3550/8270C	330
4-Methylphenol	SW846-3550/8270C	330
N-nitroso-di-*n*-dipropylamine	SW846-3550/8270C	330
Hexachloroethane	SW846-3550/8270C	330
Nitrobenzene	SW846-3550/8270C	330
Isophorone	SW846-3550/8270C	330
2-Nitrophenol	SW846-3550/8270C	330
2,4-Dimethylphenol	SW846-3550/8270C	330
bis(2-chloroethoxy) methane	SW846-3550/8270C	330
2,4-Dichlorophenol	SW846-3550/8270C	330
1,2,4-Trichlorobenzene	SW846-3550/8270C	330
Naphthalene	SW846-3550/8270C	330
4-Chloroaniline	SW846-3550/8270C	330
Hexachlorobutadiene	SW846-3550/8270C	330
4-Chloro-3-Methylphenol	SW846-3550/8270C	330
2-Methylnaphthalene	SW846-3550/8270C	330
Hexachlorocyclopentadiene	SW846-3550/8270C	330
2,4,6-Trichlorophenol	SW846-3550/8270C	330
2,4,5-Trichlorophenol	SW846-3550/8270C	800
2-Chloronaphthalene	SW846-3550/8270C	330
2-Nitroaniline	SW846-3550/8270C	800
Dimethylphthalate	SW846-3550/8270C	330
Acenaphthylene	SW846-3550/8270C	330
2,6-Dinitrotoluene	SW846-3550/8270C	330
3-Nitroaniline	SW846-3550/8270C	800
Acenaphthene	SW846-3550/8270C	330
2,4-Dinitrophenol	SW846-3550/8270C	800
4-Nitrophenol	SW846-3550/8270C	800
Dibenzofuran	SW846-3550/8270C	330
2,4-Dinitrotoluene	SW846-3550/8270C	330
Diethylphthalate	SW846-3550/8270C	330

Table A.15 S-SVOC parameter group (continued)

Analyte	Analytical method	Project quantitation level (µg/kg)
4-Chlorophenyl-phenyl ether	SW846-3550/8270C	330
Fluorene	SW846-3550/8270C	330
4-Nitroaniline	SW846-3550/8270C	800
4,6-Dinitro-2-methylphenol	SW846-3550/8270C	800
Phenanthrene	SW846-3550/8270C	330
Anthracene	SW846-3550/8270C	330
Carbazole	SW846-3550/8270C	330
Di-*n*-butylphthalate	SW846-3550/8270C	330
Fluoranthene	SW846-3550/8270C	330
Pyrene	SW846-3550/8270C	330
Butylbenzylphthalate	SW846-3550/8270C	330
3,3'-Dichlorobenzidine	SW846-3550/8270C	330
Benzo(*a*)anthracene	SW846-3550/8270C	330
Chrysene	SW846-3550/8270C	330
bis(2-Ethylhexyl)phthalate	SW846-3550/8270C	330
Di-*n*-octylphthalate	SW846-3550/8270C	330
Benzo(*b*)fluoranthene	SW846-3550/8270C	330
Benzo(*k*)fluoranthene	SW846-3550/8270C	330
Benzo(*a*)pyrene	SW846-3550/8270C	330
Indeno(1,2,3-*cd*)pyrene	SW846-3550/8270C	330
Dibenzo(*a,h*)anthracene	SW846-3550/8270C	330
Benzo(*g,h,i*)perylene	SW846-3550/8270C	330

Table A.16. Radiological parameter groups for sediment

Parameter group	Analyte	Analytical method	Project quantitation level (MDA) (pCi/g)
S-ALPHA	Gross Alpha	EPA 900.0	5
S-BETA	Gross Beta	EPA 900.0	5
S-GAMMA	Gamma scan (^{137}Cs, ^{60}Co)	EPA 901.1	1 ea.
S-AM	^{241}Am	EPA 908.0	1
S-NP	^{237}Np	EPA 908.0	1
S-PU	$^{238,239,240}Pu$	EPA 908.0	1 ea.
S-SR	$^{89/90}Sr$	EPA 905.0	1
S-TC	^{99}Tc	Liquid scint.*	10
S-U	$^{234,235,238}U$	EPA 908.0	1 ea.

*Public drinking water approved radiochemistry EPA methods. Non-EPA methods that meet or exceed the intent of the applicable methods may be substituted.

Table A.17. Activities and/or parameter groups for biological sampling

Parameter group	Parameter	Analytical method	Project quantitation level (MDA)	Units
B-MET(1)	Antimony	SW846-6010B or SW846-6020	0.1	mg/kg
	Arsenic	SW846-6010B or SW846-6020	0.1	mg/kg
	Beryllium	SW846-6010B or SW846-6020	0.05	mg/kg
	Cadmium	SW846-6010B or SW846-6020	0.05	mg/kg
	Chromium	SW846-6010B or SW846-6020	0.05	mg/kg
	Copper	SW846-6010B or SW846-6020	0.05	mg/kg
	Lead	SW846-6010B or SW846-6020	0.1	mg/kg
	Lithium	SW846-6010B or SW846-6020	0.5	mg/kg
	Nickel	SW846-6010B or SW846-6020	0.05	mg/kg
	Selenium	SW846-6010B or SW846-6020	0.1	mg/kg
	Silver	SW846-6010B or SW846-6020	0.05	mg/kg
	Thallium	SW846-6010B or SW846-6020	0.1	mg/kg
	Uranium	SW846-6010B or SW846-6020	0.05	mg/kg
	Zinc	SW846-6010B or SW846-6020	0.05	mg/kg
B-MET(2)	Total mercury	EPA 1631M	1.0	ng/g
B-MET(3)	Methyl mercury	EPA 1630M (Draft)	2.0	ng/g
B-PCB	Aroclor-1016	SW846-8082	17	µg/kg
	Aroclor-1221	SW846-8082	17	µg/kg
	Aroclor-1232	SW846-8082	17	µg/kg
	Aroclor-1242	SW846-8082	17	µg/kg
	Aroclor-1248	SW846-8082	17	µg/kg
	Aroclor-1254	SW846-8082	17	µg/kg
	Aroclor-1260	SW846-8082	17	µg/kg
	Aroclor-1262	SW846-8082	17	µg/kg
	Aroclor-1268	SW846-8082	17	µg/kg
B-PEST	Alpha-BHC	SW846-3520/8081A	8.0	µg/kg
	Beta-BHC	SW846-3520/8081A	8.0	µg/kg
	Delta-BHC	SW846-3520/8081A	8.0	µg/kg
	Gamma-BHC (Lindane)	SW846-3520/8081A	8.0	µg/kg
	Heptachlor	SW846-3520/8081A	8.0	µg/kg
	Aldrin	SW846-3520/8081A	8.0	µg/kg
	Heptachlor epoxide	SW846-3520/8081A	8.0	µg/kg

Table A.17 Activities and/or parameter groups for biological sampling (continued)

Parameter group	Parameter	Analytical method	Project quantitation level (MDA)	Units
	Endosulfan I	SW846-3520/8081A	20.0	µg/kg
	Dieldrin	SW846-3520/8081A	20.0	µg/kg
	4,4'-DDE	SW846-3520/8081A	20.0	µg/kg
	Endrin	SW846-3520/8081A	20.0	µg/kg
	Endosulfan II	SW846-3520/8081A	20.0	µg/kg
	4,4'-DDD	SW846-3520/8081A	20.0	µg/kg
	Endosulfan sulfate	SW846-3520/8081A	20.0	µg/kg
	4,4'-DDT	SW846-3520/8081A	20.0	µg/kg
	Methoxychlor	SW846-3520/8081A	90.0	µg/kg
	Endrin aldehyde	SW846-3520/8081A	30.0	µg/kg
	Chlordane	SW846-3520/8081A	60.0	µg/kg
	Toxaphene	SW846-3520/8081A	120.0	µg/kg
B-GAMMA	^{137}Cs (Cesium)	EPA 901.1	1	pCi/g
FISH	Community diversity and density	TP-306-5	NA	NA
BENTHIC	Community diversity and density	TP-306-4	NA	NA
LIPIDS	Lipid content of fish/turtle tissue	gravimetric analysis	0.1	wt %

Table A.18. SVOC parameter group

Analyte	Analytical method	Project quantitation level (µg/L)
1,2,4-Trichlorobenzene	SW 846-8270C/3510C or 3520C	10
1,2-Dichlorobenzene	SW 846-8270C/3510C or 3520C	10
1,3-Dichlorobenzene	SW 846-8270C/3510C or 3520C	10
1,4-Dichlorobenzene	SW 846-8270C/3510C or 3520C	10
2,4,5-Trichlorophenol	SW 846-8270C/3510C or 3520C	25
2,4,6-Trichlorophenol	SW 846-8270C/3510C or 3520C	10
2,4-Dichlorophenol	SW 846-8270C/3510C or 3520C	10
2,4-Dimethylphenol	SW 846-8270C/3510C or 3520C	10
2,4-Dinitrophenol	SW 846-8270C/3510C or 3520C	25
2,4-Dinitrotoluene	SW 846-8270C/3510C or 3520C	10
2,6-Dinitrotoluene	SW 846-8270C/3510C or 3520C	10
2-Chloronaphthalene	SW 846-8270C/3510C or 3520C	10
2-Chlorophenol	SW 846-8270C/3510C or 3520C	10
2-Methylnaphthalene	SW 846-8270C/3510C or 3520C	10
2-Methylphenol	SW 846-8270C/3510C or 3520C	10
2-Nitroaniline	SW 846-8270C/3510C or 3520C	25
2-Nitrophenol	SW 846-8270C/3510C or 3520C	10
3-Methylphenol	SW 846-8270C/3510C or 3520C	10
4-Methylphenol	SW 846-8270C/3510C or 3520C	10
3,3'-Dichlorobenzidine	SW 846-8270C/3510C or 3520C	10
3-Nitroaniline	SW 846-8270C/3510C or 3520C	25
4,6-Dinitro-2-methylphenol	SW 846-8270C/3510C or 3520C	25
4-Bromophenyl phenyl ether	SW 846-8270C/3510C or 3520C	10
4-Chloro-3-methylphenol	SW 846-8270C/3510C or 3520C	10
4-Chloroaniline	SW 846-8270C/3510C or 3520C	10
4-Chlorophenyl phenyl ether	SW 846-8270C/3510C or 3520C	10
4-Nitroaniline	SW 846-8270C/3510C or 3520C	25
4-Nitrophenol	SW 846-8270C/3510C or 3520C	25
Acenaphthene	SW 846-8270C/3510C or 3520C	10
Acenaphthylene	SW 846-8270C/3510C or 3520C	10
Anthracene	SW 846-8270C/3510C or 3520C	10
Benzo(a)anthracene	SW 846-8270C/3510C or 3520C	10
Benzo(a)pyrene	SW 846-8270C/3510C or 3520C	10
Benzo(b)fluoranthene	SW 846-8270C/3510C or 3520C	10
Benzo(g,h,i)perylene	SW 846-8270C/3510C or 3520C	10
Benzo(k)fluoranthene	SW 846-8270C/3510C or 3520C	10
Benzoic acid	SW 846-8270C/3510C or 3520C	25

Table A.18. SVOC parameter group (continued)

Analyte	Analytical method	Project quantitation level (µg/L)
Benzyl alcohol	SW 846-8270C/3510C or 3520C	10
Bis(2-chloroisopropyl)ether	SW 846-8270C/3510C or 3520C	10
Bis(2-chloroethoxy)methane	SW 846-8270C/3510C or 3520C	10
Bis(2-chloroethyl)ether	SW 846-8270C/3510C or 3520C	10
Bis(2-ethylhexyl)phthalate	SW 846-8270C/3510C or 3520C	10
Butyl benzyl phthalate	SW 846-8270C/3510C or 3520C	10
Carbazole	SW 846-8270C/3510C or 3520C	10
Chrysene	SW 846-8270C/3510C or 3520C	10
Di-n-butyl phthalate	SW 846-8270C/3510C or 3520C	10
Di-n-octyl phthalate	SW 846-8270C/3510C or 3520C	10
Dibenzo(a,h)anthracene	SW 846-8270C/3510C or 3520C	10
Dibenzofuran	SW 846-8270C/3510C or 3520C	10
Dieldrin*	SW 846-8270C/3510C or 3520C	10
Diethyl phthalate	SW 846-8270C/3510C or 3520C	10
Dimethyl phthalate	SW 846-8270C/3510C or 3520C	10
Fluoranthene	SW 846-8270C/3510C or 3520C	10
Fluorene	SW 846-8270C/3510C or 3520C	10
Hexachlorobenzene	SW 846-8270C/3510C or 3520C	10
Hexachlorobutadiene	SW 846-8270C/3510C or 3520C	10
Hexachlorocyclopentadiene	SW 846-8270C/3510C or 3520C	10
Hexachloroethane	SW 846-8270C/3510C or 3520C	10
Indeno(1,2,3-cd)pyrene	SW 846-8270C/3510C or 3520C	10
Isophorone	SW 846-8270C/3510C or 3520C	10
n-Nitroso-di-n-propylamine	SW 846-8270C/3510C or 3520C	10
n-Nitroso-diphenylamine	SW 846-8270C/3510C or 3520C	10
Naphthalene	SW 846-8270C/3510C or 3520C	10
Nitrobenzene	SW 846-8270C/3510C or 3520C	10
Pentachlorophenol	SW 846-8270C/3510C or 3520C	25
Phenanthrene	SW 846-8270C/3510C or 3520C	10
Phenol	SW 846-8270C/3510C or 3520C	10
Pyrene	SW 846-8270C/3510C or 3520C	10

*Reported for Sample Group BCW-2 (EMWMF wells) only.

Table A.19. Dioxin/furan parameter group

Analyte	Analytical method	Project quantitation level (ng/L)
	Dioxins	
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	SW 846-8280A	10
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	SW 846-8280A	50
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	SW 846-8280A	25
1,2,3,4,5,6,7,8-Octachlorodibenzo-p-dioxin (OCDD)	SW 846-8280A	50
	Furans	
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	SW 846-8280A	10
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	SW 846-8280A	25
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	SW 846-8280A	25
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	SW 846-8280A	50
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	SW 846-8280A	25
1,2,3,4,5,6,7,8-Octachlorodibenzofuran (OCDF)	SW 846-8280A	50

Table A.20. AWQC parameter group

Analyte	Analytical Method	Project Quantitation Level (MDA) (µg/L)
	Metals	
Antimony	SW846-6010B or SW846-6020	14.0
Arsenic (c)	SW846-6010B or SW846-6020	50.0
Cadmium	SW846-6010B or SW846-6020	0.7
Chromium, total	SW846-6010B or SW846-6020	100
Chromium, VI	SW846-6010B or SW846-6020	11
Copper	SW846-6010B or SW846-6020	6.5
Lead	SW846-6010B or SW846-6020	1.3
Mercury	SW846-6010B or SW846-6020	0.908
Nickel	SW846-6010B or SW846-6020	87.7
Selenium	SW846-6010B or SW846-6020	5
Silver	SW846-6010B or SW846-6020	1.23
Thallium	SW846-6010B or SW846-6020	1.7
Zinc	SW846-6010B or SW846-6020	58.9
Cyanide	SW846-6010B or SW846-6020	5.2
	VOCs	
Acrolein	OLM03.1VOA	320
Acrylonitrile (c)	OLM03.1VOA	0.59
Benzene (c)	OLM03.1VOA	12
Bromoform (c)	OLM03.1VOA	43
Carbon tetrachloride (c)	OLM03.1VOA	2.5
Chlorobenzene	OLM03.1VOA	680
Chlorodibromomethane (c)	OLM03.1VOA	4.1
Chloroform (c)	OLM03.1VOA	57
Dichlorobromomethane (c)	OLM03.1VOA	5.6
1,2-Dichloroethane (c)	OLM03.1VOA	3.8
1,1-Dichloroethylene (c)	OLM03.1VOA	0.57
1,2-Dichloropropane	OLM03.1VOA	0.52
1,3-Dichloropropylene (Cis)	OLM03.1VOA	10
1,3-Dichloropropylene (Trans)	OLM03.1VOA	10
Ethylbenzene	OLM03.1VOA	3100
Methyl bromide	OLM03.1VOA	48
Methylene chloride Dichloromethane (c)	OLM03.1VOA	47
1,1,2,2-Tetrachloroethane (c)	OLM03.1VOA	1.7
Tetrachlomethylene (c)	OLM03.1VOA	8
Toluene	OLM03.1VOA	6800

Table A.20. AWQC parameter group (continued)

Analyte	Analytical Method	Project Quantitation Level (MDA) (µg/L)
1,2-Trans-Dichloroethylene	OLM03.1VOA	700
1,1,2-Trichloroethane (c)	OLM03.1VOA	6
Trichloroethylene (c)	OLM03.1VOA	27
Vinyl chloride (c)	OLM03.1VOA	20
	SVOCs (Acid Extractables)	
2-Chlorophenol	SW846-8270C/3510C or 3520C	120
2,4-Dichlorophenol	SW846-8270C/3510C or 3520C	93
2,4-Dimethylphenol	SW846-8270C/3510C or 3520C	540
2-Methyl-4,6-dinitrophenol - 4,6-Dinitro-o-cresol	SW846-8270C/3510C or 3520C	13.4
2,4-Dinitrophenol	SW846-8270C/3510C or 3520C	70
Pentachlorophenol (c) (pH)	SW846-8270C/3510C or 3520C	2.8
Phenol	SW846-8270C/3510C or 3520C	21000
2,4,6-Trichlorophenol (c)	SW846-8270C/3510C or 3520C	21
	SVOCs (Base Neutrals)	
Acenaphthene	SW846-8270C/3510C or 3520C	1200
Anthracene	SW846-8270C/3510C or 3520C	9600
Benzidine (c)	SW846-8270C/3510C or 3520C	0.0012
Benzo(a)anthracene (c)	SW846-8270C/3510C or 3520C	0.044
Benzo(a)pyrene (c)	SW846-8270C/3510C or 3520C	0.044
3,4-Benzo(b)fluoranthene (c)	SW846-8270C/3510C or 3520C	0.044
Benzo(k)fluoranthene (c)	SW846-8270C/3510C or 3520C	0.044
Bis(Chlorethyl)ether (c)	SW846-8270C/3510C or 3520C	0.31
Bis(2-Chloro-isopropyl)ether	SW846-8270C/3510C or 3520C	1400
Bis(2-Ethylhexyl)phthalate (c)	SW846-8270C/3510C or 3520C	18
Butylbenzyl Phthalate	SW846-8270C/3510C or 3520C	3000
2-Chloronaphthalene	SW846-8270C/3510C or 3520C	1700
Chrysene (c)	SW846-8270C/3510C or 3520C	0.044
Dibenz(a,h)Anthracene (c)	SW846-8270C/3510C or 3520C	0.044
1,2-(o)Dichlorobenzene	SW846-8270C/3510C or 3520C	2700
1,3-(m)Dichlorobenzene	SW846-8270C/3510C or 3520C	400
1,4-(p)Dichlorobenzene	SW846-8270C/3510C or 3520C	400
3,3-Dichlorobenzidine (c)	SW846-8270C/3510C or 3520C	0.4
Diethyl phthalate	SW846-8270C/3510C or 3520C	23000
Dimethyl phthalate	SW846-8270C/3510C or 3520C	313000
Dibutyl phthalate	SW846-8270C/3510C or 3520C	2700
2,4-Dinitrotoluene (c)	SW846-8270C/3510C or 3520C	1.1
1,2-Diphenylhydrazine (c)	SW846-8270C/3510C or 3520C	0.4
Fluoranthene	SW846-8270C/3510C or 3520C	300
Fluorene	SW846-8270C/3510C or 3520C	1300
Hexachlorobenzene (c)	SW846-8270C/3510C or 3520C	0.0075
Hexachlorobutadiene (c)	SW846-8270C/3510C or 3520C	4.4
Hexachlorocyclopentadiene	SW846-8270C/3510C or 3520C	240

Table A.20. AWQC parameter group (continued)

Analyte	Analytical Method	Project Quantitation Level (MDA) (µg/L)
Hexachloroethane (c)	SW846-8270C/3510C or 3520C	19
Indeno(1,2,3-cd)Pyrene (c)	SW846-8270C/3510C or 3520C	0.044
Isophorone (c)	SW846-8270C/3510C or 3520C	360
Nitrobenzene	SW846-8270C/3510C or 3520C	17
N-Nitrosodmethylamine (c)	SW846-8270C/3510C or 3520C	0.0069
N-Nitrosodi-n-Propylamine	SW846-8270C/3510C or 3520C	0.005
N-Nitrosodiphenylamine (c)	SW846-8270C/3510C or 3520C	50
Pyrene	SW846-8270C/3510C or 3520C	960
	Pesticides	
Aldrin (c)	SW846-8081	0.0013
a-BHC (c)	SW846-8081	0.039
b-BHC (c)	SW846-8081	0.14
g-BHC-Lindane (c)	SW846-8081	0.08
Chlordane	SW846-8081	0.0043
4,4'-DDT (c)	SW846-8081	0.001
4,4'-DDE (c)	SW846-8081	0.0059
4,4'-DDD (c)	SW846-8081	0.0083
Dieldrin (c)	SW846-8081	0.0014
a-Endosulfan	SW846-8081	0.056
b-Endosulfan	SW846-8081	0.056
Endosulfan Sulfate	SW846-8081	110
Endrin	SW846-8081	0.0023
Endrin Aldehyde	SW846-8081	0.76
Heptachlor (c)	SW846-8081	0.0021
Heptachlor epoxide (c)	SW846-8081	0.001
PCB aroclors (c) (EPA 119-125)	SW846-8081	0.00044
PCB, total (c)	SW846-8081	0.00044
Toxaphene (c)	SW846-8081	0.0002
	Other	
Chlorine	EPA-330.1	11 µg/L
Dioxin	SW846-6010B or SW846-6020	0.000001 µg/L
Coliform	Standard Method 9222 B	1/100 ml

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