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DATA SUMMARY PACKAGE FOR THE BETHEL VALLEY AREA DQO WORKSHOP

WASTE AREA GROUPING 1

VOLUME 1

SECTIONS I - III
(Introduction; Tanks, Pipes, and Ducts; Impoundments)

FINAL

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WASTE AREA GROUPING 1 DQO Data Package

VOLUME I

I. Introduction

1.1 Overview
- Organization of Data Package
- Major Findings Overall
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II. Tanks, Pipes and Ducts

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- Source Information
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- Other

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- References
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VOLUME II

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- Conceptual Site Model
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- Other

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- Risk Assessment
- References
- Other

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- Introduction
- Source Information
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- Risk Assessment
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- Other

VII. Active Facilities (WMRAD)

- Introduction

1.0 INTRODUCTION

PURPOSE

This data package provides a summary of waste management and environmental data associated with waste units in the Bethel Valley Area (BVA) at the Oak Ridge National Laboratory in Oak Ridge, Tennessee. The intent of this data package is to support the Data Quality Objectives (DQO) process for the proposed BVA Remedial Investigation/Feasibility Study (RI/FS).

The seven primary steps of the DQO development process, as defined by the Environmental Protection Agency (EPA), are:

- state the problem,
- identify decisions to be made,
- identify inputs to the decision (data uses).
- define the study boundaries,
- develop the decision rule (if/then),
- specify limits on uncertainty, and
- optimize design for obtaining data.

In the DQO process, the decisions to be made and documented in a BVA Record of Decision (ROD) will set the stage for evaluating the completeness of the available data. Identification of these decisions will occur at a scoping meeting prior to a DQO workshop, or at the start of the DQO workshop. The information in this package is meant to be used during the last step of the DQO process to determine if available data are sufficient for making remediation decisions on BVA waste units or if additional data must be obtained.

A premise of the proposed BVA project is that available data likely are sufficient for decision-making at a level of detail agreed upon by the Department of Energy (DOE), the EPA and the Tennessee Department of Environment and Conservation (TDEC). It is recognized that additional data may be required at a later date for designing a remedial action. This data summary package provides available data to project managers, scientists, engineers, and regulators for critical review so that interested parties can determine if the available data are sufficient, or if not, what additional data are required before a ROD can be developed.

OBJECTIVES OF THE BETHEL VALLEY AREA RI/FS

The primary objective of the proposed BVA RI/FS is to document the watershed-wide approach for remediating waste sources, in-effect, tearing down the "Waste Area Grouping (WAG) walls" that have been an integral part of the environmental restoration strategy at ORNL. In doing so, decisions can be made on discreet waste sources or D&D facilities in the context of what is best for the entire watershed, which in turn, should lead to more timely and effective remediation projects.

The RI/FS will attempt to accomplish the following tasks:

- Clearly document the problems (waste sources and releases) in the BVA;

- Estimate the risks associated with current and potential future releases from the waste units and compare the release concentrations to ARARs;

- Estimate the risk reduction benefit and cost associated with representative process options that could be implemented to reduce risks;

- Balance benefits and costs from a watershed-wide perspective to help determine the optimal set and sequence of actions in BVA and the possible need to obtain waivers from complying with existing regulations.

Organization of Data Package

All of the WAG 1 Bethel Valley RI/FS sites are grouped into six categories: 1) Tanks, Pipelines and Ducts; 2) Impoundments; 3) D&D Buildings/Reactors; 4) Contaminated Media; 5) Burial Grounds; and 6) Active facilities. There are a total of 199 sites identified for the Bethel Valley RI/FS within WAG 1 as indicated in Table 1 and shown on Figure 1. The report is divided into Sections; one for each category. Within each section are subheadings for Source Information, Data Summary, Conceptual Site Model, Risk Assessment, References, and Other. General information regarding WAG 1 precedes the individual sections.

Source Information - Source information would include anything descriptive of the actual source of contamination. Information describing how the contaminants are released from the site, what is being released, or, for buildings, inventory that has the potential for release, media impacted, etc. Text describing nature and extent and/or fate and transport.
Data Summary - Data tables, data maps, survey maps, etc.
Conceptual Site Model - Schematics or text describing CSM or CSM components
Risk Assessment - Data or Text regarding RA
References - List of persons contacted (include Telecon Checklists) and references regarding the OUs
Other - contour maps, as-built building drawings, etc

WAG 1 DATA SUMMARY

- WAG 1 is an active, multifunctional site with a large workforce.
- WAG 1 contains 199 sites to be included in the Bethel Valley Area RI.
- WAG 1 BVA RI sites have been grouped into six categories.
- The WAG 1 Bethel Valley Area RI sites are categorized as follows:
  - Tanks, Pipelines and Ducts
  - Impoundments
  - D&D buildings/reactors
- Approximately 95% of the documented inventory of radionuclides within WAG 1 SWMUs is contained in the underground storage tanks (Gunite tanks) of the South Tank Farm. These, combined with Tanks W-11, TH-4, and the North Tank Farm, constitute a source control OU designed to prevent future releases that might result in exposure to the on-site work force.
- Surface water contaminants derived from WAG 1 are monitored at the 7500 Bridge monitoring station. WAG 3 is the only other source area that is likely to make a significant contribution to the contaminant load at the 7500 Bridge.
- In 1994, Sr-90 and H-3 concentrations measured at the 7500 Bridge contributed 22.1% and 2.7%, respectively, to the total released at White Oak Dam.
- The primary contaminant in ORNL sediments is Cs-137 with WAG 1 being the main contributor. At the 7500 Bridge, Cs-137 primarily is dissolved or attached to submicron-size colloids. 40% of the material flowing past the bridge becomes trapped, probably on sediments, in the Middle White Oak Creek reach.
- Aerial and walkover surveys show elevated gamma radiation activity in WAG 1 surface soils along White Oak Creek, and in the vicinity of GAAT and SIOU.
- Current information on the numerous waste tanks in WAG 1 are described in the data package.
- Most of the source information for the transition facilities include general information on inventory and surface contamination within the building itself.
- Very little is known about releases from the buildings to soil, surface water or groundwater.

Some of the building drains are deteriorated and may have released contaminants into surrounding soil and/or groundwater.

- Most of the data gathered consists of radiological surveys conducted inside the buildings. Also, some of the buildings still have stored sources, fuel, and/or contaminated wastes.

- Very little risk assessment information is available for the EM-40 or EM-60 facilities.

- A number of the facilities contain inventories of stored radioisotopes, fuel and/ or hazardous chemicals.

- All of the facilities can be expected to contain lead-based paint, PCBs in light fixtures, and asbestos/asbestos containing material (ACM).

- Burial grounds at WAG 1 include SWSA 1, SWSA 2 (Site 4003), Buried Waste at the Nonrad Water Treatment Site, Former Waste Pile Area, Abandoned Burn Pit, and the West End Dump Site.

- SWSA 1 is contaminated with unknown radionuclides and unidentified chemical constituents. The presence of drummed waste is suspected on the basis geophysical survey data and radiological contamination of soil, groundwater, surface water, and sediments exists near SWSA 1.

- SWSA 2 is reported to contain no waste. However, geophysical surveys suggest the presence of isolated metallic objects buried at the site.

- Buried waste was discovered during construction activities at the Nonrad Water Treatment Site. Excavated materials included general construction debris, glass bottles, transite, carbon blocks, and metal shavings. Some lead-contaminated soil was removed from the site. Personal reports suggest that additional buried waste exists at the site.

- The Former Waste Pile Area was used for disposal of waste from construction operations and as a soil borrow area. Exact dimensions and capacity of this area are not known.

- Little information is available for the West End Dumpsite and the Abandoned Burn Pit sites.

- Impoundments 3524 and 3513, built in the ORNL Main Plant area in the early 1940's, were used as holding basins for the process waste treatment system. Impoundments 3539 and 3540 were built in 1964 to hold process waste water from the Building 4500 complex. These surface impoundments occupy a total of 4 acres and contain approximately 3500 m^3 of sediment. These sediments are primarily contaminated with radionuclides with some RCRA constituents (e.g., mercury and lead) and TSCA constituents (PCBs). Two feet of water cover is maintained over these sediments to provide shielding to prevent exposure to contaminated sediments.

- The SIOU Remedial Investigation/Feasibility Study Report has been approved by EPA and TDEC.

- The GAAT FS/PP is being finalized for D2 submittal to regulators in FY97.

- Current discharge to White Oak Creek from seeps is approximately 26 pCi/L of Strontium-90.

Location	Type	status	In/Out	Comments
Bldg 3503/Mercury Contaminated Soil	Soil	In Bethel Valley RI/FS	In	
Site 3584	Active	not on 2/97 App. C	Out	
Site 3512/Decom Waste Holding Basin	Soil	In Bethel Valley RI/FS	In	
Site 3513 Waste Holding Basin	Water/Sed.	SIOU FS/PP	In	BVRI/FS to evaluate nsk from residuals
Site 3524/Equalization Basin	Water/Sed.	SIOU FS/PP	In	BVRI/FS to evaluate nsk from residuals
Site 3539/North Process Waste	Water/Sed.	SIOU FS/PP	In	BVRI/FS to evaluate nsk from residuals
Site 3540/South Process Waste	Water/Sed.	SIOU FS/PP	In	BVRI/FS to evaluate nsk from residuals
Site 2543/East Sewage Aeration Pond	Water/Sed.	Active	Out	
Site 2544/West Sewage Aeration Pond	Water/Sed.	Active	Out	
Coal Pile Settling Basin		Active	Out	
Bldg 3085/Low Intensity Test Reacto	Ponds	In Bethel Valley RI/FS	In	
Fifth Creek Watershed	Watershed Area	In Bethel Valley RI/FS	In	
First Creek Watershed	Watershed area	In Bethel Valley RI/FS	In	
Waste Water Treatment (non-rad) Bld	Active facil	Active	Out	
WAG 1 WOC Floodplain Soil (>50uR/hr	Soil	In Bethel Valley RI/FS	In	
FPPP Contaminated Soil	Soil	In Bethel Valley RI/FS	In	
Bldg. 3592- Mercury Contaminated	Soil	In Bethel Valley RI/FS	In	
Bldg 3517 Filter Pit	RA program	In Bethel Valley RI/FS	In	
Bldg 3517 LLW Transfer Line	Pipeline	In Bethel Valley RI/FS	In	
3517 LLW Transfer Line	Pipeline	In Bethel Valley RI/FS	In	
3517 LLW Transfer Line	Pipeline	In Bethel Valley RI/FS	In	
Bldg 3110/Filter House	RA program	In Bethel Valley RI/FS	In	
W-1/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
W-2/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
W-3/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	BVRI/FS to evaluate tank shells and residual sludge
W-4/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	BVRI/FS to evaluate tank shells and residual sludge
W-13/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
W-14/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
W-15/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
W-5/South Tank Farm	Inactive Tank	TS in progress	In	BVRI/FS to evaluate tank shells and residual sludge
W-6/Sorth Tank Farm	Inactive Tank	TS in progress	In	BVRI/FS to evaluate tank shells and residual sludge
W-7/South Tank Farm	Inactive Tank	TS in progress	In	BVRI/FS to evaluate tank shells and residual sludge
W-8/South Tank Farm	Inactive Tank	TS in progress	In	BVRI/FS to evaluate tank shells and residual sludge
W-9/South Tank Farm	Inactive Tank	TS in progress	In	BVRI/FS to evaluate tank shells and residual sludge
W-10/South Tank Farm	Inactive Tank	TS in progress	In	BVRI/FS to evaluate tank shells and residual sludge
W-11/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
W1-A/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
WC-1/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
Bldg 4501/Mercury contaminated Soil	Soil	In Bethel Valley RI/FS	In	
WC-15/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
WC-17/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
TH-1/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
TH-2/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
TH-3/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
TH-4/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
Site 2026/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
WC-2/Active LLW Tank	Active Tank	not in 2/97 App. C	Out	
WC-3/Active LLW Tank	Active Tank	not in 2/97 App. C	Out	
WC-4/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
WC-5/Inactive LLW Tank	Inactive Tank	grouted as maint	In	Include piping system
WC-6/Inactive LLW Tank	Inactive Tank	grouted as maint	In	Include piping system
WC-8/Inactive LLW Tank	Inactive Tank	grouted as maint	In	Include piping system
WC-9/Active LLW Tank	Active Tank	not in 2/97 App. C	Out	
WC-7/Inactive LLW Tank	Inactive Tank	grouted as maint	In	Include piping system
WC-10/Active LLW Tank	Active Tank	not on 2/97 App. C	Out	
WC-11/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
WC-12/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
WC-13/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
WC-14/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
Bldg 4508/Mercury Contaminated Soil	Soil	In Bethel Valley RI/FS	In	
WC-19/Inactive LLW Collection Tank	Inactive Tank	In Bethel Valley RI/FS	In	
W-12/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
W-16/Active LLW Tank	Active Tank	not on 2/97 App. C	Out	
W-17/Inactive LLW Tank	Inactive Tan	In Bethel Valley RI/FS	In	
W-18/Inactive LLW Tank	Inactive Tan	In Bethel Valley RI/FS	In	
W-21/NW Bldg 2531	Active Tank	not on 2/97 App. C	Out	
W-22/NW Bldg 2531	Active Tank	not on 2/97 App. C	Out	
W-23/NW Bldg 2531	Active Tank	not on 2/97 App. C	Out	
C-1/North of Bldg 2531	Active Tank	not on 2/97 App. C	Out	
C-2/North of Bldg 2531	Active Tank	not on 2/97 App. C	Out	
SWSA-1	Buried Waste	In Bethel Valley RI/FS	In	
Site 4003/SWSA 2	Buried Waste	In Bethel Valley RI/FS	In	
Bldg 2531/LLW Evaporator	Active Fac.	not on 2/97 App. C	Out	
Bldg 3518 Neutralizing Bldg	Active Fac.	not on 2/97 App. C	Out	
Site 2018N/PCB Storage Area	Active Fac.	not on 2/97 App. C	Out	
Bldg 3544 Process Waste Treat	Active Fac.	not on 2/97 App. C	Out	
Bldg 2521/Sewage Treatment Plant	Active Facil	not on 2/97 App. C	Out	
Bldg 2325 Waste Oil Storage Tanks	Active Facil	not on 2/97 App. C	Out	

Location	Type	status	In/Out	Comments
W-19/Inactive LLW Tank	Inactive Tan	In Bethel Valley RI/FS	In	
W-20/Inactive LLW Tank	Inactive Tan	In Bethel Valley RI/FS	In	
Buried waste at Nonrad Water Treatment Site	Buried Waste	not on 2/97 App. C	In	
Former Waste Pile Area	Buried Waste	In Bethel Valley RI/FS	In	
S of Bldg 3020/LLW Line Leak	Soil	In Bethel Valley RI/FS	In	
E of Bldg 3020/LLW Line Leak	Soil	In Bethel Valley RI/FS	In	
W of Bldg 3082/LLW Line Leak	Soil	In Bethel Valley RI/FS	In	
N of Bldg 3019/LLW Line Leak	Soil	In Bethel Valley RI/FS	In	
Building 3019 Southwest	Soil	In Bethel Valley RI/FS	In	
Building 3110 between W5/WC19	Soil	In Bethel Valley RI/FS	In	
Bldg 3047/LLW Line Leak	Soil	In Bethel Valley RI/FS	In	
Bldg 3037,3038,3034/General Isotope	Soil	In Bethel Valley RI/FS	In	
Bldg 3092/LLW Line Leak	Soil	In Bethel Valley RI/FS	In	
Bldg 3026/LLW Line Leak	Soil	In Bethel Valley RI/FS	In	
Bldg 3024/LLW Leak Site	Soil	In Bethel Valley RI/FS	In	
Bldg 3085/LLW Leak Site	Soil	In Bethel Valley RI/FS	In	
Bldg 3028/LLW Line Leak	Soil	In Bethel Valley RI/FS	In	
Bldg 2531/LLW Leak Site	Soil	In Bethel Valley RI/FS	In	
Bldg 3515/East of South Tank Farm	Soil	In Bethel Valley RI/FS	In	
Bldg 3525 LLW Line Leak	Soil	In Bethel Valley RI/FS	In	
Bldg 3550/Ground contamination	Soil	In Bethel Valley RI/FS	In	
Bldg 3500/LLW Line Leak/Sewer	Soil	In Bethel Valley RI/FS	In	
Bldg 3026 LLW Line Leak/Central Ave	Soil	In Bethel Valley RI/FS	In	
N of Bldg 4508/LLW Spill	Soil	In Bethel Valley RI/FS	In	
N of Bldg 3544/LLW Leak Site	Soil	In Bethel Valley RI/FS	In	
NW of SWSA-1/LLW Line Spill	Soil	In Bethel Valley RI/FS	In	
Bldg 3503/Ground contamination	Soil	In Bethel Valley RI/FS	In	
Bldg 3019/Contaminated Surface&Soil	Soil	In Bethel Valley RI/FS	In	
Bldg 1503/Waste Accumulation Area	??	Unknown	Out	
Bldg 2013/Oil Storage Area	Active Facil	not on 2/97 App. C	Out	
Bldg 2018/Waste Oil Storage Area	Active Facil	not on 2/97 App. C	Out	
Bldg 3025/Flourescent Tube Storage	Active Facil	not on 2/97 App. C	Out	
Bldg 3103/Oil Storage Area	Active Facil	not on 2/97 App. C	Out	
Bldg 3038/Waste Oil Storage Area	Active Facil	not on 2/97 App. C	Out	
Bldg 3500/Haz. Waste Accum. Area	Active Facil	not on 2/97 App. C	Out	
Site 3506/Waste Evaporator Facility	D&D Fac.	In Bethel Valley RI/FS	In	D&D Complete, include foundation
Bldg 3505/Transfer Canal/Pit	D&D Fac.	In Bethel Valley RI/FS	In	
S-223/Active LLW Tank	Active Facil	not on 2/97 App. C	Out	
S-324/Active LLW Tank	Active Facil	not on 2/97 App. C	Out	
S-424/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
F-201/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
F-501/Active LLW Tank	Active Facil	not on 2/97 App. C	Out	
W-1i/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
4501-C/Inactive LLW Tank	Inactive Tank	Rem. prior to FFA	Out	
4501-D/Inactive LLW Tank	Inactive Tank	Rem. prior to FFA	Out	
4501-P/Inactive LLW Tank	Inactive Tank	grouted as maint	In	Include piping system
Seal Tank 3002-A/Filter House	Inactive Tank	In Bethel Valley RI/FS	In	
N-71/Active LLW Tank	Active Facil	not on 2/97 App. C	Out	
P-3/Active LLW Tank	Active Facil	not on 2/97 App. C	Out	
P-4/Active LLW Tank	Active Facil	not on 2/97 App. C	Out	
Stack 3019/Base Contamination	Soil	In Bethel Valley RI/FS	In	
Tank LA-104	Inactive Tank	Rem. as maint.	In	Include piping system exterior tp building defer rest to D&D of build
P-23/Active LLW Tank	Active Facil	not on 2/97 App. C	Out	
P-24/Active LLW Tank	Active Facil	not on 2/97 App. C	Out	
H-209/Inactive LLW Tank	Inactive Tank	grouted as maint.	In	Include piping system
Tank 3001-B/Inactive LLW Tank	Inactive Tank	Rem. as maint. NFA	In	Include piping system
Tank 3003-A/Inactive LLW Tank	Inactive Tank	In Bethel Valley RI/FS	In	
Tank 3004-B/Inactive LLW Tank	Inactive Tank	Rem. as maint. NFA	In	Include piping system
Tank 3013/Inactive LLW Tank	Inactive Tank	grouted as maint. NFA	In	Include piping system
L-11/Active LLW Tank	Active Facil	not on 2/97 App. C	Out	
T-30/Inactive LLW Tank	Inactive Tank	grouted as maint. NFA	In	Include piping system
Bldg 3001/Storage Canal	RA program	grouted as removal	In	
Graphite Reactor Canal Overflow	??	May not exist	In	
Bldg 3505A/Acid Storage Tank	Inactive Tank	not on 2/97 App. C	In	
Bldg 3505b/Caustic Storage Tank	Inactive Tank	not on 2/97 App. C	In	
O.R.Research Reactor Decay Tank	Inactive Tank	In Bethel Valley RI/FS	In	
Low Intensity Test Reactor-3005	Reactor	In Bethel Valley RI/FS	In	
Graphite Reactor Building 3001	Landmark	In Bethel Valley RI/FS	In	
LITR Pond	Soil	In Bethel Valley RI/FS	In	
Ceramic Processing Facility-4508	Active Facil	not on 2/97 App. C	Out	
PS1	Active Facil	not on 2/97 App. C	Out	
High-Level Chem. Dev. Lab-4507	D&D Fac.	In Bethel Valley RI/FS	In	
Transuranium Research Lab 45- 5505	Active Facil	not on 2/97 App. C	Out	
3019B High-Level Radiochem.Analytical Lab	D&D Fac.	In Bethel Valley RI/FS	In	
O.r. Research Reactor Heat Exch.	D&D Fac.	In Bethel Valley RI/FS	In	
Off-Gas Filter House-3121	??	not on 2/97 App. C	Out	
Fan House 3003	D&D Fac.	In Bethel Valley RI/FS	In	
Filter House 3002	D&D Fac.	In Bethel Valley RI/FS	In	

Location	Type	status	In/Out	Comments
UG Exhaust Duct 3001/3003	D&D Fac.	In Bethel Valley RI/FS	In	
LITR (3077) Heat Exchangers	D&D Fac.	In Bethel Valley RI/FS	In	
Oak Ridge Research Reactor-3042	Reactor	In Bethel Valley RI/FS	In	
3086 Cooling Tower No.1, ORR	D&D Fac.	In Bethel Valley RI/FS	In	
3085 ORR Pumphouse	D&D Fac.	In Bethel Valley RI/FS	In	
3103 Cooling Tower No. 3, ORR	D&D Fac.	In Bethel Valley RI/FS	In	
3102 Heat Exchanger, No. 2, ORR and	D&D Fac.	In Bethel Valley RI/FS	In	
Demin. Water Holding Tanks	D&D Fac.	In Bethel Valley RI/FS	In	
ORR Experimental Facilities	D&D Fac.	In Bethel Valley RI/FS	In	
NOG Filter Pit	D&D Fac.	In Bethel Valley RI/FS	In	
3083 Neutron Spectrometer Station N	D&D Fac.	In Bethel Valley RI/FS	In	
Cell Vent Filters	D&D Fac.	In Bethel Valley RI/FS	In	
3107 House, Target, 25 Meter, on FI	D&D Fac.	In Bethel Valley RI/FS	In	
3089 Cooling Tower No. 2, ORR	D&D Fac.	In Bethel Valley RI/FS	In	
POG Filter Pit	D&D Fac.	In Bethel Valley RI/FS	In	
Cobalt-60 Storage Garden-3029	Active Facil	not on 2/97 App. C	Out	
Fission Product Dev. Lab-3517	D&D Fac.	In Bethel Valley RI/FS	In	
Fission Product Pilot Plant-3515	D&D Fac.	In Bethel Valley RI/FS	In	
Metal Recovery Facility-3505	D&D Fac.	In Bethel Valley RI/FS	In	
Storage Garden-3033	D&D Fac.	In Bethel Valley RI/FS	In	D&D Complete, evaluate residuals
Strontium-90 Power Generators-3028	D&D Fac.	In Bethel Valley RI/FS	In	need to confirm with Eversole
Site 1001/SWSA 3	Buried Waste	In Bethel Valley RI/FS	In	
Site 1562/Closed Scrap Metal Area	Buried Waste	In Bethel Valley RI/FS	In	
Site 1554/Contractor's Landfill	Buried Waste	In Bethel Valley RI/FS	In	
Lagoon-Melton Rd/LLW Spill Site	Soil	In Bethel Valley RI/FS	In	
4556 Pit, Filter (for bldg. 4507)	D&D Fac.	In Bethel Valley RI/FS	In	
3038 Alpha Handling Facility	Transition Fac	In Bethel Valley RI/FS	In	
3028 Alpha Powder Facility	Transition Fac	In Bethel Valley RI/FS	In	
Bulk Shielding Reactor	Transition Fac	In Bethel Valley RI/FS	In	
3038-E Isotope Material Laboratory	Transition Fac	In Bethel Valley RI/FS	In	
3083 Kryption Storage Cubicle	Transition Fac	In Bethel Valley RI/FS	In	
3026C Kryption-85 Enrichment Facility	Transition Fac	In Bethel Valley RI/FS	In	
3026D Metal Segmenting Facility	Transition Fac	In Bethel Valley RI/FS	In	
3033 Radioactive Gas Processing Facility	Transition Fac	In Bethel Valley RI/FS	In	
3038-M Radioactive Packaging and Shipping Facility	Transition Fac	In Bethel Valley RI/FS	In	
3033A Radioactive Production Laboratory Annex	Transition Fac	In Bethel Valley RI/FS	In	
3030 Radioisotope Production Lab. C	Transition Fac	In Bethel Valley RI/FS	In	
3031 Radioisotope Production Lab. D	Transition Fac	In Bethel Valley RI/FS	In	
3032 Radioisotope Production Lab. E	Transition Fac	In Bethel Valley RI/FS	In	
3118 Radioisotope Production Lab. H	Transition Fac	In Bethel Valley RI/FS	In	
3034 Radioisotope Services Building	Transition Fac	In Bethel Valley RI/FS	In	
3047 radioisotopes Development Lab.	Transition Fac	In Bethel Valley RI/FS	Out	Returned to active use
3029 Source Development Lab.	Transition Fac	In Bethel Valley RI/FS	In	
3099 Storage Pad	Transition Fac	In Bethel Valley RI/FS	In	
7025 Tritium Target Prep. Facility	Transition Fac	In Bethel Valley RI/FS	In	
Abandoned Burn Pit	RA program	In Bethel Valley RI/FS	In	
3110 Filter House Isotopes Ductwork	RA program	In Bethel Valley RI/FS	In	
Thorium Storage Wells	RA program	In Bethel Valley RI/FS	In	
West End Dumpsite	RA program	In Bethel Valley RI/FS	In	
7002A Abandoned Underground Waste Oil Storage T	RA program	In Bethel Valley RI/FS	In	
7002W Waste Oil Storage Tank	RA program	In Bethel Valley RI/FS	In	

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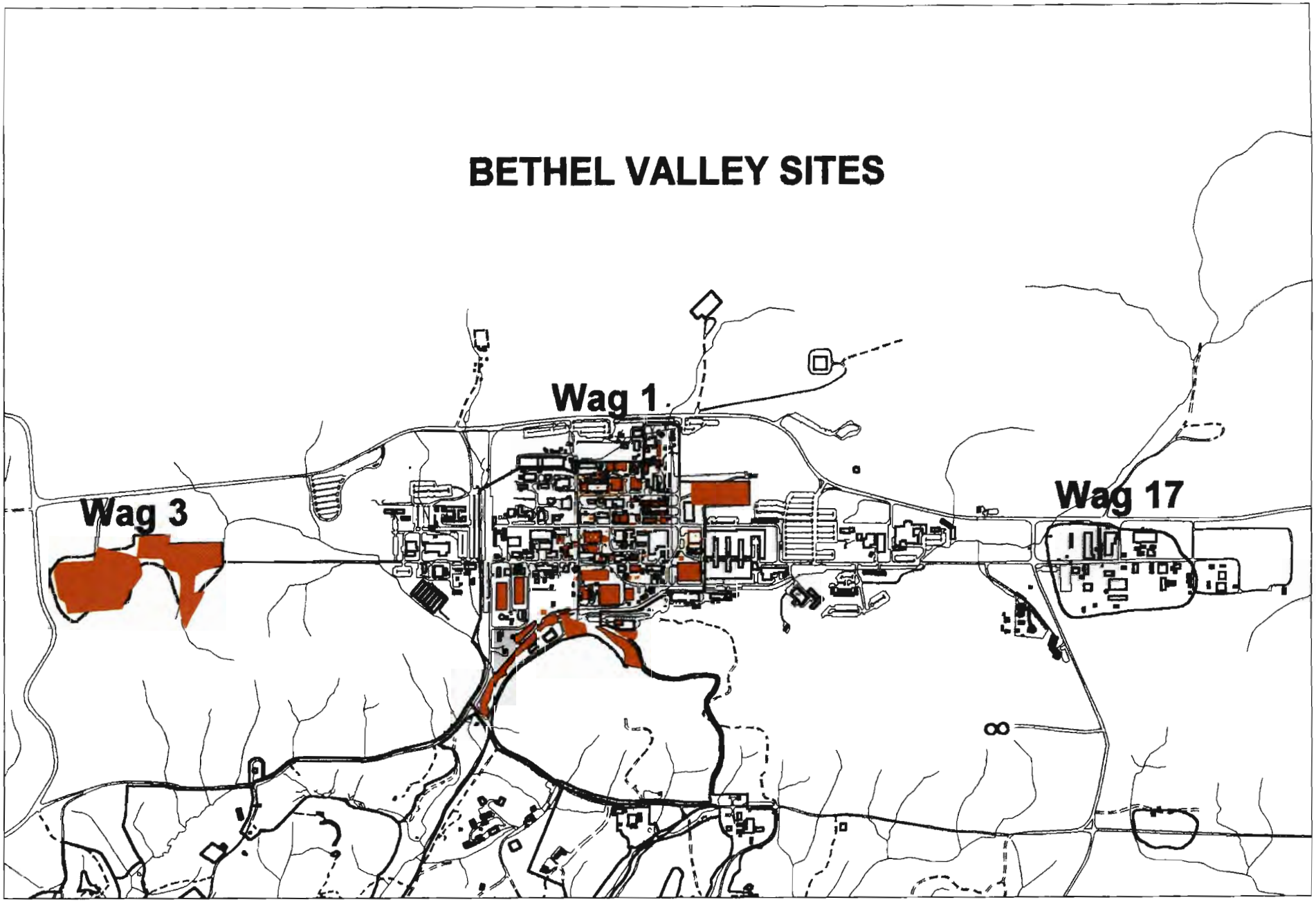
BETHEL VALLEY SITES



ERMA 3

2.4.2 WAG 1

WAG 1 encompasses a large portion of the ORNL Main Plant Area. Because WAG 1 is an active, multifunctional site with a large workforce, remediation will be technically and logistically complicated. Project planning is ongoing for the Waste Evaporator Facility demolition project, which is part of the Decontamination and Decommissioning Program. This facility is located in the Gunite and associated tanks operable unit, and removal of the building will greatly improve access to the south tank farm and facilitate other remedial actions intended for this area. This project will be conducted as a non-time-critical removal action under CERCLA. Accordingly, an engineering evaluation/cost analysis and an action memorandum will be prepared. Completion of demolition field activities is expected in the first half of FY 1996.

Remediation and/or removal actions are in progress or are planned for the Gunite and associated tanks operable unit, the surface impoundments operable unit, and the Core Hole 8 plume. Early actions are also planned for some of the tasks in the steel tanks operable unit. Final remediation of the groundwater operable unit, the Pipelines and Storm Drains operable unit, and the WAG 2 operable unit should be delayed until the other source and soil operable units have been remediated.

The Gunite and associated tanks operable unit team submitted a draft treatability study plan to EPA and TDEC in September 1994. The treatability studies will demonstrate options for using sluicing technologies to remove the tank contents, with the FS tentatively scheduled for completion in late FY 1997.

The surface impoundments operable unit team submitted an RI/FS, including the baseline risk assessment, to EPA and TDEC in February 1995 (DOE 1995a).

The WAG 1 groundwater activities focus on shallow groundwater that discharges to surface streams within WAG 1. Monitoring of groundwater began in January 1995 with analytical results suggesting that contaminant concentrations are increasing, particularly in the western portion of the WAG. Source

OU Strategy Document

WAG 1 Overview and

OPERABLE UNIT DEFINITION

2.1 OBJECTIVE

This section of the document is intended to define the WAG 1 OUs. OUs are incremental remedial actions in a systematic remediation strategy to comprehensively address site problems. Three reasons for subdividing WAG 1 into OUs (see Sect. 1.3) are:

- to deal with site problems in logical groupings, thereby facilitating technical development and evaluation of remedial alternatives;
- to divide remediation of a relatively complex site into smaller, more manageable tasks; and
- to reduce risk to human health and the environment by dealing with the most urgent problems first.

The OUs defined in this section should be regarded as preliminary. They are subject to change as additional information becomes available in subsequent investigations.

The remainder of this section is organized as follows. Section 2.2 develops the definition criteria that must be satisfied by each OU. Section 2.3 delineates the OUs based on the definition criteria, justifies the delineations, and briefly describes each OU. Section 3 prioritizes the defined OUs based on human health concerns. The SCSR provides detailed site descriptions and inventories of contaminated waste units, if additional WAG 1 background information is desired.

2.2 DEFINITION CRITERIA

In concept, an OU should manifest the following intrinsic attributes:

- It should be consistent with, and not preclude implementation of, the expected final remedy [40 CFR 300.430(a)(1)(ii)(A)].
- Sufficient characterization information about the waste unit in an OU should be known to allow detailed planning and scoping.
- Each OU should be a discrete, identifiable action with a "controllable" scope. If possible, the physical media and waste units in one OU should be distinguishable from those in other OUs, thereby minimizing recontamination potential. Because of the complexity of the WAG 1 site, some overlap of OUs is inevitable until further assessments are made.

Though important considerations, these OU attributes do not provide a working framework for defining OUs. Definition criteria—those characterizing marks or traits on which judgments or decisions may be based—are needed to compare waste units and combine them into logical groupings. Criteria developed for defining OUs are:

- contaminant pathways analysis,
- application of similar remediation technology,
- geographical considerations,
- assessment of early or time-phased action, and
- remediation efficiency or simplicity considerations.

These five criteria were extrapolated from the FFA definition of OUs ~~provided in Sect. 1.3~~. Each of these criteria is discussed in more detail below.

2.2.1 Contaminant Pathways Analysis

The FFA calls an OU a discrete portion of a remedial response that either manages migration or eliminates or mitigates a release, threat of release, or pathway of exposure. Thus, waste units with similar contaminant release, transport, and exposure routes are candidates for logical groupings into OUs. Such groupings may focus on sources of contamination (e.g., tanks, pipelines, surface impoundments, and other waste storage and accumulation areas) to mitigate a release threat. Others may center on various contaminated environmental media—such as groundwater, soils, and sediments—to manage migration. By focusing on discrete actions to control particular pathways (e.g, source releases, on-WAG migration, or off-WAG migration), alternatives assessment and risk reduction are facilitated.

2.2.2 Application of Similar Remedial Technology

According to the FFA, individual OUs may address specific types of site problems. For example, OUs may consist of multiple waste units, such as steel tanks, with similar physical features and types of contaminants. The likenesses among waste units within an OU suggest that similar remedial technologies may be applied to each. Grouping waste units together with specific types of problems that can be remediated with similar technologies facilitates the technical development and evaluation of remedial alternatives.

2.2.3 Geographical Considerations

According to the FFA, OUs may address geographical portions of a site. The location of waste units relative to each other influences the implementation of remedial actions, as well as the effort to prevent recontamination of treated areas. Grouping waste units that are in close proximity to one another may provide the benefits of integrating and streamlining remedial investigation and implementation efforts, thus minimizing logistical complications and disruption of ongoing plant operations. Preventing recontamination of treated areas requires remedying sources before contaminated media and identifying the major pathways of migration such as watersheds, groundwater, and pipe trenches that may cause recontamination. Grouping geographically-related waste units will reduce the potential for recontamination.

2.2.4 Assessment of Early or Time-Phased Remedial Action

According to the FFA, OUs may address initial phases of an action, consist of any set of actions performed over time, or include any actions that are concurrent but located in different parts of a site. Risk reduction is the principal reason for hastening the occurrence of remediation for a waste unit or group of units. However, early or time-phased action may also be needed because of interferences from ongoing plant operations, new facilities construction, decontamination and decommissioning (D&D) activities, WM activities, existing or impending regulations, and administrative requirements (see Sect. 4.3.2).

2.2.5 Remediation Efficiency or Simplification Considerations

According to the FFA, site cleanup can be divided into a number of OUs, depending on the complexity of the associated problems. Each OU must address all the CERCLA process requirements. One of the reasons (see Sect. 2.1) for dividing the WAG 1 remediation into OUs is to create a narrower focus on site problems. By dividing overall site problems among several OUs, this approach allows more accurate analysis of remedial alternatives but requires overall coordination and planning between OUs. A middle ground is needed in which enough OUs are identified so that each can give sufficient attention to detail during the CERCLA process, without excessively fragmenting the overall remediation effort.

2.3 DESCRIPTION AND JUSTIFICATION

Within WAG 1, the 167 SWMUs [of which 73 have been released to the ER Division (ERD)] and several areas of contaminated environmental media identified from the Phase I RI have been grouped into 13 OUs (Table 2.1). The table also indicates which of the five criteria were the most important in defining each OU. Figure 2.2 is a map showing the general location of a majority of the WAG 1 OUs. Not shown in Fig. 2.2, however, is the Groundwater OU, which underlies the entire site; the Pipeline and Storm Sewer Network

1992 info.

Leakage OU, a boundary-only OU for mitigating off-WAG migration; and the Steel Tanks OU, comprised of tanks scattered throughout the WAG.

In this subsection, each of the OUs is briefly described and justified (i.e., the principal reasons supporting each OU's existence are explained). Accompanying the OU descriptions are OU location maps and tables listing assigned waste units.

The OUs are intentionally defined with loosely established waste unit assignments or boundaries. This flexibility in definition permits future optimization of OU assignments or boundaries based on new data. Thus, other combinations of waste units that may become apparent during future RI/FS activities are not precluded. (For example, simplifying assumptions made for this effort may or may not be valid during the FS evaluations.) The boundaries shown on the location maps accompanying the OU descriptions are, therefore, approximations only and are only intended to convey the general area of interest. The actual boundaries will be finalized as part of the Interim Record of Decision (IROD). Any components currently defined as part of an OU that are not addressed as part of the IROD will become part of a larger media OU (e.g., 3000 Watershed Soils). Since they are initially defined as part of the first OU, the FS process will explore some alternatives for remediating all defined elements.

2.3.1 Gunite Tanks OU

Figure 2.3 shows the general location of the Gunite Tanks OU, and Table 2.2 lists the assigned waste units. The SWMUs within this OU are primarily the large Gunite tanks installed to store liquid wastes in 1943 and subsequently used as the main holding tanks for the low-level liquid waste (LLLW) system at ORNL. These tanks contain about 95% of the documented inventory of radionuclides in waste management units in WAG 1 (ORNL 1987). The inventory includes transuranic (TRU) wastes. Tank leakage has been difficult to quantify because of known problems with inleakage through the tank domes. A number of steel tanks associated with the North Tank Farm (NTF) are included in this OU.

In addition to identified SWMUs, supporting structures, ancillary pipes and fittings, and adjacent contaminated soils will be addressed under this OU. These components may be deferred to the 3000 Watershed Soils OU if an alternative only addressing tank contents is selected.

The Gunite Tanks OU is commonly referenced as three separate tank groups: South Tank Farm (STF), NTF, and Tanks TH-4 and W-11. Each group is described below.

2.3.1.1 STF

The STF is located near the center of WAG 1 at the southeast corner of the intersection of Central Avenue and Third Street ~~(Fig. 2.3)~~. This OU consists of six large, reinforced Gunite (sprayed concrete) tanks, each with a capacity of 170,000 gal (ORNL 1990). The tanks were taken out of service in 1978 and some of the tank contents (i.e., liquids and sludges) were removed via sluicing; however, liquid and sludge remain. ~~Table 2.~~3 lists the tanks in the STF and the estimated remaining volumes of contaminated
Sect. II

liquid and sludge. Much of the contamination associated with the STF consists of strontium-90, cesium-137, thorium-232, uranium-238, TRU compounds, volatile organic compounds (VOCs) that exceed Toxicity Characteristic Leaching Procedure (TCLP) regulatory thresholds, and various metals. Sampling data indicate that the soils immediately surrounding the tanks are contaminated with various hazardous constituents, probably from tank or ancillary system releases. The soils may be considered part of this OU for certain remediation strategies.

2.3.1.2 NTF

The NTF, located across from the STF in the northeast corner of Central Avenue and the Third Street intersection ~~(Fig. 2.3),~~ consists of eight tanks of varying capacities constructed of either Gunite or stainless steel. All the tanks in the NTF are buried, but they are not arranged in a grid like the STF. ~~Table 2.4 lists the tanks in the NTF and additional tank-specific information.~~

The tanks in the NTF, some of which have been taken out of service as late as 1986, were used for storage of a variety of wastes. Tanks W-1, W-1A, and W-2 were used to hold waste from the 3019 Radiochemical Pilot Plant. Tanks W-3 and W-4 were designed to hold metal waste from Building 3019. Tanks W-14 and W-15 were used to collect waste from the Operations Division, and Tank W-13 collected waste from the Chemistry Division Hot Laboratory Group. The major contaminants associated with the NTF are strontium-90, cesium-137, europium-152, uranium-233, uranium-238, plutonium-238, plutonium-239, americium-241, curium-244, other TRU elements, metals, VOCs, and other RCRA constituents. The soils adjacent to several of the tanks are contaminated with various constituents that may have leaked from the tanks. The soils are possible additional elements of the Gunite Tanks OU.

2.3.1.3 Tanks TH-4 and W-11

Tanks TH-4 (SWMU No. 1.32) and W-11 (SWMU No. 1.27) are located in separate areas of WAG 1. Tank TH-4, a 14,000-gal Gunite tank at the southwest corner of Building 3500, near the intersection of Central Avenue and Third Street ~~(Fig. 2.3),~~ received waste from the irradiated thorium and uranium pilot plant project. It contains an estimated 17,000 gal of supernate and 6300 gal of alkaline thorium and uranium sludge. In addition to thorium and uranium, other tank contaminants of concern are strontium-90, cesium-137, and TRU elements. Soil samples indicate no significant contamination at this site.

Tank W-11 is a 1500-gal Gunite tank approximately 60 ft from the southeast corner of the STF and 100 ft north of Building 3517 (Fig. 2.3). The tank, which contains an estimated 900 gal of liquid and 100 gal of sludge, was used to collect waste from research laboratories in Building 3550. Major contaminants of concern are strontium-90, cesium-137, plutonium-238, and other TRU elements. Subsurface soil samples indicate that the site is contaminated with strontium-90 and cesium-137. The soils are possible additional elements of this tank OU.

2.3.1.4 Justification

The structural integrity of the tanks is uncertain. The Gunite Tanks OU is formed to minimize or control the potential for, and effects of, leakage or failure of the containment structures. Such effects may include contaminant migration into surrounding soil, with subsequent contamination of groundwater and other environmental media, and perhaps unacceptable exposure to current on-WAG receptors (see Sect. 3). Since a significant release of tank contaminants would pose a substantial threat to public health or the environment or result in significant public concern, early attention to this OU is warranted. Additionally, all the tanks may be addressed similarly with an appropriate remedial technology. The steel tanks in the NTF were grouped with the Gunite tanks because of the added efficiency of remediating all the NTF tanks in the same time period.

2.3.2 Surface Impoundments OU

Figure 2.3 shows the location of the surface impoundments OU, ~~and Table 2.5 lists the assigned waste units~~. The surface impoundment OU consists of four holding basins located together in the south-central part of WAG 1, just north of WOC. Included in this OU are Equalization Basin 3524, Waste Holding Basin 3513, the Process Waste Pond (north) 3539, and the Process Waste Pond (south) 3540. These impoundments are inactive; however, they are still used occasionally as overflow basins and do currently contain liquids. The approximate dimensions and capacities of the impoundments are presented in Table 2.6. Including the surrounding surface soil area, this OU occupies approximately three acres.

The SWMUs within this OU were used to store liquid wastes before release to the process waste treatment facility or directly to WOC. The sludge within each SWMU was analyzed, and elevated activities of radionuclides—primarily cesium-137 and strontium-90—were detected, as well as measurable activities of other radionuclides, including TRU. Elevated concentrations of VOCs and metals, such as mercury, were also detected.

Remediation of the impoundments is considered one OU principally because the four impoundments are in the same locale. Additional justification is provided by the fact that the same remediation technology may be applied to all four impoundments since their construction, waste contents (e.g., TRU elements), and the resulting contaminant migration pathways are similar. Replacement overflow tanks for the four basins have been proposed ~~(see Sect. 4.3.6)~~ and, once built, the impoundments would be available for remediation as a group.

2.3.3 Groundwater OU

The Groundwater OU includes all the groundwater beneath the WAG (both shallow intermittent storm flow and deeper aquifer systems) and migration of contaminants off-WAG through groundwater flow. This OU will probably be redefined when a determination is made about how valley-wide groundwater contamination will be addressed.

The potential exists for off-WAG contaminant migration from various sources through groundwater movement. High levels of radiological contamination have been found in

several bedrock monitoring wells and are probably distributed throughout the groundwater matrix beneath the WAG. The remedial technologies used to address the Groundwater OU are unique to the groundwater media.

2.3.4 WOC Floodplain Soils and Sediments OU

This OU consists of soils and sediments within the floodplain of WOC, primarily in the southwestern portion of WAG 1 (Fig. 2.2). These media are primarily contaminated with cesium. This area has become contaminated from discharges into WOC and from off-WAG migration of contaminants originating almost anywhere on the WAG (e.g., the Soils OU). Some of the soil and sediments contamination eventually migrates further downstream to WAG 2.

Remediation of the WOC floodplain soils and sediments is an OU because of the geographically distinct location of the soils and sediments (1) along the water course of WOC at the southwest boundary of the WAG, and (2) along the water course extending up First Creek on the west boundary of the WAG.

2.3.5 Pipeline and Storm Sewer Network Leakage OU

An extensive network of underground utilities and storm drains exists throughout WAG 1. While many pipelines are abandoned, they are near numerous others in the same trench that are still in use. The RI data indicates that contaminants migrate to surface waters (e.g., WOC, First Creek, and Fifth Creek) through abandoned leaking pipelines, pipeline trench backfill soils or bedding materials, and leaking storm sewers. Field data collected during the Phase I investigation are being assessed (see SCSR) to determine the magnitude of the migration. Currently, Outfalls 341 and 342 are known to release measurable concentrations of radionuclides to surface water. This OU addresses the release of contaminants across the WAG boundary through this network. Remediation of pipes, bedding materials, and associated contaminated soils within the WAG 1 boundary will be discussed with the appropriate contaminated soils OU.

2.3.6 SWSA 1 OU

Figure 2.2 shows the location of the SWSA 1 OU. SWSA 1 (SWMU No. 1.45), a grass-covered, abandoned landfill in the southwest part of WAG 1 and associated contaminated soils, is the only SWMU in this OU. The composition of disposed wastes is uncertain, but radiologically contaminated soils have been found. SWSA 1 is bisected by Third Street, encompasses approximately 1 acre, and is surrounded by a fence. SWSA 1 was not included with other OUs because it is geographically isolated and, unlike the other burial sites, is suspected of contributing contamination to WOC.

2.3.7 Miscellaneous Contaminated Soils OU

The WAG 1 soils remediation is divided into four OUs principally to produce smaller, more manageable actions. Three of the four OUs have additional justification for their particular waste unit grouping that distinguishes them from the others; the fourth OU,

miscellaneous contaminated soils, does not; thus, it exists as a "catch-all" for those contaminated soils units remaining after the other soils OUs are formed.

Figure 2.6 shows the location of the significant areas of the Miscellaneous Contaminated Soils OU, ~~and Table 2.7 lists the assigned waste units~~. These soils are located in the northeast corner of the WAG, scattered along the northwestern border and western half of the WAG (west of Third Street), and in the south central area, east of the surface impoundments.

Example elements of this OU (those elements with assigned SWMU numbers) include contaminated soils at various reactor sites [e.g., the Low-Intensity Test Reactor (3005) and the Oak Ridge Reactor (3042) and associated Decay Tank Rupture (3087)]; laboratories [e.g., the Ceramic Processing Laboratory (4508) and the Hi-Level Chemical Development Laboratory (4507)]; four waste oil storage areas; the polychlorinated biphenyl (PCB) Storage Area (2018W); the Coal Pile Settling Basin (2545); the Hazardous Waste Accumulation Area; and over ten identified pipeline and storm sewer leak sites. Also included in this OU are any additional miscellaneous pipelines, trench soils, bedding materials, and backfill soils in the area of the releases that are contaminated. The Steel Tanks OU may also be located within the Miscellaneous Contaminated Soils OU. Soils contaminated by the tanks are possible additional elements to the Soils OU.

2.3.8 3000 Watershed Soils OU

Figure 2.7 shows the location of the 3000 Watershed Soils OU, ~~and Table 2.8 lists the assigned waste units~~. The 3000 Watershed Soils OU consists of the soils in the central portion of the WAG from the northern edge of the WAG to the southern edge. The soils are contaminated with various radionuclides from spills and/or leaks, as indicated by radiological survey data, and the area is believed to be the main drainage for the entire WAG; therefore, it receives contaminated runoff from various locations. This OU is bounded by Third Street to the west, and the eastern boundary is approximately one block to the east; the northern boundary coincides with the WAG boundary, and the southern boundary extends to WOC along the southern border of the WAG.

Also included in this OU are any additional soils (beyond those to be assigned to D&D) contaminated by releases from any of the 19 buildings within the OU boundaries, as well as any additional miscellaneous pipelines, trench soils, bedding materials, and backfill soils. Located within the boundary of the 3000 Watershed corridor, other OUs include the Gunite Tank OU, the Surface Impoundments OU, and the Steel Tanks OU. Soils contaminated by releases from these OUs are also possible additional elements to the 3000 Watershed Soils OU.

Remediation of the 3000 Watershed soils is considered a distinct OU because that area is the main watershed drainage on the WAG. Remedial technologies applied to this OU, though similar to those applied to other Soils OU, would be time-phased differently from the others to accommodate other active processing, ER, and D&D activities within its own boundaries. Care must be taken to coordinate the remediation of the NTF and the 3000 Watershed Soils OU ~~(see Sect. 4)~~. Potential for recontamination of the NTF from

migrating contamination originating from the 3019 Complex to the north of the NTF needs to be assessed.

2.3.9 Mercury Spill Soils OU

Figure 2.8 shows the location of the Mercury Spill Soils OU, and Table 2.9 lists the assigned waste units. The Mercury Spill Soils OU currently consists of four distinct locations in the southeastern corner of the WAG where spills of mercury have occurred. Soils, pipelines, and trenching materials in these areas are included in this OU. Subsequent soil sampling of these areas has indicated mercury contamination. Two of the spill areas are beneath occupied buildings with soil borings installed through the bottom floor. Using the WAG 1 base map (where 1 in. = 100 ft), the estimated area of the contamination under Building 4501 is approximately 6300 ft^2; that beneath Building 4508 is approximately 130,000 ft^2. The additional mercury spill areas are isolated from the above areas. One area, along the south side of Building 3592, covers about 50 ft^2. The other, beneath the roadway just south of Building 3503, covers 1,250 ft^2.

During the Phase I RI, soils analyses indicated a wider distribution of mercury in soil than originally suspected. This finding will be reported in the SCSR. Further assessments of this information may suggest that the new mercury-contaminated waste units be added to the OU.

The spill sites will remain a separate OU because similar potential technologies will be used to remediate the mercury contamination. In addition, this grouping allows for the time-phased remediation management required to interface with the surrounding active sites and other ER and D&D activities.

2.3.10 Isotope Circle Soils OU

Figure 2.9 shows the location of the Isotope Circle Soils OU, and Table 2.10 lists the assigned waste units. The Isotope Circle Soils OU, consisting of contaminated soils within a two-block area east of the NTF ~~(Fig. 2.2)~~, is currently occupied by a number of buildings and several underground steel tanks. The soils are believed contaminated primarily with cesium-137, strontium-90, and uranium isotopes from various isotope research programs within the surrounding buildings. The estimated area of the Isotope Circle Soils OU is 186,000 ft^2.

Also included in this OU are any additional soils (beyond those to be assigned to D&D) contaminated by releases from any of the buildings within the OU boundaries, as well as any additional miscellaneous pipelines, trench soils, bedding materials, and backfill soils. The Steel Tanks OU is located within the boundary of Isotope Circle. Soils contaminated by releases from this OU are possible additional elements to the Isotope Circle Soils OU.

Remediation of the Isotope Circle soils is an OU because the soils are located in a geographically distinct area. Further justification for this OU is the time-phased remediation requirement to interface with active, ER, and D&D programs within the

Isotope Circle area. Also, similar remedial technologies may be used because of similarities in nature and extent of the contamination in the waste units.

2.3.11 Steel Tanks OU

Figure 2.10 shows the location of the Steel Tanks OU, and ~~Table 2.11~~ Sect. II lists the assigned waste units. Scattered throughout WAG 1 are (31 inactive) steel tanks (excluding steel tanks in the Gunite Tanks OU) that primarily served to collect LLLW. Of these, 22 tanks are currently part of ERD, while 2 are part of D&D. Also, 2 tanks (4501-C and 4501-D) have been subject to remedial action, and 5 tanks (W-21, W-22, W-23, C-1, and C-2) have been determined to require no further action by regulatory agreement (FFA, Appendix C). Although attempts have been made to empty these tanks, sludge may still be present containing cesium-137, strontium-90, TRU elements, and other radionuclides. Additional tanks are scheduled for removal from service. The interior of these tanks and associated piping systems are contaminated, and some leakage has occurred. The soil samples at several tank locations have suggested that leaks may have resulted in soil contamination by various radionuclides. Steel tanks are in various locations throughout the WAG, but their remediation is designated a separate OU because the tanks may all be addressed with a similar remedial technology.

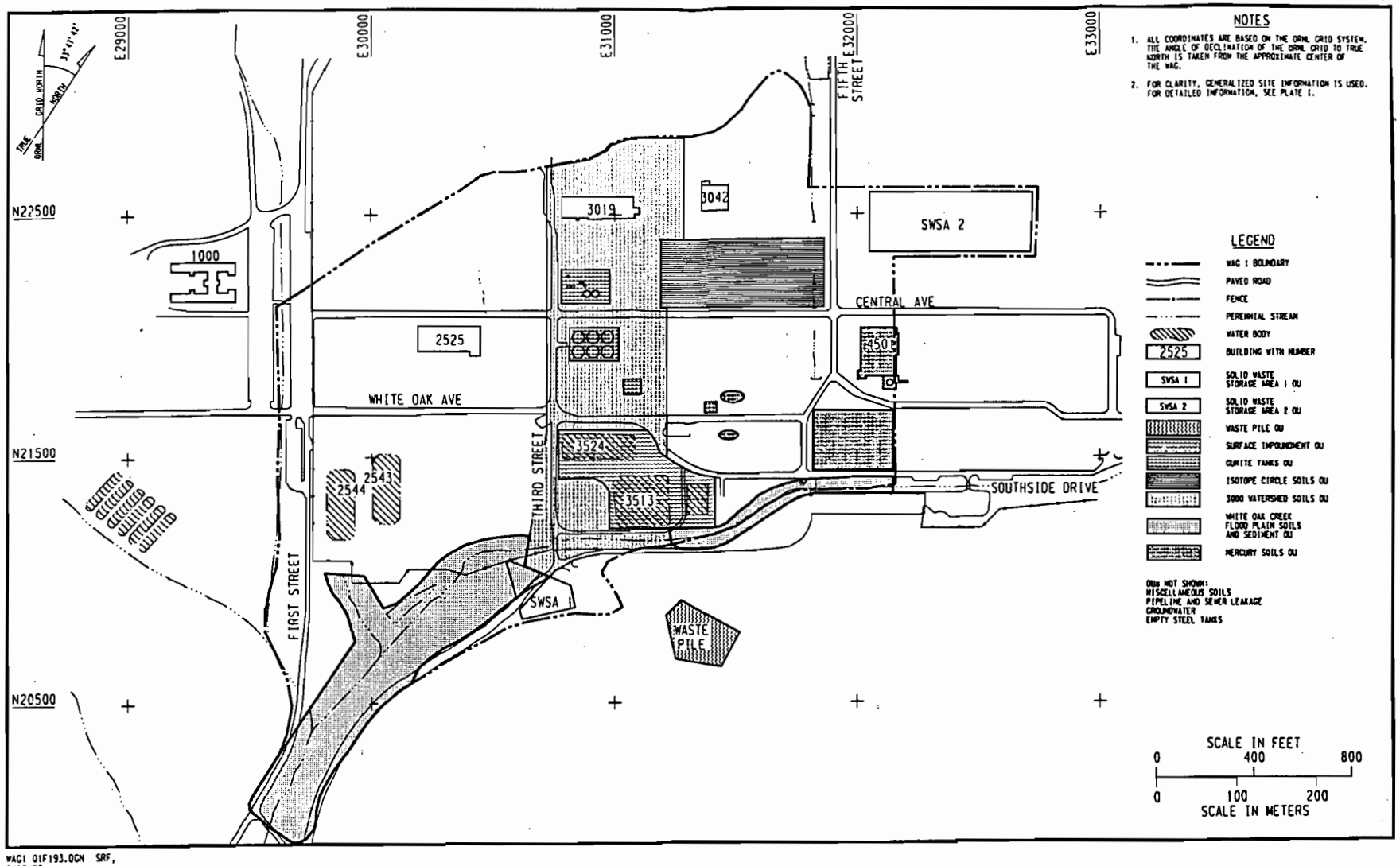
2.3.12 SWSA 2 OU

SWSA 2 (SWMU No. 1.47), in the northeast corner of WAG 1 (Fig. 2.2), was used for the disposal of solid waste containing beta- or gamma-emitting isotopes, liquid waste contaminated with plutonium in stainless steel drums, and alpha-contaminated material from off-site locations (ORNL 1990). The site was closed in 1946, and reportedly all of the buried wastes and contaminated soils were later excavated and transported to SWSA 3. SWSA 2 now thought to contain no waste, and an analysis of soil and groundwater samples indicates that the site does not contain concentrations of radionuclide constituents significantly higher than background. However, anomalies were found during geophysical investigations. A limited Phase II RI will be conducted to determine if NFI is appropriate.

SWSA 2 is considered a separate OU because of the potential for NFI, although additional field work or evaluation may be required to justify this decision. The purpose of identifying NFI candidates as separate OUs is to remove the candidates from the full CERCLA process and simplify the resulting documentation. The unit is also geographically separate from the other waste units. The soils and materials in SWSA 2 are core OU elements. Possible additional elements are the proximal contaminated soils.

2.3.13 Waste Pile OU

The one-third-acre former waste pile area (SWMU No. 1.58), directly south of the surface impoundment OU across WOC and just outside the WAG 1 boundary (Fig. 2.2), was apparently used only for stockpiling nonradiologically contaminated construction debris. Contamination is not expected at this OU; thus, it is a candidate for NFI (~~see Sect. 4~~).



WAG1 01F193.DGN SRF, 6/13/92

Fig. 2.2. Operable units.

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Remediation of the waste pile is considered a separate OU because of the potential for NFI, although additional work may be required to document this decision. The unit is also geographically separate from the other waste units. The soils and materials in the waste pile are core OU elements. Possible additional elements are the proximal contaminated soils.

This document was prepared in 1992 as part of the WAG 1 site characterization effort. Since this time some of the priority OUs (Fig. 3.5) have begun the remediation process with associated CERCLA activities and they are:

- Gunite and Associated Tank (GAAT) OU,
- Surface Impoundments Operable Unit (SIOU), and
- Corehole 8 (groundwater OU).

This OU strategy has integrating additional or newly identified CERCLA sites, active, and transition facilities, and D&D sites. The future Bethel Valley area will expend upon this strategy.

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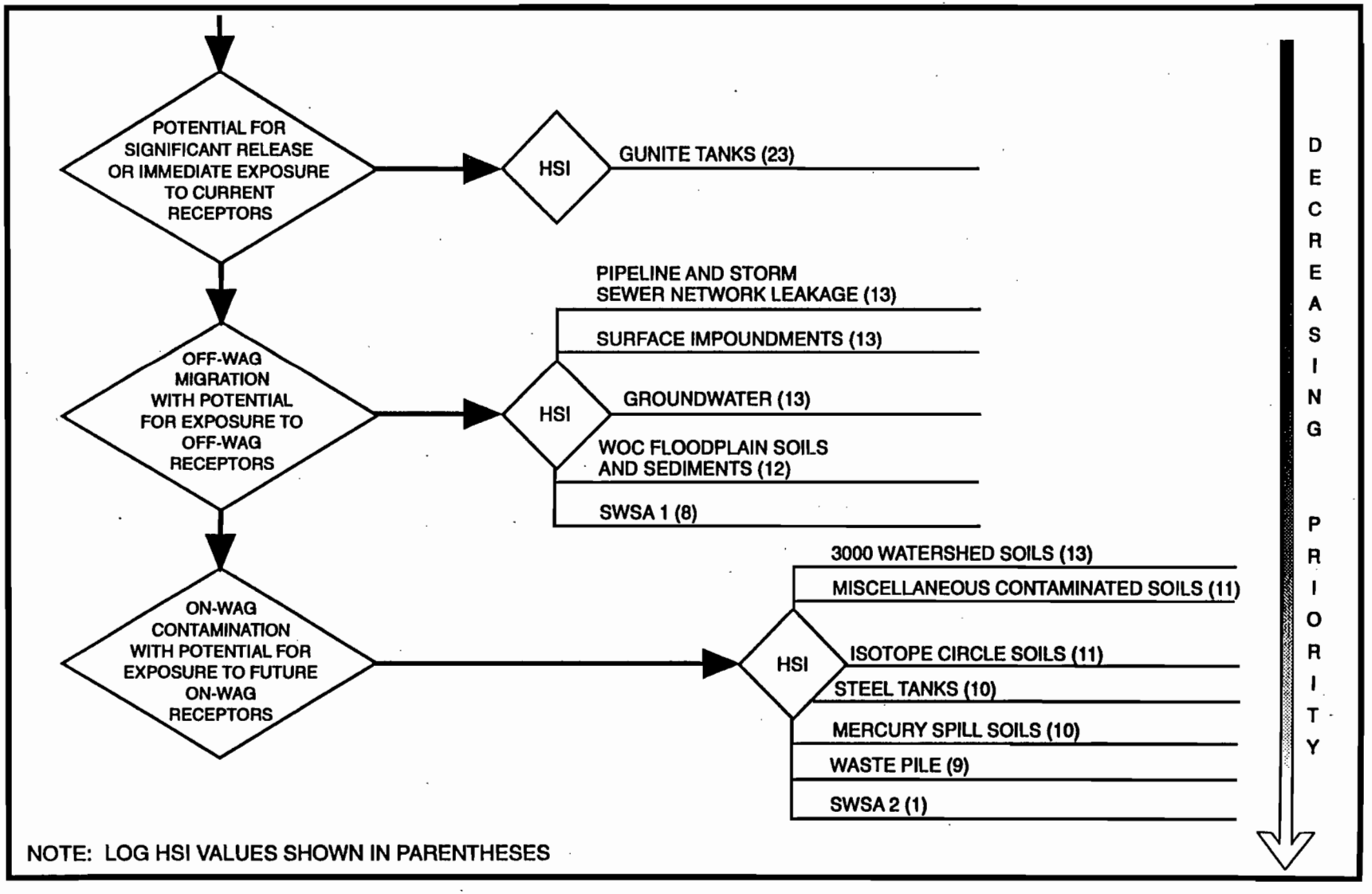

Fig. 3.5. Operable unit prioritization results.

3rd ERMA

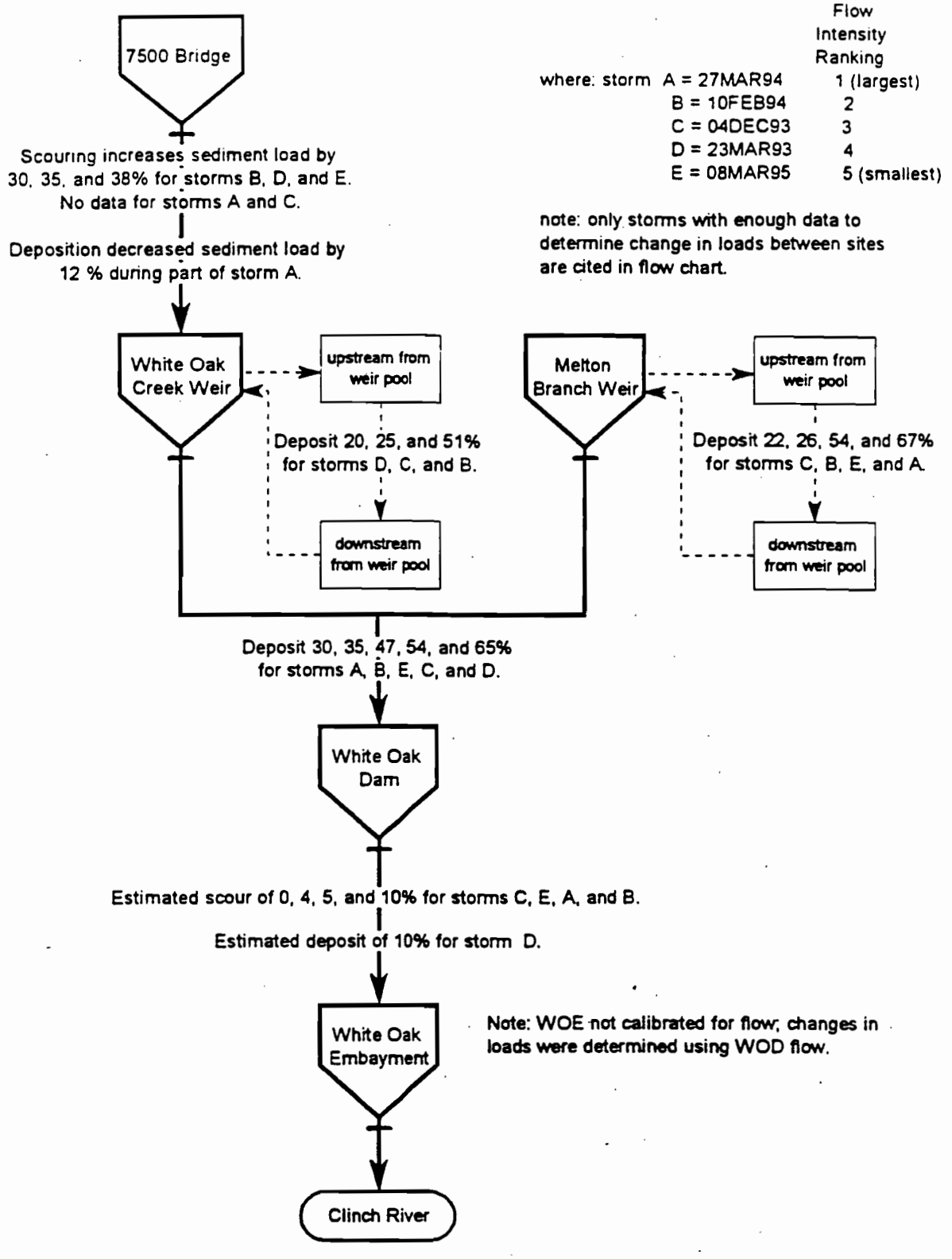

Fig. 5.2. Conceptual model of storm transport of ^{137}Cs in the White Oak Creek watershed. (Data are provisional; contaminant discharge at White Oak Dam has not been adjusted for recent revision in the weir rating curve.)

CM-1

CM-2

WAG 1 Preliminary Human Health Evaluation (1992)

2.1.2 Overview of Site Conditions

The WOC floodplain area used for the PHHE is at the southwestern end of WAG 1. The area is not fenced but is marked as a radiation area. Trees, grasses, and other vegetation cover the area. Access to this general area is restricted by guard stations located on nearby access roads. When the stations are not manned, a barrier is used to restrict road traffic. It has been known for some time that the floodplain soil was contaminated with cesium-137 as a result of historic discharges. The RI floodplain soil sampling program was designed to determine the extent of cesium-137 contamination and ascertain the presence and concentrations of other contaminants. The surface water sampling program was designed to provide information on the nature and concentration of contaminants in the surface water.

The samples used for the PHHE represent a small portion of the total number collected during the Phase I RI. A larger portion of these samples are used for the EE and the HSI. Data from all samples collected are used in the SCSR to describe the nature and extent of contamination. These samples also provide a technical foundation and source of information for future OU-specific environmental restoration activities. Site conditions are summarized in the WAG 1 Document Summary and discussed in detail in the SCSR. The rationale for using this subset of the samples is presented in Sect. 2.1.4.1.

2.1.3 Objectives

The primary objectives of the PHHE are presented in Sect. 1.3.1. Briefly, these are to

- assess the need for remedial action to control migration of contaminants from WAG 1,
- assess the need for remedial action for the WAG 1 WOC floodplain soils,
- provide a basis for comparison with other ORNL WAGs, and
- provide a basis for evaluating reduction of contaminant migration as a result of remediation relative to risk.

2.1.4 Approach

A hypothetical resident receptor on the WOC floodplain was evaluated under a no-action scenario; the following paragraphs explain why this receptor was chosen and how the PHHE was performed.

2.1.4.1 Hypothetical receptor

A hypothetical resident living on the WOC floodplain between the 7500 bridge and the main plant area fence (Fig. 1.1.2) was chosen as the receptor for the PHHE. This decision was made after consideration of the site conceptual model, EPA guidance, and the objectives for the PHHE.

The site conceptual model for WAG 1, presented in the SCSR (Sect. 5.2), assumes that groundwater flow, with its associated contaminant movement, eventually discharges to WOC upstream of the 7500 bridge. WOC also receives overland storm flow, any infiltration of groundwater to the storm sewer system, and eroded soil, as well as discharges permitted under the state's National Pollutant Discharge Elimination System (NPDES) program. It is currently believed that most, if not all, waterborne releases of environmental contaminants that originate within WAG 1 are received in WOC upstream of the 7500 bridge. A receptor exposed to the water of WOC at the WOC floodplain would be exposed to any contaminants migrating off site from WAG 1 (at upstream locations). While these are not necessarily the greatest concentrations that are present in surface water or groundwater within WAG 1, the WOC floodplain is the only area where surface water samples would represent influence from the entire WAG.

As a result of discussion at the December 4, 1991, DOE Technical Working Group meeting mentioned previously, it was decided that the human health evaluation for the first phase of the WAG 1 RI should be generalized and represent an evaluation of the risk from the overall WAG. It was also determined that since this human health evaluation will be used to document the need for continued action, it need not be as detailed as a human health evaluation presented in support of a no-further-action decision.

The PHHE intentionally only addresses discharges that represent present-day releases from WAG 1 as a whole. The analyses presented in this PHHE likely do not estimate the full magnitude of potential risk associated with individual OUs or sources of contamination within the WAG. Other potential risks (i.e., scenarios) will be addressed in future OU-specific risk assessments.

2.1.4.2 PHHE methodology

A no-action scenario was developed that assumed DOE's current access restrictions (including warning signs, patrols, and institutional controls) for the WOC floodplain became ineffective immediately, allowing a resident to occupy a homestead on the WOC floodplain. Although this is not a reasonable scenario for WAG 1, it allows evaluation of a no-action scenario as required under Sect. 300.430(e) of the National Contingency Plan (NCP) (EPA 1990a).

Approaches for quantifying conservative and nonconservative exposures were patterned after the approach used in *Preliminary Screening of Contaminants in the Off-Site Surface Water Environment Downstream of the U. S. Department of Energy Oak Ridge Reservation* (Hoffman et al. 1990). A conservative approach was designed such that there is high confidence that the actual risk is not underestimated. A nonconservative approach was designed to represent limited exposure at the site such that there is high confidence that the actual risk is not overestimated. These two approaches serve to put the calculated risk values into perspective.

Table 2.5.1. Carcinogenic risk from radioactive contaminants of potential concern to the WOC floodplain resident using the nonconservative approach

Radionuclide	Pathway				Total radionuclide risk
	Inhalation of particulates	Ingestion of surface water	Incidental ingestion of soil	Direct exposure	
^{241}Am	2.1E-06		3.5E-08	2.4E-09	2.2E-06
$^{137}Cs + D^a$	5.0E-07	2.4E-07	1.6E-06	3.9E-04	3.9E-04
^{3}H		1.2E-07			1.2E-07
$^{226}Ra + D^a$		1.7E-06			1.7E-06
$^{90}Sr + D^a$		1.4E-06			1.4E-06
^{234}U	8.0E-07	2.2E-08	1.1E-09	6.8E-12	8.2E-07
$^{238}U + D^a$	1.1E-06	1.9E-08	1.3E-09	5.5E-09	1.1-06
Pathway risk	4.5E-06	3.5E-06	1.6E-06	3.9E-04	
Cumulative pathway risk					4.0E-04

[a]D means daughter radionuclide.

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Table 2.5.2. Carcinogenic risk from radioactive contaminants of potential concern to the WOC floodplain resident using the conservative approach

Radionuclide	Pathway				Total radionuclide risk
	Inhalation of particulates	Ingestion of surface water	Incidental ingestion of soil	Direct exposure	
^{241}Am	1.7E-05		2.7E-06	3.7E-07	2.0E-05
$^{137}Cs+D^a$	2.4E-06	1.3E-05	7.7E-05	3.8E-02	3.8E-02
^{3}H		8.1E-06			8.1E-06
$^{226}Ra+D^a$		1.7E-04			1.7E-04
$^{90}Sr+D^a$		4.9E-05			4.9E-05
^{234}U	3.2E-06	1.8E-06	4.3E-08	5.5E-10	5.0E-06
$^{238}U+D^a$	4.4E-06	2.8E-06	5.1E-08	4.5E-07	7.6E-06
Pathway risk	2.6E-05	2.5E-04	8.0E-05	3.8E-02	
Cumulative pathway risk					3.8E-02

[a]D means daughter radionuclide.

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Table 2.5.3. Estimated lifetime risks associated with selected radiation protection and environmental protection and environmental radiation standards for the public

Risk	Standard exposure
3×10^{-2}	Radon concentration of 4 pCi/L in homes[a]
1×10^{-2}	Uranium mill tailings[b]
2×10^{-2}	Annual dose equivalent to whole body of 5 mSv (0.5 rem)[c]
1×10^{-2}	Annual effective dose equivalent of 3.0 mSv (0.3 rem)[d]
8×10^{-3}	Annual effective dose equivalent of 2.0 mSv (0.2 rem)[e]
3×10^{-3}	Annual effective dose equivalent of 1 mSv (0.1 rem)[f]
1×10^{-3}	Annual dose equivalent to whole body or annual effective dose equivalent of 0.25 mSv (25 mrem)[g]
6×10^{-5}	^{226}Ra plus ^{228}Ra in drinking water[h]
2×10^{-4}	Annual dose equivalent to whole body of 0.04 mSv (4 mrem)[h]
1×10^{-4}	Annual dose equivalent to thyroid of 0.75 mSv (75 mrem)[g]
3×10^{-5}	Annual effective dose equivalent of 0.01 mSv (1 mrem)[h]
8×10^{-6}	Annual dose equivalent to bone of 0.25 mSv (25 mrem)[j]
1×10^{-5}	Annual dose equivalent to bone of 0.04 mSv (4 mrem) from ^{90}Sr in drinking water[h]
8×10^{-7}	Annual dose equivalent to skin of 0.15 mSv (15 mrem)[k]
8×10^{-5}	Annual dose equivalent to thyroid of 0.04 mSv (4 mrem) from ^{219}I in drinking water[h]
5×10^{-8}	Disposal of high-level wastes[l]

[a]Recommended limit in federal guidelines.
[b]EPA standards.
[c]NRC's current and proposed radiation protection standard for all sources.
[d]NCRP estimate of average dose in U.S. population from natural sources, including radon and its decay products.
[e]NCRP estimate of average dose in U.S. population from radon and its decay products.
[f]Radiation protection standard for continuous exposure recommended by ICRP and NCRP, current and impending DOE radiation protection standard, and proposed NRC reference-level dose limit for individual licensees.
[g]Limit in several current or proposed EPA, NRC, and DOE environmental radiation standards.
[h]EPA standards.
[i]Negligible individual risk level recommended by NCRP.
[j]Limit in several current EPA and NRC environmental radiation standards.
[k]NRC's design objective for gaseous effluents from nuclear power reactors.
[l]EPA standard for cumulative releases of radionuclides to the accessible environment over 10,000 years.

Source: Kocher, D. C. 1988. Review of Radiation Protection and environmental Radiation Standards for the Public, Nuclear Safety, Vol. 29, No. 4, Oct.-Dec. 1988. Risk values were revised to reflect the effects of more recent risk factors and organ specific weight factors reported in ICRP-60 1990.

Assumptions for arriving at risk values

1 Continuous exposure of adults and average lifespan of 70 years
2 Risk per unit dose equivalent to whole body or per unit effective dose equivalent is 5×10^{-2} SV^{-1} (5×10^{-4} rem^{-1}) and the weight factors used in estimating the risks to specific organs, including skin, are those recommended by ICRP 60.

Table 2.5.4. Carcinogenic risk from chemical contaminants of potential concern to the WOC floodplain resident using the nonconservative approach

Chemical	CAS No.	Pathway				Total chemical risk
		Inhalation of particulates	Ingestion of surface water	Incidental ingestion of soil	Dermal contact with soil	
Semivolatile organics						
Benzo(a)pyrene	50-32-8	7.9E-09		1.9E-08	7.5E-08	1.0E-07
n-Nitrosodi-n-propylamine	621-64-7			2.7E-08	1.1E-07	1.4E-07
VOCs						
Chloroform	67-66-3		4.8E-09			4.8E-09
Bromodichloromethane	75-27-4		9.7E-08			9.7E-08
p-Dioxane	123-91-1		3.4E-07			3.4E-07
Inorganics						
Cadmium	7440-43-9	1.3E-07				1.3E-07
Pathway risk		1.3E-07	4.5E-07	4.5E-08	1.8E-07	
Cumulative pathway risk						8.1E-07

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Table 2.5.5. Carcinogenic risk from chemical contaminants of potential concern to the WOC floodplain resident using the conservative approach

Chemical	CAS No.	Pathway						Total chemical risk
		Inhalation of vapor phase	Inhalation of particulates	Ingestion of surface water	Incidental ingestion of soil	Dermal contact with soil	Dermal contact with surface water	
Semivolatile organics								
Benzo(a)pyrene	50-32-8		3.5E-08		7.1E-07	2.8E-07		1.0E-06
n-Nitrosodi-n-propylamine	621-64-7				9.4E-07	3.7E-07		1.3E-06
VOCs								
Chloroform	67-66-3	1.2E-07		1.9E-07			1.4E-09	3.1E-07
Bromodichloromethane	75-27-4			4.6E-06			3.5E-08	4.6E-06
p-Dioxane	123-91-1			1.1E-05			8.8E-08	1.2E-05
Inorganics								
Cadmium	7440-43-9		6.1E-07					6.1E-07
Pathway risk		1.2E-07	6.4E-07	1.6E-05	1.7E-06	6.6E-07	1.2E-07	
Cumulative pathway risk								1.9E-05

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Table 2.5.6. Noncarcinogenic hazard index from chemical contaminants of potential concern to the WOC floodplain resident using the nonconservative approach

Chemical	CAS No.	Pathway: Inhalation of particulates	Ingestion of surface water	Incidental ingestion of soil	Dermal contact with soil	Total chemical hazard index
VOCs						
Chloroform	67-66-3		6.2E-04			6.2E-04
Bromodichloromethane	75-27-4		2.9E-04			2.9E-04
Pyridine	110-86-1		1.9E-01			1.9E-01
Inorganics						
Manganese	7439-96-5		1.8E-03			1.8E-03
Silver	7440-22-4		3.2E-03	9.0E-05	7.1E-05	3.4E-03
Boron	7440-42-8	1.2E-02		2.0E-03	1.6E-03	1.6E-02
Cadmium	7440-43-9		1.0E-02	8.1E-04	6.4E-04	1.1E-02
Chromium	7440-47-3		3.2E-03	4.5E-06	3.5E-06	3.2E-03
Vanadium	7440-62-2		1.3E-03			1.3E-03
Pathway hazard index		1.2E-02	2.1E-01	2.9E-03	2.3E-03	
Cumulative pathway hazard index						2.3E-01

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Table 2.5.7. Noncarcinogenic hazard index from chemical contaminants of potential concern to the WOC floodplain resident using the conservative approach

Chemical	CAS No.	Pathway						Total chemical hazard index
		Inhalation of vapor phase	Inhalation of particulates	Ingestion of surface water	Incidental ingestion of soil	Dermal contact with soil	Dermal contact with surface water	
VOCs								
Chloroform	67-66-3			7.1E-03			5.4E-05	7.2E-03
Bromodichloromethane	75-27-4			4.1E-03			3.1E-05	4.1E-03
Pyridine	110-86-1			1.9E+0			1.5E-02	1.9E+0
Inorganics								
Manganese	7439-96-5			4.9E-02			7.5E-04	5.0E-02
Silver	7440-22-4			8.4E-02	1.2E-03	9.5E-05	1.3E-03	8.7E-02
Boron	7440-42-8		2.3E-02		3.2E-02	2.5E-03		5.8E-02
Cadmium	7440-43-9			1.5E-01	1.0E-02	8.0E-04	2.3E-03	1.6E-01
Chromium	7440-47-3			9.4E-02	5.7E-05	4.5E-06	1.4E-03	9.5E-02
Vanadium	7440-62-2			2.4E-02			3.7E-04	2.4E-02
Pathway total		0.0	2.3E-02	2.3E+0	4.3E-02	3.4E-03	2.1E-02	
Cumulative pathway hazard index								2.4E+00

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Table 2.5.8. Noncarcinogenic hazard index by specific effect from the chemical contaminants of potential concern to the WOC floodplain resident using the conservative approach

Effect	Chemical	CAS No.	Pathway: Inhalation of vapor phase	Inhalation of particulates	Ingestion of surface water	Incidental ingestion of soil	Dermal contact with soil	Dermal contact with surface water	Total chemical hazard index
Kidney	Bromodichloromethane	75-27-4			4.1E-03			3.1E-05	4.1E-03
	Cadmium	7440-43-9			1.5E-01	1.0E-02	8.0E-04	2.3E-03	1.6E-01
	Vanadium	7440-62-2			2.4E-02			3.7E-04	2.4E-02
Total kidney hazard index					1.8E-01	1.0E-02	8.0E-04	2.7E-03	1.9E-01
Liver	Chloroform	67-66-3			7.1E-03			5.4E-05	7.2E-03
	Pyridine	110-86-1			1.9E+0			1.5E-02	1.9E+0
	Chromium[a]	7440-47-3				5.7E-05	4.5E-06		6.2E-05
Total liver hazard index					1.9E+0		4.5E-06	1.5E-02	1.9E+0
Neurotoxicity	Chromium[b]	7440-47-3			9.4E-02			1.4E-03	9.5E-02
	Manganese	7439-96-5			4.9E-02			7.5E-04	5.0E-02
Total neurotoxicity hazard index					1.4E-01			2.2E-03	1.5E-01
Respiratory	Boron	7440-42-8		2.3E-02					2.3E-02
Skin	Silver	7440-22-4			8.4E-02	1.2E-03	9.5E-05	1.3E-03	8.7E-02
Reproductive	Boron	7440-42-8				3.2E-02	2.5E-03		3.5E-02
Pathway total			0.0E+0	2.3E-02	2.3E+0	4.3E-02	3.4E-03	2.1E-02	
Cumulative pathway hazard index									2.4E+0

[a]Based on Chromium(III) toxicity information.
[b]Based on Chromium(VI) toxicity information.

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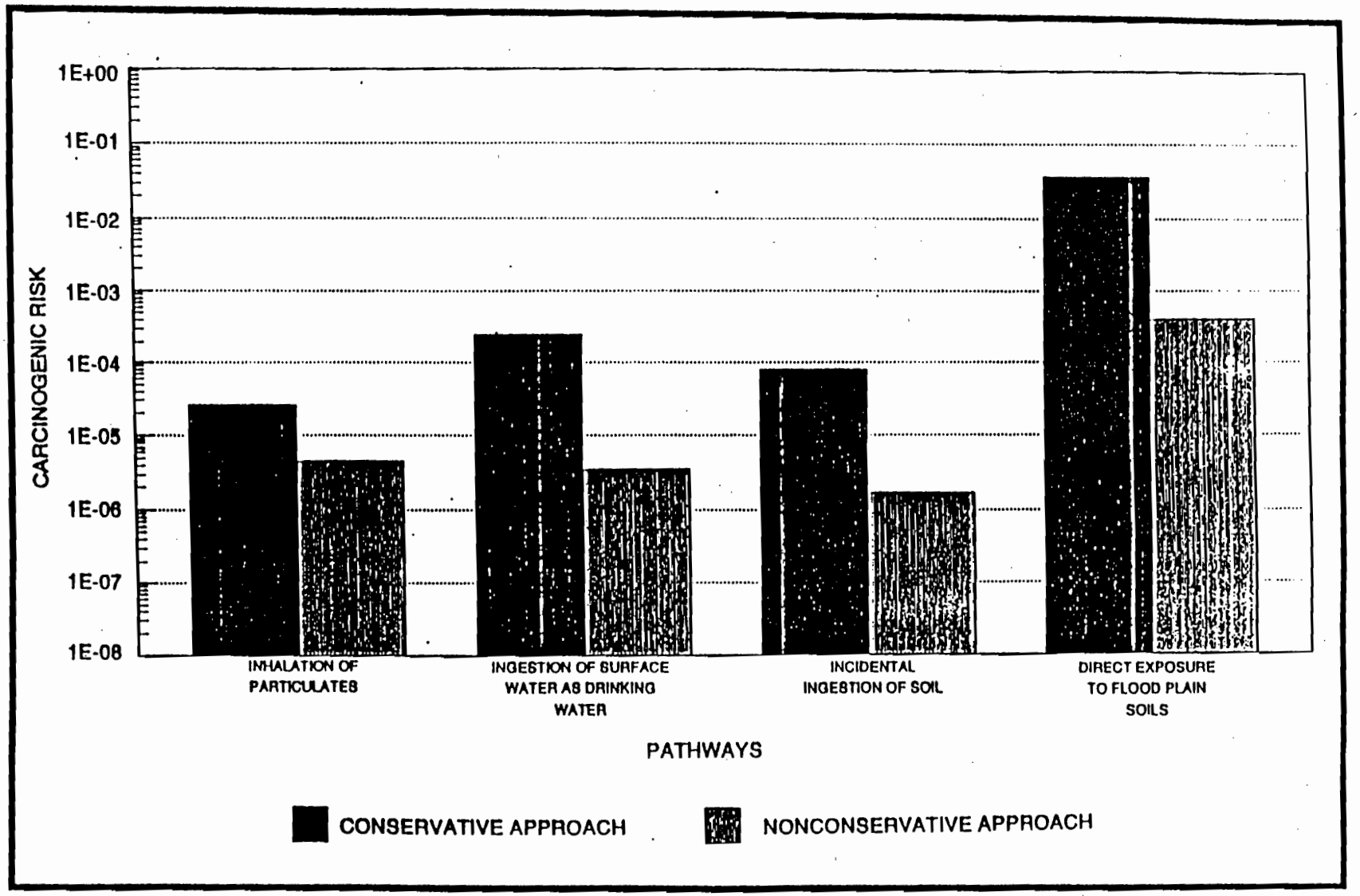

Fig. 2.5.1. Noncarcinogenic risk by pathway for radioactive contaminants of potential concern to the hypothetical WOC floodplain resident.

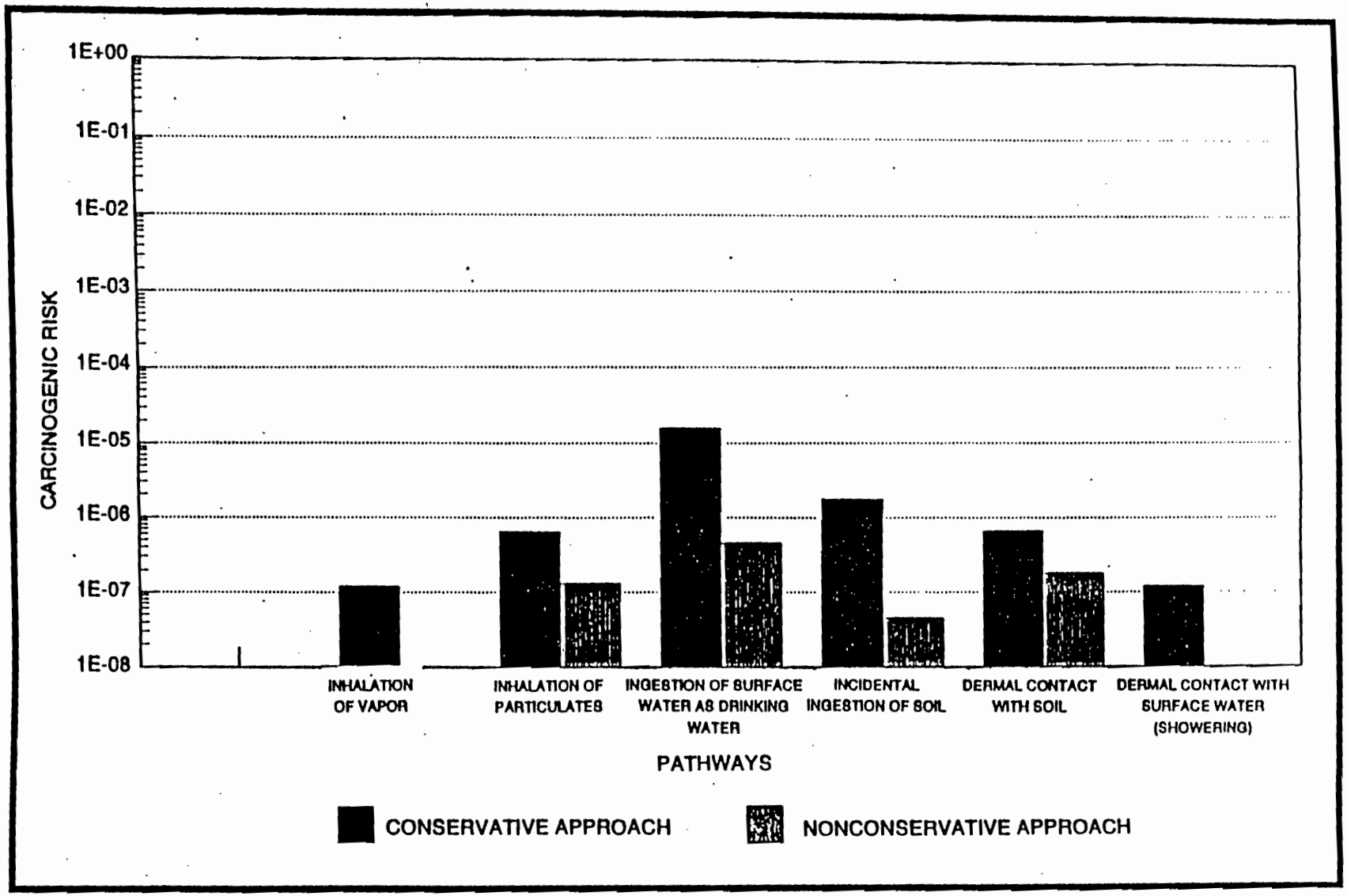

Fig. 2.5.2. Carcinogenic risk by pathway for chemical contaminants of potential concern to the hypothetical White Oak Creek floodplain resident.

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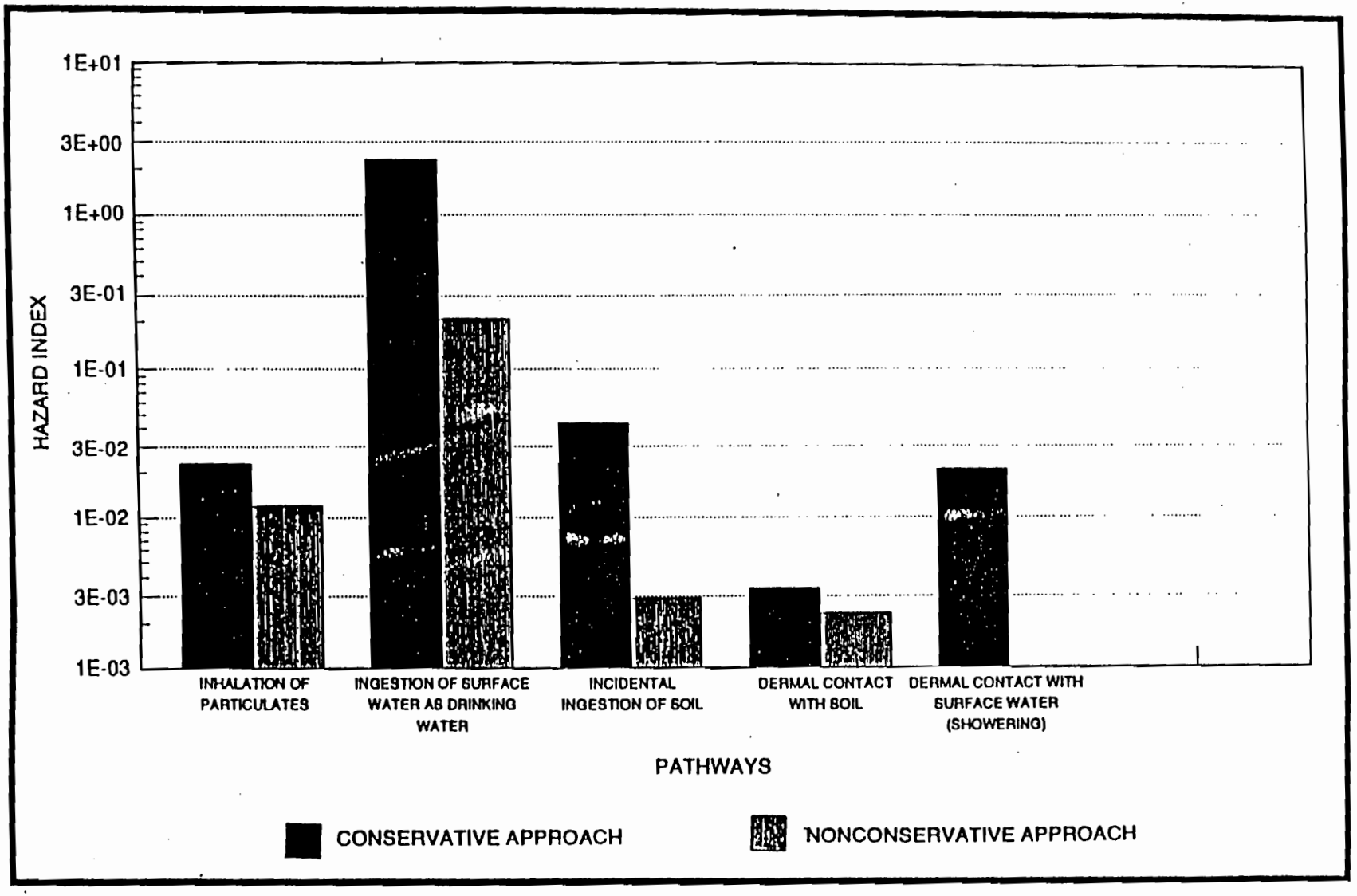

Fig. 2.5.3. Noncarcinogenic risk by pathway for chemical contaminants of potential concern to the hypothetical WOC floodplain resident.

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Table 3.5.1. Chemical analytes exceeding NAWQC for unfiltered surface water in WAG 1

	NAWQ criteria (µg/L) or approximated values[a]		Site				Reference
Contaminant	Acute	Chronic	Max (µg/L)	Mean (µg/L)	Min (µg/L)	Hits/ samples	Max (µg/L)
Aluminum	750	87	2190	611.8	88.9	18/21	44
Barium	4.4[a]	0.11[a]	48.1	35.5	23.5	21/21	44
Cadmium	1.8	0.66	2.5	2.5	2.5	1/21	[b]
Chromium[c]	16	11	13.6	11.85	10.7	5/21	[b]
Copper	9.22	6.54	96.7	53.9	11.1	2/21	12
Lead	33.8	1.32	13.9	5.3	2.1	11/18	3.8
Magnesium	6.5[a]	0.16[a]	12,500	7723	113.8	21/21	11,800
Manganese	330[a]	11[a]	143	36.3	14.5	21/21	28
Potassium	5.3[a]	0.13[a]	1710	1201.5	599	18/18	618
Silver	1.23	0.063[a]	12.3	11.03	10.2	4/21	[b]
Sodium	19,000[a]	480[a]	12,300	4074	40.6	20/21	1110
bis(2-ethylhexyl)-phthalate	2.6[a]	0.087[a]	5	4	3	2/23	[b]

[a]Approximated values are from Blaylock et al. (1991).
[b]Not detected above SQL.
[c]Assumed to be Cr^{+6}.

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Table 3.5.2. Chemical analytes exceeding action levels for soils and sediments in WAG 1

Contaminants	Action level[a] (μg/kg)	Site Max (μg/kg)	Site Mean (μg/kg)	Site Min (μg/kg)	Site Hits/samples	Reference Max (μg/kg)
Soil						
Mercury	20,000	548,000	10,178	100	113/376	150
Beryllium	200	212,000	2,777.9	280	400/445	1600
Antimony	30,000	37,600	10,678.7	2,400	72/187	[b]
Aroclor 1254	90	5,800	997.2	33	12/207	[b]
Aroclor 1260	90	1,900	444	88	7/208	[b]
Sediment						
Beryllium	200	1,900	1,140	730	9/10	1100
Aroclor 1254	90	12,000	2,900	410	6/9	1000

[a]*Federal Register* July 27, 1990.
[b]Not detected above SQL.

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5. SUMMARY AND CONCLUSIONS

5.1 PRELIMINARY HUMAN HEALTH EVALUATION

The PHHE was developed from data collected during the Phase I RI at WAG 1. Phase I, as well as previous investigations, identified contaminants present on and migrating from the WAG. Contaminants identified include radionuclides, organics, and inorganics.

Risk was calculated for a hypothetical WOC floodplain resident receptor. Two approaches, one conservative and the other nonconservative, were assessed for reasonable maximum and average exposure assumptions, respectively. The PHHE results indicated that risks to the hypothetical WOC floodplain receptor were greater than EPA's upper risk limit of 10^{-4} for radioactive contaminants of potential concern for both conservative and nonconservative approaches. For chemical contaminants of potential concern, the risk was greater than EPA's lower risk limit of 10^{-6} for the conservative approach. The PHHE results establish a need for continued action to address radioactive contaminants migrating in surface water in WOC as well as contaminated soils in the WOC floodplain.

Risk from radioactive contaminants was driven by radium-228 and strontium-90 and their daughters for ingestion of surface water and by cesium-137 and its daughter for direct exposure to the floodplain soils. For chemical contaminants, the potential carcinogenic risk for the conservative approach fall between the upper and lower bounds of EPA's target risk range. The noncarcinogenic hazard index for ingestion of surface water as drinking water (at 2.3 for the conservative approach) is greater than the adverse effect threshold of 1. Assessment of secondary exposure pathways (e.g., ingestion of vegetables irrigated with chemically contaminated water) would probably not yield a significant increase in the current risk values because one of the chemicals driving the chemical carcinogenic risk (p-dioxane) is characterized by a low K_{ow} and does not readily bioaccumulate. In addition, the noncarcinogenic risk is a result of ingestion of drinking water, and the chemical driving this risk (pyridine), is also characterized by a low K_{ow} and is not readily bioaccumulated. Many of the remedial actions that might be taken at WAG 1 to address migration of radioactive contaminants would probably produce a significant mitigation of chemical contaminant migration. With these considerations in mind, the need for further definition of the potential risks due to chemicals is probably not necessary.

When the WAG 1 PHHE results are used to compare the risk attributable to WAG 1 as a whole with the risk from other WAGs, it should be determined whether a larger or smaller number of pathways (especially secondary pathways) have been assessed for the other WAG. Assessment of different pathways for other WAGs could result in a total risk number that might not be comparable to the WAG 1 PHHE calculated risk.

The PHHE risk values should provide a basis for either quantitative or qualitative risk reduction comparisons for WAG 1 OU-specific alternatives evaluations. In these comparisons, consideration should be given to comparing the potential increased risk to workers from OU-specific remediation activities with the risk reduction for the hypothetical WOC floodplain receptor.

5.1.1 Scope

The hypothetical WOC floodplain resident was selected for evaluation under a no-action scenario based on the site conceptual model, EPA guidance, and the objective of the PHHE. The objective of the PHHE was to determine the potential threat to a hypothetical WOC floodplain resident receptor to

- assess the need for remedial action to control migration of contaminants from WAG 1,
- assess the need for remedial action for WOC floodplain soils,
- provide a basis for comparison with other ORNL WAGs, and
- provide a basis for comparison with risk reduction estimates during WAG 1 OU-specific alternative evaluations.

The site conceptual model assumes that groundwater flow (and associated contaminant movement) at WAG 1 eventually discharges to WOC before leaving the WAG. The location of the hypothetical resident exposes him or her to any contaminants migrating off site from WAG 1 via water pathways.

As required by the NCP (EPA 1990a), effects on the receptor were evaluated under a no-action scenario, which assumed that DOE's current access restrictions for the WOC floodplain (i.e., outside the WAG 1 fence) became ineffective immediately. Although this is an unrealistic assumption, it is required by the National Contingency Plant (EPA 1990a). Both conservative and nonconservative approaches were used to calculate a range of risk to the hypothetical receptor.

The *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual* (EPA 1989) and other EPA and ORNL guidance documents were used in preparing the PHHE. The PHHE consisted of four components: selection of contaminants of potential concern, exposure assessment, toxicity assessment, and risk characterization.

5.1.2 Selection of Contaminants of Potential Concern

Contaminants of potential concern were selected from surface water and soil samples taken under the Phase I RI. The PHHE included all soil and surface water samples taken in the WOC floodplain and reference samples taken from upgradient locations. Chemical and radioactive contaminants of potential concern were selected by excluding contaminants (e.g., they were naturally present in the environment, were below reference concentrations, were essential nutrients, or did not contribute significantly to risk).

The selection process resulted in a list of 7 radioactive and 21 chemical contaminants (4 VOCs, 9 semivolatile organics, and 8 inorganics) of potential concern.

5.1.3 Exposure Assessment

Because WAG 1 is on the ORR, all land around it is government-owned and there are no residents. Risks to the hypothetical resident were evaluated under a no-action scenario which assumed that DOE's current access restrictions at the WOC floodplain became ineffective immediately. Although this scenario is not reasonable because DOE plans to continue operating ORNL well into the future, it was used because a no-action scenario is required under the NCP.

Conservative and nonconservative approaches were used to estimate a range of risk for the hypothetical receptor using exposure factors developed by ORNL (White 1992). The conservative approach used reasonable maximum exposure parameters, and the nonconservative approach used average exposure parameters.

Five potential primary exposure pathways were evaluated:

- direct exposure to ionizing radiation from WOC floodplain soils,
- inhalation of particulates, volatiles, and evaporated tritium,
- ingestion of surface water for drinking,
- incidental ingestion of WOC floodplain soil, and
- dermal contact with WOC floodplain soil and surface water (for chemical contaminants only).

Secondary exposure pathways (e.g., eating vegetables grown in contaminated soil) were not evaluated because the initial assessment was that the total risk for primary pathways alone would exceed the EPA action threshold of 10×10^{-4}.

Except for inhalation, the specific concentrations of contaminants used to assess exposures were from environmental media samples collected during the Phase I RI. For inhalation, modeling was used to estimate air concentrations of VOCs and evaporated tritium from surface water and particulate-bound contaminants from soils.

5.1.4 Toxicity Assessment

Toxicity values (slope factors and reference doses) were identified for contaminants of potential concern in surface water and soil for the ingestion, external exposure, and inhalation pathways. Toxicity values were identified for all seven of the potential radioactive contaminants of concern. Seven of the nine semivolative organic and two of the eight inorganic contaminants of potential concern did not have toxicity values and were not considered further in the evaluation. All of the radioactive and seven of the chemical contaminants of potential concern are classified as known or probable human carcinogens. Nine of the chemical contaminants of potential concern are classified as noncarcinogens.

5.1.5 Risk Characterization

5.1.5.1 Risk from radioactive contaminants of potential concern

Risks from radioactive contaminants of potential concern for the nonconservative and conservative approaches were 4.0×10^{-4} and 3.8×10^{-2}, respectively. Both of these exceed the upper limit of EPA's target risk range (10^{-4}). External exposure is the dominant pathway (approximately 99% of the total risk from radioactive contaminants of potential concern). The risk due to external exposure was calculated two ways, one using the radionuclide-specific RI sampling data and the other using dose measurements from the USRADS walkover survey. The results from both methods were within the same order of magnitude. Cesium-137 and daughter were responsible for the majority of the risk from direct exposure.

The risk from ingestion of drinking water also exceeded the upper end of EPA's risk range (10^{-4}). Radium-228, strontium-90, and daughters were the major contributors to this risk.

5.1.5.2 Risk from chemical contaminants of potential concern

Carcinogenic risks from chemical contaminants of potential concern for the conservative and nonconservative approaches were 1.9×10^{-5} and 8.1×10^{-7}, respectively. These risks do not exceed the upper limit of the EPA's target risk range (10^{-4}), but for the conservative approach, they do exceed the lower limit (10^{-6}). Ingestion of surface water was the primary pathway for the conservative exposure assumptions (approximately 84% of the total risk from chemical contaminants of potential concern). p-Dioxane and dichlorobromomethane were the primary contributors to carcinogenic risk for ingestion of surface water (conservative approach).

Only ingestion of surface water using the conservative approach resulted in a noncarcinogenic hazard index greater than 1. The hazard index for this pathway was 2.3; the volatile organic pyridine was the only chemical with a hazard index greater than 1 (1.9). Pyridine produces adverse effects on the liver.

5.1.6 Identification of Uncertainties

Each step of the PHHE (selection of contaminants of potential concern, exposure assessment, toxicity assessment, and risk characterization) contributes uncertainty to the final risk estimates. Uncertainties were addressed qualitatively. The individual sources of uncertainty were discussed and categorized regarding whether they have the potential to overestimate risk, underestimate risk, or both. Qualitative assessments are also made as to the effect of each uncertainty on meeting the objectives of the PHHE. Given this uncertainty, the risk estimates should not be taken as an absolute indicator of whether adverse health effects could occur. Rather, they should be used as a gauge for the need for remedial action, as a means for comparison with other WAGs, and for future comparison in the alternatives assessment process to evaluate risk reduction.

5.2 ENVIRONMENTAL EVALUATION

Relying on a combination of BMAP studies and data collected during the Phase I RI, the EE demonstrated that there is a present or potential risk of detrimental effects to the environment in the absence of any remediation at WAG 1.

Data from BMAP studies indicated that surface waters have elevated levels of metals and elevated temperatures. Most of Fifth Creek and the middle section of WOC receive substantial inputs of chlorine and other toxicants. Studies on biota reported that benthic macroinvertebrate, periphyton, and fish populations all appear to be impacted by ORNL operations. In addition, both waterfowl and groundhogs collected from WAG 1 had high tissue concentrations of radionuclides.

Concentrations of contaminants detected during Phase I were compared with the NAWQC for surface water and with RCRA action levels (EPA 1990b) for soils and sediments to determine the initial list of contaminants of potential concern. The reference levels and known toxicity were then considered in further reducing the number of contaminants. Of the nonradiological contaminants, mercury and PCBs are likely to cause adverse effects to aquatic species and piscivorous animals. Several contaminants [cadmium, chromium, lead, copper, aluminum, silver, and bis(2-ethyl-hexyl)phthalate] are likely to cause adverse effects to aquatic species, but information was generally insufficient to assess their potential for detrimental effects to terrestrial species. Although beryllium and antimony are present in concentrations that might pose a hazard to biota, there is insufficient toxicity information on their effects to nonhuman species to evaluate their potential effects on WAG 1 biota.

Regulatory guidelines for radionuclides for the protection of environmental receptors are lacking, and information on radiation effects in the natural environment on WAG 1 species is limited, thus precluding an assessment of their specific effects. However, on the basis of BMAP studies that reported deposition in body tissues and the high concentration of radionuclides in WAG 1, it is likely that some detrimental effects are occurring at least to individual inhabitant species.

5.3 HAZARD SCREENING INDEX

A methodology for calculating the relative hazard of the OUs in WAG 1 was derived from EPA's rHRS (EPA 1990c). The HSI is one of two factors used in the prioritization of OUs (the other is a qualitative assessment of exposure potential) in the OUSD. Modifications were made to enhance the differentiation of OUs relative to concentration, toxicity, and quantity of contaminated material present.

5.3.1 Method

The HSI is the product of a concentration-weighted toxicity factor and a waste quantity factor; this is illustrated by the following equation:

$$HSI = CWTF \times WQF$$

where

HSI	=	hazard screening index
CWTF	=	concentration-weighted toxicity factor
WQF	=	waste quantity factor

The CWTF is the summation of the individual CWTF values for each hazardous constituent that exceeds its risk-based benchmark concentration for a given medium. The benchmark against which all concentrations are compared corresponds to a 10^{-6} individual cancer risk for carcinogens or to the reference dose for noncarcinogens. To determine a CWTF, a toxicity value is assigned to each hazardous constituent within an OU, as described in the rHRS. On the basis of the concentration of the constituent as reported in the sampling data, the toxicity value is weighted to give an individual CWTF value. Individual CWTF values are summed to determine the total CWTF for the OU.

The calculation of the WQF follows the methods discussed in the rHRS guidance. The WQF is based on the volume of contaminated materials associated with each OU. Both chemical and radionuclide WQFs are calculated; the chemical and radionuclide WQFs are summed to give the total WQF for the OU.

5.3.2 Results

The HSI values are used to establish a ranked order of OUs. The higher the HSI score, the higher the ranking and associated hazard for that OU. For the WAG 1 OUs, the HSI score for the Gunite tanks (liquids and sludges) was the highest (1.72×10^{23}), followed by groundwater, surface impoundments (liquids and sludges), and steel tanks (liquids) with scores of 6.43×10^{17}, 4.02×10^{16}, and 2.47×10^{15}, respectively. The lowest score was for SWSA 2 (0). Values for the remaining OUs ranged from a low of 3.25×10^{6} (pipeline discharges) to a high of 1.26×10^{13} (3000 watershed soils).

Table 3.2. Total carcinogenic risk associated with each well organized by the waste area grouping that the well monitors

Risk	WAG 1		WAG 2		WAG 3		WAG 4		WAG 5		WAG 6		WAG 7		WAG 8		WAG 11		WAG 17	
	Well	Risk	Well	Risk	Well	Risk	Well	Risk	Well	Risk	Well	Risk	Well	Risk	Well	Risk	Well	Risk	Well	Risk
1x10-1									973	2.8E-01										
									978	2.0E-01										
1x10-2	814	1.6E-02					958	8.4E-02	974	8.1E-02										
	818	1.2E-02					954	1.7E-02	969	2.2E-02										
	819	1.1E-02							975	1.1E-02										
1x10-3	812	8.7E-03					957	7.9E-03	977	8.7E-03	843	3.1E-03	1078	1.5E-03					1201	8.6E-03
	809	2.4E-03							976	8.9E-03	846	2.6E-03								
	825	1.0E-03							961	1.7E-03	837	2.6E-03								
									971	1.4E-03	1243	2.3E-03								
									970	1.3E-03	842	1.7E-03								
											831	1.5E-03								
											840	1.4E-03								
											841	1.3E-03								
											858	1.2E-03								
1x10-4	808	6.6E-04	1181	8.9E-04	994	5.5E-04	955	8.4E-04	972	5.3E-04	856	9.9E-04	1079	8.3E-04	1097	8.0E-04	1145	5.7E-04		
	807	5.5E-04	1190	7.2E-04	992	2.4E-04	956	7.4E-04	968	3.3E-04	857	8.6E-04	1078	8.2E-04	1096	7.0E-04				
	830	5.1E-04	1152	3.6E-04	993	1.6E-04	960	1.1E-04	964	1.2E-04	855	7.9E-04	1084	3.1E-04	1087	8.1E-04				
	806	4.7E-04	1158	3.2E-04	1248	1.6E-04			967	1.0E-04	847	4.7E-04	1071	1.2E-04						
	813	4.5E-04	1184	1.5E-04	998	1.3E-04					833	4.4E-04	1074	1.2E-04						
	829	4.4E-04	1195	1.2E-04							745	4.2E-04								
	824	4.0E-04									844	4.2E-04								
	828	3.6E-04									839	3.7E-04								
	827	3.4E-04									838	3.4E-04								
	811	3.2E-04									1244	2.9E-04								
	810	3.1E-04									832	2.8E-04								
	818	2.1E-04									836	2.2E-04								
	815	1.1E-04									859	2.2E-04								
	826	1.1E-04									835	1.8E-04								
	848	1.1E-04									860	1.8E-04								
	847	1.0E-04									1245	1.5E-04								
1x10-5	820	8.3E-05	1151	4.0E-05	997	8.9E-05	949	5.1E-05	962	9.3E-05			1077	8.8E-05	1088	8.6E-05	1146	8.6E-05	1196	4.9E-05
	822	8.9E-05	1192	3.7E-05	987	2.6E-05	952	4.3E-05	963	8.5E-05			1073	7.1E-05	1089	5.9E-05	1149	3.3E-05	1198	4.1E-05
	823	3.0E-05	1196	3.4E-05	985	2.5E-05	961	3.4E-05	979	7.1E-05			1075	6.1E-05	1090	3.6E-05	1148	3.0E-05	1199	2.4E-05
	821	2.7E-05	1154	3.0E-05	990	2.0E-05	958	2.7E-05	965	4.6E-05			1072	5.1E-05	1091	3.6E-05	1143	2.4E-05	1203	2.0E-05
			1193	2.7E-05	991	1.6E-05	962	2.1E-05	963	4.3E-05			1081	3.5E-05	1095	3.3E-05	1144	1.6E-05	1200	1.6E-05
			1153	2.6E-05	996	1.5E-05	951	1.5E-05	964	2.6E-05			1082	3.5E-05	1093	2.5E-05			1202	1.7E-05
			1185	1.8E-05	995	1.1E-05	950	1.1E-05	960	2.2E-05			1083	2.8E-05	1092	2.0E-05			1197	1.6E-05
			1186	1.7E-05					966	1.7E-05			1085	2.1E-05	1094	1.3E-05				
			1155	1.6E-05									1086	1.9E-05						
			1150	1.3E-05									1080	1.6E-05						
			1188	1.3E-05																
			1187	1.0E-05																
1x10-6					998	7.5E-06	953	8.7E-06									1140	8.6E-06		
					988	5.5E-06	948	5.7E-06									1139	8.5E-06		
																	1147	8.3E-06		
																	1148	8.1E-06		

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Table 6.2 Contaminants exceeding risk criteria in RCRA perimeter wells

WAG	Contaminants[a]		
	Radionuclides	Metals	Organics
1	^{90}Sr, ^{234}U	As, Ba, Be, Cd, Mn, Sb	Vinyl Chloride, N-Nitroso-Di-N-Propylamine, Carbon Disulfide, 1,2,3 Trichloropropane, 1,2 Dibromo-3-chloropropane, 1,2 Dibromomethane, 1,4 Dioxane, 2-Propenenitrile, 3,3'-Dimethylbenzidine
2	^{3}H, ^{90}Sr, ^{60}Co	Be, As, Mn	1,1 Dichloroethene, Chlorobenzene, Carbon Disulfide
3	^{90}Sr	Be, Mn	
4	^{3}H, ^{90}Sr	As, Mn	1,1 Dichloroethene, Vinyl Chloride, 1,2 Dichlorobenzene
5	^{3}H, ^{90}Sr, ^{226}Ra	Mn	Vinyl Chloride, Bis-2-ethylhexyl pthalate 1,2 Dichlorobenzene, Carbon Disulfide
6	^{3}H, ^{90}Sr, ^{60}Co	Be	1,2 Dichloroethane, Chloroform, Trichloroethene, Aroclor-1254, Vinyl Chloride, Carbon Tetrachloride, Carbon Tetrachloride, Carbon Disulfide, Acetone
7	^{3}H, ^{99}Tc, ^{60}Co	Be, Mn	
8	^{90}Sr	As, Mn	
11		Be, Mn	
17			Vinyl Chloride, 1,1 Dichloroethene, 1,2 Dichlorobenzene

[a]Underlined contaminants exceed the noncarcinogenic hazard index of 1, the remaining contaminants exceed a calculated carcinogenic risk of 1E-4.

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Table B.1. Prioritization of Individual Wells Based on Groundwater Risk

WELL	WAG	DCEE11	VINYL_CH	CO_60	TOTAL_SR	TRITIUM	BE	U_234	TC_99	Total Risk
812	1	0.00E+00	0.00E+00	2.25E-06	6.66E-03	4.87E-06	0.00E+00	3.02E-04	.	6.99E-03
825	1	0.00E+00	8.25E-04	0.00E+00	3.17E-06	1.01E-06	0.00E+00	.	.	8.29E-04
806	1	0.00E+00	0.00E+00	0.00E+00	1.65E-04	1.26E-06	0.00E+00	.	.	1.66E-04
830	1	0.00E+00	0.00E+00	0.00E+00	3.49E-05	2.11E-05	0.00E+00	.	.	5.60E-05
946	1	0.00E+00	0.00E+00	0.00E+00	2.06E-05	1.62E-06	0.00E+00	.	.	2.22E-05
829	1	0.00E+00	0.00E+00	1.29E-06	1.81E-05	1.74E-06	0.00E+00	.	.	2.11E-05
947	1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.70E-05	0.00E+00	.	.	2.03E-05
818	1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-05	0.00E+00	.	.	1.73E-05
821	1	0.00E+00	0.00E+00	0.00E+00	1.08E-05	3.94E-06	0.00E+00	.	.	1.47E-05
823	1	0.00E+00	0.00E+00	0.00E+00	5.08E-06	3.86E-06	0.00E+00	.	.	8.93E-06
811	1	0.00E+00	0.00E+00	0.00E+00	8.88E-06	0.00E+00	0.00E+00	.	.	8.88E-06
810	1	0.00E+00	0.00E+00	2.90E-06	1.71E-06	2.03E-06	0.00E+00	.	.	8.79E-06
820	1	0.00E+00	0.00E+00	0.00E+00	5.39E-06	2.39E-06	0.00E+00	.	.	7.79E-06
815	1	0.00E+00	0.00E+00	0.00E+00	2.38E-06	0.00E+00	0.00E+00	.	.	6.68E-06
816	1	0.00E+00	0.00E+00	3.11E-06	3.17E-06	0.00E+00	0.00E+00	.	.	6.47E-06
822	1	0.00E+00	0.00E+00	0.00E+00	1.55E-06	4.87E-06	0.00E+00	.	.	6.42E-06
809	1	0.00E+00	0.00E+00	0.00E+00	4.12E-06	2.19E-06	0.00E+00	.	.	6.32E-06
807	1	0.00E+00	0.00E+00	0.00E+00	3.81E-06	2.43E-06	0.00E+00	.	.	6.24E-06
819	1	0.00E+00	0.00E+00	2.04E-06	1.90E-06	2.07E-06	0.00E+00	.	.	6.01E-06
808	1	0.00E+00	0.00E+00	1.82E-06	3.81E-06	0.00E+00	0.00E+00	.	.	5.63E-06
827	1	0.00E+00	0.00E+00	0.00E+00	1.90E-06	1.54E-06	0.00E+00	.	.	3.45E-06
814	1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-06	0.00E+00	.	.	3.31E-06
828	1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.03E-06	0.00E+00	.	.	2.03E-06
1191	2	0.00E+00	0.00E+00	2.90E-06	4.12E-04	2.72E-04	0.00E+00	.	.	6.87E-04
1190	2	0.00E+00	0.00E+00	0.00E+00	5.71E-06	1.01E-04	0.00E+00	.	.	1.07E-04
1186	2	0.00E+00	0.00E+00	0.00E+00	2.92E-05	1.34E-06	0.00E+00	.	.	3.05E-05
1192	2	0.00E+00	0.00E+00	0.00E+00	8.88E-06	1.06E-05	0.00E+00	.	.	2.36E-05
1187	2	0.00E+00	0.00E+00	0.00E+00	2.47E-06	8.52E-07	0.00E+00	.	.	1.68E-05
1188	2	0.00E+00	0.00E+00	0.00E+00	1.21E-05	1.62E-06	0.00E+00	.	.	1.51E-05
1194	2	0.00E+00	0.00E+00	3.43E-06	1.59E-06	0.00E+00	0.00E+00	.	.	8.79E-06
1195	2	0.00E+00	0.00E+00	2.04E-06	3.81E-06	1.01E-06	0.00E+00	.	.	6.86E-06
1189	2	0.00E+00	0.00E+00	0.00E+00	1.81E-06	3.90E-06	0.00E+00	.	.	5.70E-06
994	3	0.00E+00	0.00E+00	0.00E+00	7.61E-04	3.08E-05	0.00E+00	.	.	7.96E-04
993	3	0.00E+00	0.00E+00	0.00E+00	3.49E-04	1.87E-05	0.00E+00	.	.	3.68E-04
996	3	0.00E+00	1.77E-04	1.07E-06	5.39E-06	2.03E-06	0.00E+00	.	.	1.87E-04
986	3	0.00E+00	1.61E-04	0.00E+00	0.00E+00	2.31E-06	0.00E+00	.	.	1.63E-04
992	3	0.00E+00	0.00E+00	1.50E-06	6.66E-05	1.83E-06	0.00E+00	.	.	7.00E-05
997	3	0.00E+00	0.00E+00	1.29E-06	3.49E-05	1.54E-06	0.00E+00	.	.	3.77E-05
991	3	0.00E+00	0.00E+00	0.00E+00	5.08E-06	1.87E-06	0.00E+00	.	.	1.12E-05
985	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.52E-06	0.00E+00	.	.	4.82E-06
990	3	0.00E+00	0.00E+00	0.00E+00	2.06E-06	1.79E-06	0.00E+00	.	.	3.85E-06
998	3	0.00E+00	0.00E+00	0.00E+00	3.49E-06	0.00E+00	0.00E+00	.	.	3.49E-06
988	3	0.00E+00	0.00E+00	0.00E+00	1.97E-06	1.26E-06	0.00E+00	.	.	3.23E-06
995	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-06	0.00E+00	.	.	1.50E-06
987	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E-06	0.00E+00	.	.	1.42E-06
973	4	0.00E+00	7.47E-04	0.00E+00	2.09E-04	3.86E-01	0.00E+00	.	.	3.86E-01
974	4	0.00E+00	0.00E+00	0.00E+00	3.49E-05	8.54E-02	0.00E+00	.	.	8.54E-02
971	4	0.00E+00	0.00E+00	0.00E+00	6.03E-06	1.62E-03	0.00E+00	.	.	1.63E-03
972	4	0.00E+00	0.00E+00	0.00E+00	1.49E-06	1.83E-05	0.00E+00	.	.	1.98E-05
953	4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	.	.	7.68E-06
952	4	0.00E+00	0.00E+00	2.25E-06	1.62E-06	0.00E+00	0.00E+00	.	.	3.87E-06
978	5	7.30E-05	1.91E-01	0.00E+00	0.00E+00	6.49E-05	0.00E+00	.	.	1.91E-01
969	5	0.00E+00	0.00E+00	0.00E+00	6.35E-04	1.45E-02	0.00E+00	.	.	1.51E-02
977	5	0.00E+00	0.00E+00	0.00E+00	9.20E-06	7.30E-03	0.00E+00	.	.	7.32E-03
970	5	0.00E+00	0.00E+00	0.00E+00	2.06E-06	1.22E-03	0.00E+00	.	.	1.22E-03
981	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.71E-05	0.00E+00	.	.	7.71E-05
979	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.46E-05	0.00E+00	.	.	5.34E-05
968	5	0.00E+00	0.00E+00	3.00E-06	0.00E+00	2.52E-06	0.00E+00	.	.	2.05E-05
983	5	0.00E+00	0.00E+00	1.07E-06	0.00E+00	8.93E-06	0.00E+00	.	.	1.27E-05
985	5	0.00E+00	0.00E+00	0.00E+00	6.03E-06	1.30E-06	0.00E+00	.	.	7.33E-06
984	5	0.00E+00	0.00E+00	0.00E+00	6.35E-06	0.00E+00	0.00E+00	.	.	6.35E-06
986	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.79E-06	0.00E+00	.	.	4.48E-06
967	5	0.00E+00	0.00E+00	0.00E+00	2.25E-06	1.91E-06	0.00E+00	.	.	4.16E-06

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Table B.2 Potential risk histories for selected* WAG perimeter wells

Well	94 Risk	95 Risk	Delta Risk	WAG
973	0.281	0.386	0.105	5
978	0.196	0.191	-0.005	5
974	0.0907	0.0854	-0.0053	5
969	0.0223	0.0151	-0.0072	5
977	0.0087	0.00732	-0.00138	5
812	0.00665	0.00699	0.00034	1
1201	0.00658	0.00646	-0.00012	17
843	0.00312	0.00232	-0.0008	6
1243	0.00232	0.00223	-9×10^{-5}	6
842	0.00165	0.000237	-0.001413	6
1076	0.00151	0.000411	-0.001099	7
971	0.00137	0.00163	0.00026	5
970	0.00132	0.00122	-0.0001	5
841	0.00129	0.000116	-0.001174	6
825	0.00103	0.000829	-0.000201	1
1191	0.000887	0.000687	-0.0002	2
1079	0.000825	0.000672	-0.000153	7
1097	0.000801	0.000207	-0.000594	8
1190	0.000716	0.000107	-0.000609	2
1096	0.000695	0.00241	0.001715	8
806	0.000658	0.000166	-0.000492	1
1078	0.00062	0.000488	-0.000132	7
1087	0.000605	0.000669	0.000064	8
994	0.000548	0.000796	0.000248	3
1242	0.000513	0.000406	-0.000107	6
847	0.000474	0.00017	-0.000304	6
844	0.000417	0.000183	-0.000234	6
1084	0.000306	0.000134	-0.000172	7
1244	0.000293	0.000134	-0.000159	6
993	0.000164	0.000368	0.000204	3
986	0.000131	0.000163	0.000032	3
1074	0.000117	0.000125	0.000008	7
996	0.0000075	0.000187	0.000795	3

*Wells included are those for which analytical results were available between May 1994 and April 1995 and for which potential risk exceeded 1×10^{-4}.

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II. Tanks, Pipes and Ducts

The following pages are copied from Key documents that summarize the ORNL tanks and associated piping system. The section includes the following exerts:

- definition and list of those tanks addressed in the FFA,
- background information from "Implementation Plan for LLLW Tank System under the FFA for FY 1998, draft" (DOE/OR/01-1587 & D0),
- additional background information and risk assessment strategy from "Inactive Tanks Remediation Strategy and Plans for ORNL (ORNL/ER-297/R1),
- GAAT OU FS/PP,
- OHF Tanks EE/CA,
- pipeline OUs from WAG 1 SCSR,
- summary table for tanks derived from various sources, and
- data summary sheets for ducts taken from the "site description" of ER Units at ORNL.

Additional information can be found in the numerous references listed at the end of this section.

DOE/OR-1014
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Federal Facility Agreement for the Oak Ridge Reservation

IX. LOW-LEVEL RADIOACTIVE WASTE TANK SYSTEM(S)

A. Applicability:

The provisions of this Section apply to the DOE's low-level radioactive waste tank system(s) that are listed and identified in Appendix F to this Agreement. Appendix F contains four categories of tank system(s) associated with the Oak Ridge National Laboratories (ORNL): (a) new or replacement tank system(s) with secondary containment; (b) existing tank system(s) with secondary containment; (c) existing tank system(s) without secondary containment; and (d) existing tank system(s) without secondary containment that are removed from service. Subsections B through D, below apply to existing tank system(s) that have secondary containment and to new or replacement tank system(s) installed after the effective date of this Agreement. Subsections E and F, below apply to existing tank system(s) that do not have secondary containment. Subsection G, below applies to all tank system(s) that are permanently removed from service. The DOE agrees to remediate all low-level radioactive waste tank system(s) that are permanently removed from service under this Agreement. The requirements of this Section are illustrated in the "ORNL Tank Logic Diagram" contained in Appendix F to this Agreement.

G. Removal of Tank System(s) From Service:

1. This Subsection shall apply to all low-level radioactive waste tank system(s) listed in Appendix F to this Agreement that are removed from service. Within ninety (90) days of the effective date of this Agreement, or within ninety (90) days of the date a tank is declared inactive, whichever is later, the DOE shall provide to EPA and TDEC a schedule for conducting the waste characterization(s) of tank contents for hazardous and/or radiological constituents in tank system(s) removed from service. The DOE's waste characterization(s) shall include the results of the sampling and analysis of the contents (including wastes, liquids, and sludges) of all tank system(s) removed from service.

2. Within ninety (90) days of the effective date of this Agreement, or within ninety (90) days of the date a tank is declared inactive, whichever is later, the DOE shall submit to EPA and TDEC for approval risk characterization plan(s) and schedule(s) for characterizing the risk(s) associated with all tank system(s)

removed from service. The DOE's risk assessment plan(s) shall characterize and define categories of risks associated with the tank system(s) pending final remediation. The DOE shall conduct risk characterization(s) for tank system(s) removed from service in accordance with the approved schedules.

3. Based upon the results of the waste and risk characterization(s) required above, the DOE shall propose a schedule(s) to EPA and TDEC for approval for operable units/ interim measures or final remedial action as described below. This schedule shall be proposed and updated as part of the annual timetables and deadlines submittal under Section XIX (Timetables and Deadlines) of this Agreement.

4. The DOE shall remediate all tank system(s) removed from service. To the "extent practicable", the DOE shall remove or decontaminate, or otherwise remediate all residues, contaminated containment system components (liners, etc.), contaminated soils and structures and equipment associated with the tank system(s).

5. The DOE shall address the following phases of tank system(s) remediation as both corrective measures and remedial actions under the applicable waste area grouping or operable unit:

Maintenance Action

a. Remediation of the tank(s) contents;

b. Remediation of the tank(s) and related piping and appurtenances; and

c. Remediation of any surrounding releases or contamination.

6. The provisions described herein shall become effective six months after the effective date of this change.

Prior to the scheduled remediation of tank system(s) as required in Sections IX.G.3 through IX.G.5, the DOE may conduct routine transfers of the liquid contents of the tank system(s) to the active portions of the LLLW system for the treatment and/or storage, upon receiving written approval from TDEC prior to such transfer operations. The DOE shall submit a written request to TDEC, for approval, and EPA, for information, of such transfers at least 14 days prior to the transfer operation. The DOE may combine requests for recurring routine transfers into a single document which may be submitted annually to TDEC, for approval, and to EPA, for information, for recurring routine (Appendix I-7) transfer operations rather than submit individual routine transfer requests. Transfers that TDEC determine are not routine (Appendix I-8) shall be conducted in accordance with the provisions of Section IX.G.5 or Section XIII. of the FFA. The declaration of whether a transfer is routine shall be within the discretion of TDEC, and subject to resolution of disputes as set forth in Section XXVI.

7. The DOE shall conduct all necessary response actions under Sections X through XV of this Agreement for all tank system(s) identified in Appendix F.

X. SITE EVALUATION(S)

For newly discovered areas with potential or known releases of hazardous substances, the DOE agree to: (a) provide notice to EPA and TDEC in accordance with Section 300.405 of the NCP; and (b) conduct removal site evaluations (SEs) in accordance with Section 300.410 of the NCP. The DOE shall submit to EPA and TDEC Removal Site Evaluation Reports based on such evaluations. If the removal SE indicates that removal action under Section 300.415 of the NCP is necessary, the DOE will satisfy the requirements of Section XIII (Removal Actions) of this Agreement. If upon completion of a Removal Site Evaluation and/or a removal action, the resulting report indicates that remedial action under Section 300.430 of the NCP may be necessary for an area, DOE will amend the ORR Remedial Site Evaluation list of Appendix C to this Agreement to

APPENDIX F

LOW-LEVEL RADIOACTIVE WASTE TANK SYSTEMS

Tanks Grouped by Category

Category A. New or replacement tank system(s) with secondary containment:

Tank	Location	Capacity (gal)
NONE		

Category B. Existing tank system(s) with secondary containment:

Tank	Location	Capacity (gal)
W-21	Evaporation Facility	50,000
W-22	Evaporation Facility	50,000
W-23	Evaporation Facility	50,000
W-24	Melton Valley Storage Tank	50,000
W-25	Melton Valley Storage Tank	50,000
W-26	Melton Valley Storage Tank	50,000
W-27	Melton Valley Storage Tank	50,000
W-28	Melton Valley Storage Tank	50,000
W-29	Melton Valley Storage Tank	50,000
W-30	Melton Valley Storage Tank	50,000
W-31	Melton Valley Storage Tank	50,000
T-13	North Hydrofracture Facility	4,000
C-1	Evaporation Facility	50,000
C-2	Evaporation Facility	50,000
N-71	Cell 7 of Building 3019	240
P3	Cell 6 of Building 3019	197
P4	Cell 6 of Building 3019	197
S-223	Pit N of building 3517	2,500
S-324	Pit N of building 3517	1,000
S-523	Pit N of building 3517	1,000
L-11	Inside building 3544	400
B-2-T	Building 7930 Radiochemical Engineering Development	1,870
B-3-T	Building 7930 Radiochemical Engineering Development	1,870
C-6-T	Building 7930 Radiochemical Engineering Development	700
F-111	Building 7920 Radiochemical Engineering Development	125
F-126	Building 7920 Radiochemical Engineering Development	1,200

Category C. Existing tank system(s) without secondary containment:

Tank	Location	Capacity (gal)
WC-3	S of building 3025	1,000
WC-20	Radiochemical Engineering Development	10,000

Category C. Existing tank system(s) without secondary containment:

Tank	Location	Capacity (gal)
WC-9	S of building 3503	2,140
HFIR	HFIR	13,000
T-1	HFIR	15,000
T-2	HFIR	15,000
WC-10	Isotope Circle	2,300
WC-2	Isotope Circle	1,000
~~WC-19~~	~~ORR/BSR~~	~~2,250~~
W-16	South Tank Farm	1,000
F-201	S of building 3525	50
F-501	S of building 3525	200

Category D. Existing tank system(s) without secondary containment that are removed from service:

Tank	Location	Capacity (gal)
3002A	S side of building 3002	1,600
WC-4	W of building 3026-C	1,700
W-11	Under the floor of building 3028	500
WC-5	S of building 3503	1,000
WC-6	S of building 3503	500
WC-8	S of building 3503	1,000
S-424	Pit N of building 3517	500
WC-11	S of building 3587	4,600
WC-12	S of building 3587	1,000
WC-13	S of building 3587	1,000
WC-14	S of building 3587	1,000
4501-P	Under floor of building 4501	140
T-14	New Hydrofracture surface facilities	48,500
W-12	South Tank Farm	700
W-17	South Tank Farm	1,000
W-18	South Tank Farm	1,000
3001-B	S of building 3001	75
3003-A	Building 3003	16,000
3004-B	Building 3004	30
3013	S of building 3013	400
WC-1	Near 3037	2,150
TH-4	SW of building 3500	14,000
LA-104	Under floor West end of building 3047	296
2026A	NW of building 2026	500
WC-7	S of building 3504	1,100
WC-19	ORR/BSR (FY97)	2,250

D. Existing tank system(s) without secondary containment that are removed from service:

Tank	Location	Capacity (gal)
TH-1	S of building 3503	2,500
TH-2	S of building 3503	2,400
TH-3	S of building 3503	3,300
H-209	W of building 3517	2,500
W-19	N of building 3517	2,250
W-20	N of building 3517	2,250
WC-15	S of building 3587	1,000
WC-17	S of building 3587	1,000
T-30	SW of building 4507	825
7560	SE of building 7500	1,000
7562	SE of building 7500	12,000
7503-A	NW corner of building 7503	11,000
W-1	North Tank Farm	4,800
W-13	North Tank Farm	2,000
W-14	North Tank Farm	2,000
W-15	North Tank Farm	2,000
W-1A	North Tank Farm	4,000
W-2	North Tank Farm	4,800
W-3	North Tank Farm	42,500
W-4	North Tank Farm	42,500
T1	Old Hydrofracture surface facilities	15,000
T2	Old Hydrofracture surface facilities	15,000
T3	Old Hydrofracture surface facilities	25,000
T4	Old Hydrofracture surface facilities	25,000
T9	Old Hydrofracture surface facilities	13,000
W-10	South Tank Farm	170,000
W-11	South Tank Farm	1,500
W-05	South Tank Farm	170,000
W-06	South Tank Farm	170,000
W-07	South Tank Farm	170,000
W-08	South Tank Farm	170,000
W-09	South Tank Farm	170,000

1. BACKGROUND

1.1 INTRODUCTION

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires a Federal Facility Agreement (FFA) for federal facilities placed on the National Priorities List. The Oak Ridge Reservation was placed on that list on December 21, 1989, and the agreement was signed in November 1991 by the Department of Energy Oak Ridge Operations Office (DOE-ORO), the U.S. Environmental Protection Agency (EPA)–Region IV, and the Tennessee Department of Environment and Conservation (TDEC). The effective date of the FFA was January 1, 1992. Section IX and Appendix F of the agreement impose design and operating requirements on the Oak Ridge National Laboratory (ORNL) liquid low-level radioactive waste (LLLW) tank systems and identify several plans, schedules, and assessments that must be submitted to EPA/TDEC for review or approval. The issue of ES/ER-17&D1 *Federal Facility Agreement Plans and Schedules for Liquid Low-Level Radioactive Waste Tank Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee* in March 1992 transmitted to EPA/TDEC those plans and schedules that were required within 60 to 90 days of the FFA effective date. This document updates the plans, schedules, and strategy for achieving compliance with the FFA as presented in ES/ER-17&D1 and summarizes the progress that has been made to date. This document supersedes all updates of ES/ER-17&D1.

Chapter 1 describes the history and operation of the ORNL LLLW System and the objectives of the FFA. Chaps. 2 through 5 contain the updated plans and schedules for meeting FFA requirements. This document will continue to be periodically reassessed and refined to reflect newly developed information and progress.

1.2 LLLW SYSTEM BACKGROUND

ORNL is a multidisciplinary research facility that began operation in 1943 as part of the Manhattan Project. The original mission of the laboratory was to develop a prototype graphite reactor and reprocess the reactor fuel for plutonium recovery. Subsequent to World War II, the primary functions of ORNL were fuel reprocessing research; radioisotopes production and applications development; and development, testing, and operation of nuclear reactor concepts. More recently, the laboratory has increased its role in biological, environmental, energy, and materials research. As a consequence of these multidisciplinary research activities, heterogeneous wastes, including solid and liquid radioactive, hazardous, and mixed wastes, have been generated in varying amounts over time.

Since its establishment, ORNL has operated numerous facilities that generate LLLW. LLLW originates from radioactive liquid discarded into sinks and drains in research and development (R&D) laboratories and from facilities such as the Radiochemical Processing Pilot Plant (RPPP, Bldg. 3019), nuclear reactors, radioisotope production facilities, and the Process Waste Treatment Plant (PWTP).

The LLLW system is a complex system with multiple facilities, users, and operators. The system is used for collection, neutralization, transfer, and concentration of aqueous radioactive waste solutions from generator facilities, followed by storage of the LLLW concentrate. Figure 1.1 is a block flow diagram depicting the movement of waste through the system. Waste solutions are typically accumulated at source buildings, often in collection tanks located inside the buildings, and discharged to below-grade collection tanks that receive wastes

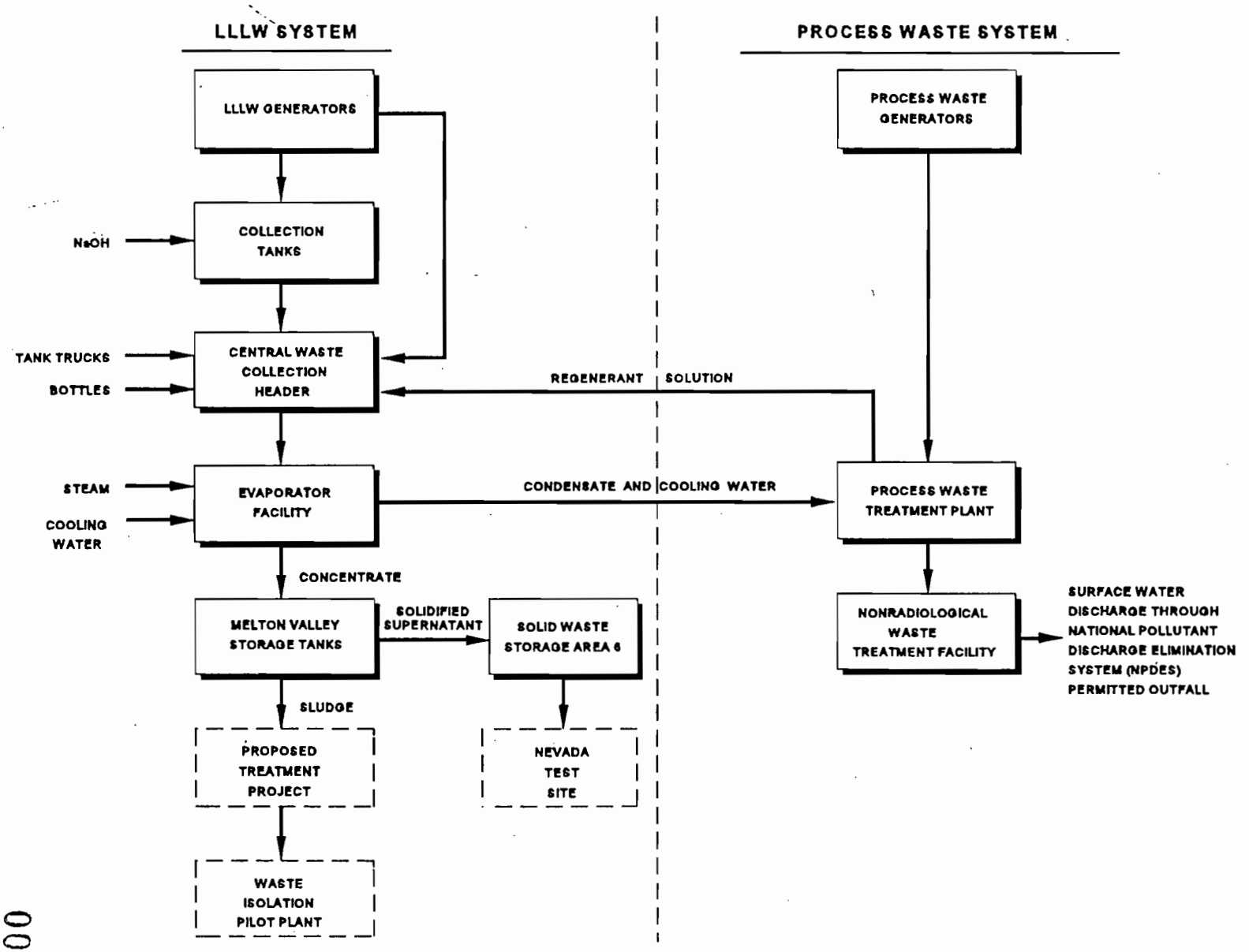

Fig. 1.1. Block flow diagram for the ORNL LLLW system.

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from several different source buildings. However, in many instances, LLLW is transferred from laboratory and hot-cell drains directly to underground collection tanks or the central waste collection header (CWCH) through unvalved piping.

A network of below-grade piping interconnects the various system components. Because their initial pH may be low, LLLW solutions often must be neutralized with sodium hydroxide (NaOH). The solutions are periodically transferred via the CWCH to the LLLW evaporator service tanks. From there, the solutions are sent to the LLLW evaporator facility where they are concentrated by a factor of approximately 30:1. The evaporator concentrate is then transferred via pipeline to the Melton Valley Storage Tanks (MVST). LLLW collection tanks are equipped with liquid-level instrumentation with high-level and low-level alarms to alert the Waste Operations Control Center (WOCC) of unusual conditions. The tanks are vented to the atmosphere through a central off-gas collection and filtration system operating at a negative pressure or through an individual tank filter system.

Most of the LLLW System was installed more than 30 years ago. The initial system and its subsequent modifications were designed to minimize radiation exposure to LLLW System users and operators. The system includes features such as unvalved, gravity-drained transfer lines to prevent waste backup into generator areas; shielded lines and tanks; and provisions for remote operations to minimize personnel exposure. As-built drawings for some of the older tank systems do not exist. Over the years, tank systems were abandoned as their integrity was breached or as programs were terminated. Some of the tanks were abandoned in place with liquid wastes and sludge left in them. As new tank systems were installed during the past 10 to 15 years, secondary containment and improved leak detection features were provided. The LLLW System is a mix of singly and doubly contained tank systems. The portions of the system that have been removed from service consist almost exclusively of tanks without secondary containment.

1.3 FFA OBJECTIVES

The objectives of the FFA are to ensure (1) that active tank systems slated to remain in service comply with the design and containment requirements specified in FFA Appendix F, Subsects. B and C; (2) that singly contained tank systems operated in the interim do not leak; and (3) that tank systems that are removed from service are evaluated and remediated through the CERCLA process. A breakdown of the LLLW tank systems by FFA category is provided in Fig. 1.2. Figures 1.3 and 1.4 are maps showing the relative locations of FFA LLLW tanks in Bethel Valley and Melton Valley, respectively.

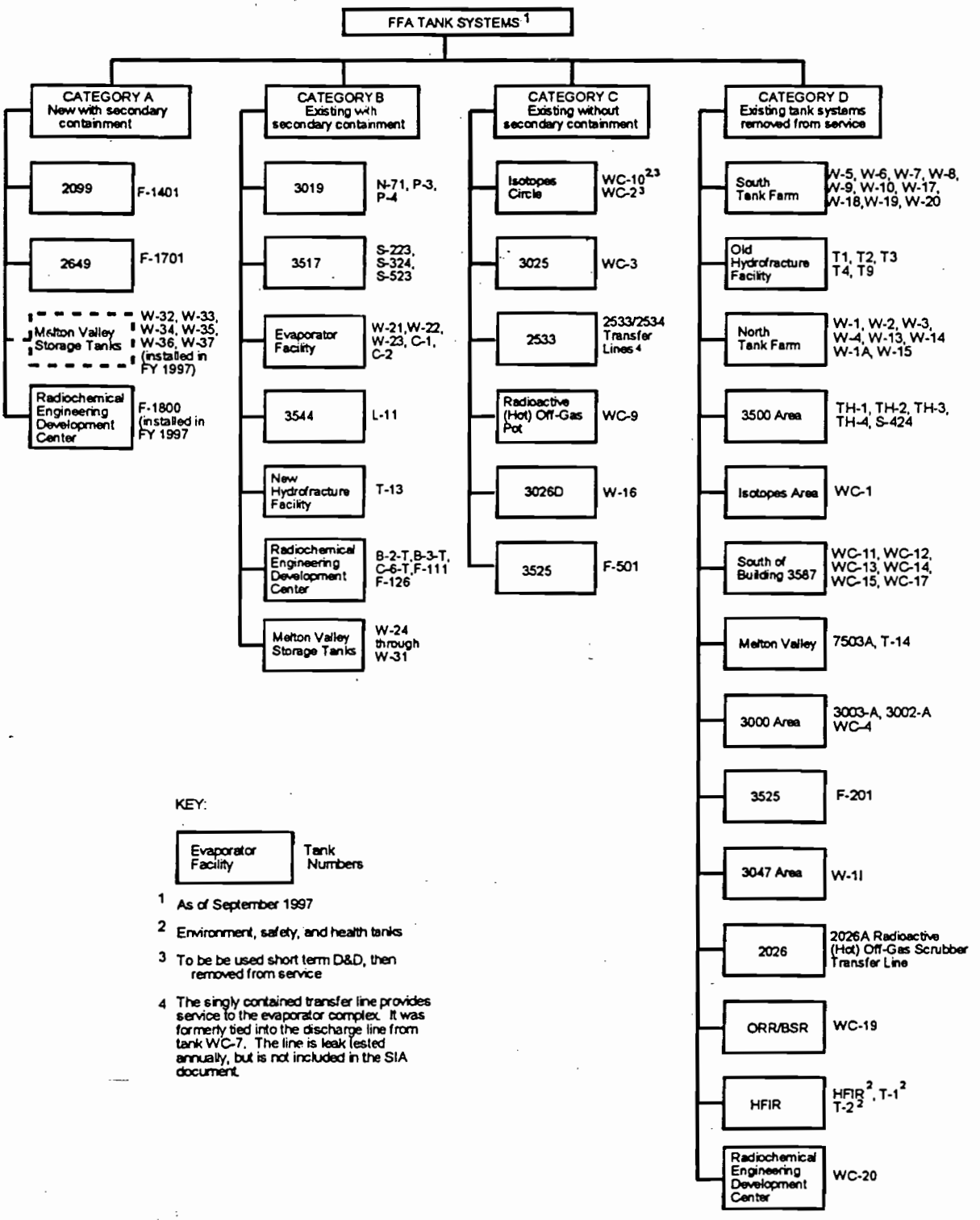

Fig. 1.2. ORNL LLLW tank systems by FFA category.

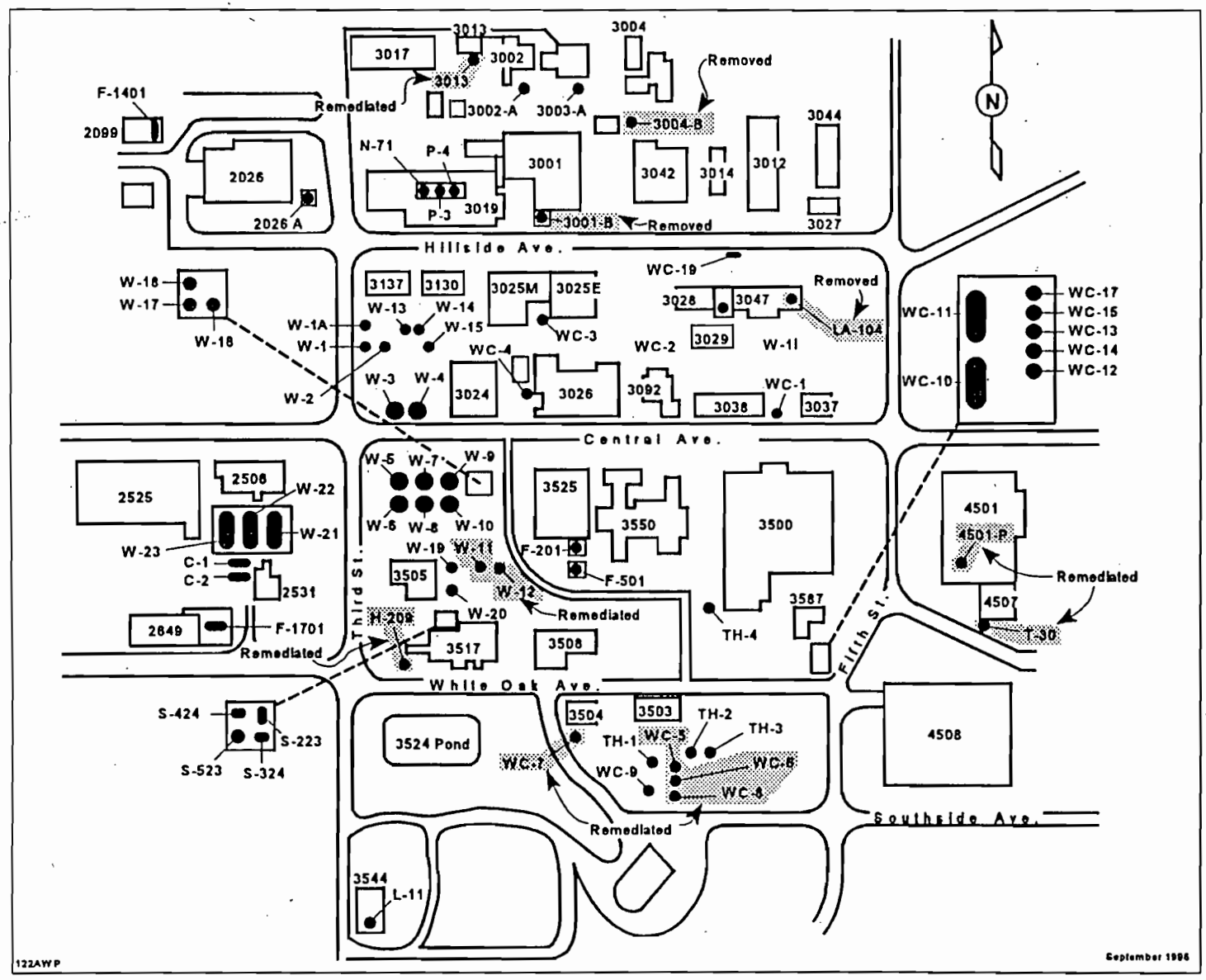

Fig. 1.3. Bethel Valley LLLW tank systems.

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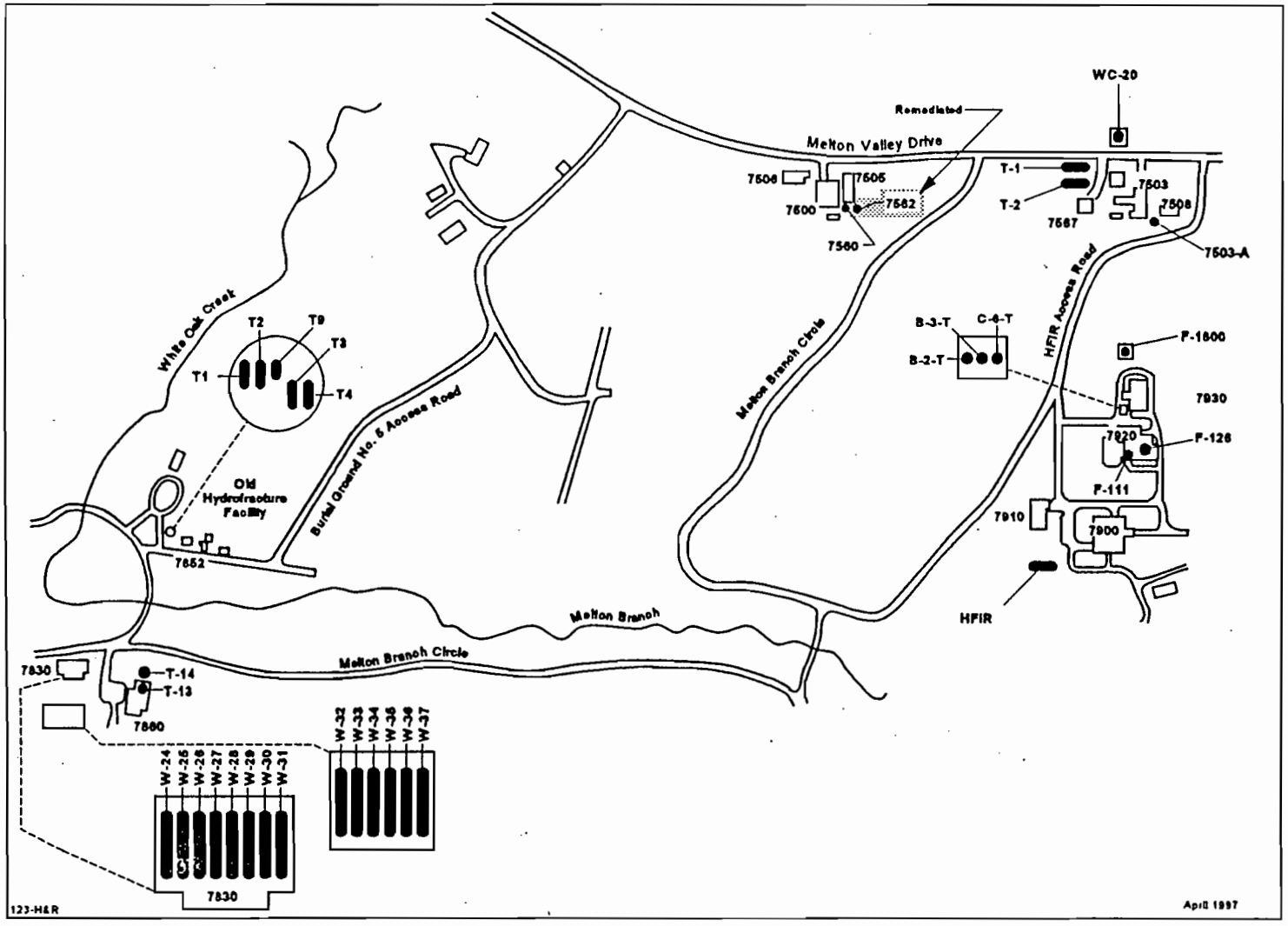

Fig. 1.4. Melton Valley LLLW tank systems.

4. CATEGORY C TANK SYSTEMS

4.1 BACKGROUND

The FFA allows tank systems that do not meet secondary containment standards to remain in service until the system can be upgraded or replaced, as long as the tank systems are not leaking and no adverse change occurs in the tank systems' baseline structural integrity data. If a tank system leaks, all programmatic inputs will be stopped, provided that complete shutdown of the tank system would not pose unacceptable environmental, health, or safety risk (e.g., reactor cooling-water treatment systems). Such systems will be repaired or replaced as soon as practicable.

4.2 FFA DELIVERABLE

4.2.1 Removal from Service

The FFA requires DOE to remove from service any tanks that do not meet the secondary containment standards in FFA Appendix F, Subsect. C. The plan and schedule for removing Category C tank systems from service is shown in Table 4.1.

4.2.1.1 Status

General plant projects (GPPs) and line-item projects are being planned and implemented to upgrade or replace the LLLW tank systems that do not meet secondary containment and leak detection standards (Category C). The schedule for line-item projects that will replace singly contained LLLW systems is shown in Table 2.1.

As scheduled in the FY 1996 Implementation Plan, Tanks HFIR, T-1, T-2, and WC-20 were removed from active service in FY 1997.

The schedules presented in this section will continue to be subject to annual negotiation to adjust for updated information based on duration of activities or for changes in priorities and funding.

4.2.2 Structural Integrity Assessment

The FFA requires DOE to provide information concerning the structural integrity of tank systems not meeting the secondary containment standards (Category C).

4.2.2.1 Status

The information submitted follows the requirements of FFA Appendix F, Subsect. A., titled "Standards for Integrity Assessment for Tank System(s)." The structural integrity assessments (SIAs) include tank system design data, generic descriptions of the hazardous or radioactive contents, a description of the system's corrosion protection measures, the age of the tank system, and the results of leak tests on the tank system.

Table 4.1. Projects for modifying FFA singly contained LLLW tank systems

Tank location	Tank system	Project title	Project scope	Funding (FY and type)	Projected completion date (FY)	Removal from service date (FY)
Isotopes Circle Facilities	WC-10	Isotope Facility Deactivation	Removes WC-10 from service	Expense	1998	1998
	WC-2	Isotope Facility Deactivation	Removes WC-2 from service	Expense	1998	1998
3025	WC-3	Bethel Valley FFA Upgrades	Removes WC-3 from service	FY 94-LIP	1998	1999
		Bethel Valley FFA Upgrades	Doubly contains LLLW piping for 2533/2534 transfer line[a]	FY 94-LIP	1998 (piping)	
Radioactive (hot) Off-gas	WC-9	Bethel Valley FFA Upgrades	Eliminates need for WC-9 tank system	FY 94-LIP	1998	1999
3026D	W-16	Isotope Facilities Deactivation	Removes W-16 from service	Expense	1998	1998
3525	F-501[b]					1998

[a]The singly contained transfer line provides service to the evaporator complex. It was formerly tied into the discharge line from tank WC-7. The line is leak tested annually, but is not included in the SIA document.

[b]The scope of the Bethel Valley LLLW-CAT Systems Upgrades no longer includes upgrades for tank F-501 as indicated in previous revisions of this document. The schedule for removing tank F-501 from service has not changed.

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The first annual issue of the structural integrity assessments for the tank systems not meeting secondary containment standards was submitted to EPA/TDEC in September 1995. The annual re-assessments were issued in September of 1996 and 1997. The next re-assessment will be completed in September 1998.

4.2.3 Leak Detection Tests

The FFA requires DOE to provide the schedule for periodic review and revision of the SIAs and to provide leak detection test results for Category C tank systems. Leak detection tests are being performed in support of the SIAs.

4.2.3.1 Status

All Category C tank systems are being leak tested. The Category B tanks that demonstrated secondary containment in accordance with FFA requirements have been removed from the Leak Testing Program. The pipelines for several Category B Tank Systems were included in the Leak Testing Program on the basis of results from the Secondary Containment Design Demonstration documents.[1,2,3] The results of these leak tests are reported in the FFA quarterly highlights. The test schedule for tanks is contained in the detailed leak detection test plan and schedule for active tanks.[4] The test schedule for pipelines is contained in the detailed leak detection test plan and schedule for active pipelines.[5]

1. INTRODUCTION

The strategy for remediation of the liquid low-level waste (LLLW) system tanks located at Oak Ridge National Laboratory (ORNL) that have been removed from service is presented in this report. These tanks are designated Category D (also known as inactive tanks) in the Federal Facility Agreement (FFA) that was made between the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC). This report also presents the (1) screening-level risk assessment methodology and other factors considered in the remediation decision process used to support the selected tank remedial action, (2) integration of the Waste Management (WM) Division tank isolation activities and the Environmental Restoration (ER) Program remediation activities, (3) review of past tank remediation activities, and (4) strategy and plans for future tank remediation activities.

1.1 BACKGROUND

ORNL is a multidisciplinary research facility that began operation in 1943 as part of the Manhattan Project. The original mission of the laboratory was to develop a prototype graphite reactor and the reactor fuel reprocessing facility. Subsequent to World War II, the primary functions of ORNL were fuel reprocessing research; radioisotopes production and applications development; and nuclear reactor concepts development, testing, and operation. More recently, the laboratory has increased its role in biological, environmental, energy, and materials research. As a consequence of these multidisciplinary research activities, heterogeneous wastes, including solid and liquid radioactive, hazardous, and mixed wastes, have been generated in varying amounts over time. These activities (past and present) have generated LLLW that must be managed and, ultimately, remediated.

The LLLW system is complex, with multiple facilities, users, and operators. The system is used for collection, neutralization, transfer, and concentration of aqueous radioactive waste solutions from generator facilities. Waste solutions are typically accumulated at source buildings, often in collection tanks located inside the buildings, and discharged to below-grade collection tanks that receive wastes from several different source buildings. However, in many instances, LLLW is transferred through unvalved piping directly to underground collection tanks or the central waste collection header from laboratory and hot-cell drains. System upgrades have improved LLLW handling and control. A network of below-grade piping interconnects the various system components.

Most of the LLLW system was installed more than 40 years ago. The original system, installed during the early 1940s, and its subsequent modifications were designed to minimize radiation exposure to LLLW system users and operators. The system includes features such as unvalved, gravity-drained transfer lines to prevent waste backup into generator areas; shielded lines and tanks; and provisions for remote operations to minimize personnel exposure. Design drawings exist for most of these tanks with only a few as-built drawings available. Over the years, tank systems were removed from service as their integrity was breached or as programs were terminated. New tank systems installed during the past 10 to 15 years incorporate secondary containment and cathodic protection and improved leak-detection features. Thus, the LLLW system is a mix of doubly contained tank systems (Category A and B) and singly contained tank systems (Category C and D)

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Excerpt from Inactive Tanks Remediation Program Strategy and Plans for ORNL (ORNL/ER-297)

as defined in Section IX (A) of the FFA. The tank category, remediation status, and locations in Bethel Valley and Melton Valley are shown in Figs. 1 and 2, respectively. These figures also make a distinction between Category D, Group 1 through 5 tanks that are managed by the ER Program and the Category D, Group 6 tanks that are managed by the WM Division, which will be discussed in more detail later in this document.

1.2 REGULATORY STATUS

The Superfund Amendments and Reauthorization Act of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires an FFA for federal facilities placed on the National Priorities List. The Oak Ridge Reservation was placed on the National Priorities List on December 21, 1989, and the agreement was signed in November 1991 by the DOE Oak Ridge Operations Office, EPA Region IV, and TDEC (DOE 1992). The effective date of the FFA was January 1, 1992.

On the basis of the July 11, 1996, revision to the FFA Appendix F, a total of 57 tanks have been removed from service. These tanks are defined in Section IX (A)(d) of the FFA as Category D tanks because they are "existing tank systems without secondary containment that are removed from service." As such, some of these tank shells have been removed or remediated in place as indicated in Fig. 1 or are currently being evaluated to determine the appropriate remediation strategy as discussed in this document. These tanks and their physical characteristics are listed in the Appendix.

1.3 FFA DELIVERABLES

According to the FFA, within 90 days of the date on which a tank is declared inactive DOE must provide EPA and TDEC with a plan and schedule for characterizing tank contents and the risks associated with the tank system. The characterization information is provided in the *Waste Characterization Data Manual for the Inactive Liquid Low-Level Waste Tank Systems at Oak Ridge National Laboratory* (Bechtel National, Inc. 1993) and the *Risk Characterization Data Manual for Category D Inactive Liquid Low-Level Waste Tank Systems at Oak Ridge National Laboratory* (Lockheed Martin Energy Systems 1993). These data manuals are controlled documents that are updated as new information becomes available (i.e., as tanks are taken out of service).

On the basis of the results of waste and risk characterization, DOE must then provide EPA and TDEC with a plan and schedule for remediation of inactive tank systems. The initial plan and schedule provided by DOE to meet the FFA requirements is presented in the *Remediation Schedule for Inactive Liquid Low-Level Waste Storage Tank Systems at Oak Ridge National Laboratory* (H&R Technical Associates, Inc. 1993). The plan and schedule in this 1993 document have been superseded by changes in remediation strategy, overall program priorities, and funding. Information presented in Chap. 3 reflects the current schedule for tank shell and content remediation. For tanks or tank groupings that are actively in the CERCLA process, current remediation schedules are negotiated annually and published in Appendix E of the FFA.

Two projects consisting of inactive tanks located at ORNL currently have Appendix E milestones: the Gunite and Associated Tanks (GAAT) remediation project and the Old Hydrofracture Facility (OHF) tanks removal action. Tank remediation activities that have not yet

been initiated are prioritized semiannually with remediation activities for the entire ER Program. This prioritization determines when the activity will be funded and, thus, also determines when the activity will begin. The status of the ongoing activities is discussed in Sect. 3.1.

1.4 OBJECTIVES

The overall objective of the Inactive Tank Program is to evaluate and remediate all LLLW tanks that have been removed from service to the extent practicable over a reasonable time period in accordance with the FFA requirements. The Inactive Tank Program will focus on the remediation of the tank residues (i.e., contents after tank has been emptied) and tank shell. Contaminated equipment, soil, and/or groundwater associated with the tank system will be considered for remediation on a case-by-case basis. These portions of the tank system may be addressed as part of the tank remediation or be remediated in conjunction with surrounding areas, whichever is the most cost-effective method. The following sections discusses this strategy in detail.

This document will focus on those tanks that are managed by the ER Program (Category D, Group 1–5) as identified in Figs. 1 and 2. However, Sect. 2.3.2 discuss the integration of WM isolation activities associated with the Category D, Group 6 tanks with the ER remediation activities required of these same tanks once they are transferred to the ER Program.

2. REMEDIATION STRATEGY

The Inactive Tank Program comprises several projects that work together and in parallel to accomplish remediation of all inactive LLLW tank systems at ORNL. The ER Program's approach for remediating tanks within the inactive LLLW tank systems was first documented in a January 1995 strategy document (H&R Technical Associates, Inc. 1995). Revision 1 reflects the current Inactive Tank Program strategy for remediation of inactive LLLW tank systems. The following sections will discuss the evolution of this strategy and the current remediation decision process and implementation strategy.

2.1 BACKGROUND

The ORNL Category D, Groups 1 through 5 tanks (Figs. 1 and 2) are included in ER Program planning. In 1987, the Resource Conservation and Recovery Act (RCRA) Facility Assessment at ORNL (Oak Ridge National Laboratory 1987) identified tanks as solid waste management units under RCRA. As ORNL developed its remediation strategy, these inactive tanks were included in larger groupings as solid waste management units, within a delineated geographic area, called waste area groupings (WAGs). Investigations and remediation activities would be handled for each WAG as a unit. The tanks were sampled in 1988 to obtain information for use in planning the remediaton of these tanks. When ORNL was placed on the National Priorities List in 1989, the ORNL remediation strategy was adapted for use under CERCLA. The FFA, which became effective in January 1992, identified waste characterization, risk characterization, and remediation requirements, based on CERCLA for the inactive tanks.

The majority of the inactive tanks are contained in WAG 1, which is the main plant area at ORNL. The WAG 1 operable unit (OU) strategy (Bechtel National, Inc. 1992) identified the Gunite tanks as an OU, with the highest priority of all the WAG 1 OUs. The remaining WAG 1 inactive tanks were grouped into a lower priority OU because the residual tank contents posed minimal risk. Remaining liquids were removed from the inactive tanks, although some of these tanks receive nonprogrammatic inflows and require periodic pumping. The five OHF tanks were included in the WAG 5 remediation planning, with the remaining tanks included in the WAG for their geographic area.

The GAAT Project and the OHF Tanks Sludge Removal Action are currently in progress and their status is provided Sects. 2.1.1 and 2.1.2. Some of the low-risk tanks have been remediated as maintenance actions, as discussed in Sect. 2.3. Two watershed-scale Record of Decisions (RODs) will be prepared for ORNL to document the end state after remediation and to define what projects are required to achieve this end state. Any inactive tanks or tank systems that remain to be remediated at the time of the approval of the appropriate ROD (Bethel Valley or Melton Valley area depending on tank location) will be included in this ROD. These watershed RODs are scheduled to be approved by the end of fiscal year 2000. The Inactive Tanks Program will continue to address remediation of the tank shell and residual contents as funding permits.

2.1.1 GAAT Project

The feasibility study and proposed plan describe the interim remedial action proposed for removing sludges from the GAAT OU. The action proposed in this plan is the removal of sludge from eight tanks (W-3, W-4, W-5, W-6, W-7, W-8, W-9, and W-10). DOE proposes to combine waste from the GAAT OU into the Melton Valley Storage Tanks for interim storage. Seven of the sixteen tanks (W-1, W-1A, W-2, W-11, W-13, W-14, and W-15) referred to as GAAT OU are not addressed as part of this interim action because they contain no sludge, have low contaminant levels, and therefore do not pose a threat in the future to human health and the environment. Tank TH-4 is part of the GAAT OU and contains sludge; however, its contents are very different from the contents of the other sludge-containing tanks. Final decisions regarding remediation of the tank shells, other related equipment, and tank TH-4 sludge will be addressed in future decisions associated with the main ORNL complex (i.e., Bethel Valley ROD). {See GAAT FS/PP Insert}

2.1.2 OHF Tanks Project

An engineering evaluation/cost analysis (EE/CA) was prepared in 1996 for the OHF Tanks project. The baseline risk assessment for the OHF tanks was presented in the WAG 5 Remedial Investigation Report (DOE 1995a), which was approved by DOE, EPA, and TDEC in September 1995. The EE/CA developed, evaluated, and recommended a preferred alternative for the non–time-critical removal action to reduce the risk of a release of radioactively contaminated liquid and sludge wastes stored in the OHF tanks. Alternatives considered were in situ treatment, encapsulation, and waste removal. After the alternatives were screened, waste removal was chosen as the preferred alternative and was achievable without interfering with future actions. On the basis of technology evaluations and screening, a conventional sluicing and pumping operation was selected for removal of tank contents and transfer to the Melton Valley Storage Tanks. Waste removal activities are expected to be implemented in the first part of 1998. The tank shell and associated piping and equipment will be remediated as part of the White Oak Creek Watershed: Melton Valley Area ROD. {See OHF Tanks EE/CA Insert}

United States Department of Energy
Environmental Restoration Program

DOE/OR/02-1509/V1&D2

Feasibility Study/Proposed Plan for Sludge Removal from the Gunite and Associated Tanks Operable Unit, Waste Area Grouping 1, Oak Ridge National Laboratory, Oak Ridge, Tennessee

March 1997

This Feasibility Study/Proposed Plan Describes:

- Current and future risks to human health and the environment
- Remedial action alternatives being considered
- The U.S. Department of Energy's preferred alternative
- How to participate in the selection/modification of the preferred alternative
- Where to get more information

Your opinion is invited

The U.S. Department of Energy invites you to express your opinion of the alternatives presented in this feasibility study/proposed plan for environmental restoration of the Gunite and Associated Tanks. This report tells how to obtain further information. Interested citizens are encouraged to read the remedial investigation and baseline risk assessment for additional background and more detailed technical information and regulatory history. A form has been attached for your comments, but you are not restricted to using the form. Decision makers will consider all written comments.

The reports and other documents are available at the Information Resource Center, 105 Broadway Avenue, Oak Ridge, Tennessee.

INTRODUCTION

This feasibility study (FS)/proposed plan (PP) describes the interim remedial action proposed for removing sludges from the Gunite and Associated Tanks (GAAT) Operable Unit (OU). The GAAT OU consists of tanks located in or near the North and South Tank Farms at the Oak Ridge National Laboratory (ORNL). The scope of the GAAT OU includes the tanks and contained waste materials. The action proposed in this plan is the removal of sludge from eight tanks (W-3, W4, W-5, W-6, W-7, W-8, W-9, and W-10).

The GAAT OU has been the subject of numerous investigations since the tanks began operations in 1943. Recent investigation reports that form the basis for this action include the remedial investigation and baseline risk assessment (DOE/OR/02-1275&D2, October 1994) and addendum (DOE/OR/02-1275&D2/A1, April 1996). These reports document current conditions of these tanks and associated risks. The baseline risk assessment concluded that these tanks and their contents pose a current or potential future unacceptable risk to human health and the environment. Thus, a remedial action is required to address the GAAT OU.

The U.S. Department of Energy (DOE), Tennessee Department of Environment and Conservation (TDEC), and U.S. Environmental Protection Agency (EPA) agree that adequate information exists to make an interim decision for the wastes, sludges, and liquids in the GAAT OU. DOE proposes to combine wastes from the GAAT OU into the Melton Valley Storage Tanks (MVST) for interim storage. This approach is being proposed for several reasons:

1. DOE currently manages an inventory of more than 100,000 gal of similar waste at MVST. This waste is separate from the waste in the GAAT OU. DOE plans to treat and dispose the MVST waste as part of the Oak Ridge Reservation's (ORR) Site Treatment Plan. It is expected that this waste will be sent to the Waste Isolation Pilot Plant (WIPP) for permanent disposal in a geologic repository. Combining the GAAT OU wastes

2.1.3 Other Tanks

Other inactive LLLW tanks that are not included in the GAAT or OHF projects must also be remediated as part of the FFA agreement. These tanks are prioritized for remediation based on several factors:

- tank residues/contents and associated risk to the environment,
- tank integrity,
- tank disposal requirements/options (tank contents and shell),
- WM tank isolation schedule,
- remediation activities associated with adjacent facilities/operable units,
- stakeholder (regulators and public) concurrence,
- future land-use considerations, and
- funding availability.

These factors are used in the remediation decision process and are discussed in greater detail in the remainder of this chapter.

with other similar wastes seems logical and prudent from engineering, policy, and acceptance viewpoints.

2. MVST meets all requirements for the safe storage of hazardous materials and is suitable for storing the GAAT OU wastes. The structural integrity of the GAAT tanks and their potential for possible releases present unacceptable risks to human health and the environment. Storage of wastes at MVST will provide safe storage until the materials can be treated and transferred for disposal.

3. DOE, TDEC, and EPA agree that permanent disposal of these wastes in their current configuration is not acceptable. Therefore, the wastes must be removed from the tanks.

DOE has investigated various options to address the tank shells as well as the contents of the tanks. A treatability study is being conducted to evaluate the performance of various methods of removing waste from the tanks. At this time, DOE, TDEC, and EPA are not ready to propose a remedy for the ultimate disposition of the tank shells. Final decisions regarding the tank shells and other related equipment will be addressed in future decisions associated with the main ORNL complex. Those decisions will consider the recommendations being developed by public working groups (i.e., the "End-Use" Group) as well as the public.

DOE, with concurrence from EPA and TDEC, proposes to conduct a remedial action that removes waste from the tanks.

This FS/PP meets Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Section 117(a) requirements and provides the public an opportunity to participate in selecting or modifying the remedial action for these tanks. DOE will issue a record of decision (ROD) for the site after public review and comments on this FS/PP. During the 30-day public comment period, a public meeting will be conducted to discuss sludge removal plans.

More information about the site and activities conducted to date on the Gunite tanks is available in the Administrative Record Files at the Information Resource Center, 105 Broadway Avenue, Oak Ridge, Tennessee. A shaded box on page 12 describes how to participate in the process and how to obtain additional information.

BACKGROUND INFORMATION

This section of the FS/PP includes the site description, site history, nature and extent of contamination, summary of baseline risk assessment and supplemental impact analysis, and site remediation strategy.

Site Description

GENERAL

ORNL is on the DOE ORR in Anderson and Roane counties in East Tennessee, approximately 24 km (15 miles) west of Knoxville and 16 km (10 miles) southwest of Oak Ridge. The ORNL main plant area is located on the south side of Bethel Valley Road, approximately 2.5 km (1.5 miles) east of its intersection with Tennessee State Highway 95 (Fig. 1). The ORNL main plant area consists of research laboratories, process buildings, and office buildings surrounded by a security fence.

Mixed (radioactive and hazardous) wastes generated from operations of these processing and research facilities were stored in a network of underground tanks beginning in the 1940s. Twelve tanks were made of reinforced concrete using the Gunite process by which a portland cement/sand mixture was applied with a spray nozzle over a preconstructed form of reinforcing wire mesh supported by metal bars. Four Gunite tanks [W-1 through W-4 (Fig. 2)] were constructed in the North Tank Farm, six Gunite tanks [W-5 through W-10 (Fig. 2)] were constructed in the South Tank Farm, and two Gunite tanks (TH-4 and W-11) were constructed at separate locations outside these tank farms. Four stainless-steel underground tanks [W-1A, W-13, W-14, and W-15 (Fig. 2)] were added later in the North Tank Farm to support continuing ORNL operations.

The tanks being considered for remedial action in this FS/PP are underground in the main plant area at the intersection of Central Avenue and Third Street (Fig. 2). The surfaces of the South Tank Farm are covered with grass. The area above Tanks W-3 and W-4 has been covered with crushed stone, and a structural steel platform has recently been constructed above these two tanks. The structure supports waste removal equipment being tested in a treatability study. All areas containing the Gunite tanks are roped off and posted as restricted and controlled access areas.

utility trenches, as well as around some of the tanks. These man-made features are likely to greatly influence flow, resulting in preferential pathways toward the south and to White Oak Creek.

Site History

The Gunite tanks were originally projected to have a 1-year operational life. They were initially built to store radioactive liquid wastes generated by ORNL site operations, particularly wastes generated from plutonium recovery from graphite reactor fuel.

Liquids and solid materials stored in the tanks included mixed wastes containing radionuclides, organics in trace quantities, and heavy metals. The solids in some of the tanks contained U, Pu, Th, and other long-lived (1,000s of years) isotopes. These wastes also contained ^{137}Cs and ^{90}Sr, which have relatively short half-lives (approximately 30 years), in addition to other radionuclides with short half-lives (i.e., ^{131}I, 8 days; ^{141}Ce, 28 days; ^{143}Ce, 33 hours; ^{103}Ru, 41 days; ^{140}Ba, 12.8 days; and ^{140}La, 40 hours).

Wastes from various processes were stored in GAAT until the late 1950s or early 1960s when Tanks W-1, W-2, W-3, W-4, W-13, W-14, and W-15 were removed from service. After the tanks were removed from service, most of their liquid waste was removed. Sludges and residual liquid were left in the tanks. The large Gunite tanks (i.e., W-5, W-6, W-7, W-8, W-9, and W-10) were removed from service in the late 1970s. From 1982 to 1984, most of the accumulated sludge contained in these larger tanks was removed by sluicing.

Although monitoring data have not indicated any tanks are leaking, remote visual interior inspections of the tanks have revealed some degradation of the interior surface of Tanks W-5 and W-6. These inspections and the age of the tanks have raised questions about their long-term integrity. Tank appurtenances (e.g., lines entering the tanks) are allowing infiltration of groundwater into several tanks. Water that collects in the tanks is periodically removed. For these reasons and the significant radionuclide inventory still remaining, DOE and federal and state regulatory agencies have assigned a high priority to remediation of the tanks.

Nature and Extent of Contamination

Although liquids and most of the solids were removed from the tanks and disposed of between 1982 and 1984, approximately 189,000 L (50,000 gal) of sludge remain in the tanks. Figure 3 provides a graphical representation of these tanks and their contents.

The upper 95 percent confidence limit for the total sludge radionuclide inventory is 28,595 Ci for all GAAT.

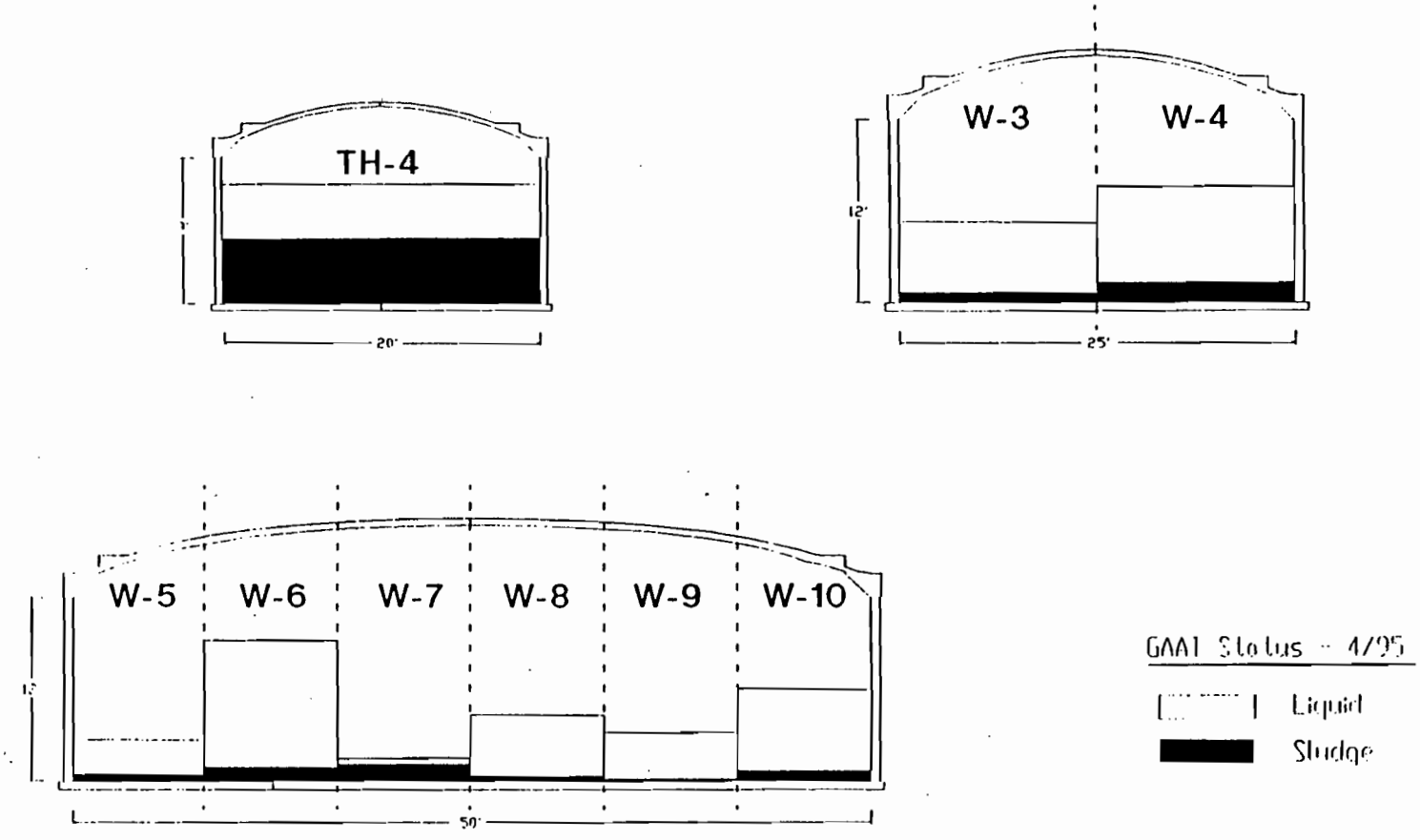
Table 1 summarizes the curie content for each of these tanks. A more detailed discussion of the tank contents and characteristics is presented in the *Remedial Investigation/Baseline Risk Assessment for the Gunite and Associated Tanks Operable Unit at Waste Area Grouping 1, Oak Ridge, Tennessee* (DOE 1994) and the *Addendum to the Remedial Investigation/Baseline Risk Assessment for the Gunite and Associated Tanks Operable Unit at Waste Area Grouping 1 at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE 1996a).

Summary of Baseline Risk Assessment and Supplemental Impact Analysis

Currently, DOE enforces strict institutional controls at the GAAT OU to mitigate uncontrolled exposures to contaminants within the tanks. Institutional controls are mandated and currently in place to comply with regulatory limits for exposures to on-site individuals, minimize chances for direct contact with the tank contents, and ensure that off-site receptors are protected if a tank leaks. Tank liquid levels are monitored to assess potential tank leakage, and records indicate that the tanks are not currently leaking. As previously noted, the North and South Tank Farms include a groundwater collection system that lowers the ambient groundwater below the base of the tanks and directs the water to a pump station for transfer to a water treatment system. Potential releases not captured by this system could eventually reach White Oak Creek.

A baseline risk assessment was conducted to determine and document whether current or future remedial action of the tanks is necessary to protect human health and the environment if institutional controls are removed. The assessment used Tank W-10 as the basis for the evaluation because this tank contains the highest volume and concentrations of radionuclides of the nine tanks that contain sludge.

The source release/groundwater transport model used in the baseline risk assessment assumed that the tank shell immediately failed and contaminants in the sludge (primarily strontium and cesium, which are readily released) leached into



JE	Fig. 3	Gunite tank contents DOE - ORNL, WAG 1 Gunite and Associated Tanks - Oak Ridge, Tennessee	DOCUMENT ID 35H530 0058 85 / FS FP	DRAWING ID 97 11145 DWG	DRAWING DATE FEBRUARY 1 1997 SD

Table 1. Curie loading for GAAT, ORNL, Oak Ridge, Tennessee

Tank	Contents	Volume (gal)	Curies statistical confidence[a]	
			0.50	0.95
TH-4	Sludge	5,452	4	6
	Supernate	5,410	0	0
W-3	Sludge	628	16	37
	Supernate	15,668	1	2
W-4	Sludge	1,313	32	89
	Supernate	29,754	13	63
W-5	Sludge	3,422	24	40
	Supernate	27,964	10	14
W-6	Sludge	7,037	523	861
	Supernate	41,479	364	2,178
W-7	Sludge	8,812	2,367	3,461
	Supernate	3,565	238	238
W-8	Sludge	10,309	3,714	4,386
	Supernate	64,581	2,065	2,511
W-9	Sludge	2,861	803	950
	Supernate	45,616	212	272
W-10	Sludge	9,298	6,536	18,764
	Supernate	105,860	1,123	2,197
Subtotal	Sludge	49,132	14,019	28,594
	Supernate	339,732	4,026	7,475
	Total	388,864	18,045	36,069

[a]Upper confidence limit of the mean

GAAT = Gunite and Associated Tanks gal = gallon ORNL = Oak Ridge National Laboratory

the groundwater. The groundwater was assumed to follow a nondispersive, direct path to White Oak Creek where it surfaced and mixed with the White Oak Creek flow. The nearest downgradient location of White Oak Creek relative to the North Tank Farm is approximately 370 m (1,200 ft) south (Fig. 1). The geochemical and physical properties of the environmental media along the groundwater flow path from the failed tank to White Oak Creek are assumed to be such that retarded and dispersive flow of the radionuclides does not occur. This simplified conceptual model of the pathway was adequate to provide an initial estimate of the risk to determine the need for remedial action.

For the current scenario, there is no evidence of contamination release from the tanks to a pathway for an off-site receptor. The institutional controls presently in place adequately protect workers by limiting access to the site and monitoring exposure. The future scenario considers risks to an on-site resident, an employee, a nearby resident, and a child wading in the White Oak Creek. For on-site receptors, direct radiation from the tanks because of a dome collapse contributes the majority of the risk. For the nearby resident, ingestion of drinking water from White Oak Creek and White Oak Dam is the major risk contributor.

For the future on-site resident, total risk from all pathways is 6×10^{-1} for the reasonable maximum exposure (RME) and 9×10^{-2} for the mean exposure. The future employee has a risk of 9×10^{-2} for the RME and 1×10^{-2} for the mean exposure. A scenario was modeled for a resident

drinking water from White Oak Creek that was contaminated from the tank farms. The RME risk is 1×10^{-3} and 3×10^{-4} for the mean exposure. All these scenarios exceed the EPA target risk range of 1×10^{-4}. Only the child-wading scenario does not exceed the target with risk of 4×10^{-6} for the RME and 1×10^{-7} mean exposure.

The pathways of concern are direct radiation exposure in the event of a dome collapse and the ingestion of contaminated drinking water by future residents. Therefore, tank remediation must prevent dome collapse or structural degradation, as well as isolate or remove the residual contaminated sludges and overlying liquids to prevent their contact with the groundwater.

Although the baseline risk assessment clearly demonstrated the general need for action to mitigate potential failure of one or more tanks in the future, a more refined tank-by-tank assessment was developed to assess the risk associated with each tank and the risk posed by residuals imbedded or absorbed into the tank shell. This model will be used to evaluate the risks from the residual materials in the tank shells. A more detailed evaluation of the contaminant release and subsequent groundwater transport was conducted in the *Risk Assessment Pathway/Transport Modeling for the Gunite and Associated Tanks, Oak Ridge, Tennessee* (DOE 1996).

Site Remediation Strategy

There are 16 tanks referred to as the GAAT. Of these 16 tanks, seven (W-1, W-1A, W-2, W-11, W-13, W-14 and W-15) contain no sludge, have low contaminant levels, and do not pose a threat now or in the future to human health or the environment. Discussions are underway with EPA and TDEC on closing these tanks. Therefore, these tanks are not addressed as part of this action. Tank TH-4 is part of GAAT and contains sludge; however, its contents are very different from the contents of the other sludge-containing tanks. DOE is deferring action on the contents of Tank TH-4 until a later date for the following reasons:

- The waste is two orders of magnitude lower in radionuclide concentration than the other tanks. Therefore, the treatment process proposed at MVST may be more rigorous and more expensive than necessary.
- The waste is low in transuranic (TRU) content. Therefore, treating the waste for disposal at WIPP uses valuable disposal space that could be used for waste with higher TRU content.
- The waste is similar in radionuclide content to the waste in the surface impoundments. A decision on the surface impoundments waste is pending and may be appropriate for the waste in Tank TH-4.

Therefore, TH-4 has not been included in this interim action. Information on this tank is included in this document for completeness.

Evaluations of the remaining Gunite tanks indicated the need to remove some or all of the waste. Therefore, a treatability study was initiated to determine the effectiveness and cost of waste removal technologies. Data collected and analyzed as part of the treatability study investigation indicate that the radionuclide inventory of the tanks varies substantially from that of the surrounding soils and appurtenances. As a consequence, actions on the tank contents have been separated from actions addressing tank appurtenances, surrounding soils, and groundwater. In addition, the hazards associated with the tank shells have not been clearly defined. Therefore, actions discussed within this document address only the tank contents. Following removal of the waste, remedial actions to address the tank shells, appurtenances, surrounding soils, and groundwater will be assessed. Evaluations will be presented at a later time.

GAAT REMEDIAL ACTIONS

Scope and Remedial Action Objective

This section describes the scope and remedial action objective of the remedial action for the GAAT contents.

Scope

The scope of this remedial action is to remove and transfer the contents of Tanks W-3, W-4, W-5, W-6, W-7, W-8, W-9, and W-10 to MVST.

Remedial Action Objective

The remedial action objective for the tanks is to mitigate the off-site risk from the tank contents to a hypothetical future receptor at White Oak Creek.

This will be accomplished by reducing the potential for sludge to migrate to groundwater and surface water and by reducing the potential for direct exposure to radiation from the sludge. Potential collapse of the tank dome will be evaluated at a later time.

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 106 of CERCLA requires that interim remedial actions for cleanup of hazardous substances comply to the extent practicable, considering the urgencies of the situation, with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate to the hazardous substances or particular circumstances at a site. These applicable or relevant and appropriate requirements (ARARs) may be chemical-, location-, or action-specific.

There are no chemical-specific ARARs for this remedial action. Radiation protection requirements are triggered for remedial storage and closure and postclosure activities; these are addressed in the action-specific ARARs section.

The only location-specific ARAR relates to the GAAT OU being in an historic district. DOE-Oak Ridge Operations and the State Historic Preservation Officer signed a Memorandum of Agreement for the GAAT OU, which the Advisory Council on Historic Preservation accepted January 31, 1995. This requires agencies to document historic properties that may be destroyed or altered as a result of federal action.

Actions addressed in these ARARs include:

- excavation,
- control of fugitive dust,
- control of radionuclide emissions,
- control of surface water runoff,
- removal of tank contents,
- characterization and disposal of treatment residuals and decontamination fluids, and
- institutional controls.

On-site wastewater treatment units that are part of a wastewater treatment facility are subject to regulation under Sections 402 or 307(b) of the Clean Water Act of 1972 [i.e., are National Pollutant Discharge Elimination System-permitted]. As such, they are exempt from the requirements of Resource Conservation and Recovery Act of 1976 (RCRA) Subtitle C standards for all tank systems, conveyance systems, and ancillary equipment [40 *Code of Federal Regulations* (CFR) 260.10; 40 CFR 270.1(c)(2); 53 *Federal Register* 34079, September 2, 1988] as part of an ongoing operation that meets regulatory compliance. Wastes transferred to the MVST will be in permitted storage; therefore, no ARARs are developed for this step in the removal process. No ARARs are presented for the removal process beyond transferral to a storage and disposal operation facility.

The sludge removal alternative addresses the ARARs for excavation, control of fugitive dust, control of radionuclide emissions, control of surface water runoff, removal of tank contents, characterization/disposal of treatment residuals and decontamination fluids, and institutional controls.

Additional ARARs specific to Alternative 2 are outlined and described in Volume II.

DESCRIPTION AND SCREENING OF ALTERNATIVES

The alternatives considered for this FS include:

- Alternative 1—No action
- Alternative 2—Sludge removal

Alternative 1—No Action

The no action alternative is included for comparative purposes as required by the National Contingency Plan. The no action alternative assumes that existing institutional controls, including monitoring, are maintained for a continuous 30-year period, but no action is taken when the tank domes eventually collapse.

Alternative 2—Removal/Transfer of Tank Contents to Melton Valley Storage Tanks

This alternative includes removal of the waste and transfer through an existing pipeline to MVST. The waste already contained in MVST is to be treated in a privatization effort currently proposed by DOE. This effort will treat the waste for eventual disposal at the Nevada Test Site or the WIPP.

Waste from the Gunite tanks would be included in this effort. Specific elements include:

- removing the sludge from the tanks,
- transferring the sludge to a tank in the South Tank Farm or other interim transfer tank for conditioning (i.e., adjusting the water content, particle size, or chemistry), and
- transferring the waste through an existing pipeline to MVST.

The sludge will be removed using the technologies being evaluated in the treatability study for the Gunite tanks. Technologies that have been developed to remove the waste use a unit that combines a high pressure water spray with a vacuum system to loosen and remove sludge. The spray/vacuum unit will be moved in the tanks by a remotely operated mechanical arm and a remotely operated vehicle. The dislodged sludge will be conveyed out of the tank and will be transferred to a consolidation tank.

Contents of Tanks W-3 and W-4 will be transferred to Tanks W-8 or W-9 during the treatability study. Contents from Tanks W-5, W-6, W-7, W-8, W-9, and W-10 will be transferred to a consolidation tank and subsequently to the MVST as part of this remedial action. If tanks in the active waste system near the Gunite tanks can be emptied of their current waste inventory, an active tank will be used for consolidation of sludge from the Gunite tanks. If an active tank is not available, Tank W-8 or W-9 will be used for consolidation of the waste to facilitate transfer of the waste to MVST. Tanks W-8 and W-9 may also be needed for solids and liquids separation, allowing the solids to settle. Before using Tanks W-8 or W-9, the integrity of the tanks will be assessed in accordance with Federal Facility Agreement requirements. Results will be provided to regulatory agencies.

The walls and floor of each tank will be cleaned to the reasonable limit of the technology. The tank walls and floor will be sampled and analyzed to determine the residual risk posed by the remaining contents and contaminants in the tank shells. The sampling approach is being evaluated in the treatability study. The initial approach includes limited field radiation measurements to determine "hot spots" and samples collected from the floor and walls of each tank. Four samples will be collected and analyzed from the floor (i.e., one sample from each quadrant) and eight samples from the walls (i.e., four samples spaced vertically along the wall in two locations). The evaluation of the residual risk and associated potential actions will be presented in a later document.

SELECTION OF THE PREFERRED ALTERNATIVE

The preferred alternative is removing the waste from Tanks W-3, W-4, W-5, W-6, W-7, W-8, W-9, and W-10 and deferring action on Tank TH-4. Remediation of the tank shells will be addressed in a separate action. DOE selected the preferred alternative based on the following information.

1. DOE manages an inventory of more than 100,000 gal of TRU waste (i.e., suspected TRU because analytical results are not complete) at MVST and in other portions of the active waste management system not part of this proposed action. DOE is proceeding with procurement of services to treat and dispose this inventory as a consolidated effort at MVST in compliance with the TDEC Commissioner's order on the site treatment plan.

2. TDEC issued a letter July 26, 1996, indicating it would not support in situ disposal of any of the sludge waste in these tanks for the following reasons:

   - TDEC cited previous agreements with DOE to construct additional tanks at Melton Valley to support waste removal from the Gunite tanks.
   - TDEC requested that the tank shells, soils and groundwater should be considered jointly.

3. Sludge from Tanks W-3 and W-4 will be removed during the treatability study and transferred to a tank in the South Tank Farm and subsequently to MVST.

Based on this information, DOE has selected waste removal as the only viable action that can be conducted at this time. Evaluation of the tank shells, surrounding contaminated soil, and tank appurtenances will be included in a future action.

Total cost for this action, excluding costs for the treatability study and sludge treatment and disposal costs at WIPP, is as follows:

Total Capital Cost: $35,103,000
Total Operation and
Maintenance Cost: $1,700,000 (5 years)
Total Project Present Worth: $34,316,000

Table 2 summarizes the costs for the preferred alternative. This action will be conducted following the conclusion of the treatability study in fall 1997 and will be concluded in 2000. Waste transfers to MVST will be coordinated with other waste transfers in the active system. These transfers and other remedial actions could cause the proposed schedule to vary from 1998 to 2000.

DOE believes that this selected alternative will protect human health and the environment, comply with ARARs, and be cost-effective. EPA and TDEC concur with the release of this PP for public comment.

Table 2. GAAT sludge removal

Activity	Cost ($1,000)
Project management	2,375
Design and support documents	1,313
Contaminated equipment removal	1,668
Construction	2,394
Waste removal RD/RAWP	59
Equipment relocation	671
Waste removal	19,602
Subtotal	28,082
Contingency—25 %	7,021
Total	35,103

GAAT = Gunite and Associated Tanks
RAWP = remedial action work plan
RD = remedial design

COMMUNITY PARTICIPATION

Community involvement is critical to the CERCLA RI/FS process.

DOE encourages public participation in the selection of the remedial action for remediation of GAAT. The 30-day public comment period will be announced in local newspapers. During this time the public is invited to submit written comments on the preferred and no action alternatives. A public meeting will be held, if requested, and will include responses to questions and concerns.

These comments will be evaluated and documented as part of the subsequent ROD. Based on public comments or new information, DOE may modify the preferred alternative or select another.

THE NEXT STEP

Following the public comment period and consideration of public concerns, DOE will issue a ROD. The ROD will describe the selected alternative and include the responses to comments received from the public. After the document is signed by EPA, TDEC, and DOE, a remedial design plan for implementing the alternative will be prepared.

OPPORTUNITIES FOR PUBLIC INVOLVEMENT

Public Comment Period: DOE will hold a 30-day public comment period for this FS/PP. The comment period provides an opportunity for local residents and interested parties to express their views and concerns on the remedial alternatives being considered. Copies of the proposed plan and supporting documents are available at the following location:

DOE Information Resource Center
105 Broadway Avenue
Oak Ridge, TN 37830

Hours: Monday–Friday: 7:30 a.m.–5:30 p.m.

Telephone: (423) 241-4582

OHF Tanks EE/CA for Sludge Removal

DOE/OR/02-1450&D2

EXECUTIVE SUMMARY

Five underground tanks at the Old Hydrofracture Facility (OHF) contain approximately 132,475 L (35,000 gal) of liquid radioactive waste and approximately 22,710 L (6,000 gal) of sludge categorized as mixed transuranic waste. There is concern about the condition of these tanks because they have stored waste for more than 30 years. The tanks are near White Oak Creek and Melton Branch, and an uncontrolled release of tank contents could be hazardous to human health and the environment.

In 1995, the U.S. Department of Energy (DOE), the Tennessee Department of Environment and Conservation (TDEC), and the U.S. Environmental Protection Agency (EPA) decided to initiate a non-time-critical removal action to reduce the risk of a release of radioactively contaminated liquid and sludge wastes stored in the OHF tanks. This removal action is being conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 process to reduce potential risk to workers, off-site receptors, and the environment until a final action can be implemented for this site.

This engineering evaluation (EE)/cost analysis (CA) develops, evaluates, and recommends a preferred alternative, a description of which is provided to the public for comments. A 30-day public comment period for the OHF removal action is being held following review of the EE/CA by TDEC and EPA, and approval by DOE for release to the public. The recommended alternative may be modified or changed based on public comments. An action memorandum will then be prepared to address public comments and document the decision to implement the selected alternative.

The objective of this removal action is to reduce the risk to human health and the environment that would result from a spill or leak of mixed and transuranic waste from any or all of the OHF tanks. Approaches considered were encapsulation, in situ treatment, and waste removal. After screening these approaches, waste removal and transfer to the Melton Valley Storage Tanks was chosen because it met the screening criteria, the removal action objective, and was achievable without interfering with future actions. In addition, the action can be implemented on a reasonable schedule.

Based on technology screening and evaluation, a conventional sluicing and pumping operation will be used to remove tank contents, which will be transferred to the Melton Valley Storage Tanks. Following removal of the OHF tanks' contents, plans are to address the OHF tank shells, contaminated areas, and equipment and/or buildings in the vicinity of OHF.

3.2.2 Background and Uses of the Tanks

The OHF tanks supported the old hydrofracture process that began in 1964. Contaminated liquid, with dissolved and suspended solids removed from the South Tank Farm, was pumped to the OHF tanks for temporary storage. Contents of the OHF tanks were mixed with grout before injecting the mix into a fractured shale formation. These tanks were used for this process until OHF was shut down in 1980.

The pipeline from the South Tank Farm to the valve box near the OHF tanks was upgraded to be doubly contained. This doubly contained pipeline now connects with the Melton Valley Storage Tanks (MVST). The pipeline from the OHF tanks to the valve box was not upgraded; however, this portion of the pipeline continues to be maintained.

3.2.3 Current Condition of the Tanks

The five OHF tanks have been inactive since 1980. Most of the waste was removed before the tanks become inactive. Material currently in the tanks comes from three sources:

- small quantities of radioactive and mixed TRU solids liquid from the South Tank Farm;
- supernate from the WAG 5 L-6 pond, and
- water with suspended solids from the OHF waste pits.

There is no evidence of any leaks, either inward or outward. The tanks had cathodic protection against corrosion beginning in 1968; however, when the protection was checked in 1991, it was found to be inoperable (Harco 1993) and cathodic protection was not started again.

3.3 DESCRIPTION OF THE TANKS CONTENTS

The OHF tanks were sampled in 1988 with results reported in 1990 (Autrey, et al. 1990). These results are used in this EE/CA to determine the risk associated with the tanks and to describe the contents of the tanks sufficiently to evaluate the alternative. A sampling and analysis plan was approved in December 1995, and sampling was performed in the second quarter of fiscal year 1996. Results of the sampling in 1996 are not available at this time. These results would not change the decision that an action is appropriate or change the evaluation and selection of alternative. The sampling results will be used to develop the design for this proposed action. Results for the sampling will be presented in a separate report.

3.3.1 General Description

As stated previously, the OHF tanks contain material from three sources and have not been emptied since the shutdown of the hydrofracture facility. Table 2 presents a portion of the 1988 sampling results (Autrey, et al. 1990), revealing that the OHF tanks contain liquid supernate and sludge components. This sampling also concluded that the contents in each tank were similar.

Table 2. Current inventory of OHF tanks, ORNL, Oak Ridge, Tennessee

Tank	Supernate (gal)	Sludge (gal)	Calculated total (gal)	Calculated percent capacity
T-1	11,047	791	11,838	79
T-2	11,048	1,205	12,253	82
T-3	2,063	2,029	4,092	16
T-4	9,341	1,328	10,669	43
T-9	1,290	481	1,771	14

gal = gallon
OHF = Old Hydrofracture Facility
ORNL = Oak Ridge National Laboratory

3.3.2 Radiological Analysis Results

The 1988 sampling results (Autrey, et al. 1990) indicated that radioactivity was similar in all the OHF tanks. The results indicate that liquid activities were 5,676 pCi/mL (210 Bq/mL) gross alpha, 3.78×10^6 pCi/mL (140,00 Bq/mL) gross beta, 3.78×10^6 pCi/mL (140,000 Bq/mL) ^{137}Cs, 75,684 pCi/mL (2,800 Bq/mL) ^{90}Sr, and < 2,027 pCi/mL (75 Bq/mL) ^{60}Co. In the sludge, the alpha activity level was 7,083 nCi/g (262,000 Bq/g), and gross beta count was 5.41×10^8 pCi/mL (2.0×10^7 Bq/mL). Based on the 1988 sampling results, sludge in all the tanks can be classified as TRU waste.

3.3.3 Nonradiological Analysis Results

The sampling results from 1988 (Autrey, et al. 1990) provide nonradiological contaminant data used to characterize the tanks for this removal action. Since the tanks are buried, samples were withdrawn from a small area beneath the manway. Only limited quantities were taken to minimize radiation exposure. All of the sludges were of a soft consistency. Analysis of the samples indicates that the sludge in all of the tanks can be characterized as Resource Conservation and Recovery Act of 1976 (RCRA) hazardous characteristic waste. Furthermore, the liquids in

Tanks T-3, T-4, and T-9 are also RCRA wastes; Cr, Pb, and Hg in the waste exceed RCRA toxicity limits. The pH of the supernate of Tank T-3 exceeded RCRA limits. Results from the 1988 sampling (Autrey, et al. 1990) are summarized in Table 3. The tanks do not contain appreciable amounts of either volatile or semivolatile organic compounds (Autrey, et al. 1990). However, trace amounts of phthalates, naphthalene, tributyl phosphate, methanol, benzoic acid, and benzyl alcohol are present.

Table 3. RCRA characterization from a 1988 sampling of OHF tanks, Oak Ridge, Tennessee

Tank	RCRA waste status		Liquid		Sludge
	Liquid	Sludge	Corrosive	Metals above reg. limit (mg/L)	Metals above EP toxicity (mg/kg)
T-1	Non-RCRA	RCRA	No	None	Cr(130), Hg(74), Pb(860)
T-2	Non-RCRA	RCRA	No	None	Cr(180), Hg(70), Pb(350)
T-3	RCRA	RCRA	Yes (pH 12.7)	Cr(14), Hg(5.7)	Hg(40), Pb(300)
T-4	RCRA	RCRA	No	Cr(14), Hg(7.9)	Cr(102), Hg(585), Pb(510)
T-9	RCRA	RCRA	No	Hg(3.4)	Hg(39), Pb(540)

Cr = chromium
EP = extraction procedure
Hg = mercury
kg = kilogram
L = liter
mg = milligram
OHF = Old Hydrofracture Facility
Pb = lead
RCRA = Resource Conservation and Recovery Act

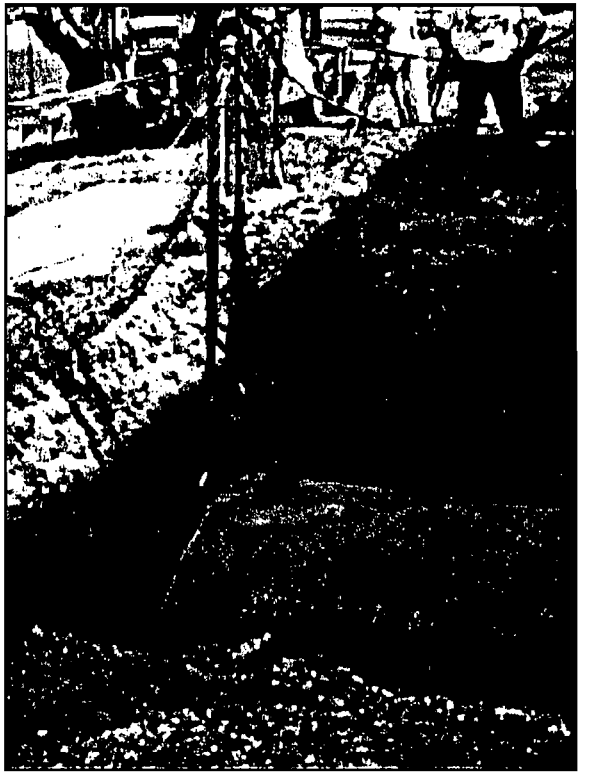
8. RECOMMENDED REMOVAL ACTION ALTERNATIVE

Sluicing and pumping was selected as the recommended action for removing the contaminated liquid and sludge from the five OHF tanks. Evaluation indicated that this alternative meets the removal action objective and can be effective, implementable, and cost-effective. Sluicing and removing the tank contaminants were selected because this action uses (1) applicable experience, (2) the latest information about technologies and techniques for removing the wastes from the tanks, and (3) actions that are currently acceptable for storage of mixed TRU waste. In addition, because the tanks are located near the buried pipeline that can carry wastes from the OHF tanks to the MVST, use of that pipeline may facilitate removal of the wastes.

ORNL Underground Storage Tank (UST) Program Overview

Introduction and Scope

- *In support of their missions, many ORNL organizations use underground storage tanks (USTs) to store petroleum products and hazardous substances.*
- *In response to RCRA Subtitle I, the Tennessee Petroleum Underground Storage Tank Act was passed by the Tennessee legislature.*
- *Subtitle I of the Resource Conservation and Recovery Act (RCRA) regulates petroleum and hazardous substance USTs. (Note: Hazardous waste USTs are regulated under Subtitle C of RCRA and are not included within the scope of this program, since all hazardous substance USTs at ORNL have been closed in previous years.)*



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ORNL Underground Storage Tank (UST) Program Overview

Introduction and Scope (Cont'd.)

- *The Tennessee Department of Environment and Conservation (TDEC) UST regulations are codified in TDEC Rule 1200-1-15 and the EPA regulations in Title 40 of the Code of Federal Regulations, Part 280 (40 CFR 280). These regulations require that all petroleum and hazardous substance USTs (except for certain categories of USTs excluded from regulation, such as tanks with volumes for less that 110 gallons and heating oil tanks) that do not meet the UST standards established by these regulations be upgraded, replaced, or taken out of service by December 22, 1998.*

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UST List

- USTs are identified and tracked using the UST List.

Tank Number	Installed	Closed/Sch. to be Closed	Capacity (gal)	Content	Regulatory Status	Physical Status	Tightness Test Passed	Replacement
0002B	1964	1980	50	Gasoline	Closed	Closed-in-Place	NA	
1505	1977	1997	285	Diesel	Active	Operating	May-96	
2009	Unknown	1989	345	Gasoline	Closed	Removed	NA	
2011	1973	1994	285	Diesel	Closed	Removed	NA	
2026	1964	1992	285	Diesel	Closed	Removed	NA	AST
2088	1975	1996	285	Diesel	Closed	Removed	NA	
2519A	1964	1995	500	Gasoline	In Closure	Closed-in-Place	NA	AST
2519B	1975	1992	750	Diesel	In Closure	Removed	NA	AST
2521	1974	1997	285	Diesel	Active	Operating	May-96	
2572A	1980	1997	285	Diesel	Active	Operating	May-96	
2572B/2500	1965	1985	110	Gasoline	Closed	Closed-in-Place	NA	
2572C	Unknown	1973	Unknown	Gasoline	Closed	Closed-in-Place	NA	
3001C	1941	Unknown	50	Oil	Closed	Closed-in-Place	NA	
3019B	1952	1992	110	Blends	Closed	Removed	NA	
3029/3032	1985	1995	250	Diesel	In Closure	Closed-in-Place	NA	AST
3042	1960	1995	3000	Diesel	In Closure	Closed-in-Place	NA	
3047A	1973	1995	285	Diesel	In Closure	Closed-in-Place	NA	AST
3047B	1965	1989	50	Diesel	Closed	Closed-in-Place	NA	
3123	1972	1994	285	Diesel	Closed	Removed	NA	AST
3125	1973	1988	1000	Diesel	Closed	Removed	NA	AST
3130	1982	1996	550	Diesel	In Closure	Closed-in Place	May-96	AST
3131	1979	1995	550	Diesel	In Closure	Closed-in-Place	NA	AST
3132	1979	1995	1000	Diesel	In Closure	Removed	NA	AST
3146	1985	1995	550	Diesel	In Closure	Removed	NA	AST
3598	1962	1994	400	Diesel	In Closure	Closed-in-Place	NA	AST
4500N	Unknown	1995	5000	Diesel	In Closure	Removed	NA	UST
4500N(B)	1995	NA	1000	Diesel	In Compliance	Operating	NA	
4500S	1960	1990	1000	Diesel	Closed	Removed	NA	AST
4501	1960	1984	325	Diesel	Closed	Closed-in-Place	NA	
4514/4515	1986	1997	1000	Diesel	Active	Operating	May-96	
5500A	Unknown	1970	200	Gasoline	Closed	Closed-in-Place	NA	
6554	1977	1990	3000	Ethylene Glycol	Closed	Removed	NA	
7002A	1948	1989	300	RAD OIL/PCB	Closed	Removed	NA	
7002B	1947	1977	8000	Gasoline	Closed	Closed-in-Place	NA	
7009E	1975	1990	5000	RAD OIL/PCB	Closed	Removed	NA	
7063A	1964	1989	50	Gasoline	Closed	Closed-in-Place	NA	
7069A	1956	1989	8500	Diesel	Closed	Removed	NA	
7069B	1956	1988	8300	Gasoline	Closed	Removed	NA	
7069C	1956	1989	4000	Gasoline	Closed	Removed	NA	
7069D	1972	1990	10000	Diesel	Closed	Removed	NA	
7069E	1988	NA	6000	Diesel	In Compliance	Operating	NA	
7069F	1988	NA	15000	Gasoline	In Compliance	Operating	NA	
7600A	1960	1996	24000	Heating Oil	Closed	Closed-in-Place	NA	AST
7605	1962	1989	1000	Diesel	Closed	Removed	NA	
7606	1960	1993	1000	Heating Oil	Closed	Removed	NA	
7615	1962	1989	280	Paint Solvents	Closed	Removed	NA	
7618	1980	1995	2000	Diesel	In Closure	Removed	NA	AST
7740B	Unknown	1978	Unknown	Gasoline	Closed	Closed-in-Place	NA	
7860B	1982	1993	500	Diesel	Closed	Closed-in-Place	NA	
7901	1962	1996	4000	Diesel	In Closure	Closed-in-Place	NA	AST
7921	1966	1996	1500	Diesel	In Closure	Closed-in-Place	May-96	AST
7931	1967	1996	550	Diesel	In Closure	Removed	May-96	AST
CRBR	1971	1991	800	Gasoline	Closed	Removed	NA	
PARCEL "A"	Unknown	1989	250	Gasoline	Closed	Removed	NA	
ROGERS	1967	1991	750	Gasoline	Closed	Removed	NA	

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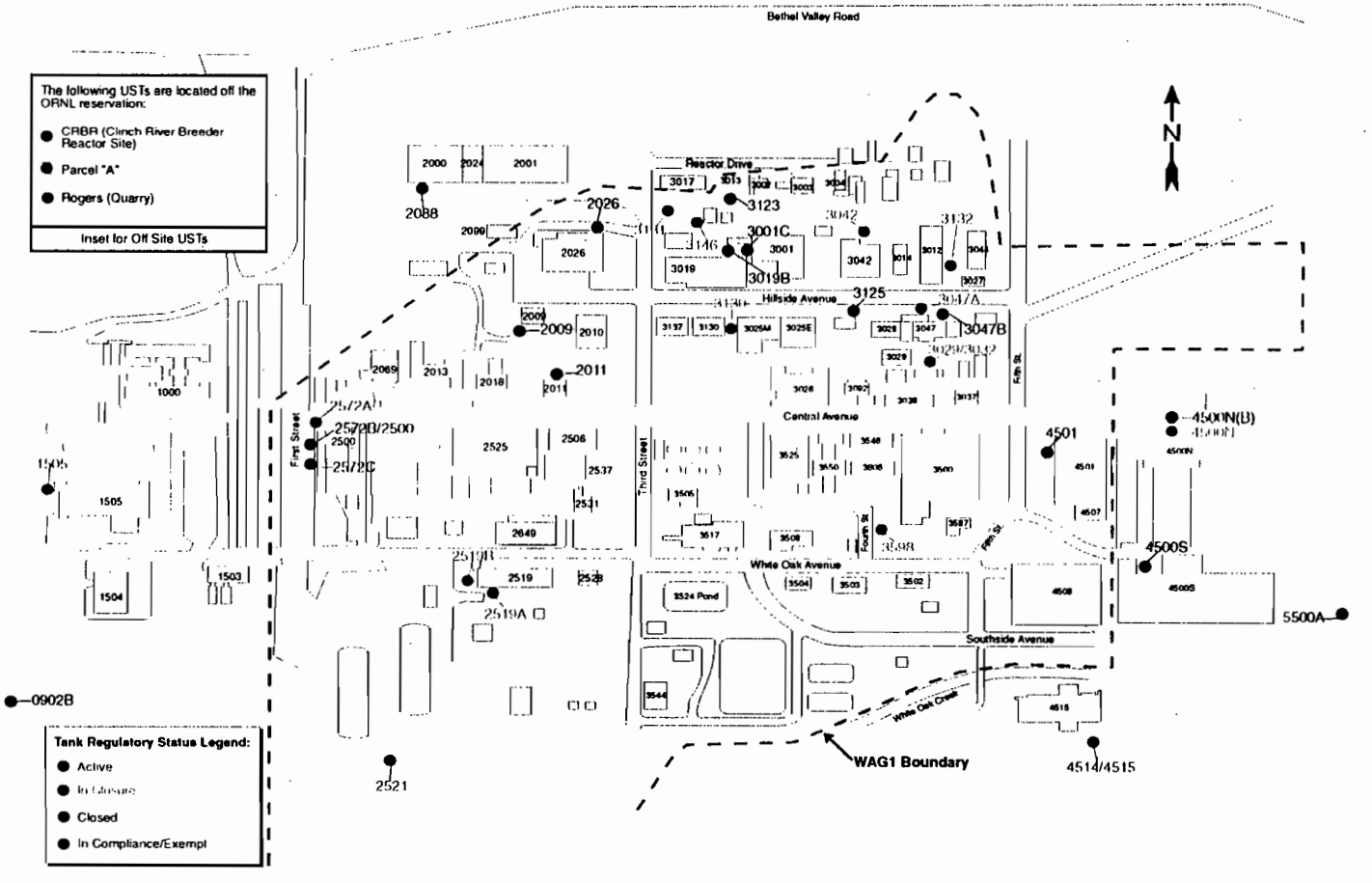
ORNL Underground Storage Tank (UST) Program Overview

Bethel Valley UST Map



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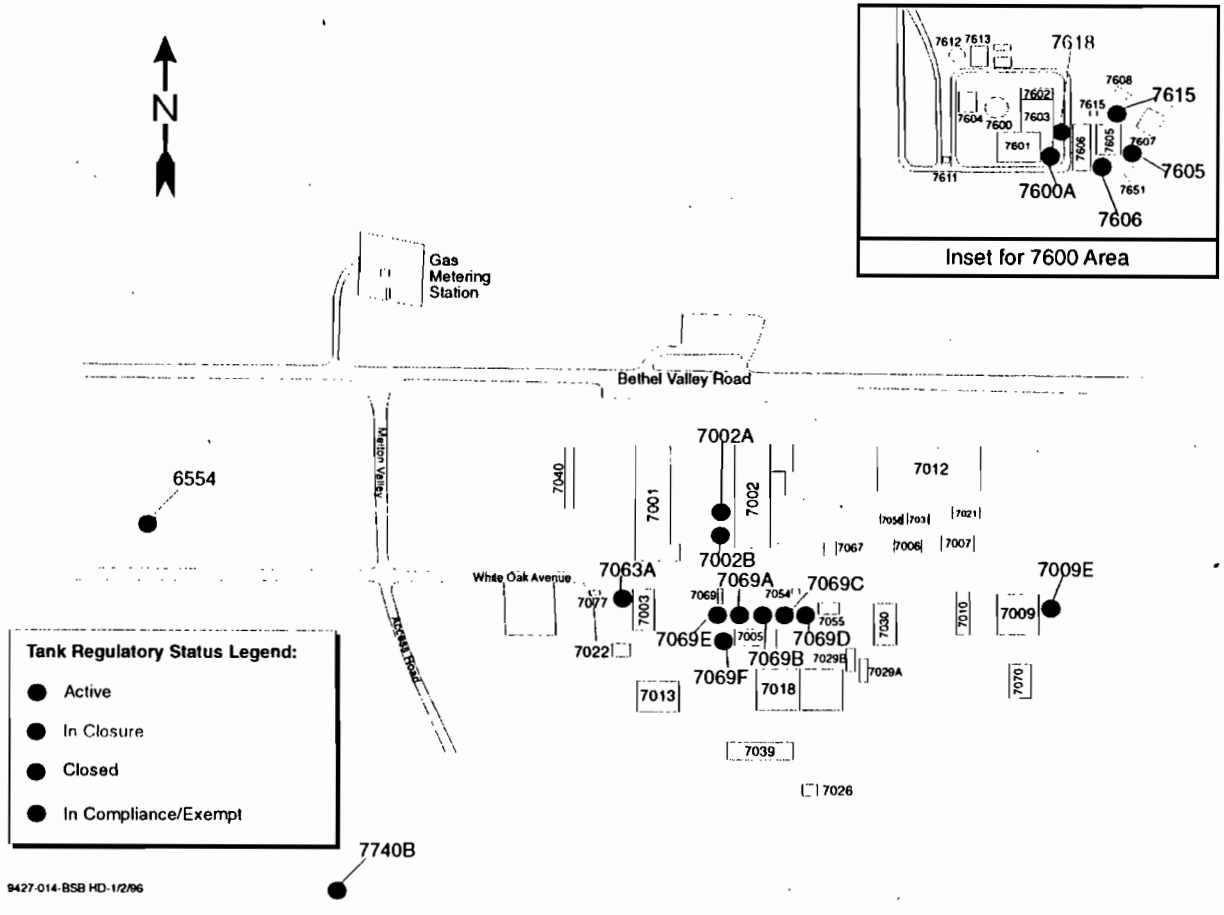
ORNL Underground Storage Tank (UST) Program Overview

Bethel Valley 7000 Area Map



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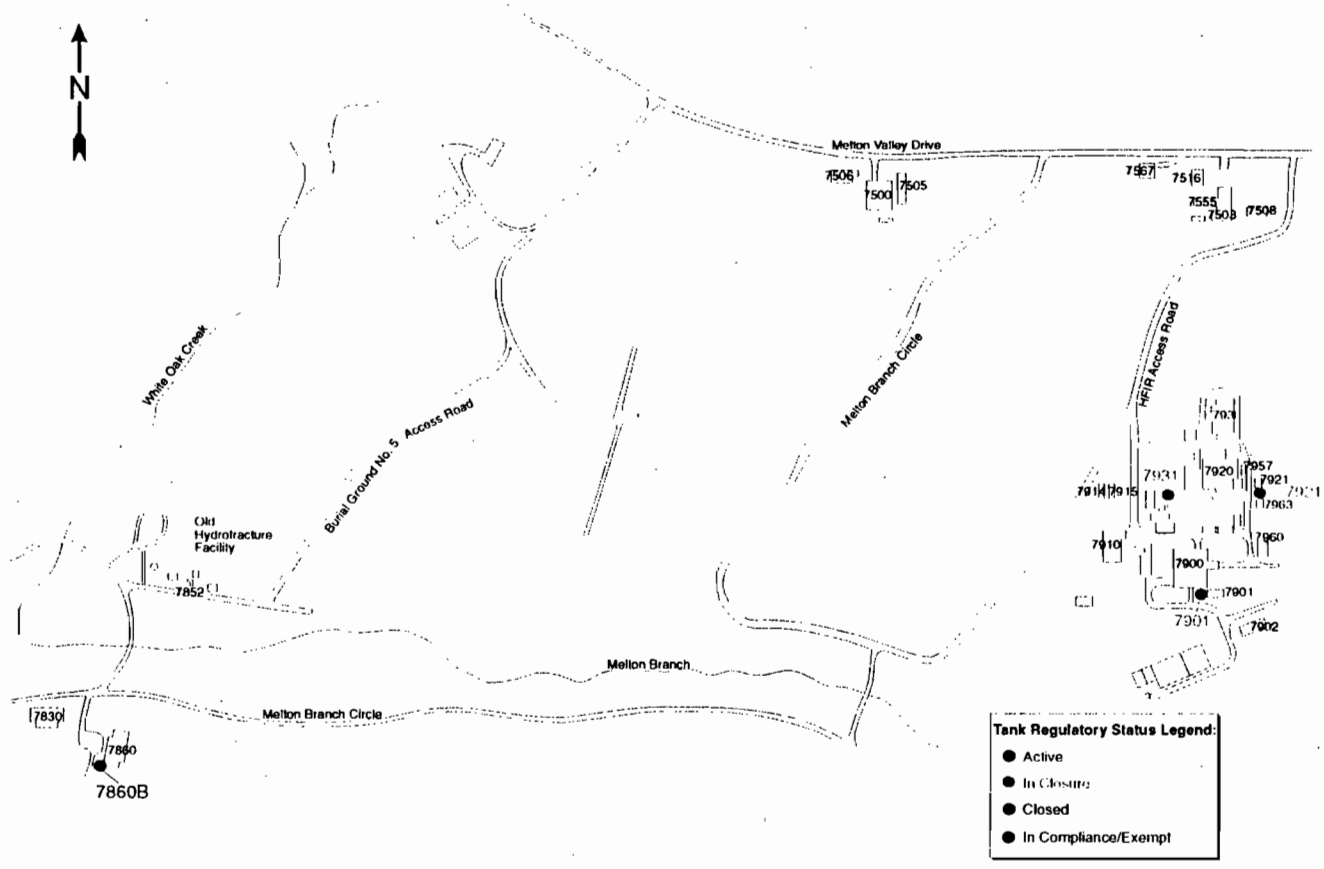
ORNL Underground Storage Tank (UST) Program Overview

Melton Valley Map



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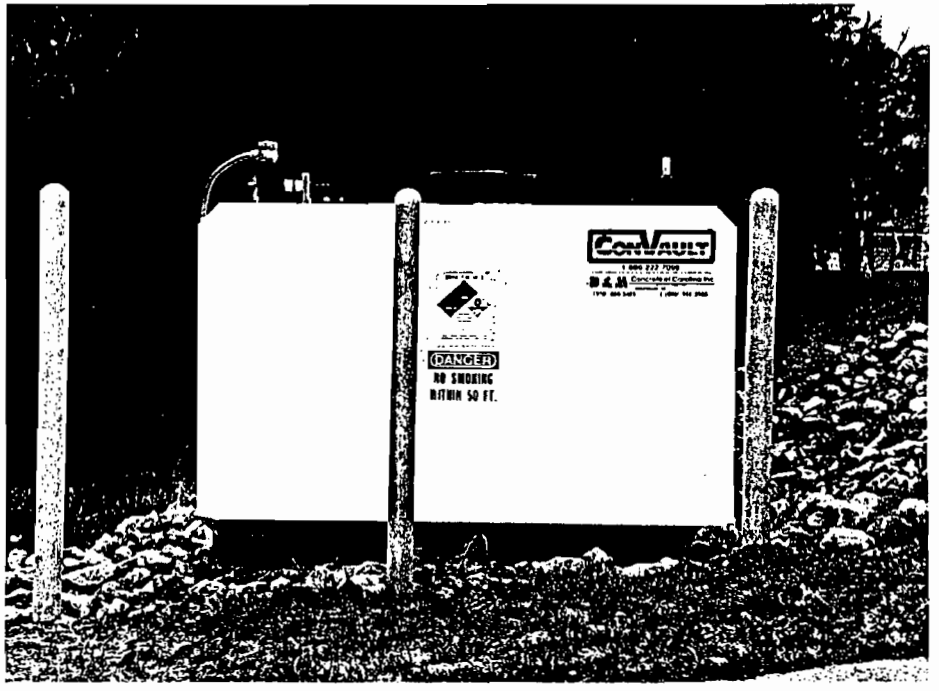
ORNL Underground Storage Tank (UST) Program Overview

Replacing USTs with ASTs

- At a minimum, newly installed ASTs include secondary containment and spill and overfill prevention devices.
- ASTs simplify leak detection and spill prevention and reduce costs



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ORNL Underground Storage Tank (UST) Program Overview

- Risk Based Scheduling Approach
  - Any known leaking USTs were closed first.
  - USTs posing the most safety and health risk to the environment were closed next.
  - Other risks being equal, USTs inside Waste Area Group (WAG) 1 were closed first.
  - Older USTs were generally closed before newer USTs.

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ORNL Underground Storage Tank (UST) Program Overview

Hazards Encountered

- Petroleum from spills and leaks.
- For any additional hazards found in WAG 1, TDEC has given permission to evaluate corrective action steps on a site by site basis.
  - This allows the USTs in radiation contaminated areas of WAG 1 to be closed-in-place, rather than having to excavate.
  - To reduce costs, TDEC now encourages closing-in-place for areas outside of WAG 1.

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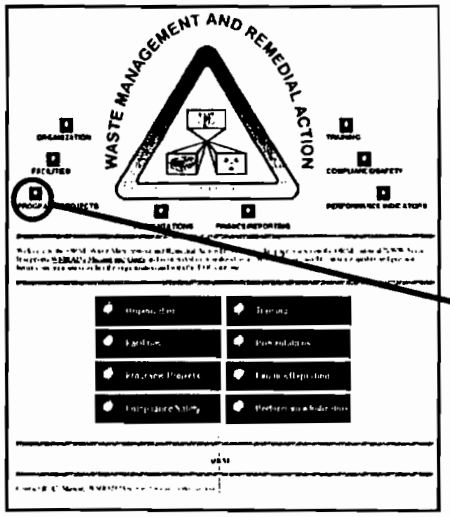
RNL Underground Storage Tank (UST) Program Overview

To find additional information, see the UST Program web page (WMRAD internal page)



WMRAD Page
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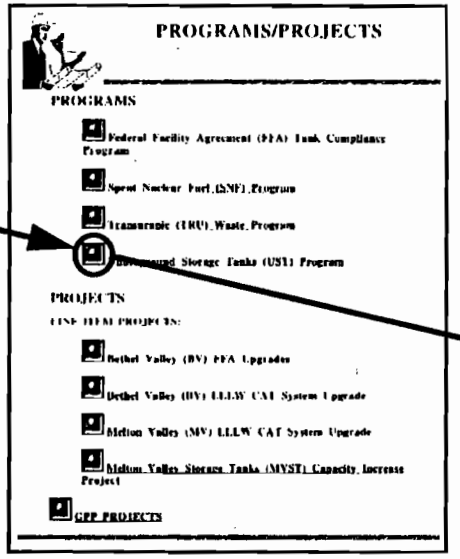

Program/Project Page
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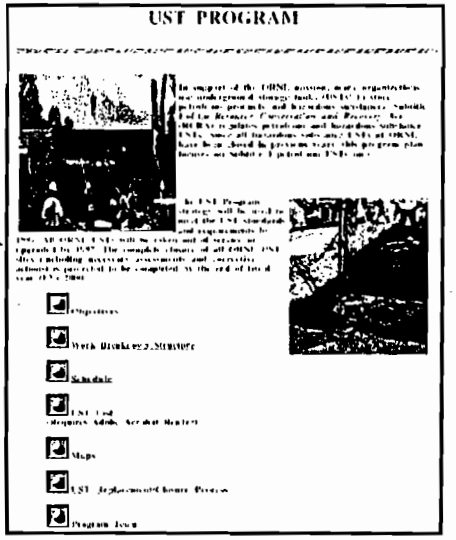

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WAG 1 SCSR (1992)

3.5.4.1 Piping and utility trenches

When the underground storage tank system was installed at ORNL in 1943 to collect and store LLLW from various process and laboratory buildings, a network of gravity drain pipes and valve boxes was laid in trenches to transport intermediate-level liquid waste (ILW) to a central group of large underground Gunite tanks in STF (Binford and Orfi 1979). NTF was also started in 1943 with four buried Gunite waste collection tanks; it was expanded in 1950 to collect wastes from additional processes in Building 3019. Pipelines were laid in trenches from the building to valve pits, to the NTF tanks, and from the tanks to retention ponds and the large STF Gunite tanks. Additional buried piping was installed for the process waste treatment system to handle liquid wastes generated during normal operations that were not known to be contaminated but required treatment and monitoring before discharge to WOC.

Individual waste collection tanks and associated buried piping systems were added to the LLLW system during the early 1950s for individual buildings and processes at ORNL that were generating radioactive and chemical wastes (Binford and Orfi 1979). Piping systems were added to provide interconnections from most of the newly added tanks to various valve pits for connection to pipes running to the large STF tanks, the ultimate destination for most of the radioactive and chemical waste generated at ORNL. Lines were run to many of the tanks to provide steam for jetting liquids from one tank to another. Vent lines were also run to many tanks to carry the radioactive off-gas wastes to filtration and condensation systems.

The LLLW piping system was modified to meet the operational needs of ORNL activities. The supernatant liquid from the STF tanks was piped to waste holding basin 3513 from 1944 until 1949, when the system was changed to divert the liquids to the pot-type evaporator. The evaporator received the liquid from STF until 1954, when the piping was again changed to transport the effluent from the STF tanks to open pits in WAG 7. That

system was superseded in 1965 when a new evaporator system was built to reduce liquid waste by separating the water from the solid contaminants.

Documentation for many of the older underground piping systems is incomplete. The burial of these piping systems and subsequent burial of other utilities such as water, sewer, steam, gas, and electricity resulted in a complex network of trenches that crisscross the entire main plant area and intersect one another at an undocumented number of locations. The ORNL Atlas process waste maps show that these underground lines are particularly dense around the heart of WAG 1, at Isotopes Circle, the tank farms, and the Graphite and Oak Ridge Research reactors. The Atlas index lists 24 types of underground lines, conduits, ducts, and sewers constructed of 18 different materials. See Figures 3.2.14 - 3.2.16.

The LLLW piping system has been a significant potential source of contaminants, and the interconnecting utility trench system has the potential to provide preferred pathways for contaminant transport. The original LLLW system piping consists primarily of single-walled stainless steel pipe; leaks from these pipes are responsible for 23 SWMUs identified in WAG 1. Known pipeline leaks data back as far as the 1950s. Twenty of the 23 leak sites are located in the 3000 and 3500 blocks of the ORNL complex (see Plate I). Most of the leaks are located close to facilities (buildings or tanks); contamination has been reported under buildings 3026, 3047, 3515, and 3550 (Grimsby 1986). The leaks are commonly near transfer line and tank junctions, and contamination ranges in depth from the ground surface to 20 feet below the ground surface. Contamination has also been documented in the sanitary sewer system as a result of inleakage from leaks in the LLLW lines (Grimsby 1986).

Contaminants from LLLW leaks include fission products (e.g., strontium-90 and cesium-137), activation products (e.g., cobalt-60 and cadmium-115), and transuranics (e.g., americium-241 and plutonium-239). In some cases, contaminated soil was removed when the leak was repaired, although in other cases the soil was not removed. Grimsby (1986) describes individual leak sites in detail.

Certain active singly-contained portions of the LLLW system are now being replaced with double-walled pipe as part of the program for upgrade/replacement of the collection and transfer system to meet the secondary containment provisions of the FFA (Robinson et al. 1991).

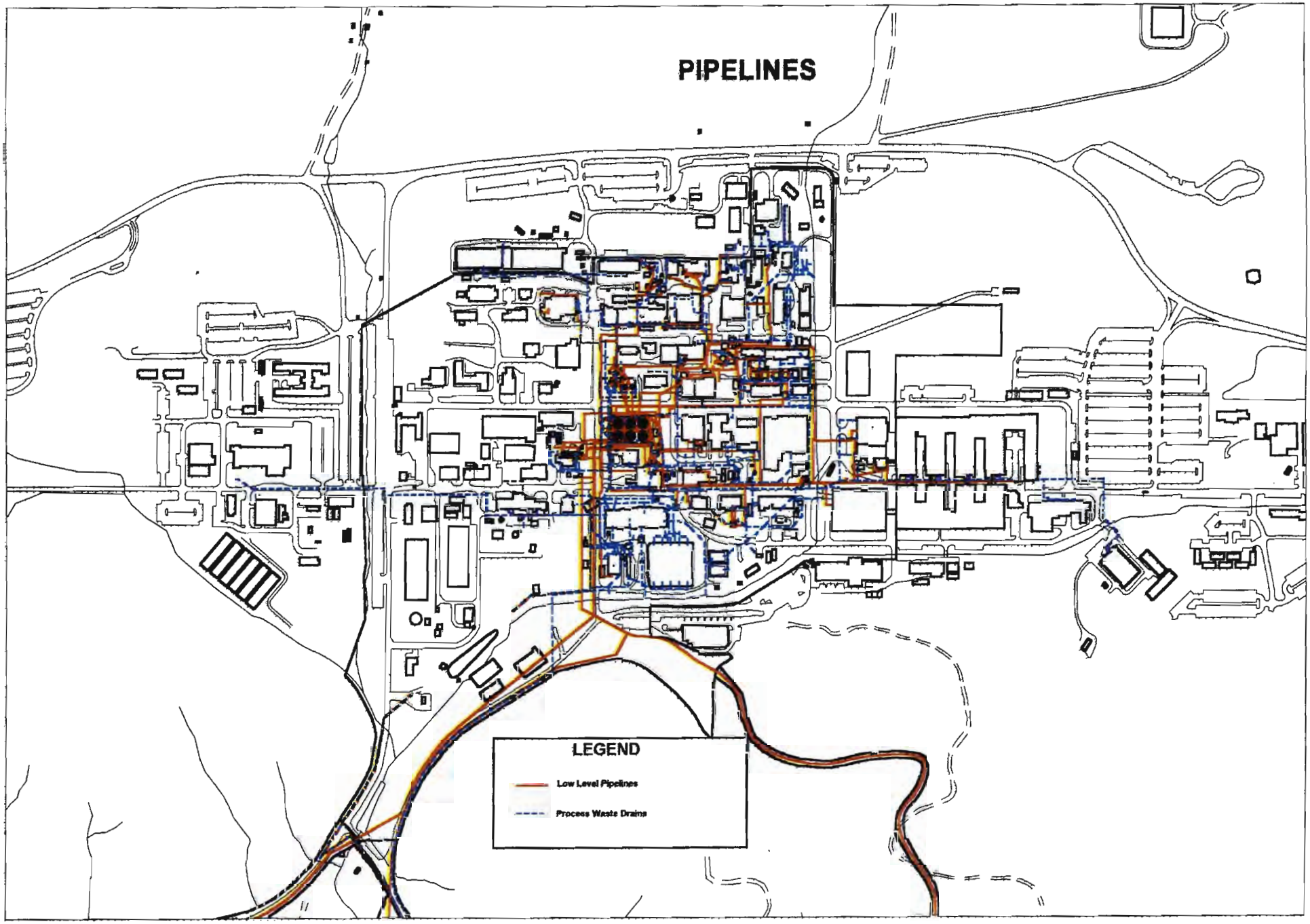
An estimate of the total length of known underground lines in WAG 1, based on the Atlas, yields approximately 50 miles of buried lines. Some of these lines are in common trenches, and some lines were not counted because they are not on the Atlas drawings.

Types of lines identified in the Atlas include potable water, process water, distilled water, sanitary sewer, process sewer, cooling water, hot waste, demineralized water, steam, chemical, condensate, air, telephone, electrical conduit, exhaust duct, electrical cable, natural gas, off gas, fuel, hydrogen/helium, oxygen, nitrogen, vacuum, and storm sewer. Construction materials include vitrified pipe, chemical ware, cast iron, galvanized iron, Hastelloy, wrought iron, copper, reinforced concrete, corrugated metal, aluminum, sheet iron, steel, wrought steel, Duriron, stainless steel, concrete-coated steel, concrete-encased conduit, concrete, and PVC. The LLLW system consists primarily of stainless steel pipe,

while the process waste and sewer lines are typically vitrified clay pipe. Most of the process waste and some of the sewer lines have been lined using the Insituform process. Over the long history of ORNL, many construction materials and methods have been used, making generalizations of system characteristics difficult.

Chen et al. (1988) modeled the effects of trenches on shallow groundwater flow and concluded that a factor of 10 difference in hydraulic conductivity between trench fill materials and native soils would cause groundwater flow to preferentially follow the trenches. This could lead to accelerated contaminant transport and could result in inaccurate interpretations of data from piezometers and monitoring wells that miss these preferential flow paths. In 1985, a dye-tracing investigation provided some evidence for this theory (Huff 1985). Dye injected at a line break north of Building 3019 moved east, toward a nearby sump and along strike, and south. The movement south is believed to follow sewer trenches under Building 3019. A limited assessment of contaminant migration along trench backfill soils performed as part of the Phase I investigation is discussed in Sect. 3.3. No significant differences in hydraulic conduction were found between the trench backfill material and the surrounding overburden. The relationship between buried pipelines and groundwater is shown graphically in Fig. 3.3.24.

In summary, the underground LLLW piping has been major source of potential contamination in WAG 1. The trenches in which these and other pipes are located are likely to provide preferential pathways for groundwater flow and contaminant transport. With approximately 50 miles of trenches in WAG 1, distortion of shallow groundwater flow could be significant.


PIPELINES
LEGEND
Low Level Pipelines
Process Waste Drains

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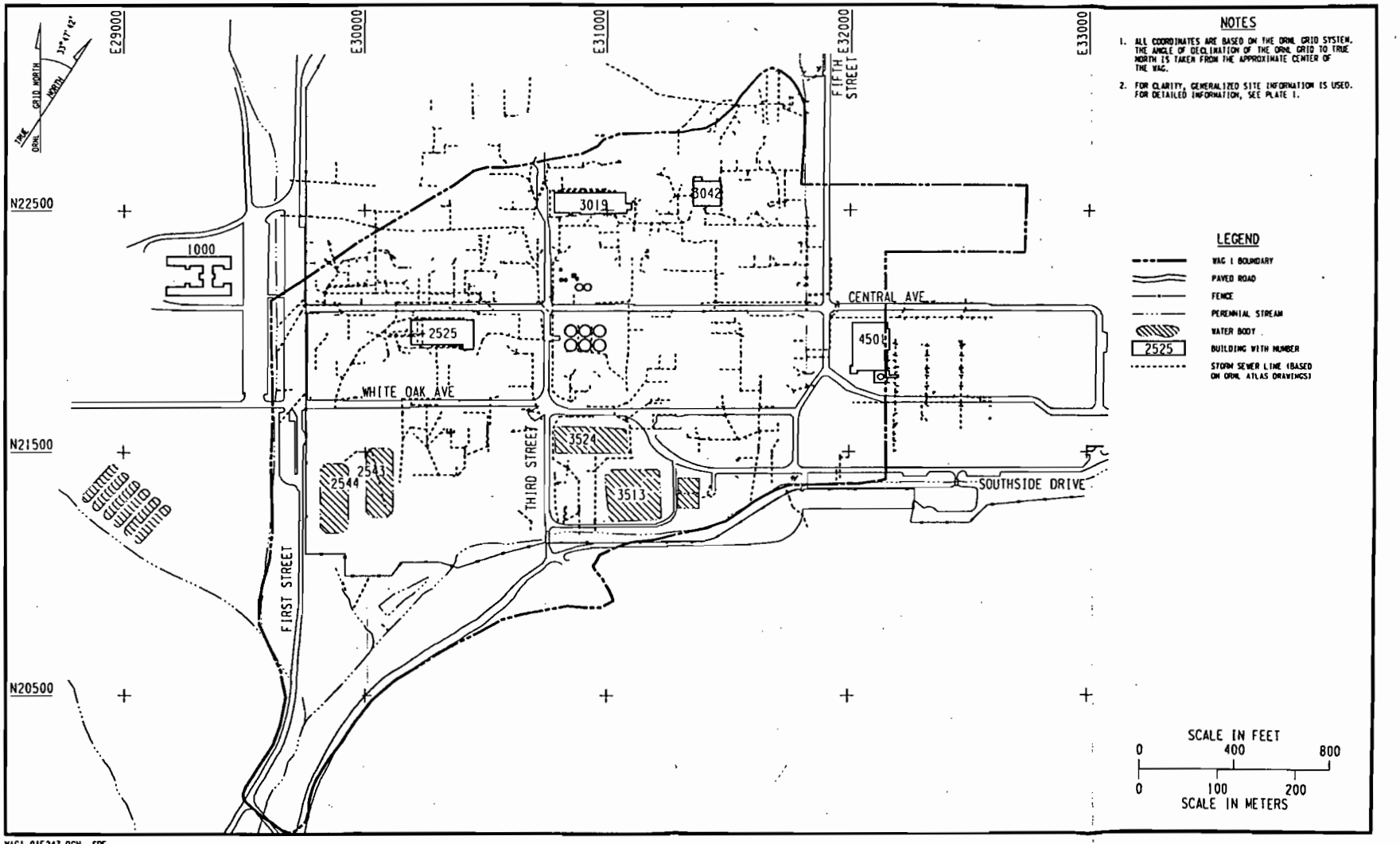

WAG1 01F247.DGN SRF, 6/10/92

Fig. 3.2.14. Storm sewer lines.

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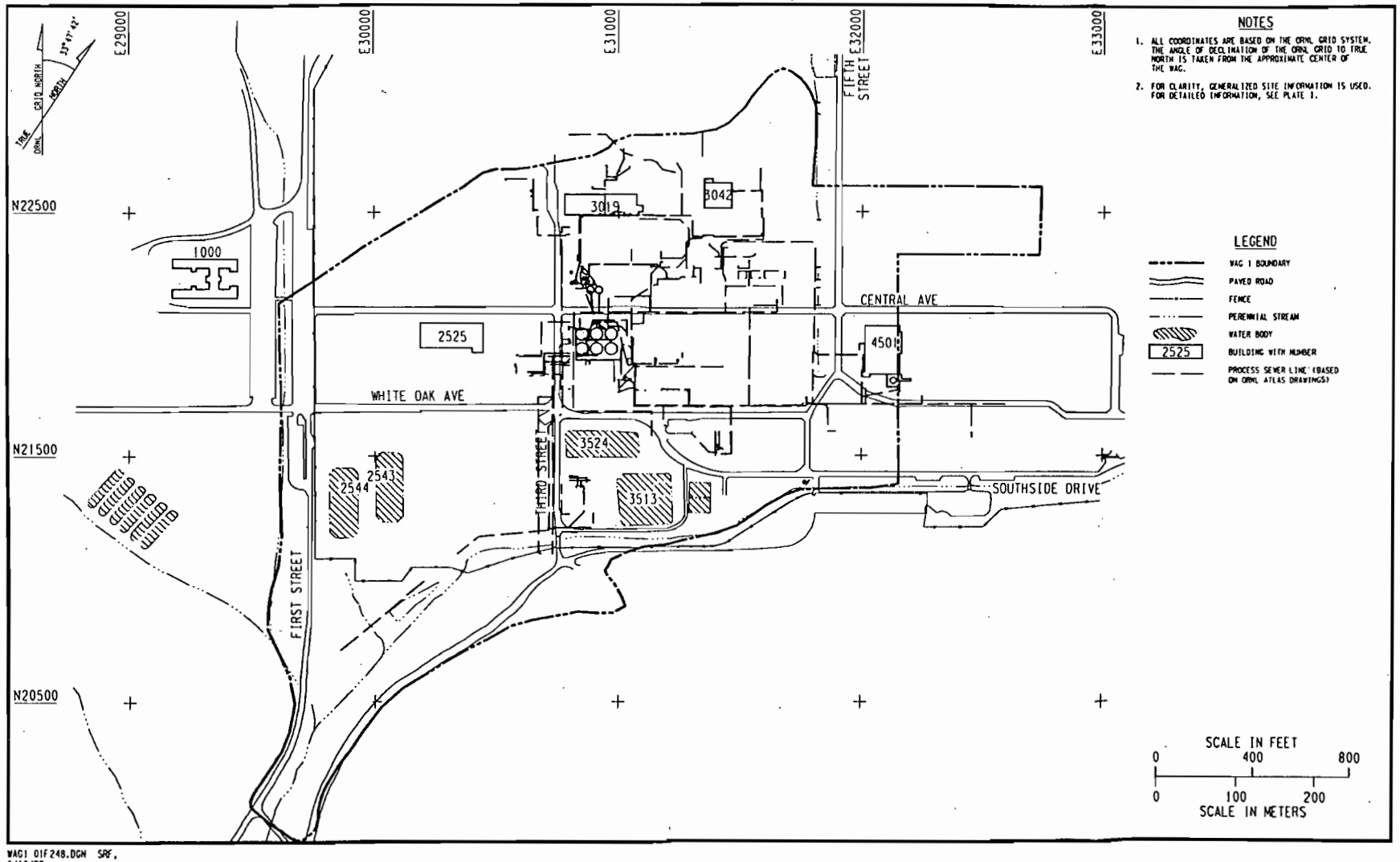

WAG1 01F248.DGN SRF,
6/10/92

Fig. 3.2.15. Process sewer lines.

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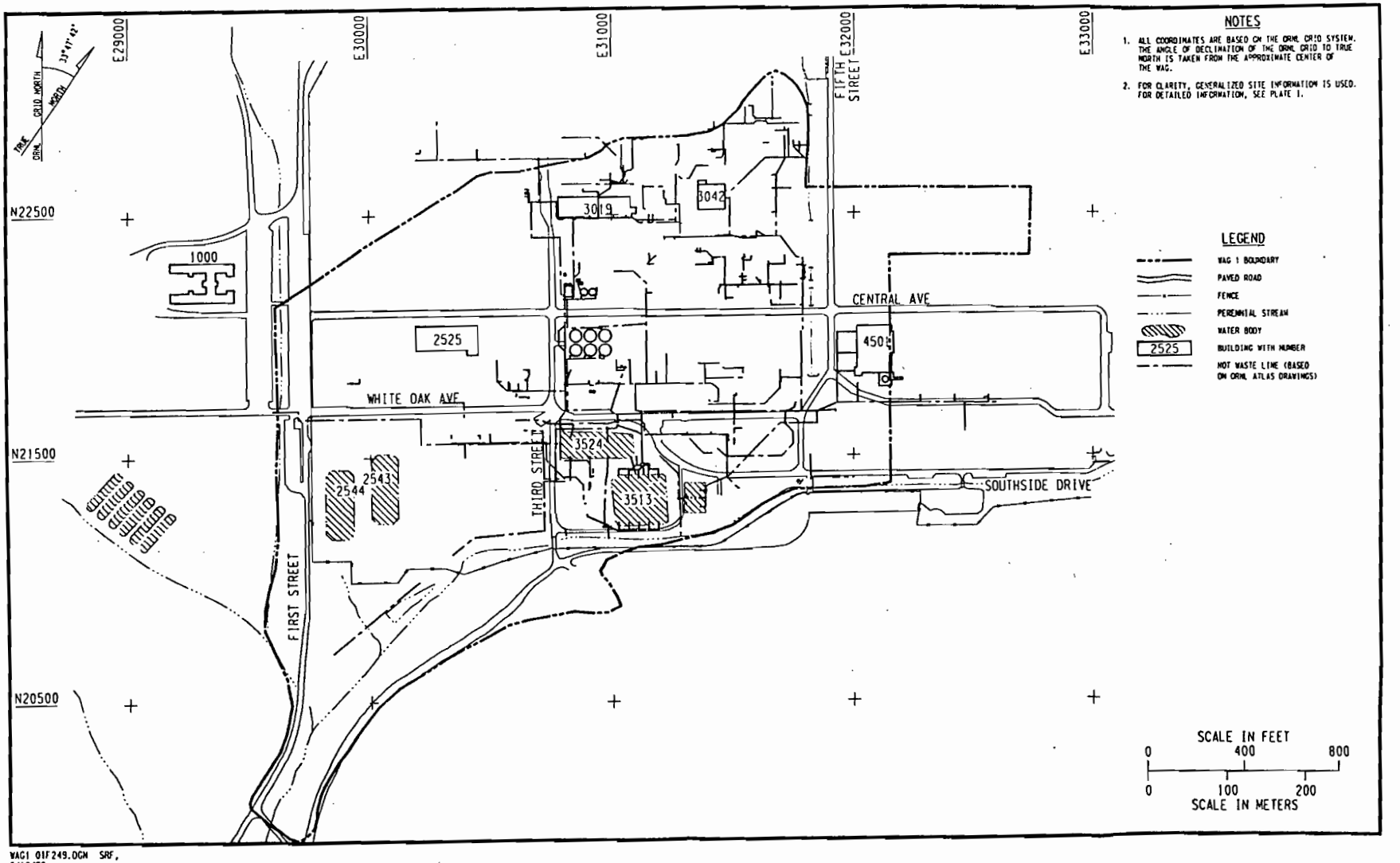
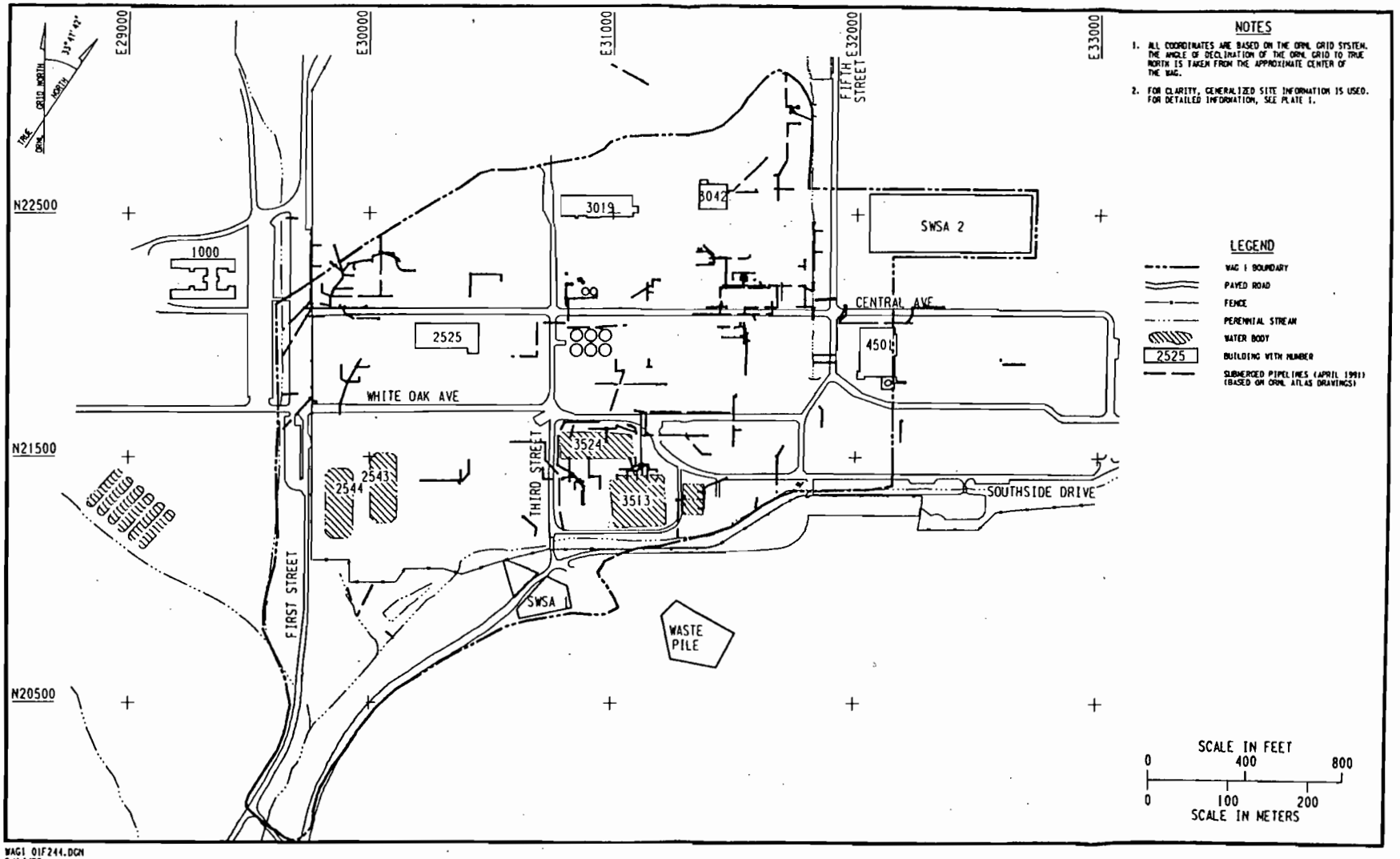


WAG1 01F249.DGN SRF, 6/10/92

Fig. 3.2.16. Hot waste lines.

000206



WAG1 01F244.DGN
6/14/92

Fig. 3.3.24. Locations of pipelines (process sewer, hot waste, or storm sewer lines) that were below groundwater tables, April 1991.

000207

000208

WAG 1 Pipelines and Leak Sites

The old LLLW piping system has been a significant potential source of contaminants, and the interconnecting utility trench system has the potential to provide preferred pathways for contaminant transport. The original LLLW system piping consists of single-walled, stainless steel pipe; past leaks from these pipes are responsible for 23 SWMUs identified in

WAG 1. The active portions of the LLLW piping system are being replaced with a new double-walled system designed to prevent leaks.

Pipeline / Leak Sites

Table 1.2.1. Solid waste management units in WAG 1

SWMU No.	Description of unit	Remark
1.5A	LLLW lines & leak sites - south of Building 3020	
1.5B	LLLW lines & leak sites - east of Building 3020	
1.5C	LLLW lines & leak sites - west of Building 3082	
1.5D	LLLW lines & leak sites - north of Building 3019	
1.5E	LLLW lines & leak sites - southwest corner of Building 3019	
1.5F	LLLW lines & leak sites - between W-5 & WC-19	
1.5G	LLLW lines & leak Sites - underneath Building 3047	
1.5H	LLLW lines & leak sites - gen. isotopes area (3037, 3038, 3034)	
1.5I	LLLW lines & leak sites - Building 3092 area	
1.5J	LLLW lines & leak sites - underneath Building 3026	
1.5K	LLLW lines & leak sites - between WC-1 & W-5	
1.5L	LLLW lines & leak sites - ORR water line (Building 3085)	
1.5M	LLLW lines & leak sites - Building 3028	
1.5N	LLLW lines & leak sites - east of Building 2531	
1.5O	LLLW lines & leak sites - underneath Building 3515	
1.5P	LLLW lines & leak sites - Building 3525 to a sump	
1.5Q	LLLW lines & leak sites - underneath Building 3550	
1.5R	LLLW lines & leak sites - sewer near Building 3500	
1.5S	LLLW lines & leak sites - abandoned line, Central Avenue area	
1.5T	LLLW lines & leak sites - Building 4508, North	
1.5U	LLLW lines & leak sites - Building 3518, West	
1.5V	LLLW lines & leak sites - northwest of SWSA 1	
1.5W	LLLW lines & leak sites - Building 3503, ground contamination	

Source: WAG1 SCSR (1992).

WAG 1 Ducts ER-391

UNIT NAME: Isotopes Ductwork/3110 Filter House

Unit Number:

Project Status: Remedial Investigation completed. (Bechtel et al 1992)

Unit Location: Located on Hillside Avenue, between Third Street and Fifth Street in the ORNL main plant area. ORNL grid coordinates are N 22,400 ft and E 31,290 ft. (ORNL 1990)

Approximate Dimensions and Capacity: Site consists of a filter house connected to nearby buildings by underground ductwork. For specific information, see engineering drawings D39120 - D39125, D43475, D45152, and D45155. (ORNL 1990)

Dates Operated: Site began operation in early 1960s. Site was removed from service in 1986. (ORNL 1990)

Present Function: Not in operation.

Life Cycle Operation: The Filter House was designed to handle air exhaust from cell ventilation in the isotopes area (Buildings 3028, 3029, 3030, 3031, 3032, 3033, and 3033A). This site also served Building 3038 and Building 3047. The Filter House received exhaust from connected buildings and transfer air to the 3039 stack. Inside the Filter House are 42 HEPA filters. Also inside is a floor drain that collected groundwater and transported it by gravity to a sump; water was then pumped to Tank WC-10 (liquid radioactive waste system). (ORNL 1990)

Waste Characteristics: Type of wastes are not identified but are known to include radionuclides. (ORNL 1990)

Release Data: Contamination results from continuous operation of the Filter House. Specific details of characterization and release data are not available. (Bechtel et al 1992)

Site Status: CERCLA (ORNL 1990)

Media of Concern:

Comments: This site was included in a CERCLA remedial investigation (Bechtel et al 1992) and will be remediated in accordance with the FFA.

References:

Bechtel National, Inc. /CH2M Hill/Ogden/Peer, September 1992. *Site Characterization Summary Report for Waste Area Grouping 1 at Oak Ridge National Laboratory*, DOE/OR-1043/VI & DI, Oak Ridge, Tennessee.

Oak Ridge National Laboratory, September 1990. Contaminated Site Summary Sheet, Oak Ridge, Tennessee.

Date Prepared: December 1996

Photo: No photo available.

UNIT NAME: Underground Exhaust Ducts 3001-3003

Unit Number:

Project Status: Remedial Investigation completed. (Bechtel et al 1992)

Unit Location: ORNL grid coordinates are N 22,680 ft and E 31,185 ft. Duct system is mainly north of Building 3001 in the ORNL main complex. (ORNL 1990)

Approximate Dimensions and Capacity: Not Applicable. (ORNL 1990)

Dates Operated: 1943-present. Duct changes were made in 1948 when Filter House was added to the cooling system. (ORNL 1990)

Present Function: The underground concrete duct system transmits the Graphite Reactor cooling air from the reactor (3001) to the Filter House (3002), the Fan House (3003), and then to the stack (3018). (Bechtel et al 1992)

Life Cycle Operation: The exhaust ducts served the Graphite Reactor which was built to produce the first gram-sized quantities of plutonium. Later is was used as a training reactor. Fuel was removed from the reactor in 1966. A large portion of the facility has been altered to allow public access to view the reactor face and ORNL visual displays. (Ford and Holder 1992)

Waste Characteristics: Duct walls are probably contaminated with fission products Cs-137 and Sr-90. Both alpha and beta-gamma contamination has been reported on the duct walls. (Ford and Holder 1992)

Release Data: No reported releases. (Bechtel et al 1992)

Site Status: CERCLA (ORNL 1990)

Media of Concern:

Comments: Contaminated Site Summary Sheet (CSSS) lists stack no. as 3010. This site was included in a CERLCA remedial investigation (Bechtel et al 1992) and will be remediated in accordance with the FFA.

References:

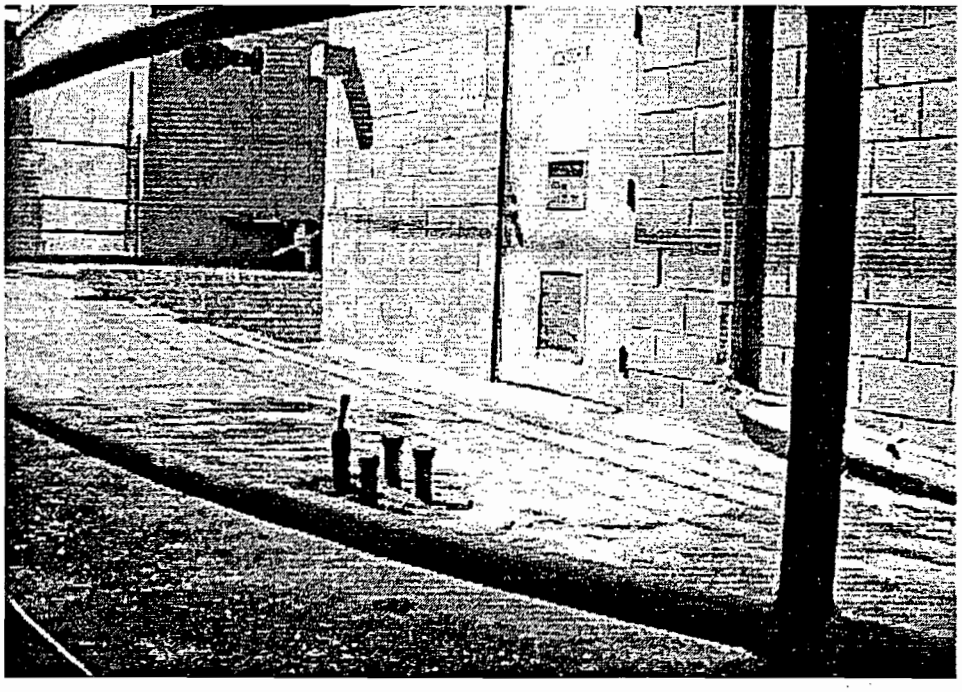
Bechtel National, Inc. /CH2M Hill/Ogden/Peer, September 1992. *Site Characterization Summary Report for Waste Area Grouping 1 at Oak Ridge National Laboratory*, DOE/OR-1043/V1 & D1, Oak Ridge, Tennessee.

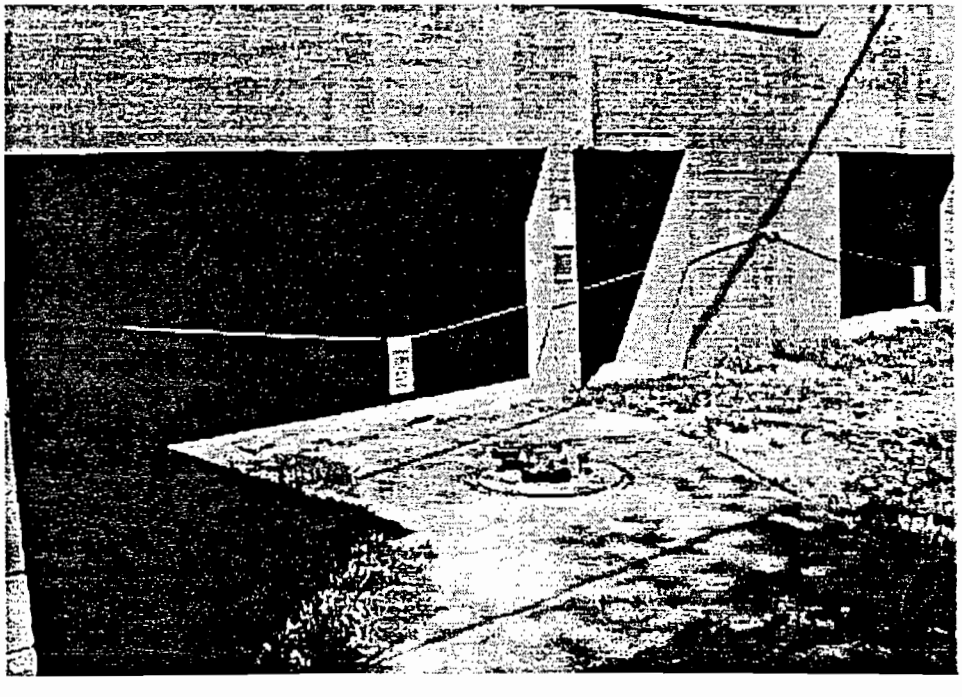
Ford, M.K. and L. Holder, Jr., July 1992. *Surveillance and Maintenance Plan for the ORNL Decontamination and Decommissioning Program, FY 1993 - 2002*, prepared by Waste Management and Remedial Action Division, Oak Ridge, Tennessee. 1992.

Oak Ridge National Laboratory, September 1990. Contaminated Site Summary Sheet, Oak Ridge, Tennessee.

Date Prepared: December 1996

Photo: 14_03.JPG; 14_06.JPG





WORKING DRAFT

ORNL FFA Category C and D Tanks Summary Information (Page 1 of 8)

Tank Number	Tank Physical Characteristics					Capacity (gal)	Current Content Volume (gal)[5]	Contaminants of Concern (RAD, TRU, RCRA, TSCA)	Inleakage/ Outleakage	Status
	Material[1]	Orientation[2]	Dia./Length (ft)	Riser/Dia. (in.)[3]	Location[4]					
2026A	SS	V	4/6.5	Y/3	IGV	500	Sludge < 50 gal	RAD, TRU, RCRA, TSCA	Slight Inleakage	Remediate FY 1998
3001-B	—	-	-	-	-	—	—	-	—	Removed FY 1995
3001-S	—	-	-	-	-	—	—	-	—	Non-existent
3002-A	SS	V	8/6	Y/4	IGV	1,600	Varies	RAD	Nonprogramatic waste input (filter house)	Remediation FY 1997 via in-place stabilization
3003-A	C	V	7/14	Y/36	BT	16,000	4,000 (est.)	RAD	Unknown	Tank evaluation
3004-B	—	-	-	-	-	—	—	-	—	Removed FY 1995
3013	SS	-	-	-	-	400	—	-	—	In-place stabilization FY 1995
4501-C	—	-	-	-	-	—	—	-	—	Remediated prior to FFA
4501-D	—	-	-	-	-	—	—	-	—	Remediated prior to FFA
4501-P	SS	-	-	-	-	100	---	-	---	In-place stabilization FY 1996
7503-A	SS	V	11/16	?	IGV	11,000	Empty	-	No evidence of leaks	Include in MSRE D&D?
7560	SS	H	4.5/9	Y/?	BT	1,000	Empty	-	No evidence of leaks	Remediate FY 1997 via in-place stabilization

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000217

ORNL FFA Category C and D Tanks Summary Information (Page 2 of 8)

Tank Number	Tank Physical Characteristics					Capacity (gal)	Current Content Volume (gal)[5]	Contaminants of Concern (RAD, TRU, RCRA, TSCA)	Inleakage/ Outleakage	Status
	Material[1]	Orientation[2]	Dia./Length (ft)	Riser/Dia. (in.)[3]	Location[4]					
7562	SS	-	-	-	-	12,000	Emptied/Rinsed September 1996	-	No	Remediate FY 1997 via in-place stabilization
F-201	SS	V	2/2.5	N	IGV	40	Unknown volume	RAD	No	Taken Out of Service in late FY 1996; Remediate in FY 1998
F-501	SS	V	4/3.8	N	IGV	200	Varies (Active)	RAD	No	Active til FY 1998; Remediate in FY 2000
HFIR	SS	H	8/35	Y/3	BT	13,000	Varies(Active)	RAD	No	Isolate FY 1998 and transfer the HFIR facility process waste system???
H-209	CS	-	-	-	-	2,500	---	-	---	In-place stabilization FY 1996
LA-104	—	-	-	-	-	—	—	-	—	Removed FY 1996
S-223	SS	V	7/10.5	N	IGV	2,500	Varies (Active)	RAD	No	Active until FY 1999; Remediate in FY 2000
S-324	SS	V	5.3/6	N	IGV	1,000	Varies (Active)	RAD	No	Active until FY 1999; Remediate in FY 2000
S-424	SS/ GL	V	5.5/7	Y/3	IGV	500	Dried Residues	-	No	Remediation FY 2000
S-523	SS	v	5.3/6	N	IGV	1,000	Varies (Active)	RAD	No	Active until FY 1999; Remediate in FY 2000

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ORNL FFA Category C and D Tanks Summary Information (Page 3 of 8)

Tank Number	Tank Physical Characteristics					Capacity (gal)	Current Content Volume (gal)[5]	Contaminants of Concern (RAD, TRU, RCRA, TSCA)	Inleakage/ Outleakage	Status
	Material[1]	Orientation[2]	Dia./Length (ft)	Riser/Dia. (in.)[3]	Location[4]					
T1	MS	H	8/44.2	Y/?	BT	15,000	8,479 Sludge = 791	RAD, TRU	No	OHF EE/CA
T2	MS	H	8/44.2	Y/?	BT	15,000	10,544 Sludge = 1,205	RAD, TRU	No	OHF EE/CA
T3	MS/ RL	H	10.5/42	Y/?	BT	25,000	2,918 Sludge = 2,029	RAD, TRU	No	OHF EE/CA
T4	MS/ RL	H	10.5/42	Y/?	BT	25,000	14,668 Sludge = 1,328	RAD, TRU	No	OHF EE/CA
T9	MS	H	10/19.5	Y/?	BT	13,000	4,981 Sludge = 481	RAD, TRU	No	OHF EE/CA
T-1	SS	H	10/27.5	N	BT	15,000	Varies (Active)	RAD, TRU, Organics	No	Active until FY 1997; Remediate in FY 2001
T-2	SS	H	10/27.5	N	BT	15,000	Varies (Active)	RAD, TRU, Organics	No	Active until FY 1997; Remediate in FY 2001
T-14	C	V	29.3/11.7	Y/12	BT	48,500	Unknown; Jan. 97 video shows sludge and hardened grout	RAD, Oil (TSCA?)	No	Isolation in FY 1997; Remediate FY 2000?
T-30	SS	-	-	-	-	825	---	-	---	In-place stabilization FY 1996
TH-1	SS	V	7/10	Y/?	BT	2,500	Empty	-	No evidence of leaks	Tank evaluation
TH-2	SS	V	7/10	Y/?	BT	2,400	Empty	-	No evidence of leaks	Tank evaluation

file name: tank-sum.tbl - 5/4/97

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000222

ORNL FFA Category C and D Tanks Summary Information (Page 4 of 8)

Tank Number	Tank Physical Characteristics					Capacity (gal)	Current Content Volume (gal)[5]	Contaminants of Concern (RAD, TRU, RCRA, TSCA)	Inleakage/ Outleakage	Status
	Material[1]	Orientation[2]	Dia./Length (ft)	Riser/Dia. (in.)[3]	Location[4]					
TH-3	SS	V	9.2/10	Y/?	BT	3,300	Empty	-	No evidence of leaks	Tank evaluation
TH-4	G	V	20/9	Y/?	BT	17,900	5,400 Sludge = 5,500	RAD, RCRA	Inleakage	GAAT OU
W-1	G	V	8/12	Y/?	BT	4,800	2,900	RAD	Inleakage	GAAT OU
W-1A	SS	H	7.5/13.5	Y/?	BT	4,000	Varies	RAD, TRU, RCRA	Inleakage	GAAT OU
W-1I	SS	H	4/5	N	BT	500	Empty	RAD	No	Remediate FY 2001
W-2	G	V	8/12	Y/?	BT	4,800	2,000	RAD	Inleakage	GAAT OU
W-3	G	V	25/12	Y/?	BT	42,500	15,700 Sludge = 600	RAD, TRU, RCRA	Inleakage	GAAT OU
W-4	G	V	25/12	Y/?	BT	42,500	29,800 Sludge = 1,300	RAD	Inleakage	GAAT OU
W-5	G	V	50/12	Y/?	BT	170,000	28,000 Sludge = 3,400	RAD, TRU, RCRA	Inleakage	GAAT OU
W-6	G	V	50/12	Y/?	BT	170,000	41,500 Sludge = 7,000	RAD, TRU, RCRA	Inleakage	GAAT OU
W-7	G	V	50/12	Y/?	BT	170,000	3,600 Sludge= 8,800	RAD, TRU, RCRA	Probably not	GAAT OU
W-8	G	V	50/12	Y/?	BT	170,000	64,600 Sludge = 10,300	RAD, TRU, RCRA	Inleakage	GAAT OU

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000224

ORNL FFA Category C and D Tanks Summary Information (Page 5 of 8)

Tank Number	Tank Physical Characteristics					Capacity (gal)	Current Content Volume (gal)[5]	Contaminants of Concern (RAD, TRU, RCRA, TSCA)	Inleakage/ Outleakage	Status
	Material[1]	Orientation[2]	Dia./Length (ft)	Riser/Dia. (in.)[3]	Location[4]					
W-9	G	V	50/12	Y/?	BT	170,000	45,600 Sludge = 2,900	RAD, TRU, RCRA	Very slight leakage	GAAT OU
W-10	G	V	50/12	Y/?	BT	170,000	105,900 Sludge = 9,300	RAD, TRU, RCRA, TSCA (34 ppm)	Very slight leakage	GAAT OU
W-11	G	V	8/5.5	Y/?	BT	1,500	800	RAD, RCRA	Inleakage during heavy rain	GAAT OU
W-12	SS	V	4/5.3	Y/3	BT	700	Varies	RAD	Slight Inleakage	Remediate FY 1997
W-13	SS	H	6/11	Y/?	BT	2,000	Empty	-	No evidence of leaks	GAAT OU
W-14	SS	H	6/11	Y/?	BT	2,000	Empty	-	No evidence of leaks	GAAT OU
W-15	SS	V	8/6	Y/?	BT	2,000	Empty	-	No	GAAT OU
W-16	SS	V	5.5/7.3	Y/3	BT	1,000	Varies (Active)	RAD	No	Active Until FY 1998; Remediate FY 1999
W-17	SS	V	5.5/7.3	Y/2	BT	1,000	Varies	RAD	Inleakage	Remediate FY 1999
W-18	SS	V	5.5/7.3	Y/3	BT	1,000	Varies	RAD	Inleakage	Remediate FY 1999
W-19	SS	V	7/8.5	Y/?	BT	2,250	Empty	-	Dry when last inspected	Remediate FY 1998
W-20	SS	V	7/8.5	Y/?	BT	2,250	Empty	-	Dry when last inspected	Remediate FY 1998
WC-1	SS	V	8.7/6	Y/3	BT	2,150	Empty	RAD, TRU	No (since March)	Tank evaluation

file name: tank-sum.tbl - 5/4/97

000221

000226

ORNL FFA Category C and D Tanks Summary Information (Page 6 of 8)

Tank Number	Tank Physical Characteristics					Capacity (gal)	Current Content Volume (gal)[5]	Contaminants of Concern (RAD, TRU, RCRA, TSCA)	Inleakage/ Outleakage	Status
	Material[1]	Orientation[2]	Dia./Length (ft)	Riser/Dia. (in.)[3]	Location[4]					
WC-2	SS	V	5.5/6.75	Y/2	BT	1,000	Varies (Active)	RAD	No	Active Until FY 1998; Remediate FY 1998
WC-3	SS	V	5.5/6.75	?	BT	1,000	Varies (Active)	RAD	No	Active Until FY 1999; Remediate FY 2000
WC-4	SS	V	7/7	Y/2	BT	1,700	Varies Sludge Cake < 250 gal	RAD, TRU, RCRA	Very slight Inleakage	Remediate FY 1998
WC-5	SS	-	-	-	-	1,000	-	-	-	In-place stabilization FY 1997
WC-6	SS	-	-	-	-	500	-	-	-	In-place stabilization FY 1997
WC-7	SS	-	-	-	-	1,100	-	-	-	In-place stabilization FY 1996
WC-8	SS	-	-	-	-	1,000	-	-	-	In-place stabilization FY 1997
WC-9	SS	V	7/10.75	Y/?	BT	2,150	Varies (Active)	RAD	No	Active Until FY 1999; Remediate FY 2000
WC-10	SS	H	6.3/10.3	Y/?	BT	2,000	Varies (Active)	RAD, Oil (TSCA?)	Inleakage	Active Until FY 1998; Remediate FY 1999
WC-11	SS	H	7.7/13.7	Y/?	BT	4,600	Varies Sludge = ? (Sediment = 1" depth)	RAD	Nonprogramatic waste input (filter pit, cell ventilation pump)	Remediate FY 2001 (Has an oily later)

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000228

ORNL FFA Category C and D Tanks Summary Information (Page 7 of 8)

Tank Number	Tank Physical Characteristics					Capacity (gal)	Current Content Volume (gal)[5]	Contaminants of Concern (RAD, TRU, RCRA, TSCA)	Inleakage/ Outleakage	Status
	Material[1]	Orientation[2]	Dia./Length (ft)	Riser/Dia. (in.)[3]	Location[4]					
WC-12	SS	V	5.5/7.3	Y/?	BT	1,000	Varies Sludge = ? (Sediment = 0.5" depth)	RAD	Nonprogramatic waste input (sump)	Remediate FY 2001 (Has an oily later)
WC-13	SS	V	5.5/7.3	Y/?	BT	1,000	Varies Sludge < 170	RAD, RCRA	Nonprogramatic waste input (floor sump)	Remediation FY 2001 (Has an oily later)
WC-14	SS	V	5.5/7.3	Y/?	BT	1,000	Varies Sludge < 130	RAD, TRU. RCRA, TSCA	Nonprogramatic waste input	Sludge removal in FY 1997; Remediate FY 2001
WC-15	SS	V	5.5/7.3	Y/?	BT	1,000	1,000	RAD	No	Tank evaluation
WC-17	SS	V	5.5/7.3	Y/?	BT	1,000	400	RAD	Inleaks groundwater	Tank evaluation
WC-19	SS	H	6/10.6	Y/?	BT	2,250	Varies	RAD	Inleakage Via Filter Pit	Taken Out of Service in late FY 1996; Remediate FY 1997
WC-20	SS	V	10/19	N	IGV	10,000	Varies (Active)	RAD, TRU (organic solvents and extractants)	No	Active Until FY 1997; Remediate FY 2001

000229

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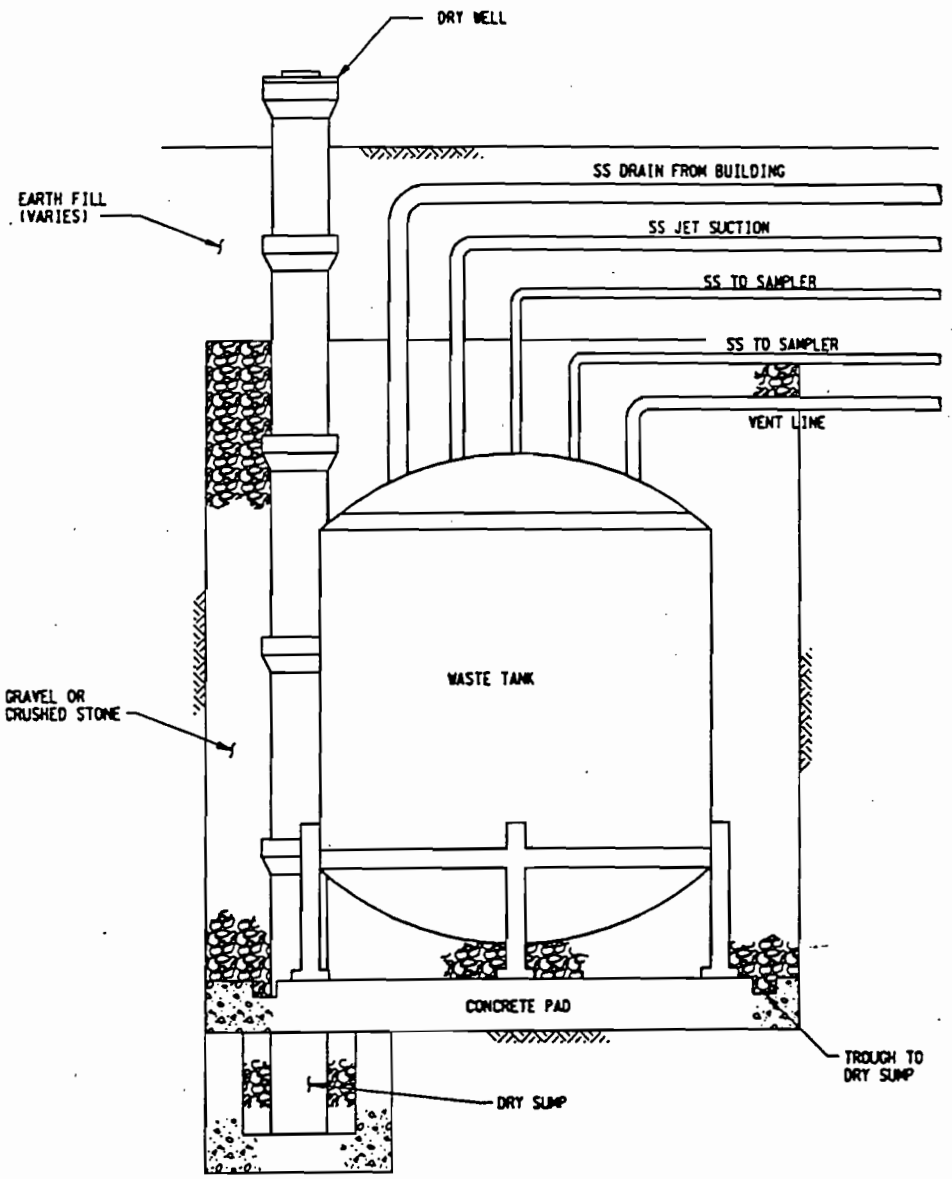
Table Legend and Notes:

CERCLA—Comprehensive Environmental Response, Compensation, and Liability Act
EE/CA—engineering evaluation/cost analysis
FY—Fiscal Year
GAAT—Gunite and Associated Tanks
OHF—Old Hydrofracture Facility
OU—Operable Unit

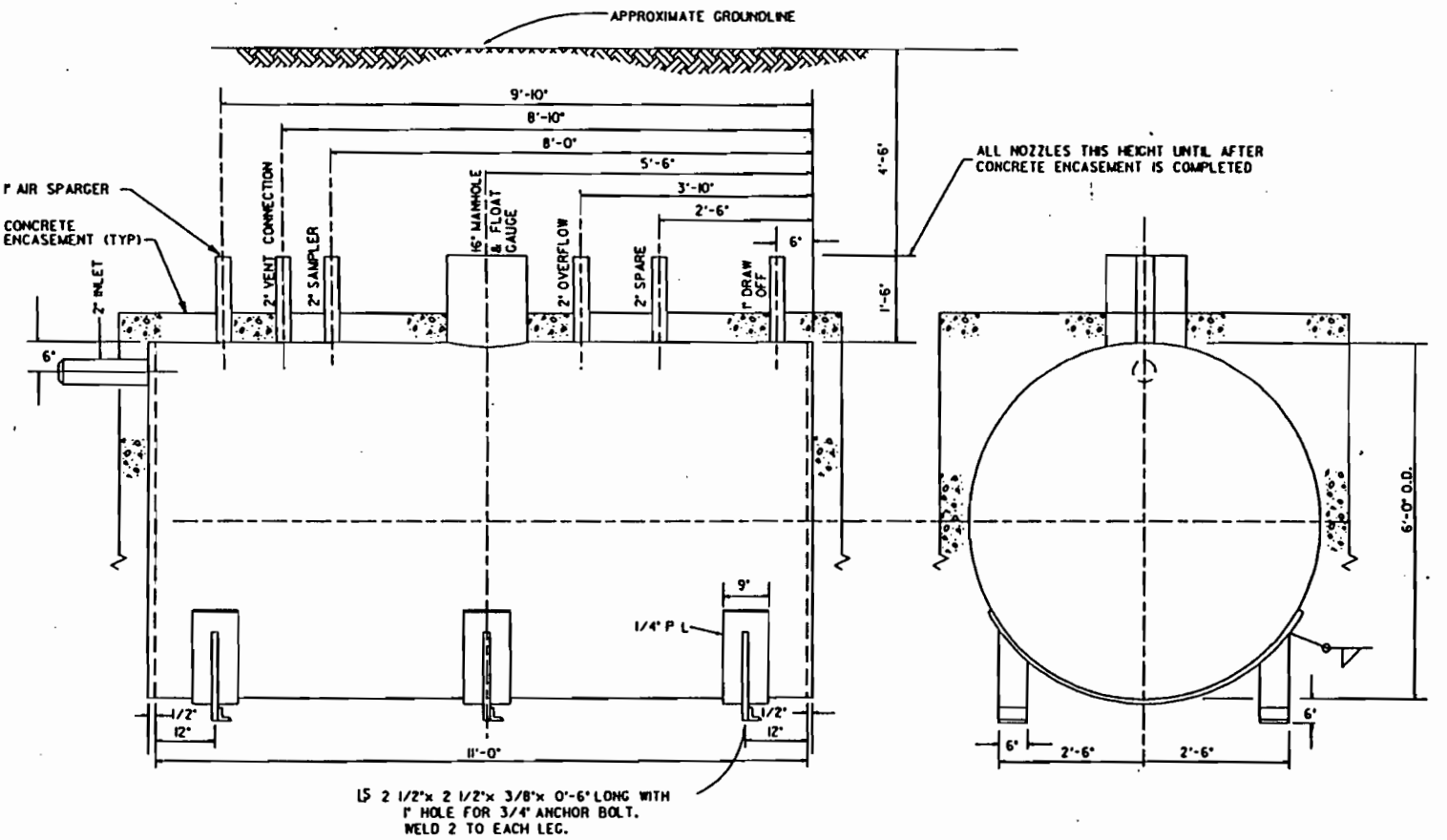
Note 1 - Tank Construction material: C = concrete; CS = carbon steel; G = Gunite; GL = glass lined; MS = mild steel; RL = rubber lined; SS = stainless steel.
Note 2 - Tank Orientation: H = horizontal; V = vertical.
Note 3 - Tank riser is present (Y=yes, N = no) with the diameter (dia.) reported in inches.
Note 4 - Tank location: BT = buried tank; IGV = in-ground vault.
Note 5 - Current contatent volume reported represents the liquid volume with additional sludge volume indicated where present.

See attached figures which show typical cross-sections for: (1) Gunite tank, (2) stainless-steel, horizontal tank, and (3) stainless-steel, vertical tank.

000232

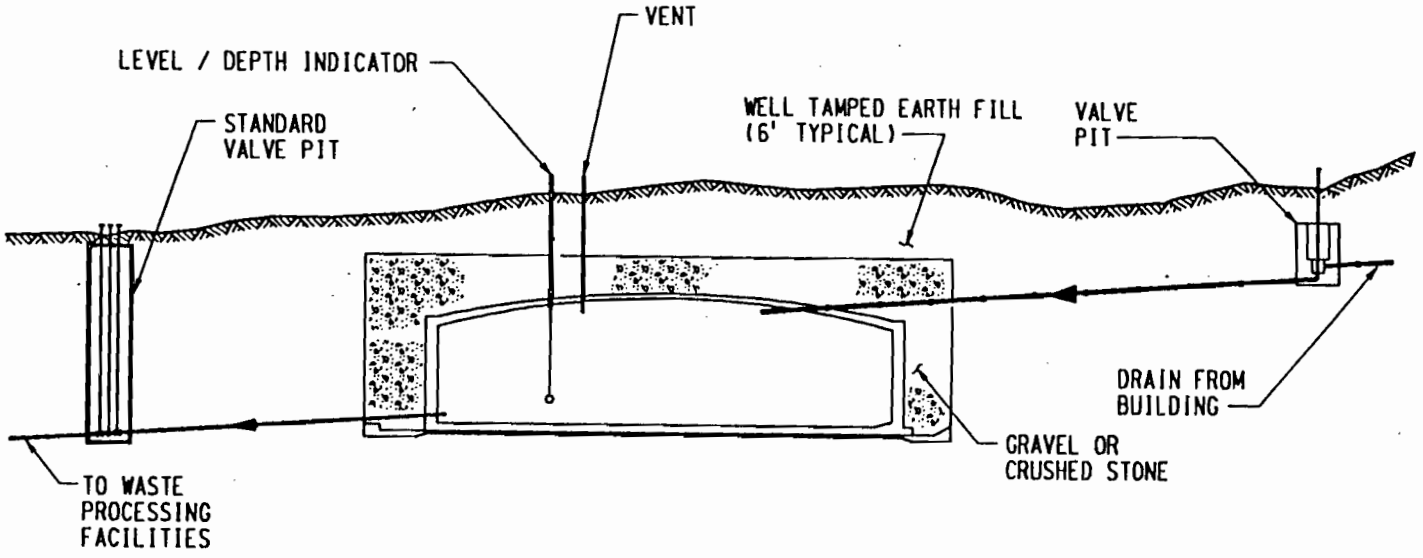


~~Fig. 3.5.8~~. Typical vertical stainless steel waste tank installation.



~~Fig. 3.3.7~~. Typical horizontal stainless steel waste tank installation.

000235



~~Fig. 3.5.~~6. Typical concrete (Gunite) waste tank installation.

000237

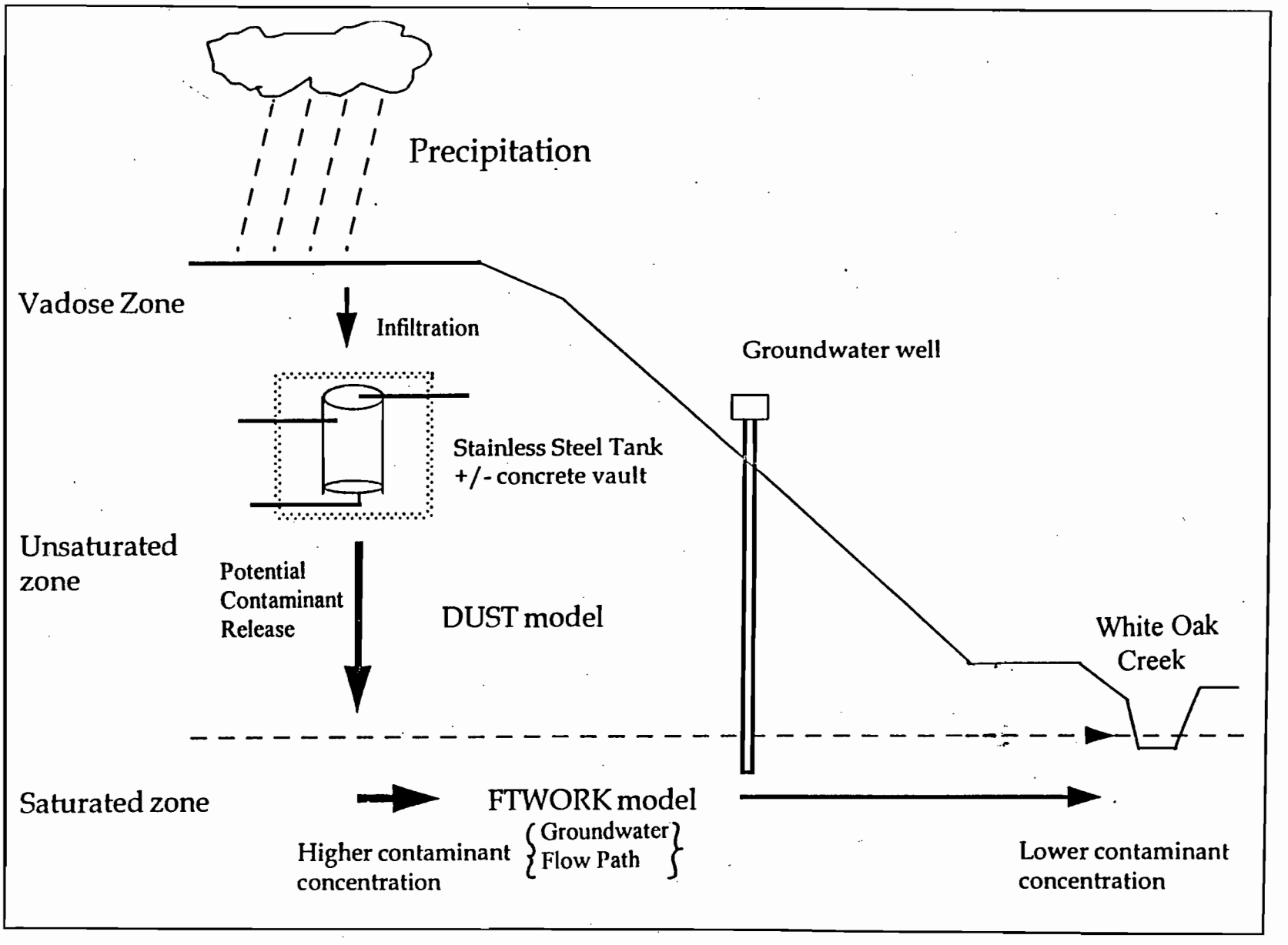


Fig. 3. Site conceptual model for human health risk assessment.

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000240

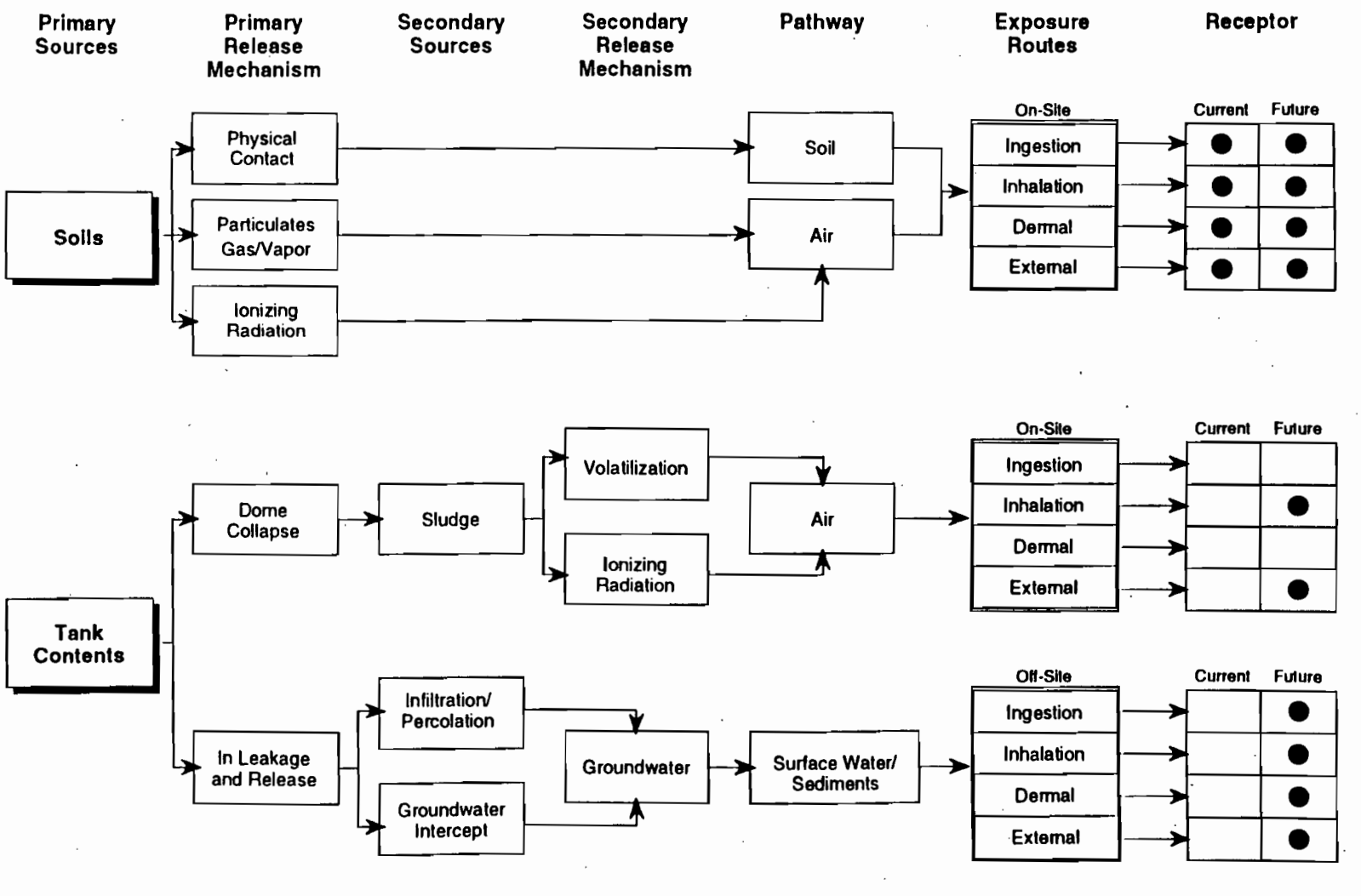

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Fig. 5.1

GAAT

Conceptual model for fate, transport, and risk assessment

DOE — ORNL, WAG 1, Gunite and Associated Tanks — Oak Ridge, Tennessee

DOCUMENT ID 35H830 5801-70 / RI/RA

DRAWING ID 94-11075D PD3

DRAWING DATE: OCTOBER 20, 1994 Be

000241

Inactive Tank Remediation Strategy and Plans for ORNL (1997).

2.2 RISK ASSESSMENT STRATEGY

The ORNL Inactive Tank Program risk assessment strategy is based on an incremental approach in which quantitative decision rules are used to help ensure a conservative method with a minimum of modeling (DOE 1995b). The primary radionuclide contaminants of potential concern (COPCs) evaluated include ^{137}Cs, ^{60}Co, ^{244}Cm, ^{239}Pu, ^{90}Sr, ^{3}H (tritium), and ^{238}U. Inorganic COPCs are also factored into the risk evaluation, but because of their low concentrations, they usually are negligible risk contributors. As stated in many ORNL CERCLA documents, the primary risk drivers are the radionuclides. Ingestion of groundwater is the only exposure pathway that is evaluated for the future residential exposure scenario. Because leached COPCs in groundwater are assumed to be at 100% concentration in drinking water, this pathway reflects the most conservative risk evaluation as compared with other potential residential exposure pathways (i.e., inhalation or dermal contact). Additional conservative assumptions for the ingestion through the groundwater pathway are a 2 L/day intake rate for a 350 day/year exposure frequency. Calculated contaminant concentrations in groundwater are used to estimate projected risk by comparison with risk-based screening levels (also referred to as preliminary remediation goals, PRGs).

The site conceptual model for this exposure assessment is presented in Fig. 3. This exposure assessment assumes tank failure (either localized or general) has occurred and contaminants have been released to the surrounding environment. After release from the tank, contaminants are transported to the groundwater interface at the saturated zone by precipitation/infiltration through the unsaturated soil. Precipitation/infiltration into tanks has been modeled by using Oak Ridge Reservation–specific precipitation rates. Infiltration rates are assumed to equal precipitation rates. Vertical fate and transport modeling of contaminant migration into groundwater is performed through the use of the Disposal Unit Source Term (DUST) code developed at the Brookhaven National Laboratory for the Nuclear Regulatory Commission. In the DUST code, general failure is

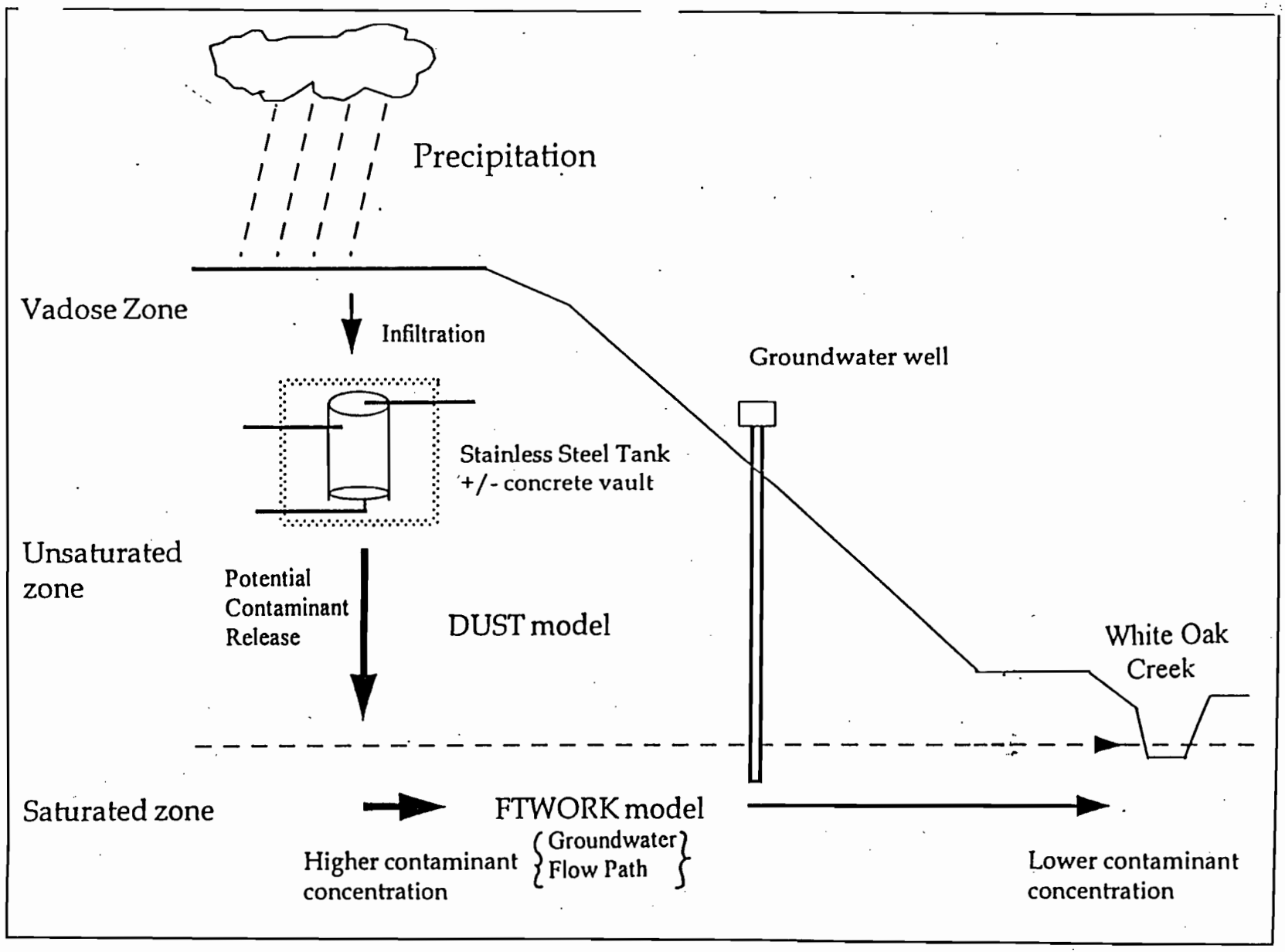

Fig. 3. Site conceptual model for human health risk assessment.

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estimated to be the thickness of the container (i.e., tank shell) divided by the time averaged corrosion rate at which time the container is assumed to no longer provide a barrier for contaminant releases.

Flow through the saturated zone (groundwater medium) is performed by using FTWORK. This is a three-dimensional, finite-difference model that is used to simulate groundwater flow and solute transport process under confined and unconfined conditions. FTWORK was developed for the Savannah River Site to simulate groundwater flow through large, complex, multilayered, fully saturated, porous hydrogeologic systems. The model is currently being calibrated by ORNL hydrogeologists to simulate groundwater flow underlying the ORNL WAG 1 area (main plant area) and the flow scenario to White Oak Creek.

In summary, this conservative risk assessment model assumes that the tank fails, the tank residual waste leaches into the unsaturated-saturated zone interface, and an on-site resident consumes 2-L/day of the contaminated groundwater. If this risk exceeds or is within the EPA range of concern, more realistic assumptions are made (i.e., groundwater modeling is performed to include dilution of contaminants at the nearest surface water source) and an enhanced risk assessment is performed to determine if the tank should be addressed through a more rigorous CERCLA risk assessment/remediation process. This enhanced risk assessment allows for attenuation of the contaminants through soil as they transport via groundwater to the nearest stream, which usually results in an acceptable risk to the receptor in contact with this surface water.

Tanks that pose no significant risks by CERCLA definition still require remediation under the FFA because they are listed in Appendix F of the FFA. If the risk is below the EPA range of concern, the tank shell and residuals are a candidate for remediation as a maintenance action. If after performing a more rigorous risk assessment and is above the EPA range of concern, the tank shell and residuals should be included in a seperate removal action process (EE/CA) or Bethel Valley RI/FS/PP ROD.

Table 3.3 is a summary of results from the initial screening-level risk assessment performed for the Group D tanks in June 1995. This table has been annotated to show current (April 1995) status.

Table 3.3

Overview of Screening-level Risk Assessment for Inactive Tanks

		Risk at saturated zone	Risk after FTWORK	Risk Assessment Status
Batch I Series I	3001-B	9.E-08		NFRA } Closed 12/96
	3013	1.E-08		NFRA }
	T-30	2.E-04	5.E-09	NFRA – Closed 8/96
	3004-B	6.E-34		NFRA, Removed 12/96
Batch I Series II	H209	3.E-07		NFRA — Closed FY96
Batch I Series III	WC-1	1.E+00	2.E-02	W/GW analysis
	W-19			New data } Empty Tanks
	W-20			New data } -need to take smears (rad)Cs
Batch II	T-1	2.E-01	Prefer.Path	Full RA } Sludge Removal Being Addressed by OHF Tank Proj.
	T-2	8.E-02	Prefer.Path	Full RA
	T-3	1.E-01	Prefer.Path	Full RA
	T-4	2.E-01	Prefer.Path	Full RA
	T-9	1.E-01	Prefer.Path	Full RA
Batch III	4501-P	1.E-06		NFRA — closed FY96
	WC-5	7.E-08		NFRA } closed FY97
	WC-6	< 7.E-08		NFRA
	WC-8	2.E-07		NFRA
	WC-9	No info.		
	TH-1	Tank emptied. No inventory info.		} Empty Tanks
	TH-2	Tank emptied. No inventory info.		
	TH-3	Tank emptied. No inventory info.		
	3002-A	No inventory info. – Sampled FY96/97 Risk $<10^{-6}$		} To be closed FY97
	3003-A	Concrete failure		Model

		Risk at saturated zone	Risk after FTWORK	Risk Assessment Status
Batch IV	S-424	Tank empty. No inventory info.		
	T-14	Concrete failure.		Model
	W-12	(L) 9.E-04		Sludge, GW
	WC-4	(L) 8.E-05		Sludge, GW (FY9
	W-11	No inventory info.		
	LA-104	Vault a problem. – Removed 3/96		
Batch V	7503-A	No inventory info.		
	7560	~~Low amounts, but not sampled.~~ Empty } Clo		
	7562	3.E-04		GW model } FY9
	WC-10	No info. (Active til FY98) – FY		
	WC-11	7.E-04		GW model
	WC-12	(L) 9.E-04		Sludge, GW
	WC-13	1.E-04		GW model
	WC-14	2.E-02		GW model
	WC-15	1.E-06		GW model
	WC-17	1.E-07		NFRA

WC-19 Sampled FY97 Risk $<10^{-6}$ (To be closed FY97)

WC-7 Sampled FY96 Risk $<10^{-6}$ (~~to be~~ closed FY96)

Updated 4/22/97

{Risk Assessment performed by Martin Clauberg}

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GAAT RI/BRA

6. RISK ASSESSMENT

Chapter 6 discusses the potential health effects associated with the GAAT OU. It describes the scope, objectives, and methodology for the risk assessment; toxicity assessment; risk characterization; and uncertainties present in the performance of the risk assessment. It discusses possible health risks from direct and indirect exposures to the source and quantitatively evaluates the range of possible off-site future impacts.

Risk is a two-dimensional concept involving the possibility of an adverse outcome and uncertainty over the occurrence, timing, or magnitude of the outcome. If either of these attributes is absent, there is no risk. Risk assessment is therefore a systematic process for describing and quantifying the risks associated with hazardous substances, processes, actions, or events. There are various numerical measures available to quantify the occurrence, magnitude, and timing of health and environmental consequences. However, given the high degree of uncertainty associated with both the probability and magnitude of risk for this particular OU and the inherent subjectivity in making the assessment, the quantitative assessment generally applies conservative assumptions and extreme conditions based on limited available data. Baseline risk assessments are always site-specific, and, therefore, may vary from site to site in both detail and the extent to which quantitative and qualitative analyses are used.

6.1 APPROACH TO RISK ASSESSMENT

This section describes the approaches chosen for the human health and ecological risk assessments and addresses land use considerations.

6.1.1 Human Health Risk Assessment

To effectively make risk management decisions for the GAAT OU, the risk assessment must evaluate current and future risks to human health and the environment for receptors located in the on-site and off-site areas. A risk assessment was performed for the GAAT OU to meet these two objectives and to provide quantitative and qualitative risk information needed to make remedial action selection decisions. The level of assessment for impacts to environmental media outside the scope of the GAAT OU must be complete enough to determine whether the tank sources have a potential to impact other media above levels of concern. However, a complete baseline risk assessment for previously impacted media (soil, groundwater, stream sediment, and surface water) is not necessary for this source OU risk assessment and associated remedial action decision making, since these media will be addressed in separate RI and FS evaluations. An analysis of the risk assessment results obtained for the GAAT OU will also serve to evaluate the

degree of coupling that the GAAT OU has with other OUs, and accordingly influence decisions regarding the other OUs.

This human health risk assessment focuses on the Gunite tanks and their respective contents and is intended to supplement the preliminary risk assessment report (Bechtel 1992a) and the site characterization summary report (Bechtel 1992b) previously issued for WAG 1. The assessment utilizes existing and available information from previous investigations to evaluate present and future risk to on-site and off-site receptors, for reasonable current and future land uses. Characterization information regarding the D&D facilities and the assessment necessary to support alternative selection for these facilities is being conducted separately, as discussed in Chapter 5. It is assumed that the D&D evaluation and conclusions can be decanted from the risk assessment effort for the Gunite tanks.

6.1.2 Ecological Risk Assessment

Protection of wildlife, fisheries, threatened and endangered species, and sensitive habitats is required by CERCLA as amended by Superfund Amendments and Reauthorization Act. The ecological risk assessment is the second element of the baseline risk assessment and provides a basis for decisions on remediation as it concerns risks to nonhuman species. Guidelines for conducting ecological risk assessments are provided in *Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual* (EPA 1989b), which allows some flexibility in conducting the ecological risk assessment depending on the nature and extent of environmental resources impacted by a site.

The GAAT OU consists of tanks and their associated appurtenances and is in a highly developed site at ORNL. The tanks themselves do not provide habitat for any ecological receptors, and, hence, no current completed exposure pathways exist. A breach in the tanks under some future land use scenario could result in contamination of the surrounding soils and groundwater and subsequently of the surface water. Although ecological receptors would be likely under this scenario, an evaluation of any impacts will be assessed during future risk assessments for those separate OUs. During the WAG 1 RI, a preliminary ecological risk assessment was conducted (Bechtel 1992). Similarly, any releases from the GAAT OU will primarily impact (i.e., groundwater and soil) White Oak Creek and White Oak Lake (WAG 2), for which a separate ecological risk assessment is being conducted.

Due to the nature of the GAAT OU and the fact that effects of any releases from the tanks will be addressed by future investigations, this risk assessment for the GAAT OU does not address any potential, adverse ecological effects. However, in the FS, ARARs and ecological

risks for future off-site impacts from the GAAT OU should be considered for remedies that leave the waste contents in a leachable state.

Moreover, the primary COCs are radionuclides, the effects of which can be difficult to assess on various components of an ecosystem. Radionuclides released to aqueous environments may accumulate in bottom sediment or remain suspended in the water column in a dissolved state, depending on the element and chemical form. They can subsequently accumulate in biota and be transported throughout the food chain. This results in an increase in the radiation exposure of exposed natural populations. Generally, the result is the long-term, low-dose-rate exposure of organisms in the environment. This type of exposure does not result in acute mortality; rather, a very small increase in morbidity and mortality is likely. The prediction and detection of these effects is problematic because of natural fluctuations in population sizes (Blaylock et al. 1993).

The general approach to establishing cleanup goals and for assessing remedial actions for the GAAT OU is to maintain levels of radioactivity that protect the environment and result in no anticipated adverse effects on ecological systems. Therefore, establishing criteria that protect human health is expected to be sufficiently conservative to protect ecological receptors during decontamination and restoration efforts for this source OU.

An excavation worker scenario was evaluated in the initial assessment of receptors. Because parameters for this scenario rely on professional judgment without guidance of published references, there is a high uncertainty associated with assumptions for intake parameters and subsequent calculations. This scenario was not considered in this baseline risk assessment because screening indicated this receptor most likely would not have the highest exposure. Any exposure this receptor would receive would be short-term and acute, and the associated uncertainty would be high.

The exposure pathways quantified in this baseline risk assessment were determined on the basis of the site conceptual model and related characterization data. The uncertainty associated with selected pathways for this assessment is low because site characterization data support the conceptual model.

6.6 SUMMARY OF HEALTH RISK CHARACTERIZATION

The radiological health risks considered are limited to induction of cancer. Risk from exposure to radioactive contaminants was estimated following EPA (EPA 1989c) and BEIR V (National Research Council 1990) recommendations. A population-weighted average excess cancer risk of 6×10^{-7} per mrem was assumed.

For the current use scenario, the estimated radiological risks (2×10^{-3}) for the RME and the mean (2×10^{-4}) exceed the EPA target risk range for an employee at GAAT OU. In the future use scenario, both the estimated radiological risk for the RME exposure (2×10^{-2}) and

mean exposure (5×10^{-2}) greatly exceed the EPA target risk range for an employee at GAAT OU. The external gamma irradiation pathway contributes the highest percentage of the radiological risk in the current employee scenario. Risk estimates may be biased by sampling location and might not accurately reflect the current situation since employees do not often work in these areas.

For the future on-site resident, both the RME (6×10^{-1}) and mean (9×10^{-2}) exceeded the EPA target risk range.

For the hypothetical future use scenarios, RME and mean exposures for children wading in the drainage system accessible at White Oak Creek do not exceed the EPA target range. Additionally, risks calculated for nearby residents consuming groundwater exceed the EPA risk range for the RME (1×10^{-3}) and mean (3×10^{-4}) exposures. Drinking groundwater is the major contributor to risk in future use scenarios.

OHF Tanks EE/CA

3.4 STREAMLINED RISK EVALUATION

The ORNL Risk Analysis Section has conducted a screening level risk assessment on the five OHF tanks. Liquid-level monitoring and dry well sampling indicate that the tanks are not leaking, so current use scenarios are not evaluated because there are no completed exposure pathways. This risk analysis focuses only on future use scenarios. It was assumed that the tanks would eventually rust through and release their contaminants and eventually infiltrate the soil and groundwater. A transport pathway for the contaminants was assumed to be a direct preferential flow path through the underlying gravel and through or along a vitrified clay pipe that outflows close to the access road on Melton Branch. Two receptor points were evaluated on site and off site, with the most conservative being the future on-site resident using the contaminated groundwater immediately below gradient of the tanks.

The Disposal Unit Source Term (DUST) model was used to estimate the time to failure for the OHF tanks. Based on the DUST estimates, the time to failure, when the entire tank shell will disappear, is 160 years. However, contaminants will be released earlier because the tank shells experience localized failures resulting from corrosion and stress. Insufficient data are available to predict time or degree of localized failure; localized failure may occur at any time. The DUST model was also used to calculate the flux of contaminants entering the groundwater, from which the predicted maximum groundwater concentration was derived for each contaminant. These maximum concentrations were compared to preliminary remediation goals for residential groundwater usage to calculate resultant screening level risks.

Risks from each tank exceeded the EPA-acceptable risk range of 1×10^{-6} to 1×10^{-4}. Table 4 summarizes these risks and presents the contaminants that individually contribute a risk of more than 1×10^{-6}, in their relative order of magnitude, for each tank.

Table 4. Summary of future risk for the OHF tanks, ORNL, Oak Ridge, Tennessee

Tank	Total risk	Significant contaminants
T-1	2×10^{-1}	^{90}Sr, ^{238}Pu, ^{239}Pu, ^{233}U, ^{137}Cs
T-2	8×10^{-2}	^{90}Sr, ^{239}Pu, ^{238}Pu, ^{233}U, ^{137}Cs
T-3	1×10^{-1}	^{233}U, ^{90}Sr, ^{239}Pu, ^{238}Pu, ^{244}Cm, ^{137}Cs
T-4	2×10^{-1}	^{90}Sr, ^{241}Am, ^{238}Pu, ^{239}Pu, ^{233}U, ^{244}Cm, $^{230,232}Th$, ^{137}Cs
T-9	1×10^{-1}	^{90}Sr, ^{238}Pu, ^{239}Pu, ^{233}U, ^{244}Cm, ^{137}Cs

Am = americium
Cm = curium
Cs = cesium
OHF = Old Hydrofracture Facility
ORNL = Oak Ridge National Laboratory
Pu = plutonium
Sr = strontium
Th = thorium
U = uranium

Because this was a streamlined analysis, several uncertainties are associated with these calculated risks. Major sources of uncertainty involve the assumption of a local or general failure scenario for these tanks, use of default solid-to-liquid distribution coefficients and other modeling parameters, and presence of a future on-site resident who uses water drawn from the location 2where the contaminant plume interacts with the groundwater (i.e., the point of maximum concentration). These uncertainties tend to err on the side of conservatism. Actual future risks may be significantly lower than those reported. However, given the calculated risks were two to three orders of magnitude greater than the upper limit of the EPA target risk range, the calculations are sufficient to justify remedial actions for these tanks.

ORNL/ER-297/R1

Energy Systems Environmental Restoration Program

Inactive Tanks Remediation Program Strategy and Plans for Oak Ridge National Laboratory, Oak Ridge, Tennessee

Date Issued—March 1997

Prepared by
STEP, Inc.
Oak Ridge, Tennessee
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Environmental Management Activities at
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Oak Ridge, Tennessee 37831
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Inactive Tank Strategy and Plans

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DOE/OR/01-1587&D0

Energy Systems Environmental Restoration Program
ORNL Environmental Restoration Program

Implementation Plan for Liquid Low-Level Radioactive Waste Tank Systems Under the Federal Facility Agreement for Fiscal Year 1998 at Oak Ridge National Laboratory Oak Ridge, Tennessee

April 1997

Prepared by
Waste Management and Remedial Action Division
Oak Ridge, Tennessee

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ORNL/ER-391

Energy Systems Environmental Restoration Program

Site Descriptions of Environmental Restoration Units at Oak Ridge National Laboratory, Oak Ridge, Tennessee

A. J. Kuhaida, Jr.
A. F. Parker

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OHF Tank EE/CA

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NO ADDITIONAL INFORMATION IS AVAILABLE

Data Summary - Surface Impoundments

- Impoundments 3524 and 3513, built in the ORNL Main Plant area in the early 1940's, were used as holding basins for the process waste treatment system. Impoundments 3539 and 3540 were built in 1964 to hold process waste water from the Building 4500 complex.

- The four surface impoundments occupy a total of 4 acres and contain approximately 3500 m^3 of sediment. These sediments are primarily contaminated with radionuclides with some RCRA constituents (e.g., mercury and lead) and TSCA constituents (PCBs).

- The SIOU Remedial Investigation/Feasibility Study Report has been approved by EPA and TDEC.

- Corrective actions are taken, as needed, to mitigate seepage from the Impoundment 3513 berm into White Oak Creek.

- A No Action alternative will result in human health and ecological risks from leaching of contaminants into groundwater, and ecological risks due to consumption of fish by wildlife from the impoundments and White Oak Creek.

- Consolidation of the contaminants in an on-site cell should result in no off-site risk (i.e., at White Oak Creek).

- Two feet of water cover is maintained to provide shielding to prevent exposure to contaminated sediments.

- Current discharge to White Oak Creek from seeps is approximately 26 pCi/L of Strontium-90.

Documents Reviewed

Remedial Investigation/Feasibility Study for Surface Impoundments Operable Unit Waste Area Grouping 1 Oak Ridge National Laboratory, Oak Ridge, Tennessee, DOE/OR/02-1346&D2, November 1995.

Bethel Valley RI/FS Historical Data Review

Form Completed by: M. Collins Sigmond
Date: 4/16/97

Document Reviewed: RI/FS for S/OU WAG 1 at ORNL
Doc ID: DOE/OR/02-1346 & D2
Author/Date: LMES / Nov 1995

Comments:

WAG	Description of Study	Waste Unit	Waste Unit Characteristics	Sampling Dates	Sampling Media	Sampling Locations	Sampling Protocol	Analytical Fraction	Decision Rule(s)	Quality or Confidence
1	R/FS	S/OU	Intermittent	'84	SED	3524	G	P ISO	1C	M
			accumulation of	87	SED	3524	G	ISO/GR	1C	M
			radionuclides in	84	SED	3513	G	ISO	1C	M
			3524, 3513, &	87	SED	3513	G	ISO/GR	1C	M
			3539	87	SED	3513	G	ISO	1C	M
				84	SED	3513	G	I/P	1C	M
				85	SW	"	"	I/P/O/ISO/GR	1C	M
				78	SW	"	G	I/ISO	1C	M
				1987	SED	3539	G	ISO/GR	1C	M
				1986	SED	3539	G	P	1C	
		WOC		1994	SW		G	GR	1D	
				1990-91	GW	3513	BG/SG	O/I/ISO	1D	
						3524			"	
						3539-40			"	
	STATISTICAL ANALY.	S/OU			GW	ALL		I/ISO/GR	1C	
				1986	GW	3513	G	GR/mercury	1D	

General:
NA = Not Available
NR = Not Researched
(blank) = Unknown

Sampling Media:
surface soil
subsurface soil
surface water
groundwater
seep or spring
sediment
waste
biota

Sampling Protocol:
G = grab
SG = stormflow grab
BG = baseflow grab
FC = flow composite
SC = spatial composite
V = vertical profile
S = site survey

Analytical Fraction:
I = Inorganics
O = Organics
P = PCBs/Pesticides/Herbicides
GR = gross alpha/beta
ISO = isotopic rads
B/G = beta/gamma survey
FLD = field measurements

Decision Rule / Hypothesis
1 = Source characteristics
1A = design/operation
1B = leachate
1C = waste inventory
1D = waste unit hydrology
1E = other FS information
2 = Current releases
2A = shallow groundwater, seeps
2B = deep groundwater
2C = soil around waste units
2D = sediment
2E = cummulative @ integration point
3 = Current risk
4 = Modeling for future risk
3A/4A = human health risk
3B/4B = ecological risk

Waste Unit Characteristics:
type?
status?
size/capacity?
ownership?

Sampling Locations:
List specific locations if possible.
Otherwise, indicate scope of sampling effort.

Confidence:
H = High
M = Medium
L = Low

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Bethel Valley RI/FS Historical Data Review

Form Completed by: M. Collins Shepard
Date: 4/16/97
Comments: Continued -

Document Reviewed: RI/FS SOU (Cont.)
Doc ID:
Author/Date:

WAG	Description of Study	Waste Unit	Waste Unit Characteristics	Sampling Dates	Sampling Media	Sampling Locations	Sampling Protocol	Analytical Fraction	Decision Rule(s)	Quality or Confidence
1	RI/FS	SOU		1994	SED	3524/3513	G	O/I/ISO	1C	H
				"	I SW	"	G	ISO/GR	1C	H
				"	SED	3539/3540	G	ISO/I/O/P	1C	H
				"	FISH	3513	Comp.	ISO/I	1C	H
		WOC		"	SW			ISO/I/O	1D	H
	RI/FS STAT. ANALY.	3513		1994				ISO		

General:
NA = Not Available
NR = Not Researched
(blank) = Unknown

Sampling Media:
surface soil
subsurface soil
surface water
groundwater
seep or spring
sediment
waste
biota
I = INTERSTITIAL

Sampling Protocol:
G = grab
SG = stormflow grab
BG = baseflow grab
FC = flow composite
SC = spatial composite
V = vertical profile
S = site survey
I =

Analytical Fraction:
I = Inorganics
O = Organics
P = PCBs/Pesticides/Herbicides
GR = gross alpha/beta
ISO = isotopic rads
B/G = beta/gamma survey
FLD = field measurements

Decision Rule / Hypothesis
1 = Source characteristics
1A = design/operation
1B = leachate
1C = waste inventory
1D = waste unit hydrology
1E = other FS information
2 = Current releases
2A = shallow groundwater, seeps
2B = deep groundwater
2C = soil around waste units
2D = sediment
2E = cummulative @ integration point
3 = Current risk
4 = Modeling for future risk
3A/4A = human health risk
3B/4B = ecological risk

Waste Unit Characteristics:
type?
status?
size/capacity?
ownership?

Sampling Locations:
List specific locations if possible.
Otherwise, indicate scope of sampling effort.

Confidence:
H = High
M = Medium
L = Low

0003309

DATA SUMMARY SHEET FOR WASTE AREA GROUPING 1
CERCLA Status:

Waste Unit Description	Unit Type	Status	Size/ Capacity	Ownership	Waste Forms	Inventory					Contaminant Releases				Hydrologic Model		Potential Risk			
																	Human		Ecological	
						RAD	TRU	PCB	Hg	Other*	Surface Water	Groundwater	Soil	Sediment	Hydrologic Class	Transport Pathways	Current	Future	Current	Future
Waste Holding Basin 3513	I	I	220' x 220'	EMEF	SW/SD	X		X	X	X	◒	◒	◒	◒	●	●	●	◒	●	◒
Equalization Basin 3524	I	I	95' x 250'	EMEF	SW/SD	X		X	X	X	◒	◒	◒	◒	●	●	●	◒	●	◒
Process Waste Pond 3539	I	I	65' x 90'	EMEF	SW/SD	X		X	X	X	◒	◒	◒	◒	●	●	●	◒	●	◒
Process Waste Pond 3540	I	I	65' x 90'	EMEF	SW/SD	X		X	X	X	◒	◒	◒	◒	●	●	●	◒	●	◒

Unit Types:
B = Building
T = Tank
R = Reactor
P = Pipeline
DD = D&D Facility
BW = Buried Waste
I = Impoundment
CS = Contaminated Soil
CG = Contaminated Groundwater
CW = Contaminated Surface Water

Status:
A = Active
T = Transition
I = Inactive
R = Remediated

Ownership:
(See Attachment 1)

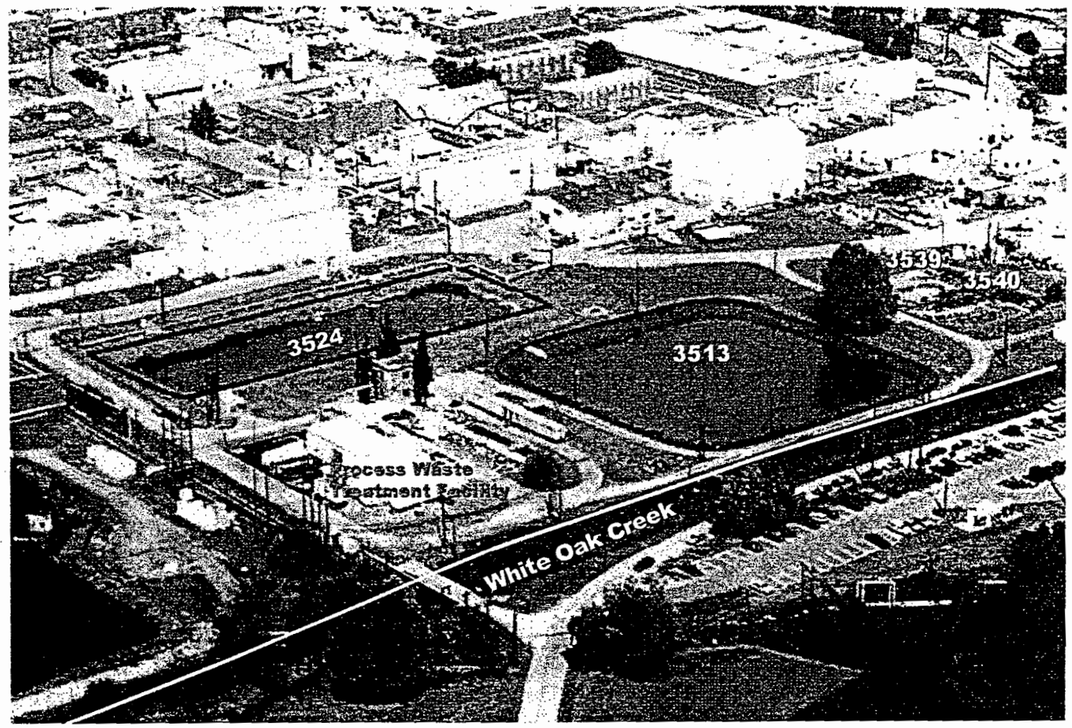
Waste Forms:
G = Gas
GW = Groundwater
SW = Surface Water
SD = Sediment
SL = Sludge
SS = Surface Soil
SB = Subsurface Soil
L = Liquid

*** Other:**
VOA
Metals

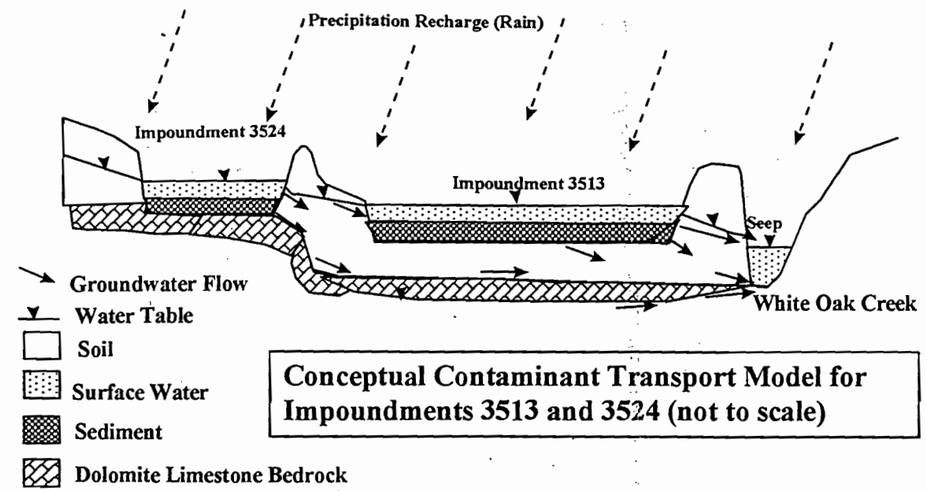
Well Defined: ●
Partially Defined: ◒
Not Defined: ○

0003311

Waste Area Grouping 1:
Surface Impoundments Operable Unit (SIOU)
Information Sheet



Aerial View of the Surface Impoundments Operable Unit - 1993 (Photo #: 9230-93)



Conceptual Contaminant Transport Model for Impoundments 3513 and 3524 (not to scale)

SIOU Data Summary Table

Impoundment Number	Construction Type	Dates of Operation	Liquid Volume (ft^3)	Sediment Volume (ft^3)*	Percent Solids (%)	Radionuclide Inventory (Ci)	Current Releases
3513	unlined	1944-1976	138,000	85,320	9		seepage through berm into WOC & seepage into groundwater
3524	unlined	1943-1989	83,400	37,800	16	180	seepage into groundwater
3539	clay-lined	1964-1990	11,100	1,080			no measurable releases
3540	clay-lined	1964-1990	11,100	1,080		0.3	no measurable releases

* Based on 1996 engineering study on sediment samples from Impoundments

References:

(1) *Remedial Investigation/Feasibility Study for Surface Impoundment OperableUnit WAG 1, ORNL, Oak Ridge, Tennessee* (DOE/OR/02-1346 & D2), November 1995.

(2) *Site Description of ER Units at ORNL, Oak Ridge, Tennessee* (ORNL/ER-391), February 1997.

(3) *Engineering Support Studies Report.* Prepared by Operational Technologies Corporation, September 12, 1996.

Monday, April 14, 1997
SIOUfact

Historical Summary: Impoundment 3524 was built in the ORNL Main Plant area in 1943 to provide backup capacity for storage of waste water from tanks (e.g., Gunite tanks) to allow the further precipitation of radionuclides before discharge to White Oak Creek. Impoundment 3513 was built in 1944. These two impoundments were used as holding basins for the process waste treatment system. Impoundments 3529 and 3540 were built in 1964 to hold process waste water from the Building 4500 complex. The impoundments occupy 4 acres.

Status: The SIOU Remedial Investigation/Feasibility Study (RI/FS) Report has been approved by EPA and TDEC. The draft D2 Proposed Plan has not been released to the public pending guidance from the public on future land use at ORNL. Corrective actions are taken, as needed, to mitigate seepage from the Impoundment 3513 berm into White Oak Creek. Also, twofeet of water cover is maintained to provide shielding to prevent exposure to contaminated sediments.

Risk Summary: No action will result in:

- human health and ecological risks from leaching of contaminants into groundwater and
- ecological risks due to consumption of fish by wildlife from the impoundments and White Oak Creek.

Consolidation of the contaminated sediments in an on-site cell should result in no off-site risk (i.e., at White Oak Creek).

Impacts to Watershed: Current discharge to White Oak Creek from seeps is approximately 26 pCi/L of Strontium-90, which is over three times the drinking water standard of 8 pCi/L. Unidentified sources from the ORNL main plant area, and seepage from the SIOU, account for approximately 8.3% of the Strontium-90 concentration at the White Oak Creek Dam.

DRAFT

S10U RI/FS

EXECUTIVE SUMMARY

This remedial investigation (RI)/feasibility study (FS) supports the decision-making process concerning remedial action for the Waste Area Grouping 1, Surface Impoundments Operable Unit (surface impoundments) located at the Oak Ridge National Laboratory (ORNL). The surface impoundments are located within the confines of the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee. ORNL, as part of ORR, is listed on the U.S. Environmental Protection Agency (EPA) National Priorities List. The DOE Oak Ridge Operations Office is responsible for managing remedial activities on ORR.

The surface impoundments are located in an industrial setting typical of most national laboratories, with institutional controls such as zoning, posted areas, fencing, engineering controls, and security features. Access to contaminated areas is restricted, and employees entering surface impoundments are medically monitored. Due to these active institutional control measures, risk levels from current exposures are acceptable and well below the EPA criteria.

The impetus for this document and remedial action includes mitigating future risks to human health and reducing/preventing the ongoing release of radioactive and chemical contamination to the groundwater and surface waters. Also important is to prevent the failure of berms never intended to last 50 years.

DOE is performing this RI/FS as a streamlined approach for an environmental restoration (SAFER) pilot project. The document is streamlined, and the format is adjusted to facilitate this decision process while meeting regulator requirements and guidance.

INTRODUCTION

The initial ORNL mission was to conduct pilot radiochemical separation operations, produce gram quantities of plutonium, and demonstrate production technologies relating to separation techniques. A network of underground storage tanks and pipelines was constructed in 1943 to handle and store the radioactive and chemical waste liquids generated by these ORNL operations. This liquid waste was allowed to precipitate in the tanks, diluted in large volumes of process wastewater, and then discharged to White Oak Creek.

Impoundment 3524 was built at this time as a backup for storage of wastewater from these tanks to allow further precipitation of radioisotopes before discharge to White Oak Creek. Following this, Impoundment 3513 was built. Later these two natural clay impoundments were

used as holding basins as part of the process waste treatment system. The other two smaller impoundments (3539 and 3540) that make up the surface impoundments were built in 1964 with a 15.2-cm (6-in.) clay liner to hold process wastewater from the Building 4500 complex. These four impoundments contain approximately 3,500 m^3 (4,640 yd^3) of sediment. These sediments are primarily contaminated with radionuclides with some Resource Conservation and Recovery Act constituents (e.g., mercury and lead) and Toxic Substances Control Act constituents (polychlorinated biphenyls).

Remediation of the Waste Area Grouping 1 surface impoundments is being addressed under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as specified in the Federal Facility Agreement. Because the sediments in the two unlined impoundments interact with groundwater, contaminants in these sediments currently are transported into White Oak Creek and Clinch River; therefore, these impoundments were selected for remediation through the ORR prioritization process.

The first step in the RI/FS process is to collect data. Historical data and data from the Waste Area Grouping 1 Phase I RI are available, so limited sample collection to support the RI/FS was performed concurrently with preparation of the RI/FS.

The second step in the RI/FS process is to evaluate the site data to identify threats to human health and the environment. Current off-site risk from water ingestion downstream from ORNL was evaluated assuming that institutional controls prevent access to the impoundments and that the only current off-site pathway is migration of contaminants from the sediments through groundwater into White Oak Creek and then to Clinch River. Clinch River is the first point where off-site receptors can be exposed to contaminants from the surface impoundments. Current off-site risk from this scenario (off-site receptor drinking Clinch River water) is well below EPA's target risk range of 1×10^{-4} to 1×10^{-6}.

Future risks were evaluated for several scenarios. This area will probably be an industrial site for at least the next 30–100 years. Hypothetical, unrestricted residential scenarios were also evaluated. For the unrestricted scenario, the estimated risks suggest that corrective action is necessary to protect on-site and off-site employees and residents. The majority of the risk occurs when the protective water cover is removed by drought or berm failure, exposing sediments in the impoundments. When radionuclides such as ^{137}Cs and ^{239}Pu in the soil and sediment are exposed, future on-site risk to employees and residents is always unacceptable. Direct radiation contributes the majority of the risk. In addition, when contamination is modeled to simulate off-site migration after a berm failure, the risk at White Oak Dam and Clinch River is unacceptable.

In summary, the risk drivers for the remediation of these surface impoundments include the following:

- contaminated sediments remain in contact with groundwater, and this contamination migrates into White Oak Creek;

- future risks are unacceptable in all scenarios when DOE no longer retains institutional control; and

- future risk, both on site and off site, is also unacceptable if the 50-year-old berms that retain the contents of the impoundments continue to lose their structural integrity, allowing contamination from the impoundments to increasingly migrate into White Oak Creek.

Remediation decisions for the surface impoundments will focus on risk management, which will achieve overall protection of human health and the environment, as well as the other nine CERCLA criteria (i.e., compliance with applicable or relevant and appropriate requirements, effectiveness, implementability, cost, etc.). Primary benefits to taking action at the surface impoundments at this time include the following:

- human and ecological risk reduction/prevention (both on site and off site);

- controlling migration of contamination so that future remediation is not made more difficult because contamination is more widespread;

- isolating/relocating contamination to facilitate monitoring and maintenance; and

- preventing berm failure.

Remediation decisions for the surface impoundments must also consider the condition and likely remediation decisions for the surrounding areas: Waste Area Grouping 1, ORNL, and ORR. Waste management (i.e., final disposition of wastes on or off site) issues must also be addressed in the decision process.

REMEDIAL ACTION OBJECTIVES

The following remedial action objectives must be addressed by the alternatives evaluated:

- prevent direct exposure to, direct contact with, and inhalation or ingestion of contaminated sediments by humans and animals;
- prevent movement of contaminants to groundwater and surface water;
- prevent failure of the impoundments berm/embankment; and
- prevent the bioaccumulation of contaminants in ecological receptors.

ALTERNATIVE EVALUATION

Alternatives developed to achieve these goals range from no action to complete removal of contaminated sediments and off-site disposal. As required by CERCLA, these alternatives were selected to represent the range of potential actions at the site and are not intended to limit the decision. The alternatives evaluated include the following:

- multilayer cap and institutional control,
- consolidation cell with simple dewatering,
- consolidation cell with ex situ treatment,
- consolidation cell off-surface impoundments/on-ORNL, and
- removal, treatment, and off-site disposal.

Important considerations regarding alternative evaluation for the surface impoundments include the following:

- Actions to be implemented at this site should be protective of human health and the environment and cost-effective for the foreseeable future (30–100 years) thus maximizing available funds for remediation of surface impoundments and other environmental problems at ORR.
- The impoundments remediation must be viewed in the context of the environmental concerns in the main plant areas as a whole, so that actions taken at this individual site are consistent with actions likely for the entire area.

Following is a brief description of the alternatives and issues to be considered in their evaluation.

ALTERNATIVE 1—NO ACTION

This alternative provides a baseline for comparison with other alternatives as agreed to in the National Contingency Plan. In this alternative, for current use the surface impoundments would pose a potential total risk to employees at ORNL that would exceed 4×10^{-3}. External exposure to direct radiation would account for essentially all of the total exposures, and the responsible radionuclides would be ^{137}Cs and ^{60}Co. Institutional controls, such as restricted access, fencing, and other security features, as well as maintaining the protective water cover, would mitigate this risk, thus making the current exposures acceptable.

If at any time these controls are eliminated, risk to the on-site employee and off-site resident exposure scenario would exceed 6×10^{-2}, over two orders of magnitude higher than the EPA target risk range. If the water cover is not maintained on the lagoons, risk at White Oak Creek, White Oak Dam, and Clinch River would all exceed 1×10^{-2}. Airborne contamination resulting in widespread human health risk would be possible.

In this alternative, releases of ^{90}Sr contamination to the groundwater and to White Oak Creek would continue, causing degradation of the environment in White Oak Creek and White Oak Lake. Environmental receptors would continue to have a risk from the consumption of contaminated fish in the area.

This alternative is not protective of human health and the environment as required by CERCLA, is not effective in the long term, and does not reduce the toxicity or mobility of the contamination.

ALTERNATIVE 2—MULTILAYER CAP AND INSTITUTIONAL CONTROLS

Alternative 2 includes installing a cap over all the ponds and long-term monitoring and maintenance. Implementation of this alternative would result in a risk to future employees of 1×10^{-6}, which is within the EPA target risk range. There would also be acceptable risks for residents at White Oak Dam and Clinch River (1×10^{-5} and less than 1×10^{-6}, respectively). However, unacceptable risks would exist to on-site residents and residents at White Oak Creek (3×10^{-3} and 2×10^{-3}, respectively), necessitating the use of institutional controls at these locations.

The cap would prevent airborne contamination during its several-hundred-year life. If the cap were to fail in the future, unacceptable risks from airborne contamination would be possible.

In this alternative, releases of ^{90}Sr would continue to the groundwater and to White Oak Creek, causing degradation of the environment in White Oak Creek and White Oak Lake. However, consumption of contaminated fish within the impoundments would no longer continue to present a risk to environmental receptors.

This alternative is protective of human health and the environment as required by CERCLA for future employees and for future residents during the period of institutional controls. It is not protective of on-site residents after the period of institutional controls. It is long-term effective for eliminating the airborne dispersion pathway, but does not significantly reduce the mobility of contaminants into the groundwater, and thus into White Oak Creek.

ALTERNATIVE 3—CONSOLIDATION CELL WITH SIMPLE DEWATERING

Alternative 3 includes relocation of sediment and solid contaminants from Impoundment 3524 into Impoundment 3513, followed by retrofitting Impoundment 3524 with a consolidation cell liner and leachate collection system. The contaminated sediment from the surface impoundments would then be placed in this consolidation cell and maintained with a temporary cover to promote dewatering of these sediments through the leachate collection system. Once dewatering is complete, the final cap would be placed over the consolidation cell. This alternative would be protective of human health and the environment. The cap and liner would prevent airborne and groundwater contamination for their life of greater than 100 years.

ALTERNATIVE 4—CONSOLIDATION CELL WITH EX SITU TREATMENT

Alternative 4 includes the same activities as Alternative 3 with the addition of constructing a new treatment facility to stabilize the waste (i.e., stabilization, solidification, and containerization of waste) before placing it in the consolidation cell. Thus, no dewatering within the disposal cell would be required. This alternative protects human health and the environment during the period of institutional control. The cap and liner would prevent airborne and groundwater contamination for their life of greater than 100 years.

ALTERNATIVE 5—OFF-SURFACE IMPOUNDMENTS CONSOLIDATION CELL

Alternative 5 includes the same activities as Alternative 3 except that the sediment would be transported to a consolidation cell constructed off-surface impoundments at a preferred location

at ORNL. This alternative would protect human health and the environment at the surface impoundments site during institutional control. The cap and liner would prevent airborne and groundwater contamination for their life of greater than 100 years. Potential benefits of this alternative include (1) the opportunity to select a more hydrogeologically suitable site than the surface impoundments, (2) location of the consolidation cell away from the most active areas of ORNL, and (3) the ability to incorporate wastes from other impoundments within ORNL into the same consolidation cell.

ALTERNATIVE 6—REMOVAL, TREATMENT AND OFF-SITE DISPOSAL

Alternative 6 includes building a new treatment facility to stabilize the waste before shipment to the Nevada Test Site for disposal. Because surrounding soils and groundwater are contaminated from other sources, long-term monitoring and other actions at the site would be subject to the Waste Area Grouping 1 3000 Watershed Soils and Groundwater Operable Units requirements.

KEY ISSUES FOR CONSIDERATION IN THE DECISION PROCESS

To select acceptable remedial actions, regulators and decision-makers must consider the following key issues:

- determination of future land use and location of receptor for risk assessment;
- compatibility with remedial action for the main plant area;
- availability of treatment, storage, and disposal capacity for mixed waste at ORNL, ORR, and nationally; and
- combining waste from other operable units into off-surface impoundments consolidation cell.

A discussion of each of these issues follows.

Determination of Future Land Use and Location of Receptor for Risk Assessment

Each remedial alternative will protect human health and the environment; however, some remedial strategies include restrictions on the use of the site to prevent unacceptable exposure to

contaminants. Remedial actions that include restricting the surface impoundments area to industrial use would require additional action in the future if unrestricted land use is chosen for ORR.

If ORNL is to be federally controlled industrial land use, DOE believes that existing institutional controls (fencing, access and use restrictions, and continued monitoring and maintenance) extending to Clinch River would be readily implementable. This determination of future land use will dictate to a large degree the likelihood of exposure at these levels. If land use on ORR remains industrial with institutional controls restricting use of surface water and groundwater, then the nearest off-site resident would be at Clinch River, about 2.4 km (1.5 miles) from the impoundments.

If this facility were not federally controlled with active institutional controls, the future reasonable maximum exposure risk for an employee and resident would be unacceptable (i.e., outside EPA target risk range). This is due primarily to the receptor (i.e., human or environmental) being exposed to the contaminated sediments.

The designation of the site for federally controlled industrial land use for the foreseeable future, however, appears reasonable because (1) the federal government has long-term plans to continue to use the site as a national laboratory, (2) the administrative controls in place and projected for the future are adequate to minimize risk of exposure of employees to residual contamination remaining after remediation, (3) adjacent areas will likely require similar use restrictions, and (4) the federal government cannot legally release control of a contaminated site. However, these institutional controls are costly and require a continued commitment from DOE to fund the necessary operation and maintenance.

Compatibility with Remedial Action for the Main Plant Area

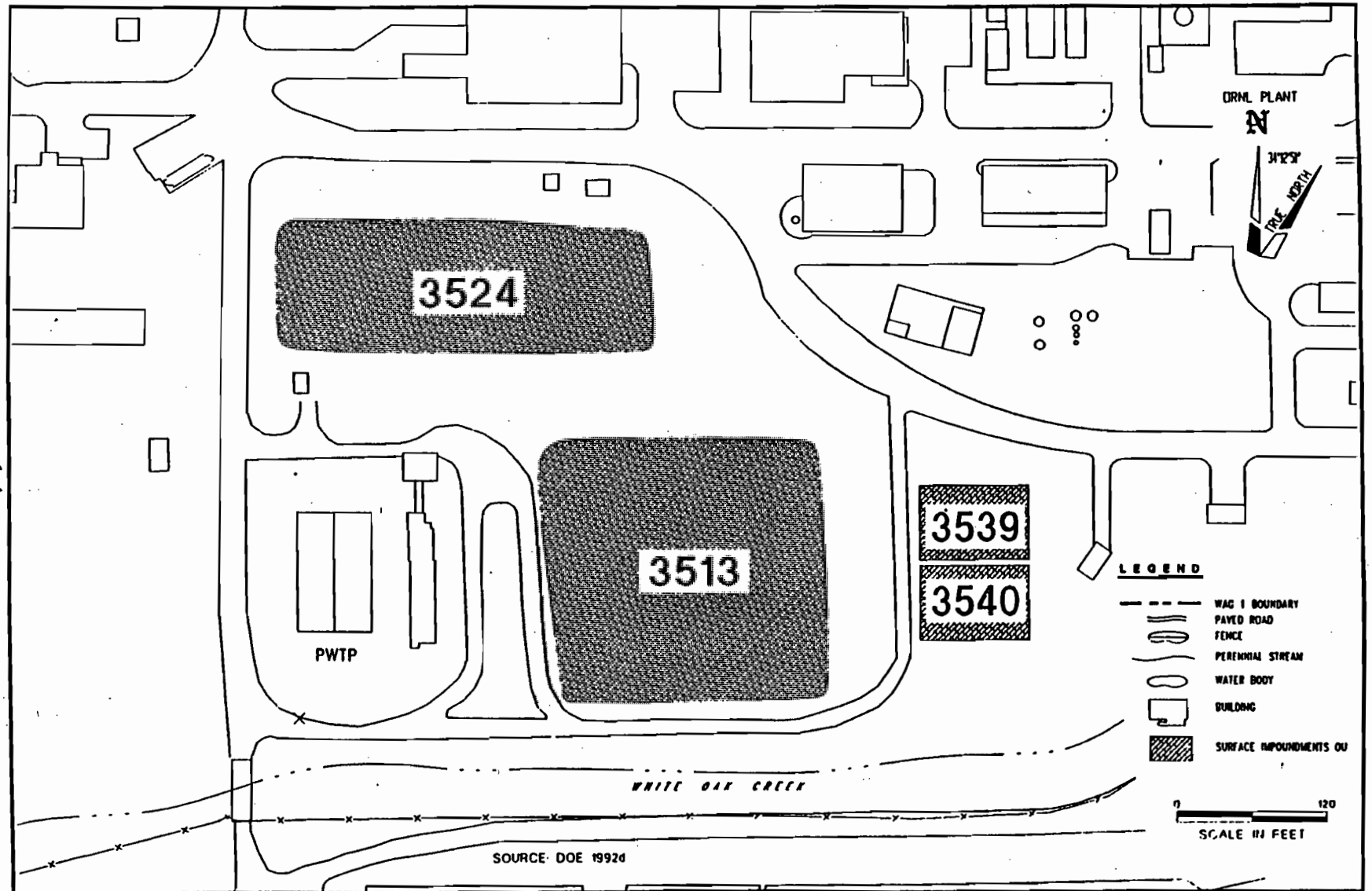
Remediation activities at the surface impoundments should be consistent with actions taken for the surrounding ORNL area. The main plant area of ORNL surrounding the surface impoundments is characterized by contaminated soils and groundwater; miles of contaminated piping; other impoundments; and inactive, low-level transuranic and mixed-waste storage tanks. If surface impoundments were remediated to unrestricted release levels, these other plant areas could recontaminate the surface impoundments area such that it would require additional remedial action in the future. Therefore, attempts to remediate surface impoundments should primarily focus on the principal areas of contamination and should defer action on the secondary source areas (e.g., remedial actions on the surrounding soils should be deferred to the Waste Area Grouping 1 3000 Watershed Soils Operable Unit).

Availability of Treatment, Storage, and Disposal Capacity for Mixed Waste at ORNL, ORR, and Nationally

Removal of the contaminated sediment from the surface impoundments is limited by current disposal capacities for mixed, low-level, and hazardous wastes. Alternatives that allow the sediments and soils to be managed in situ do not require additional on-site storage, handling, or packaging facilities or off-site transportation and disposal capabilities. Alternatives that include actions to remove the sediments and soils depend upon the future availability of adequate mixed-waste treatment, storage, disposal facilities, and permits for shipping waste through several states.

Combining Waste from Other Operable Units into Off-Surface Impoundments Consolidation Cell

It was determined early in the evaluation process that an off-surface impoundments consolidation cell would cost more than the on-site cell due to the additional transportation requirements (pipe or truck). However this could be attractive from a long-term planning standpoint because it allows for one controlled cell to be constructed in a preferred location with potential to be expanded for consolidation with other ORNL waste. Other strategies include consolidation of waste from other ORNL impoundments with like contaminants using an expedited RI/FS process with a presumptive remedy, using the surface impoundments as an example.



JE	Fig. 1.3	**Surface Impoundments Operable Unit** DOE - ORNL, WAG 1, Surface Impoundments - Oak Ridge, Tennessee	DOCUMENT ID: 35H830 4004-15 / RI/FS	DRAWING ID 96-11402 DWG	DRAWING DATE OCTOBER 19, 1995 Rev

000333

Table 2.1. Chronology of operations, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

Date	Event
1943	Original east and west ponds that comprised Impoundment 3524 are constructed.
1944	Impoundment 3513 is constructed to hold wastewater for settling and decay of radionuclides. Diversion box north of Impoundment 3524 is installed to direct high activity wastewater to Impoundment 3524 for decay and lower activity wastewater to Impoundment 3513 for eventual discharge to White Oak Creek. A distribution box north of Impoundment 3513 directs wastewater into a system of weirs and baffles in Impoundment 3513.
1945	Overflow pipe from Impoundments 3524 and 3513 is installed.
1947	Piping is installed in south berm of Impoundment 3513 to allow collection, monitoring, and recycling of impoundment water through the impoundments, if needed.
1949	Evaporator installed to reduce the radioactivity of supernatant discharged to the impoundments from the South Tank Farm.
1953	East and west ponds (Impoundment 3524) are joined by removing central berm.
1954	High activity wastes are diverted. Impoundments begin receiving process wastewater of low activity.
1957	Process Waste Treatment Plant begins operations to provide chemical treatment and removal of suspended solids. Impoundment 3524 provided equalization of feedwater to the Process Waste Treatment Plant. Lower activity process wastewater was sent to Impoundment 3513. Weir and baffle system is removed from Impoundment 3513.
1961	Impoundment 3524 expansion to the west encounters shallow bedrock.
1964	Impoundments 3539 and 3540 are built to receive wastewater from Building 4500 and to provide emergency storage capacity.
1976	Impoundment 3513 is removed from service and retained for emergency storage capacity only.
1978	Accidental input of radionuclides to Impoundment 3513 results from a diversion box failure.
1986	Under National Pollutant Discharge Elimination System agreement, the weir box for Impoundment 3513 effluent is sealed, and accumulated water is pumped to Impoundment 3524 for treatment in Process Waste Treatment Plant. Piping in the south berm of Impoundment 3513 is sealed.
1989	Melton Valley Storage Tanks are completed and emergency storage capacity of Impoundment 3513 is no longer needed. Piping in the north berm of Impoundment 3513 is sealed. Impoundment 3524 stops receiving wastewater, except for emergency storage capacity.
1990	Impoundments 3539 and 3540 are removed from service.
1994	Corrective actions are taken to mitigate seal seeps in Impoundment 3513 embankment.

Note: See Appendix A for additional details and references.

ORNL = Oak Ridge National Laboratory
SIOU = Surface Impoundments Operable Unit
Waste Area Grouping 1 = consisting of the main plant area of ORNL

Table 3.1. Sources of contamination, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

Percent of contamination[a]	Source	Description
> 90	Sediment	Deposited material within impoundments
< 5	Subimpoundment soils	Native soils in contact with and contaminated by sediment or impoundment water
< 3	Surface water	Ponded water within each of the four impoundments
< 2	Surface soils	Native soils around (and contaminated by) impoundments

[a]Based on total activities (i.e., contaminant concentrations and volumes), not risk.

ORNL = Oak Ridge National Laboratory
SIOU = Surface Impoundments Operable Unit

3.2 NATURE AND EXTENT OF CONTAMINATION

The following sections examine the various media at SIOU in more detail and discuss the mechanisms that would allow migration of these contaminants. The data used to derive these interpretations were obtained from various historical investigations and the recent sampling events. Where necessary, some extrapolations were made from limited data sets.

3.2.1 Sediment

Containing over 90 percent of the contamination in the OU, sediments within the impoundments are composed of materials that have settled out or were precipitated from the various process waste streams. Organic matter from natural biological processes are also present, the product of a diverse, freshwater ecosystem that includes mixed phytoplankton, benthic algae, and varied aquatic invertebrates (Stansfield and Francis 1986a). The sediment characteristics vary slightly with each impoundment, depending mainly on the source of the process wastes received by each impoundment.

Appendix B presents geotechnical information for the impoundment sediments. Table 3.2 presents volumes of sediment along with other contaminated media.

Representative mean and reasonable maximum concentrations are reported for each impoundment in Table 3.3 for radionuclide concentrations and in Table 3.4 for chemical concentrations; data from Impoundments 3539 and 3540 were combined since the process history of these two ponds was identical. In accordance with *Risk Assessment Guidance for Superfund*

Table 3.2. Summary of volumes of contaminated media, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

	Impoundment 3513		Impoundment 3524		Impoundments 3539 and 3540		Totals	
	Probable	Maximum	Probable	Maximum	Probable	Maximum	Probable	Maximum
Dimension at crest (e−w × n−s)(ft)	228 × 228	NA	305 × 105	NA	90 × 60	NA	—	—
Dimensions at base (e−w × n−s)(ft)	200 × 200	NA	275 × 95	NA	74 × 44	NA	—	—
Slope of berm	0.5	NA	0.5	NA	1.0	NA	—	—
Sediment volume (in situ)[a] (yd^3)	3,160	3,460	1,400[b]	2,100	40	40	4,600	5,600
Sediment volume (dewatered)[c] (yd^3)	2,210	2,420	980	1,470	28	28	3,218	3,918
Depth of sediment layer[d] (ft)	2.0	2.2	1.8	2.3	0.3	0.3	—	—
Surface water volume[e] (ft^3)	138,000	139,000	83,400	85,700	11,100	11,100	—	—
Subimpoundment soils volume[f] (yd^3)	2,110	2,750	1,320	1,700	290	380	3,720	4,830
Surrounding soils volume[g] (yd^3)	740	960	670	870	370	480	1,780	2,310

[a]Based on probable conditions and reasonable deviation of sediment depth, respectively, and assuming regular dimensions for the pond.
[b]Probable volume from Braunstein et al. (1984), which accounts for bedrock directly underlying the impoundment. Deviation is based on deviation of sediment depth.
[c]Assume dewatering from 80 percent to approximately 50 percent moisture content by weight (based on centrifuging data from Tamura, Sealand, and Duguid 1977) results in 30 percent volume reduction.
[d]Sediment depths are mean and UCL_{95} from the following: Tamura, Sealand, and Duguid (1977) for Impoundment 3513 and Braunstein et al. (1984) for Impoundment 3524. Sediment depth of 4 in. in Impoundments 3539 and 3540 is from sampling logs for 1994 remedial investigation sampling.
[e]Water depth assumed to be 3 ft above top of sediment in all impoundments.
[f]Assumes probable condition is excavation 1 ft into subimpoundment soil on bottom and sides of impoundment. Deviation assumes 30 percent increase in volume from additional excavation.
[g]Assumes probable condition is excavation 1 ft deep over a 20-ft area surrounding crest of the berm. Deviation assumes 30 percent increase in volume from additional excavation.

e = east
ft = foot
n = north
NA = not applicable
ORNL = Oak Ridge National Laboratory
s = south
SIOU = Surface Impoundments Operable Unit
UCL = upper confidence limit
w = west
yd = yard

Table 3.3. Summary of concentrations for radioactive COCs, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

Radionuclide	Average (pCi/g dry)	RME (pCi/g dry)
Summary for sediments in Impoundment 3513		
Americium-241	4,200	4,600
Cesium-137	450,000	1,100,000
Cobalt-60	1,300	3,000
Plutonium-238	630	2,500
Plutonium-239, -240	19,000	24,000
Strontium-90	73,000	140,000
Summary for sediments in Impoundment 3524		
Americium-241	16,000	33,000
Cesium-137	210,000	360,000
Cobalt-60	3,000	7,800
Plutonium-238	1,100	3,500
Plutonium-239, -240	17,000	72,000
Strontium-90	91,000	140,000
Summary for sediments in Impoundments 3539 and 3540		
Americium-241	< 270	< 270
Cesium-137	54	92
Cobalt-60	5	6
Plutonium-238	0	20
Plutonium-239, -240	93	160
Strontium-90	96	140

COC = contaminant of concern
ORNL = Oak Ridge National Laboratory
pCi/g = picocurie per gram
RME = reasonable maximum exposure
SIOU = Surface Impoundments Operable Unit

(EPA 1989a), the reasonable maximum exposure (RME) concentration of a contaminant is the lesser of the 95th percentile upper confidence limit of the mean (UCL_{95}) or maximum detected concentration. Since the sediments within the impoundments originated from a variety of operations over the course of their active periods, the distribution of contaminants within the sediments varies both aerially and vertically. However, though this fact had to be taken into account for the calculation of mean and reasonable maximum concentrations, it does not materially affect the outcome of the subsequent risk assessments.

Using the SAFER pilot program to enhance the presentation of data in this document, only the contaminants requiring remedial action (see Tables 3.3 and 3.4) were reported. This had the net effect of presenting only the COCs for chemicals and radionuclides and utilizes the results of the full screening process of analyzing contaminants to derive contaminants of potential

Table 3.4. Summary of concentrations for chemical COCs, Waste Area Grouping 1 SIOU, ORNL, Oak Ridge, Tennessee

Contaminant	Frequency of detection	Range of detected concentration	Mean concentration (mg/kg)	RME concentration (mg/kg)
Summary for sediments in Impoundment 3513				
N-Nitroso-di-n-propylamine	6/9	3.6–34	12	26
Mercury	9/9	110–470	340	410
Zinc	9/9	260–620	580	620
Aroclor-1254	9/9	20–99	40	75
Aroclor-1260	3/9	21–38	23	29
Summary for sediments in Impoundment 3524				
N-Nitroso-di-n-propylamine	1/9	23	12	23
Mercury	9/9	43–920	396	560
Zinc	9/9	760–8,000	3,900	5,900
Aroclor-1254	9/9	11–140	75	130
Aroclor-1260	—	—	—	—
Summary for sediments in Impoundments 3539 and 3540				
N-Nitroso-di-n-propylamine	1/2	3.4	2.8	3.4
Mercury	2/2	730–800	760	800
Zinc	2/2	1,100–1,200	1,200	1,200
Aroclor-1254	2/2	150–180	170	180
Aroclor-1260	1/2	120	130	160

COC = contaminant of concern
mg/kg = milligram per kilogram
ORNL = Oak Ridge National Laboratory
RME = reasonable maximum exposure
SIOU = Surface Impoundments Operable Unit

concern (COPCs), and then calculating risks to derive COCs. Appendix B details concentrations for all chemicals and radionuclides that were analyzed for during the sampling events. Appendix C provides additional detail on the contaminant screening process. Appendices G and H present the detailed output of calculations for one scenario as representative examples of the full process.

As indicated in Tables 3.2, 3.3, and 3.4, volumes and levels of radioactive contamination in Impoundments 3539 and 3540 are much lower than in either Impoundment 3513 or 3524. Substances regulated by RCRA and the Toxic Substances Control Act are also present. As detailed in Appendix B, additional calculations were performed to derive representative sediment concentrations for risk assessment modeling. Though not their primary use, the average concentrations also show that the transuranic radionuclides present in wastes generated from these ponds are not in sufficient quantity to be classified as transuranic wastes by regulatory definition.

WAG 1 SCSR (1992)

Sewage aeration pond 2543 (SWMU 1.16). This pond was operated in series with pond 2544 as an aeration lagoon for treating sanitary sewage (Fig. 3.5.3). The pond has a capacity of about 1 million gal. The aeration ponds were constructed in 1974 with plastic liners (ORNL 1990) and aeration systems and were used until the new STP was completed. Pond 2543 has been removed from service (ORNL 1990), but is available for emergency use. Some radioactivity can be detected in the sludge, assumed to be due to leakage of contaminated groundwater and of LLLW from leaking pipelines into the domestic sewer lines (Grimsby 1986). The inventory of radionuclides in the sludge is estimated to be less than 10 Ci (ORNL 1990).

Analysis of samples of the sludges (85 to 95% water) in the bottom of this pond collected in August 1991 indicated tritium at 2940 pCi/L, americium-241 at 247 pCi/L, cobalt-60 at 1279 pCi/L, cesium-137 at 31,120 pCi/L, europium-152 at 966 pCi/L, europium-154 at 279 pCi/L, and europium-155 at 182 pCi/L. Chemical analysis of the sludge showed barium at 540 mg/kg, cadmium at 23 mg/kg, chromium at 188 mg/kg, lead at 315 mg/kg, mercury at .0146 mg/kg, nickel at 95.6 mg/kg, and silver at 833 mg/kg. Section 4 of this report describes these samples and reports the analytical results.

R:\WAG1SCS\SECTION3

Decommissioned waste holding basin 3512 (SWMU 1.11). This basin (Fig. 3.5.3) was constructed in the 1940s with an earthen dike perimeter; it measured approximately 40 × 40 ft and had a holding capacity of approximately 30,000 gal (ORNL 1990). The pond was used as a retention pond from 1944 to 1950 as part of the LLLW system, receiving process waste from the LLLW storage tanks. After it was removed from service in 1957, the soil was excavated in conjunction with construction of the PWTP and the hole was backfilled with gravel.

Remaining radioactive contamination has been estimated at less than 10 Ci. In addition to radionuclides from the LLLW tanks, the pond is known to have received as much as 250 gal of isobutyl methyl ketone during the late 1940s (ORNL 1990). The site is presently the parking lot for Building 3544. Soil sampling was performed in this area in 1991; results are described in Sect. 4.

LITR pond 3075 (SWMU 1.19). Two 18,000-gal retention ponds measuring 8 by 40 ft and ranging in depth from 6 to 8 ft were built in 1951 to retain primary coolant water from LITR (Fig. 3.5.3). The water contained low levels of radioactive contaminants. After treatment in these ponds, water was released to the Fifth Creek branch of WOC (ORNL 1990). The ponds, removed from service in 1964, were later filled with soil and clay. Soil and sludge samples were collected from each former pond location in 1985 to a depth of 7 to 8 ft (Taylor 1986a). The inventory of radioactive materials at this site was estimated to be 20 mCi of cesium-137, 1 mCi of strontium-90, and 100 μCi of plutonium-239. Levels of curium, lead, and selenium were higher than RCRA criteria for hazardous wastes. Mercury concentrations ranged from 0.04 to 0.39 mg/kg in five core samples. The contaminant inventory may be incomplete because the soil borings did not extend deeper than the bottom of the ponds.

3.5.2.2 Active surface impoundment

Sewage aeration pond 2544 (SWMU 1.17). This pond was operated in series with pond 2543 as an aeration lagoon for treating sanitary sewage (Fig. 3.5.3); it has a capacity of about 1 million gal. The aeration ponds were constructed in 1974 with plastic liners and aeration systems and were used until the STP was completed; 2544 is still in operation as an equalization basin and is available for holdup and temporary treatment of sewage if STP is out of service. Effluent from this pond currently goes to STP; before construction of STP, effluent was chlorinated and discharged to WOC.

Analysis of samples of the sludges (85 to 95% water) collected from the bottom of this pond in August 1991 showed the presence of the following radionuclides (reported at their highest detection levels): tritium at 1800 pCi/L, americium-241 at 109 pCi/L, cobalt-60 at 1186 pCi/L, cesium-137 at 21,050 pCi/L, europium-152 at 1311 pCi/L, europium-154 at 707 pCi/L, europium-155 at 269 pCi/L, plutonium-238 at 185 pCi/L, and plutonium-239/240 at 292 pCi/L. The level of plutonium detected in three sludge samples from this pond is higher than levels detected in soil and groundwater samples taken elsewhere at WAG 1 and may have entered the sanitary sewer system where sewer lines cross leaking LLLW lines. These high concentrations are also likely the result of accumulation of plutonium by adsorption onto the fine-grained sludge sediment.

Chemical analysis of the sludge revealed barium at 693 mg/kg, cadmium at 26.4 mg/kg, chromium at 272 mg/kg, lead at 262 mg/kg, mercury at 21.9 mg/kg, and nickel at 65.0 mg/kg. Section 4 describes these samples and reports the analytical results.

SIOU RI/FS Report

Table 3.2. Summary of volumes of contaminated media, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

	Impoundment 3513		Impoundment 3524		Impoundments 3539 and 3540		Totals	
	Probable	Maximum	Probable	Maximum	Probable	Maximum	Probable	Maximum
Dimension at crest (e−w × n−s)(ft)	228 × 228	NA	305 × 105	NA	90 × 60	NA	—	—
Dimensions at base (e−w × n−s)(ft)	200 × 200	NA	275 × 95	NA	74 × 44	NA	—	—
Slope of berm	0.5	NA	0.5	NA	1.0	NA	—	—
Sediment volume (in situ)[a] (yd^3)	3,160	3,460	1,400[b]	2,100	40	40	4,600	5,600
Sediment volume (dewatered)[c] (yd^3)	2,210	2,420	980	1,470	28	28	3,218	3,918
Depth of sediment layer[d] (ft)	2.0	2.2	1.8	2.3	0.3	0.3	—	—
Surface water volume[e] (ft^3)	138,000	139,000	83,400	85,700	11,100	11,100	—	—
Subimpoundment soils volume[f] (yd^3)	2,110	2,750	1,320	1,700	290	380	3,720	4,830
Surrounding soils volume[g] (yd^3)	740	960	670	870	370	480	1,780	2,310

[a]Based on probable conditions and reasonable deviation of sediment depth, respectively, and assuming regular dimensions for the pond.
[b]Probable volume from Braunstein et al. (1984), which accounts for bedrock directly underlying the impoundment. Deviation is based on deviation of sediment depth.
[c]Assume dewatering from 80 percent to approximately 50 percent moisture content by weight (based on centrifuging data from Tamura, Sealand, and Duguid 1977) results in 30 percent volume reduction.
[d]Sediment depths are mean and UCL_{95} from the following: Tamura, Sealand, and Duguid (1977) for Impoundment 3513 and Braunstein et al. (1984) for Impoundment 3524. Sediment depth of 4 in. in Impoundments 3539 and 3540 is from sampling logs for 1994 remedial investigation sampling.
[e]Water depth assumed to be 3 ft above top of sediment in all impoundments.
[f]Assumes probable condition is excavation 1 ft into subimpoundment soil on bottom and sides of impoundment. Deviation assumes 30 percent increase in volume from additional excavation.
[g]Assumes probable condition is excavation 1 ft deep over a 20-ft area surrounding crest of the berm. Deviation assumes 30 percent increase in volume from additional excavation.

e = east
ft = foot
n = north
NA = not applicable
ORNL = Oak Ridge National Laboratory
s = south
SIOU = Surface Impoundments Operable Unit
UCL = upper confidence limit
w = west
yd = yard

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Table 3.3. Summary of concentrations for radioactive COCs, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

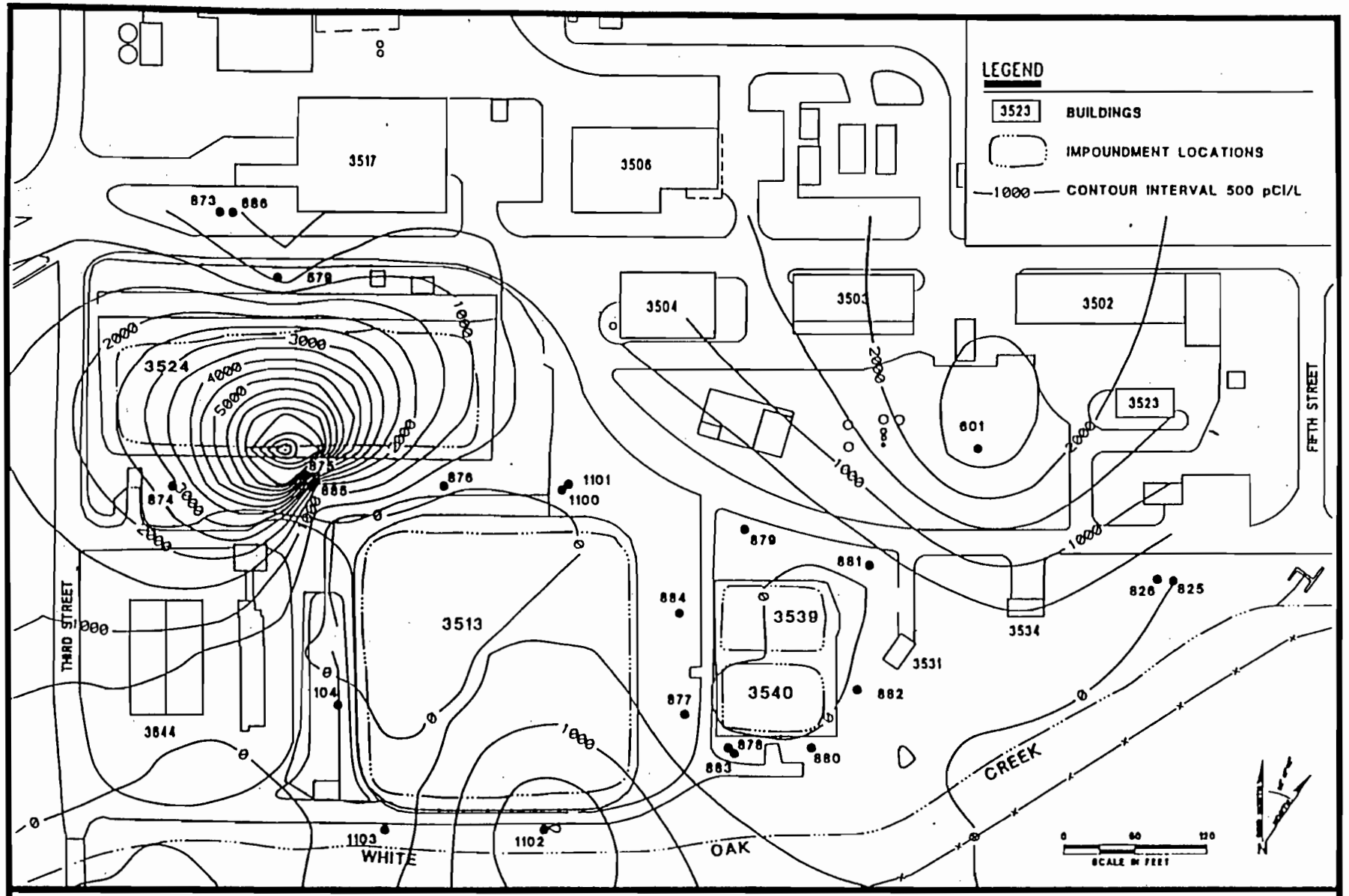
Radionuclide	Average (pCi/g dry)	RME (pCi/g dry)
Summary for sediments in Impoundment 3513		
Americium-241	4,200	4,600
Cesium-137	450,000	1,100,000
Cobalt-60	1,300	3,000
Plutonium-238	630	2,500
Plutonium-239, -240	19,000	24,000
Strontium-90	73,000	140,000
Summary for sediments in Impoundment 3524		
Americium-241	16,000	33,000
Cesium-137	210,000	360,000
Cobalt-60	3,000	7,800
Plutonium-238	1,100	3,500
Plutonium-239, -240	17,000	72,000
Strontium-90	91,000	140,000
Summary for sediments in Impoundments 3539 and 3540		
Americium-241	< 270	< 270
Cesium-137	54	92
Cobalt-60	5	6
Plutonium-238	0	20
Plutonium-239, -240	93	160
Strontium-90	96	140

COC = contaminant of concern
ORNL = Oak Ridge National Laboratory
pCi/g = picocurie per gram
RME = reasonable maximum exposure
SIOU = Surface Impoundments Operable Unit

Table 3.4. Summary of concentrations for chemical COCs, Waste Area Grouping 1 SIOU, ORNL, Oak Ridge, Tennessee

Contaminant	Frequency of detection	Range of detected concentration	Mean concentration (mg/kg)	RME concentration (mg/kg)
Summary for sediments in Impoundment 3513				
N-Nitroso-di-n-propylamine	6/9	3.6–34	12	26
Mercury	9/9	110–470	340	410
Zinc	9/9	260–620	580	620
Aroclor-1254	9/9	20–99	40	75
Aroclor-1260	3/9	21–38	23	29
Summary for sediments in Impoundment 3524				
N-Nitroso-di-n-propylamine	1/9	23	12	23
Mercury	9/9	43–920	396	560
Zinc	9/9	760–8,000	3,900	5,900
Aroclor-1254	9/9	11–140	75	130
Aroclor-1260	—	—	—	—
Summary for sediments in Impoundments 3539 and 3540				
N-Nitroso-di-n-propylamine	1/2	3.4	2.8	3.4
Mercury	2/2	730–800	760	800
Zinc	2/2	1,100–1,200	1,200	1,200
Aroclor-1254	2/2	150–180	170	180
Aroclor-1260	1/2	120	130	160

COC = contaminant of concern
mg/kg = milligram per kilogram
ORNL = Oak Ridge National Laboratory
RME = reasonable maximum exposure
SIOU = Surface Impoundments Operable Unit



Gross beta (unfiltered) concentrations in groundwater

CDM FEDERAL PROGRAMS CORPORATION
a subsidiary of Camp Dresser & McKee Inc.

Oak Ridge National Laboratory
Oak Ridge, Tennessee

Fig. B3.2

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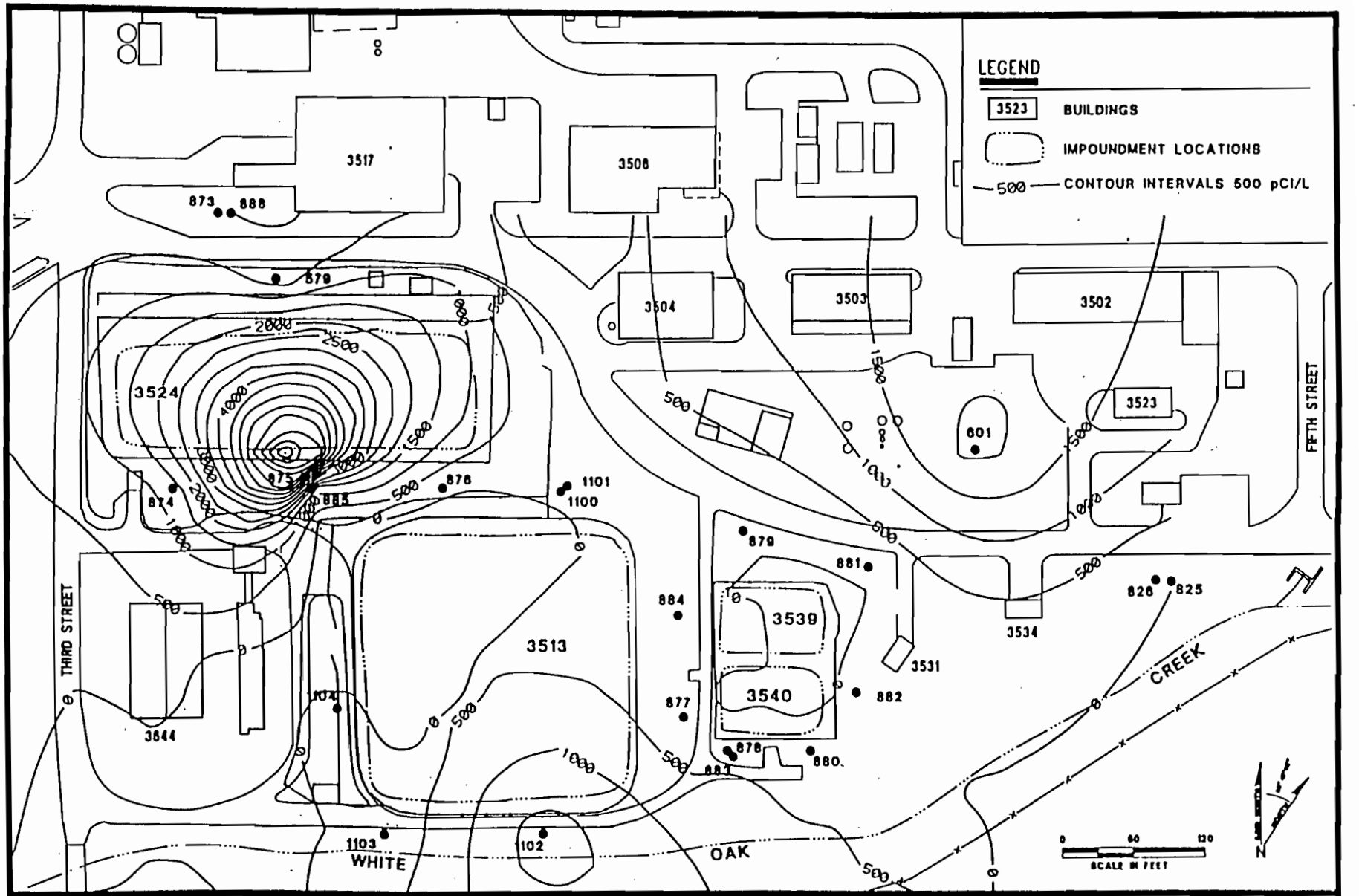

CDM FEDERAL PROGRAMS CORPORATION
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Gross beta (filtered) concentrations in groundwater

Oak Ridge National Laboratory
Oak Ridge, Tennessee

Fig. B3.3

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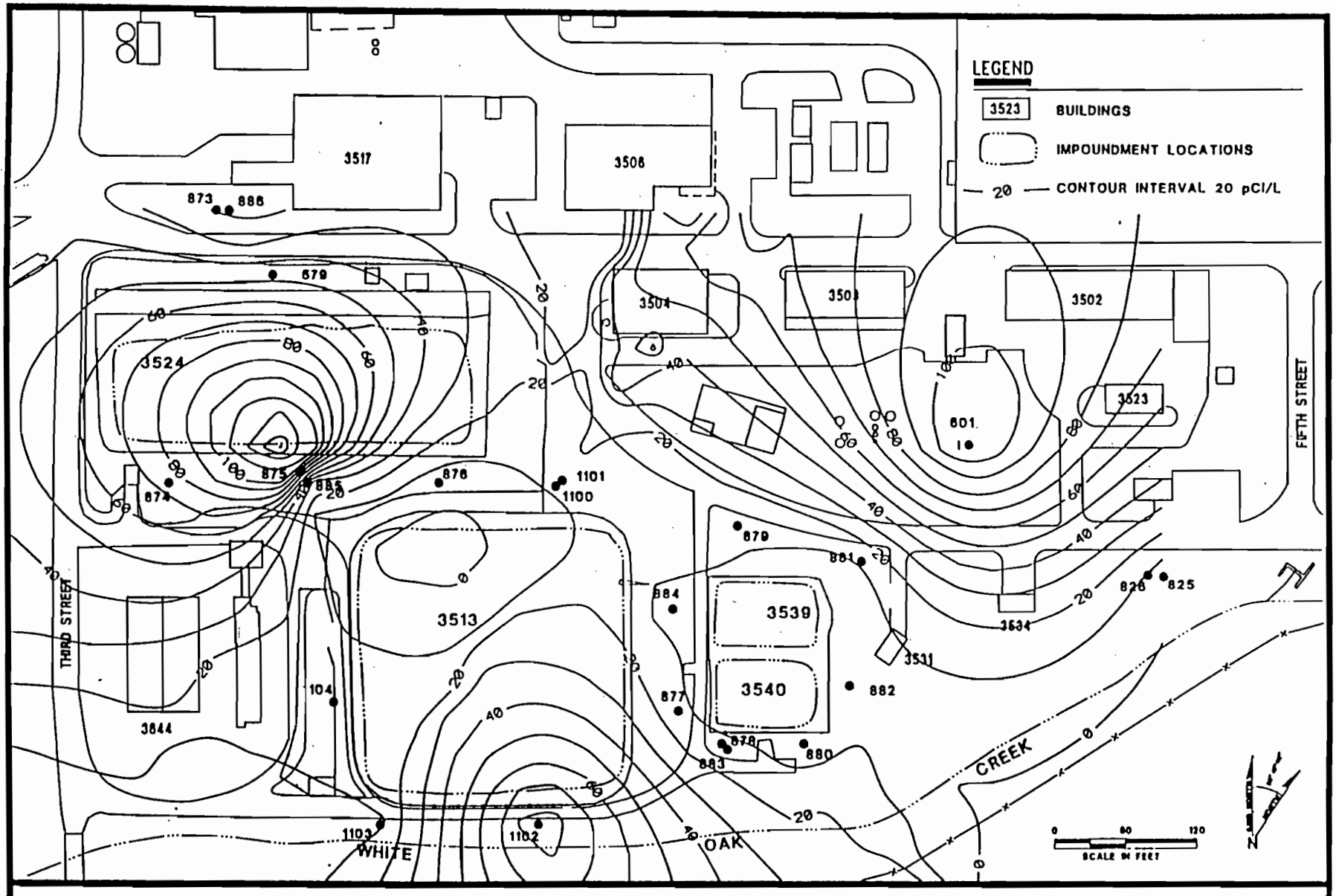

Gross alpha (unfiltered) concentrations in groundwater

CDM FEDERAL PROGRAMS CORPORATION
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Oak Ridge National Laboratory
Oak Ridge, Tennessee

Fig. B3.4

A2059/14NOV94/118

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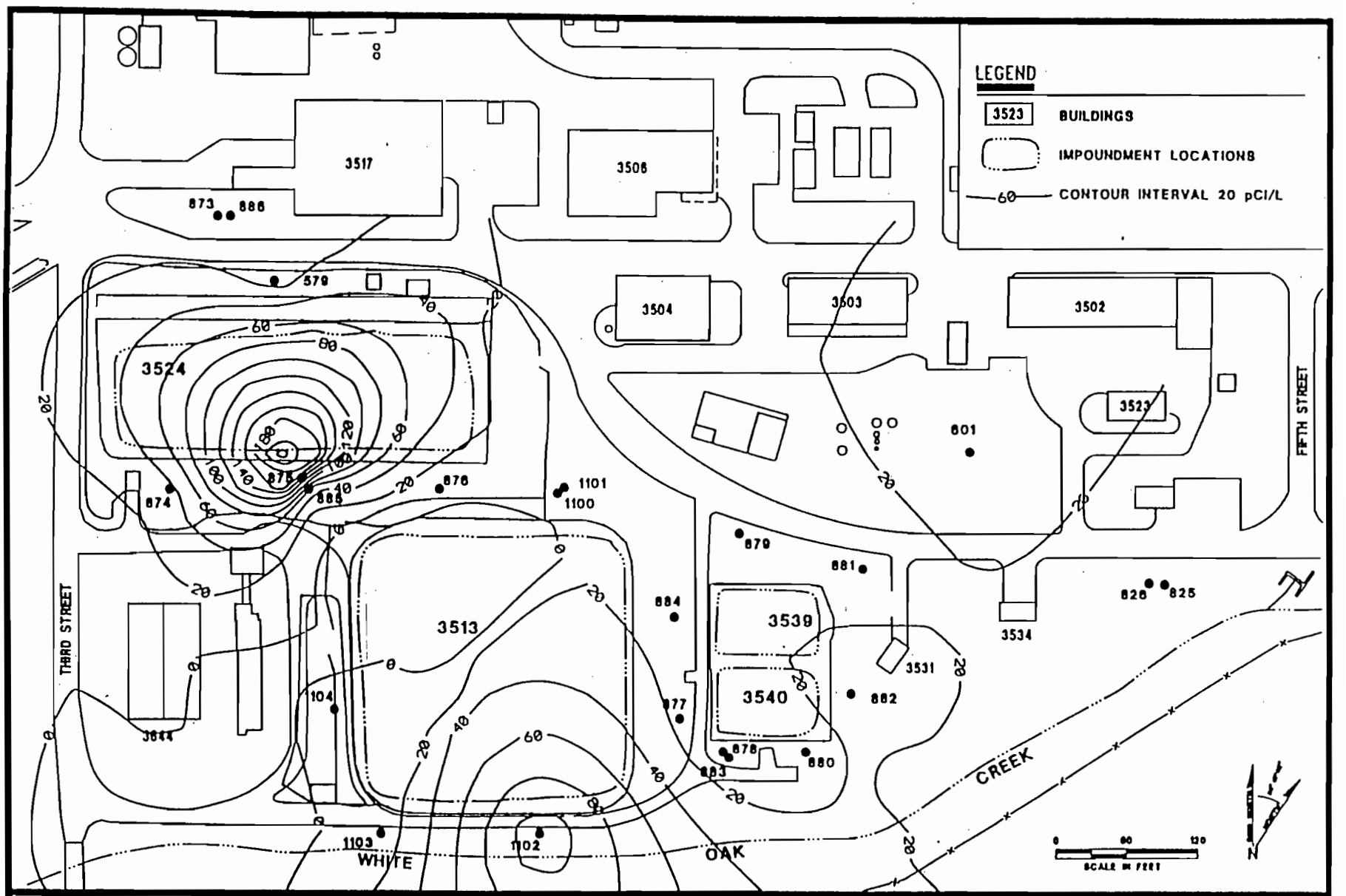

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Gross alpha (filtered) concentrations in groundwater

Oak Ridge National Laboratory
Oak Ridge, Tennessee

Fig. B3.5

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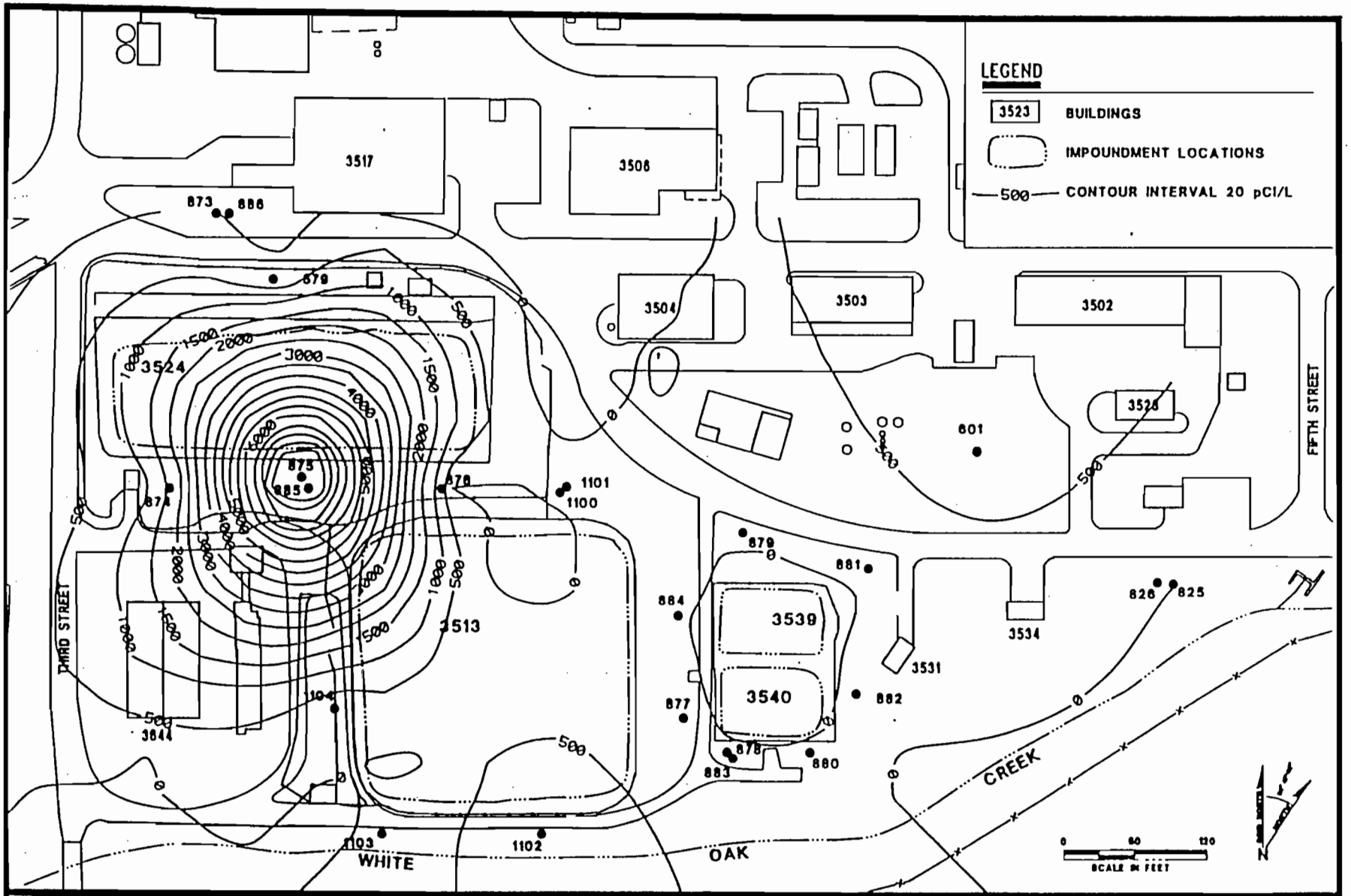

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Strontium-90 (unfiltered) concentrations in groundwater

Oak Ridge National Laboratory
Oak Ridge, Tennessee

Fig. B3.6

A2026/14NOV94/118

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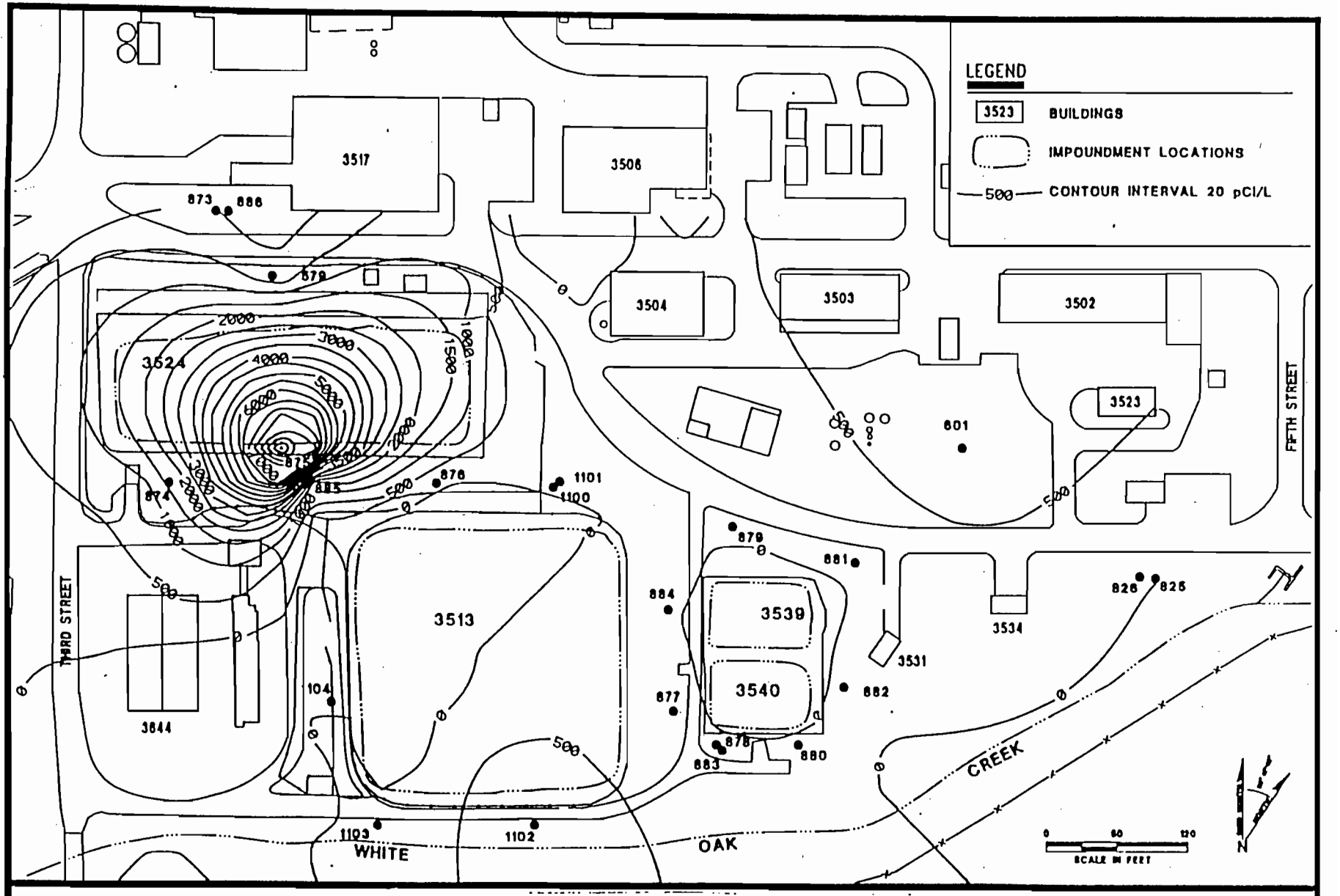

CDM FEDERAL PROGRAMS CORPORATION
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Strontium-90 (filtered) concentrations in groundwater

Oak Ridge National Laboratory
Oak Ridge, Tennessee

Fig. B3.7

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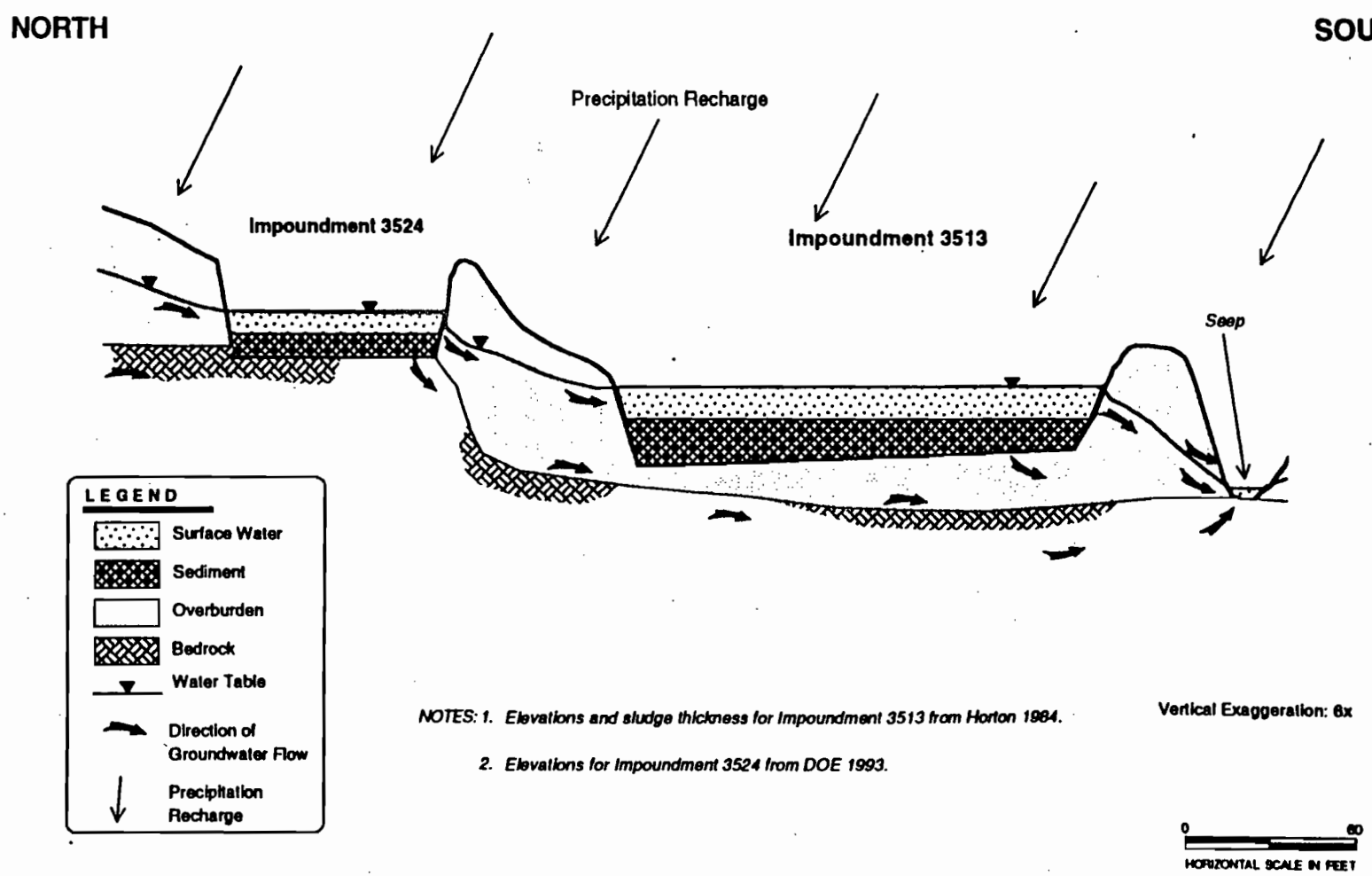

JE	Fig. 2.3	**Fate and transport conceptual model** DOE — ORNL, WAG 1 Surface Impoundments — Oak Ridge, Tennessee	DOCUMENT ID. 35HB30 4004-15 / RI/FS	DRAWING ID 96-10364.PD0-A	DRAWING DATE: OCTOBER 23, 1995 Bs

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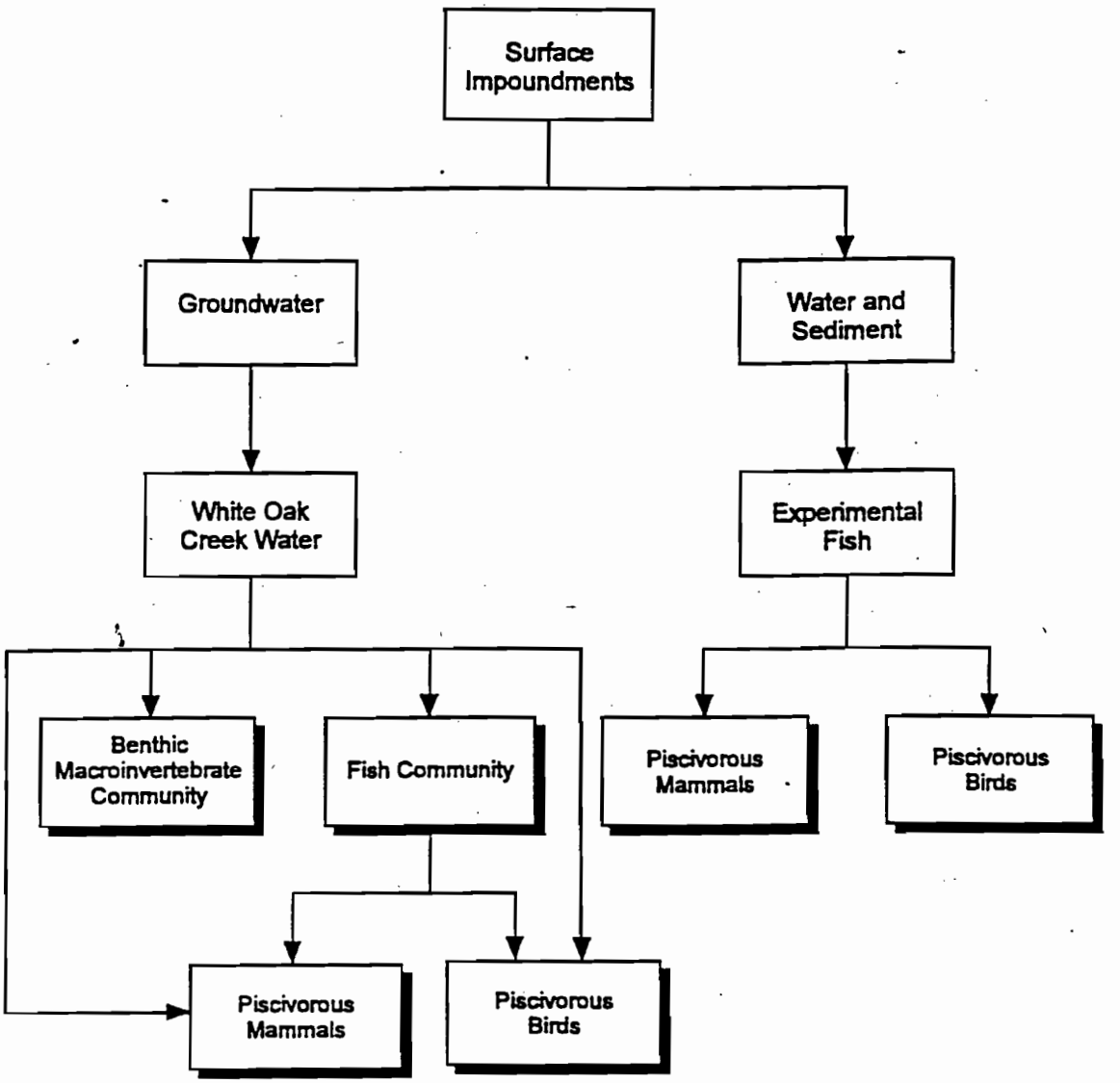

Primary or Secondary Contaminant Source

Assessment Endpoint

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Fig. 3.2

Ecological risk conceptual model

DOE - ORNL, WAG 1, Surface Impoundments - Oak Ridge, Tennessee

DOCUMENT ID: 35HE30 4004-15 / RIFFS	DRAWING ID: 95-11670.CDR	DRAWING DATE: OCTOBER 30, 1995 Bs

Table 3.7. Scenario/receptor descriptions, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

Employee at SIOU
Current
The RME and average current employee are estimated to spend 8 hours/day on the site. One hour/day (RME) or 0.5 hour/day (mean) is spent outside maintaining or monitoring the property; the remainder of the day (7 hours/day) is spent in an uncontaminated building. The employee works 250 days/year and consumes no drinking water from the site.
Future
The RME and average future employee spends 1 hour/day (RME) or 0.5 hour/day (mean) outdoors and 7 hours/day within the building for 250 days/year as described above. The future employee does not consume contaminated drinking water from the site.
Child wading in White Oak Creek
Future
Both the RME and average individuals are represented as a child wading in the creek receiving runoff from the SIOU site. The child is assumed to play in the creek for 1 hour 7 times a year (average) and 45 times a year (RME) over the course of 6 years.
Resident at White Oak Creek, White Oak Dam, and Clinch River
Future
The RME and average future resident is assumed to reside at the specified nearby location and consume, contact, and inhale contaminants from surface water or groundwater at the location or from airborne particulates that might migrate from SIOU.
On-site resident
Future
The RME and average, future on-site resident is assumed to reside at SIOU. The on-site resident consumes contaminated groundwater or water from White Oak Creek and receives a direct radiation exposure (4 hours/day RME and 2 hours/day average) from the impoundments. In addition, in the future, it is assumed that the water cover will evaporate or be removed, exposing the sediment contents to the open air. No direct contact with sediments is assumed.

ORNL = Oak Ridge National Laboratory
RME = reasonable maximum exposure
SIOU = Surface Impoundments Operable Unit

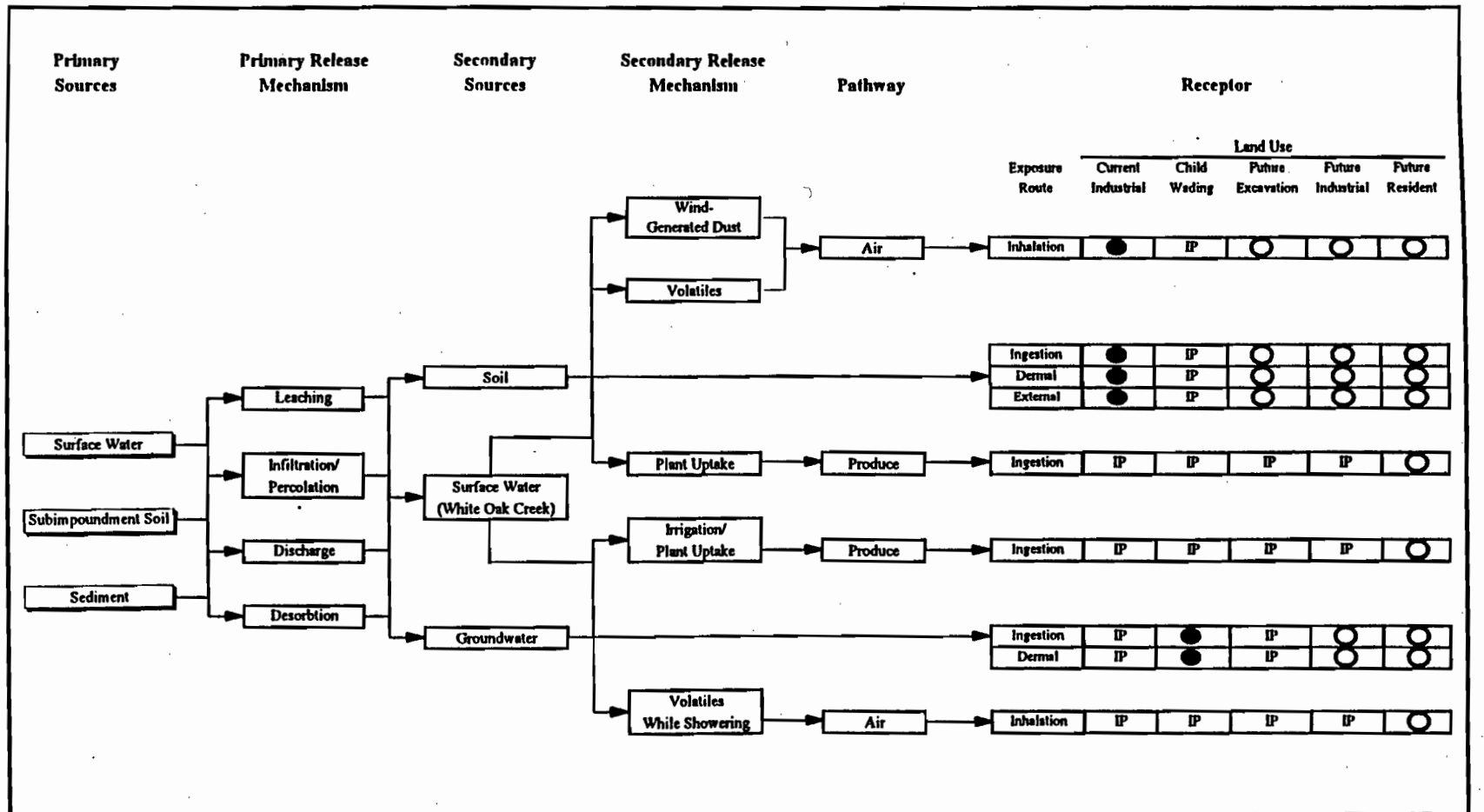

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Fig. 3.1

Conceptual site model for Surface Impoundments Operable Unit

DOE - ORNL, WAG 1, Surface Impoundments - Oak Ridge, Tennessee

DRAWING ID 35-R10	DRAWING SIZE 36.11125 x 1.5	DRAWING DATE OCTOBER 23, 1995 Bw

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Table 3.8. Screening of potential exposure pathways, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

Media/potential exposure route	Potential receptors	Pathway included in assessment? (yes/no)	Screening rationale
Sediment			
Direct radiation (radiological contaminants only)	Current employee	Yes	Radiological COPCs assessed
	Future employee	Yes	Radiological COPCs assessed
Dermal contact	Current employee	Yes	Direct access to soil considered
	Future employee	Yes	Direct access to soil considered
Air (from sediment)			
Particulate inhalation	Future nearby resident	Yes	All COCs assessed
	Future on-site resident	Yes	All COCs assessed
	Current employee	Yes	Air resuspension pathway
	Future employee	Yes	Air resuspension pathway
Vapor inhalation	Current employee	No	No applicable COCs
	Future employee	No	No applicable COCs
Surface water and sediment in White Oak Creek			
Dermal	Future child	Yes	No applicable COCs
Ingestion	Future child	Yes	All COCs assessed
Vapor inhalation	Future child	No	No applicable COCs
Groundwater or surface water			
Dermal	Current employee	No	No current groundwater usage
	Future employee	No	No future groundwater usage
	Future nearby resident	Yes	Applicable COCs assessed
	Future on-site resident	Yes	Applicable COCs assessed
Ingestion	Current employee	No	No current groundwater usage
	Future employee	No	No future groundwater usage
	Future nearby resident	Yes	All COCs assessed
	Future off-site resident	Yes	All COCs assessed
Vapor inhalation	Current employee	No	No current groundwater usage
	Future employee	No	Showering not evaluated for commercial land use
	Future nearby resident	No	No Applicable COCs
	Future on-site resident	No	No Applicable COCs
Food			
Ingestion	Future nearby resident	Yes	Mechanism for food contamination
	Future on-site resident	Yes	Mechanism for food contamination

COC = contaminant of concern
COPC = contaminant of potential concern
ORNL = Oak Ridge National Laboratory
SIOU = Surface Impoundments Operable Unit

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3.5.5 Radiological Risk Estimates

Table 3.11 presents the radiological risks for the SIOU site. Potential risks as a result of exposure to contaminants found at the SIOU site were estimated for reasonable current uses and hypothetical future uses of the site properties.

Table 3.11. Summary of radiological risk, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

Location	Receptor	Risk[a]	
		Mean	RME
Current use scenario			
SIOU	Employee	6×10^{-6}	6×10^{-5}
Future use scenario, all pathways			
SIOU	Employee	1×10^{-2}	8×10^{-2}
SIOU	On-site resident	5×10^{-2}	2×10^{-1}
White Oak Creek	Child wading	ND	4×10^{-4}
White Oak Creek	Resident	8×10^{-5}	7×10^{-4}
White Oak Dam	Resident	4×10^{-6}	5×10^{-3}
Clinch River	Resident	3×10^{-2}	5×10^{-3}

[a]Numbers are rounded to one significant figure.

Note: Shading indicates values that exceed EPA's target risk range.

ND = not detected
ORNL = Oak Ridge National Laboratory
RME = reasonable maximum exposure
SIOU = Surface Impoundments Operable Unit

3.5.5.1 Current use

Estimated RME and mean carcinogenic risks for occupational workers spending time both indoors and outdoors on the SIOU site were 5.7×10^{-5} and 5.9×10^{-6}, respectively. Gamma irradiation contributes 100 percent of the total radiological risk to the worker. As mentioned earlier, there is no significant migration of contamination from ORR from SIOU and, therefore, no off-site current exposure and negligible risk to residents or sensitive populations surrounding ORR.

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risks are likely overestimated. Also, using White Oak Creek at the dam as a domestic source of water is highly unlikely. The hazard indices estimated for this exposure scenario are less than 1, suggesting that adverse health effects are not likely to occur, based on the exposure evaluated (Tables 3.12 and 3.13). Therefore, N-nitrosodi-n-propylamine is not carried forward in the screening of alternatives.

3.6 UNCERTAINTY IN THE ASSESSMENT PROCESS

The risks presented in the SIOU baseline risk assessment are single-point estimates of risk rather than probabilistic estimates. Therefore, it is important to attempt to specify the uncertainties inherent in the risk assessment to place the risk estimates in proper perspective.

A quantitative statistical analysis of uncertainty has not been performed. Instead, key assumptions and site-related variables that contribute most to the uncertainty have been identified. The uncertainty associated with each variable discussed is described as low (i.e., probably will not impact the risk outcome), moderate (i.e., may impact the risk outcome slightly), or high (i.e., is likely to significantly impact the risk estimate).

Table 3.12. Summary of chemical carcinogenic risks for Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

Location	Receptor	Risk	
		Mean	RME
Current use scenario			
SIOU	Employee	2×10^{-7}	1×10^{-6}
Future use scenario			
SIOU	Employee	4×10^{-7}	4×10^{-6}
White Oak Creek	Child wading	7×10^{-7}	6×10^{-6}
White Oak Creek	Resident	4×10^{-4}	2×10^{-3}
White Oak Dam	Resident	2×10^{-4}	8×10^{-4}

ORNL = Oak Ridge National Laboratory
RME = reasonable maximum exposure
SIOU = Surface Impoundments Operable Unit

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Table 3.13. Summary of chemical noncarcinogenic hazards, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

Location	Receptor	Hazard index	
		Mean	RME
	Current use scenario		
SIOU	Employee	0.006	0.013
	Future use scenario		
SIOU	Employee	0.0005	0.002
White Oak Creek	Child wading	0.000001	0.00008
White Oak Creek	Resident	0.007	0.01
White Oak Dam	Resident	0.004	0.007

ORNL = Oak Ridge National Laboratory
RME = reasonable maximum exposure
SIOU = Surface Impoundments Operable Unit

There are several categories of uncertainties associated with baseline risk assessments. These include:

- sampling data adequacy,
- selection of COPCs,
- exposure assessment variables, and
- toxicity values.

In each of these categories, Appendix C presents a discussion on the radiological risk characterization, chemical risk characterization, and uncertainties for ecological risk assessment.

3.7 SUMMARY OF HEALTH RISK CHARACTERIZATION

3.7.1 Radiological and Chemical Risks

At SIOU, radiological risk from sediment contaminants in the bottoms of the impoundments dominate the baseline risk assessment. In almost every future scenario, the EPA's target risk range is exceeded, making for an unacceptable future risk. In addition, the risk from radiological contamination as compared to the chemical risk is often several orders of magnitude greater in both the current and future scenarios. If chemical risks were the only consideration at SIOU, the associated risk from the chemicals present would not necessitate a remedial action.

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Under current conditions with institutional controls, there is no unacceptable on-site or off-site risk to employees or the public. Energy Systems monitors and maintains the protective water covers on the impoundments and handles any compromise in the berms surrounding the impoundments expeditiously. All monitoring station data indicate that contamination is limited to the immediate SIOU area and is not significantly migrating off site. As reported, all current risks are well within the EPA's acceptable target risk range.

For comparison purposes only, hypothetical scenarios were developed to estimate future risk from SIOU. These scenarios are conservative and assume that DOE would return ORR to its original, unrestricted farming, residential, or commercial land uses. In every one of these scenarios, the risks that were estimated suggest that a corrective action be taken to protect both on-site and off-site employees and residents. Again, the majority of the risk occurs when the protective water cover is removed by a drought condition or a berm failure, exposing the sediments in the impoundments, thus releasing large quantities of contamination to White Oak Creek. When contamination is modeled to allow off-site migration, the risk from contaminated drinking water at all locations is unacceptable for the RME.

The baseline risk assessment concludes that, when radionuclides such as ^{239}Pu, ^{241}Am, or ^{60}Co and ^{137}Cs in the soil and sediment are exposed, the on-site future risk to the employees or residents is always unacceptable. The pathways contributing the majority of the risk are direct radiation, inhalation of airborne particulates, and incidental ingestion of soil and sediment. Strontium-90, which is readily mobilized by water, accounts for the majority of the risk that results from off-site migration. The drinking water pathway is the main contributor to this risk.

When the protective water cover is removed, the airborne pathway results in unacceptable risk at both White Oak Creek and Clinch River.

3.8 BASELINE ECOLOGICAL RISK ASSESSMENT SUMMARY

This section presents a summary of the baseline ecological risk assessment for SIOU; Appendix C includes supporting documentation. This baseline ecological risk assessment evaluates risks to populations and communities of nonhuman organisms that are currently on the site or may live there in the future. It also assesses the contribution of the site contaminants to off-site risks.

3.8.1 Ecological Problem Formulation

Ecological problem formulation defines the scope of the assessment, the sources being assessed, the endpoints of the assessment, and the site conceptual model. The objective of

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ecological risk assessment is to provide a basis for decisions on remediation as it concerns risks to nonhuman species. The relative risks to receptors are estimated by comparing environmental concentrations of contaminants to toxicological benchmarks provided by the Risk Assessment Council at ORNL and EPA Region IV.

3.8.1.1 Potentially affected habitat and potentially exposed species

SIOU, which is composed of four man-made impoundments, has minimal natural habitat; however, some species may visit the site on a limited basis.

Impoundments 3513 and 3524. Fish were introduced into these impoundments in May 1977 (Garten, Trabalka, and Bogle 1982). Species included goldfish (*Carassius auratus*), channel catfish (*Ictalurus punctatus*), mosquito fish (*Gambusia affinis*), and bluegill sunfish (*Lepomis macrochirus*). These fish species supplemented an existing vertebrate fauna consisting of frogs (*Rana catesbeiana* and *R. palustris*) and possibly some turtles. In addition to aquatic species, birds and small mammals may forage in and around the impoundments.

Impoundments 3539 and 3540. Impoundments 3539 and 3540 do not contain fish and presumably do not contribute to groundwater contamination because they have a clay liner. Therefore, they were not included in the determination of risks to off-site receptors from migration of contaminants from SIOU or for impacts to piscivorous wildlife.

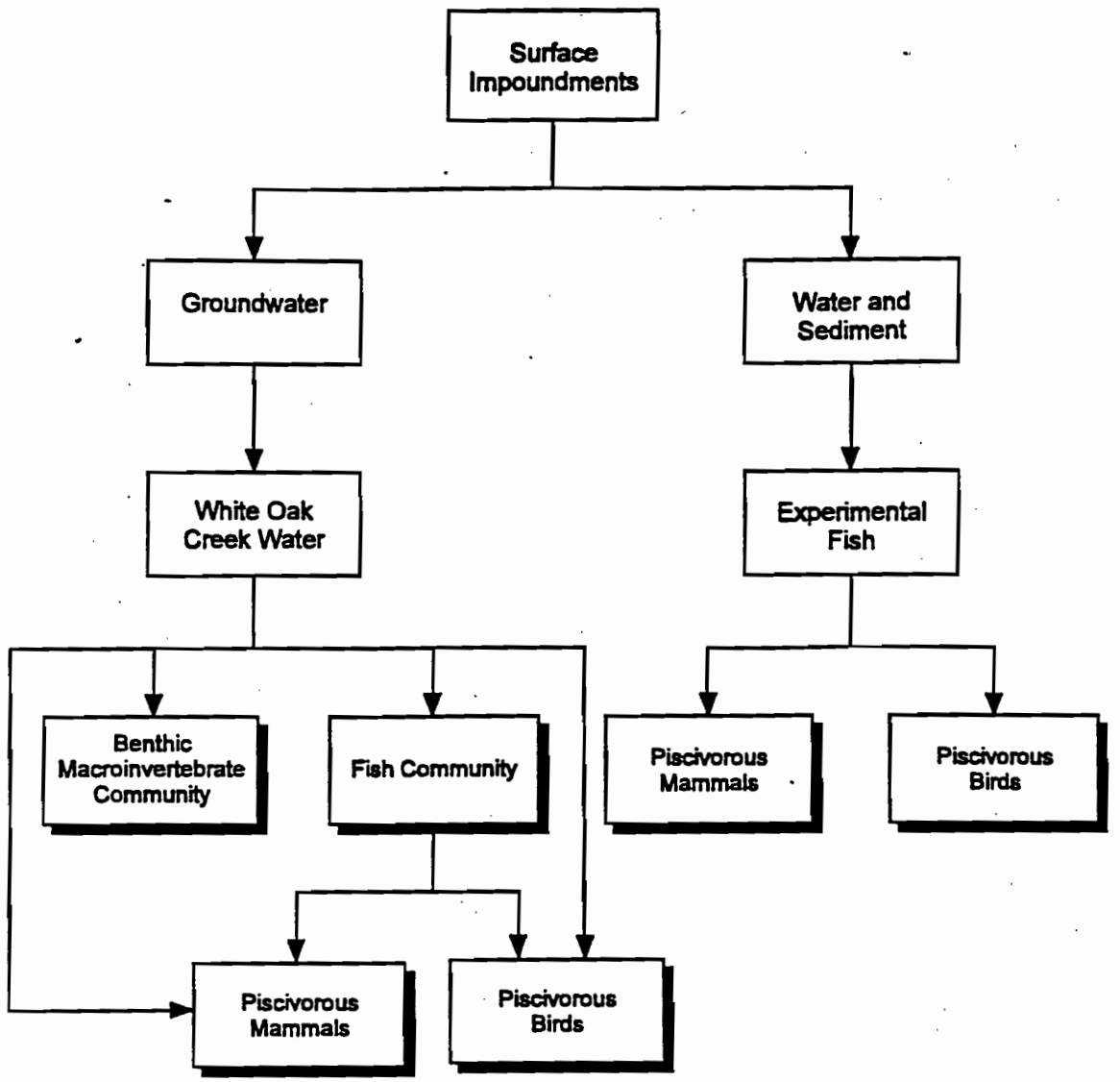
3.8.1.2 Ecological assessment endpoints

This baseline ecological risk assessment does not address aquatic receptors in SIOU. The surface impoundments are man-made, and the fish species that are present in the impoundments are experimental animals introduced several years ago. However, effects to fish and aquatic invertebrates were evaluated in White Oak Creek adjacent to SIOU, at White Oak Dam, and in Clinch River.

The belted kingfisher (*Ceryle alcyon*) and mink (*Mustela vison*) were selected as piscivorous endpoints.

3.8.1.3 Site conceptual model

The site conceptual model, which is illustrated in Figure 3.2, graphically represents the relationships between the contaminant sources and the endpoint receptors. It includes the SIOU sources, the receptors that are designated as assessment endpoint species, and the major routes that result in exposure.



Primary or Secondary Contaminant Source

Assessment Endpoint

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Fig. 3.2

Ecological risk conceptual model

DOE - ORNL, WAG 1, Surface Impoundments - Oak Ridge, Tennessee

DOCUMENT ID: 35HB30 4004-15 / RI/FS	DRAWING ID: 96-11670.CDR	DRAWING DATE: OCTOBER 30, 1995 Ba

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3.8.2 Ecological Exposure Assessment

The only significant route of exposure for aquatic biota is respiratory uptake. Therefore, concentrations of contaminants in water constitute a complete model of exposure for aquatic biota.

The primary routes of exposure for terrestrial wildlife species are ingestion of food and surface water. Tables C.5.3 through C.5.16 present the total exposure of the endpoint receptors to contaminants of ecological concern in surface water and food items. Appendix C includes assumptions and equations for computing total exposure.

3.8.3 Ecological Effects Assessment

Effects assessment involves identifying known effects of contaminants on receptors using conventional and ambient toxicity data. These data will be used in the risk characterization section to evaluate risks to piscivorous wildlife at SIOU and White Oak Creek and aquatic biota in White Oak Creek and Clinch River. Contaminant concentrations and total estimated exposures are compared to benchmarks to compute a hazard quotient used in the risk characterization.

Appendix C includes toxicity information for the contaminants of ecological concern at SIOU.

3.8.4 Ecological Risk Characterization

The risk characterization in this assessment is performed for each assessment endpoint by (1) screening all measured contaminants against toxicological benchmarks, (2) estimating the effects of the contaminants retained by the screening analysis, and (3) discussing the uncertainties in the assessment.

The ecological risk assessment addresses both current and modeled concentrations of contaminants. The current condition includes the present contaminant levels, environment of the site, and current risks to biotic receptors. Seepage from Impoundments 3513 and 3524 to White Oak Creek was modeled using sediment concentrations. The modeled data, which are presented in Table C.5.1 in Appendix C, represent the contaminant concentrations contributed to surface water in White Oak Creek adjacent to the impoundments. These values were used to evaluate whether aquatic biota in White Oak Creek are at risk.

3.8.4.3 Preliminary remediation goals

The concentration of mercury in fish in SIOU (0.795 mg/kg) would have to be decreased to less than 30 percent of the current levels for there to be insignificant risks to piscivorous wildlife.

The concentration of Aroclor-1254 in fish in SIOU (23.8 mg/kg) would have to be decreased to less than one third of the current levels for risks to be insignificant to piscivorous wildlife.

Silver concentrations (0.0024 mg/L) in surface water at White Oak Creek (WCK 3.9) and White Oak Dam exceed the secondary chronic value and the lowest chronic value for fish. These modeled surface water concentrations appear to be conservative and may not truly be representative of the current surface water concentrations at WCK 3.9 or White Oak Dam. However, if modeled concentrations are accurate, a preliminary remediation goal of 0.00012 mg/L (lowest chronic value for fish) would be established for silver.

The measured mercury (< 0.00002 mg/L) concentration at WCK 3.9 exceeded the secondary chronic value (0.000003) if methyl mercury is assumed. This value is considered an appropriate preliminary remedial goal; however, the value is below the practical quantitation limit for the analytical method.

The risk characterization for piscivorous wildlife feeding out of White Oak Creek (WCK 3.9) (Sect. 3.8.4.1) suggested no unacceptable risks for either piscivorous bird or mammal populations. Therefore, no PRGs are set for these endpoints.

Table 4.2. Addressing remedial action objectives, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

Alternative	Remedial action objective			
	Minimize direct exposure, direct contact, inhalation, and ingestion of contaminants	Control leaching of contaminants to drinking water sources	Control potential future failure of the impoundments berm/embankment	Minimize bioaccumulation of contaminants in sensitive ecological receptors
Alternative 1—No action	Maintaining water cover and prohibiting access will meet objective during period of institutional control. Will not meet objective thereafter	Prohibits access to drinking water sources up to Clinch River during period of institutional control	Operational controls and monitoring moderately effective during period of institutional control. Not effective thereafter	Not effective
Alternative 2—Multilayer cap and institutional controls	Cap will minimize direct exposure, direct contact, and inhalation of contaminants for life of cap. Prohibiting access from the SIOU site to Clinch River will minimize ingestion from waterborne pathways	Prohibits access to drinking water sources up to Clinch River	Structural stability somewhat improved	Contaminated ponds are eliminated and fish in the impoundment are no longer in the food chain. Lesser contamination in White Oak Creek continues
Alternative 3—Consolidation cell with simple dewatering	Cap and liner will minimize direct exposure, direct contact, inhalation, and ingestion of contaminants for life of cap	Controls leaching with cap and liner	Structural stability improved	Isolates contamination from ecological receptors
Alternative 4—Consolidation cell with ex situ treatment	Cap and liner will minimize direct exposure, direct contact, inhalation, and ingestion of contaminants for life of cap. Treatment will reduce risk of inadvertent intrusion for a longer period	Controls leaching with cap and liner	Structural stability improved	Isolates contamination from ecological receptors
Alternative 5—Off-operable unit consolidation cell	Will minimize risk at SIOU site and all points downgradient. Risk at consolidation cell site will be the same as Alternative 3	Controls leaching with cap, liner, and geologic isolation	Structural stability improved	Isolates contamination from ecological receptors
Alternative 6—Removal, treatment, and off-site disposal	Removal will minimize all long-term risks. Short-term risks during removal, treatment, transport, and disposal will increase	Eliminates contamination source	Eliminates contamination source	Eliminates contamination source

ORNL = Oak Ridge National Laboratory
SIOU = Surface Impoundments Operable Unit

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Table 5.7. Summary of comparative analysis of alternatives for CERCLA criteria, Waste Area Grouping 1, SIOU, ORNL, Oak Ridge, Tennessee

CERCLA criteria	Alternative 1 No Action	Alternative 2 Multilayer cap, institutional controls	Alternative 3 Consolidation cell with simple dewatering	Alternative 4 Consolidation cell with ex situ treatment	Alternative 5 Off-SIOU consolidation cell	Alternative 6 Removal, treatment, and off-site disposal	CERCLA criteria
Overall protection of human health and the environment							Overall protection of human health and the environment
Future RME Risk		Total risk	Total risk	Total risk	Total risk	Total risk	Future RME Risk
Employee on site	[illegible]	[illegible]	<1 × 10^{-4}	<1 × 10^{-4}	<1 × 10^{-4}	<1 × 10^{-4}	Employee on site
Resident Clinch River	[illegible]	<1 × 10^{-4}	<1 × 10^{-4}	<1 × 10^{-4}	<1 × 10^{-4}	<1 × 10^{-4}	Resident Clinch River
Resident White Oak Dam	[illegible]	[illegible]	[illegible]	<1 × 10^{-4}	<1 × 10^{-4}	<1 × 10^{-4}	Resident White Oak Dam
Resident White Oak Creek	[illegible]	[illegible]	[illegible]	[illegible]	<1 × 10^{-4}	<1 × 10^{-4}	Resident White Oak Creek
Resident on site	[illegible]	[illegible]	[illegible]	[illegible]	<1 × 10^{-4}	<1 × 10^{-4}	Resident on site
Human health risk discussion	Risk to human health from migration of contamination to groundwater and White Oak Creek. If water cover over sediment is lost, airborne contamination resulting in widespread human health risk is possible. Very high external gamma exposures to on-site receptors	Protective to receptor at White Oak Dam. Possible risk to human health from migration of contamination to groundwater and White Oak Creek. Protective while DOE maintains institutional controls	Protective to receptors at White Oak Dam, and possibly at White Oak Creek and at the site while DOE maintains institutional controls	Protective to future employees, residential receptors at White Oak Dam, and possibly at White Oak Creek while DOE maintains institutional controls	Protective to all receptors while DOE maintains institutional controls	Protective to all receptors due to removal of source material	Human health risk discussion
Ecological risk discussion	Risk to environmental receptors from consumption of fish in impoundments. Small risk from consumption of fish in White Oak Creek	No risk to environmental receptors	No risk to environmental receptors	No risk to environmental receptors	No risk to environmental receptors	No risk to environmental receptors	Ecological risk discussion
Compliance with ARARs	No ARARs under CERCLA. Not protective as required by CERCLA	[illegible] waivers required	[illegible] waivers required	[illegible] waivers required	[illegible] waivers required	Meets all ARARs	Compliance with ARARs
Short-term effectiveness	No increase or reduction in short-term effects on human health and environment	Potential for small, adverse short-term effects	Potential for moderate, adverse short-term effects	Potential for moderately high, adverse short-term effects	Potential for moderately high, adverse short-term effects	Potential for very high, adverse short-term effects	Short-term effectiveness
Long-term effectiveness	Not effective	Effective for period of institutional control	Very effective for period of institutional control	Very effective for period of institutional control	Very effective for period of institutional control	Very effective at site	Long-term effectiveness
Reduction of toxicity, mobility, or volume through treatment	None	None	Small reduction in volume	Significant increase in volume. Some decrease in mobility of most contaminants	Small reduction in volume	Significant increase in volume. Some decrease in mobility of most contaminants	Reduction of toxicity, mobility, or volume through treatment
Implementability	Very easy to implement	Easy to implement	Somewhat difficult to implement	Difficult to implement	Fairly difficult to implement	Extremely difficult to implement, both technically and administratively	Implementability
Present worth cost	$5,569,000	$21,230,000	$45,650,000	$87,243,000	$48,252,000	$148,637,000	Present worth cost

[illegible]Risk associated with soils to be remediated as part of the 3000 Watershed Soil Operable Unit.

ARAR = applicable or relevant and appropriate requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
DOE = U.S. Department of Energy
ORNL = Oak Ridge National Laboratory
RME = reasonable maximum exposure
SIOU = Surface Impoundments Operable Unit

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DOE/OR/02-1346&D2

Remedial Investigation/Feasibility Study for Surface Impoundments Operable Unit Waste Area Grouping 1 Oak Ridge National Laboratory Oak Ridge, Tennessee

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NO ADDITIONAL INFORMATION IS AVAILABLE