012371

United States Department of Energy

Savannah River Site

Record of Decision
Remedial Alternative Selection for the Chemicals, Metals, and Pesticides Pits Operable Unit (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) (U)

CERCLIS Number: 24

WSRC-RP-2004-4090

Revision 1

December 2004

Prepared by:
Westinghouse Savannah River Company LLC
Savannah River Site
Aiken, SC 29808

SRS

Prepared for U.S. Department of Energy under Contract No. DE-AC09-96SR18500

DISCLAIMER

Printed in the United States of America

Prepared for
U.S. Department of Energy
and
Westinghouse Savannah River Company LLC
Aiken, South Carolina

RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION (U)

Chemicals, Metals, and Pesticides Pits Operable Unit
(080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) (U)

CERCLIS Number: 24

WSRC-RP-2004-4090
Revision 1

December 2004

Savannah River Site
Aiken, South Carolina

Prepared by:

Westinghouse Savannah River Company LLC
for the
U. S. Department of Energy under Contract DE-AC09-96SR18500
Savannah River Operations Office
Aiken, South Carolina

This page was intentionally left blank.

DECLARATION FOR THE RECORD OF DECISION

Unit Name and Location

Chemicals, Metals, and Pesticides Pits Operable Unit (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G)

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number: OU-24

Savannah River Site

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Identification Number: SC1 890 008 989

Aiken, South Carolina

United States Department of Energy

The Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) (CMP Pits) Operable Unit (OU) is listed as a Resource Conservation and Recovery Act (RCRA) 3004(u) Solid Waste Management Unit/CERCLA unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS).

The FFA is a legally binding agreement between regulatory agencies [United States Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC)] and regulated entities [United States Department of Energy (USDOE)] that establishes the responsibilities and schedules for the comprehensive remediation of SRS. The CMP Pits OU is comprised of (1) Ballast Area soils, (2) CMP Pits and associated vadose zone (Field A), (3) Vadose zone (Field B), (4) Groundwater, and (5) Surface Water and Sediment (Figure I). The media associated with this OU are surface soil, subsurface soil, groundwater, sediment and surface water.

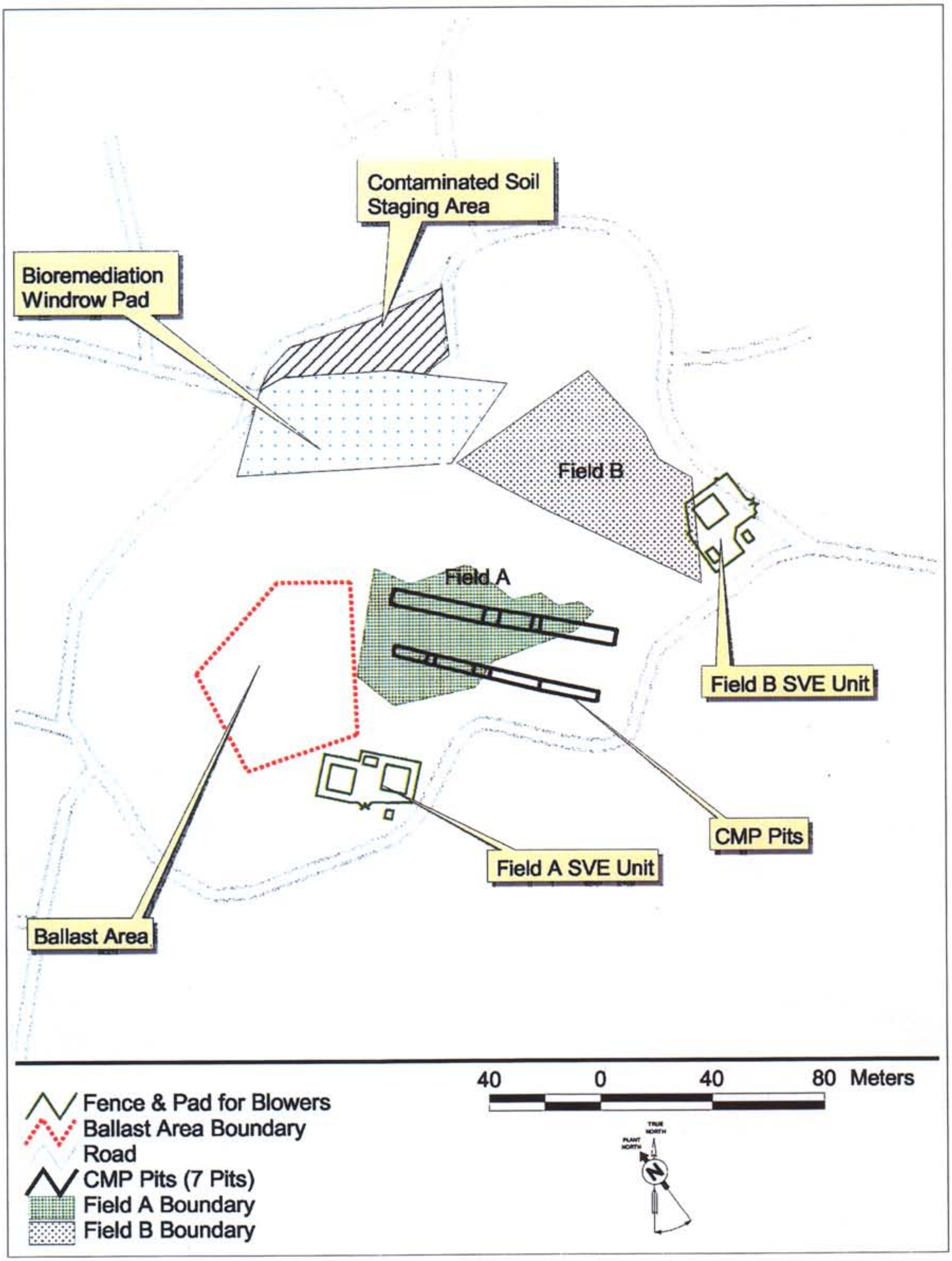


Figure I. Layout of the CMP Pits OU

Based on investigation results (WSRC 1997), an interim action was performed that included enhanced bioremediation in the Ballast Area, and soil vapor extraction (SVE) in Field A and Field B. Additional characterization data (WSRC 2003b) was used to identify the selected remedy for the CMP Pits OU.

Statement of Basis and Purpose

This decision document presents the selected remedy for the CMP Pits OU, located at the SRS in Barnwell County, South Carolina. The remedy was chosen in accordance with CERCLA, as amended by the Superfund Amendments Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record File for this site.

The USEPA, SCDHEC and USDOE concur with the selected remedy.

Assessment of the Site

There has been a release of polychlorinated biphenyls (PCBs) and pesticides in the Ballast Area, volatile organic compounds (VOCs) in Field A and Field B vadose zone, and VOCs in groundwater. Enhanced bioremediation and SVE have been implemented as interim action remedies for the Ballast Area (WSRC 2003a) and Fields A and B vadose zone (WSRC 1999b), respectively. The final response actions selected in this Record of Decision (ROD) are necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Description of the Selected Remedies

The following remedies have been selected for the CMP Pits OU:

Ballast Area – Institutional controls after completion of the enhanced bioremediation interim action for pesticide and PCB contaminated surface soils

- Land use controls (LUCs) will be implemented in the form of property record notices, the Site Use Program, Physical Access Controls at the SRS boundary, warning signs, and security surveillance.

The Ballast Area interim action (enhanced bio-remediation) will remediate the contaminated soil to be protective of the industrial worker and ecological receptors. LUCs will be required to prevent future residential (unrestricted) use of the surface soil.

CMP Pits and associated vadose zone (Field A) – Combination of electrical resistance heating (ERH) to remove dense non-aqueous phase liquid (DNAPL) from the vadose zone and continued operation of the SVE system

- Electrodes will be installed in an array in the area of DNAPL.
- Electricity will be provided to the electrodes to heat the soil and increase the volatilization of contaminants.
- SVE will continue to operate to remove the contaminants.
- LUC will be implemented to maintain the soil cover that was installed following excavation of the pits.

Dichloromethane (DCM) and tetrachloroethylene (PCE) were identified as principal threat source material (PTSM) in the Field A vadose zone. ERH with SVE will treat the areas of maximum VOC concentration and eliminate the Field A as a source of contamination to the groundwater.

Field B – Passive SVE (Baroballs™)

- Baroballs™, installed during the interim action, will continue to remove residual VOC contamination in the Field B vadose zone.

Passive SVE will remove residual VOCs in the Field B that are considered a low-level threat waste.

Groundwater – Monitored Natural Attenuation (MNA) and institutional controls

- Groundwater monitoring will be performed semi-annually. The frequency of groundwater monitoring will be changed with the concurrence of EPA and DHEC, based on monitoring results.
- Groundwater monitoring results will be reported annually.
- The monitoring results will be compared to modeling results to confirm that groundwater contamination is being attenuated.
- LUCs will be implemented to prevent groundwater use.

Institutional controls will be implemented in conjunction with MNA to address low-level threats in the groundwater.

Upon implementation of the groundwater remedial action, there will be known and projected points where contaminated groundwater may discharge to surface water at Pen Branch. However, groundwater and surface water compliance monitoring and computer modeling will ensure that the groundwater discharge does not result in any statistically significant increase of constituents from the groundwater in the surface water at the point of entry or at any point where there is reason to believe accumulation of constituents might occur downstream. The 2002 modeling results will be updated by modeling the Tan Clay Confining Zone as a potential secondary source to generate time-trend plots for groundwater contamination. Additionally, the remedial action includes enforceable land use controls to preclude human exposure to contaminated groundwater at any point between the facility boundary and all known and projected points of entry of the groundwater into the surface water.

The Pen Branch Surface Water and Sediment subunit is included with the CMP Pits OU to determine the impact of the OU on the surface water and sediment. No constituents of concern were identified in the surface water and sediment (WSRC 1997). Therefore no action is required for the Pen Branch Surface Water and Sediment due to impacts from the CMP Pits.

The future land use assumed for the CMP Pits OU is industrial land use.

Institutional controls are being implemented to limit human exposure to the low-level threats in the Ballast Area surface soils following enhanced bioremediation that was implemented during the interim remedial action.

Due to the complexity of multiple contaminant areas, the SRS is divided into integrated operable units (IOUs) for the purpose of managing a comprehensive cleanup strategy. OUs within an IOU are evaluated and remediated individually.

The CMP Pits OU is located within the Pen Branch IOU. This ROD addresses the contamination in CMP Pit OU soils and groundwater and presents the final response action for this site. Upon disposition of the CMP Pits OU and all other OUs within the Pen Branch IOU, a final comprehensive ROD for the Pen Branch IOU will be pursued with additional public involvement. Upon disposition of all IOU RODs, a final comprehensive ROD for the SRS will be pursued with additional public involvement.

The following activities have been performed to support the overall cleanup strategy for the CMP Pits OU:

- Original excavation of the CMP Pits conducted (1984)
- Ballast Area Soil Excavation/Off-site Incineration (Interim Action) (2000)
- SVE in CMP Pits Field B (Interim Action) (2001)
- Ballast Area Soil Excavation / Bioremediation (Treatability Study – Phase I) (2001)
- SVE in CMP Pits Field A (Interim Action) (2002)

- Ballast Area Soil Excavation / Bioremediation (Treatabililty Study – Phase II) (2002)
- Ballast Area Soil Excavation / Bioremediation (Interim Action) (2004)

The RCRA permit will be revised to reflect selection of the final remedy using the procedures under 40 CFR Part 270, and SCHWMR R.61-79.264.101; 270.

Statutory Determinations

Based on the unit RCRA Facility Investigation (RFI)/Remedial Investigation (RI) with Baseline Risk Assessment (BRA) report, the CMP Pits OU poses a threat to human health and the environment. Therefore, the selected remedies for the CMP Pits OU are institutional controls for the Ballast Area, ERH and SVE for the Source Area (Field A), Passive SVE (Baroballs™) for Field B, and MNA with institutional controls for groundwater. The future land use of the CMP Pits OU is assumed to be industrial land use.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduce the toxicity, mobility, or volume of materials comprising principal threats through treatment).

In the long term, if the property is ever transferred to nonfederal ownership, the U.S. Government will take those actions necessary pursuant to Section 120(h) of CERCLA. Those actions will include a deed notification disclosing former waste management and disposal activities as well as remedial actions taken on the site. The contract for sale and the deed will contain the notification required by CERCLA Section 120(h). The deed notification shall, in perpetuity, notify any potential purchaser that the property has been used for the management and disposal of waste. These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination remains at the unit.

The deed shall also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for the deed restrictions will be done through an amended ROD with USEPA and SCDHEC review and approval.

In addition, if the site is ever transferred to nonfederal ownership, a survey plat of the OU will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency.

The selected remedy for the CMP Pits OU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for an indefinite period of time. As agreed on March 30, 2000, among the USDOE, USEPA, and SCDHEC, SRS is implementing a Land Use Control and Assurance Plan (LUCAP) to ensure that the LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific Land Use Control Implementation Plan (LUCIP) incorporated by reference into this ROD will provide details and specific measures required to implement and maintain the LUCs selected as part of this remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the Corrective Measures Implementation (CMI)/Remedial Action Implementation Plan (RAIP), as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect unless and until modifications are approved as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document.

Data Certification Checklist

This ROD provides the following information:

- Constituents of concern (COCs) and their respective concentrations (Section VII)
- Baseline risk represented by the COCs (Section VII)
- Cleanup levels established for the COCs and the basis for the levels (Section VIII)
- Current and reasonably anticipated future land and groundwater use assumptions used in the BRA and ROD (Section VII)
- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section XI)
- Estimated capital, operation and maintenance, and total present worth cost; discount rate; and the number of years over which the remedy cost estimates are projected (Section IX)
- Key decision factor(s) that led to selecting the remedy (i.e., describe how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria) (Section X)
- How source materials constituting principal threats are addressed (Section VII)

This page intentionally left blank.

2/22/05
Date

Jeffrey M. Allison
Manager
U. S. Department of Energy, Savannah River Operations Office

3/29/05
Date

for Winston A. Smith
Director
Waste Management Division
U. S. Environmental Protection Agency - Region 4

5/2/05
Date

Robert W. King, Jr.
Deputy Commissioner
Environmental Quality Control
South Carolina Department of Health and Environmental Control

This page intentionally left blank.

DECISION SUMMARY
REMEDIAL ALTERNATIVE SELECTION (U)

Chemicals, Metals, and Pesticides Pits OU

CERCLIS Number: 24

WSRC-RP-2004-4090
Rev. 1

December 2004

Savannah River Site
Aiken, South Carolina

Prepared By:

Westinghouse Savannah River Company LLC
for the
U. S. Department of Energy under Contract DE-AC09-96SR18500
Savannah River Operations Office
Aiken, South Carolina

This page was intentionally left blank

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulation
CMI	Corrective Measures Implementation
CMP Pits	Chemicals, Metals, and Pesticides Pits
COC	constituent of concern
CSM	conceptual site model
CVOC	chlorinated volatile organic compound
DNAPL	dense non-aqueous phase liquid
EPC	exposure point concentration
ERH	electrical resistance heating
ESD	explanation of significant difference
FFA	Federal Facility Agreement
HBL	health-based limit
HI	hazard index
IRIS	Integrated Risk Information System, USEPA
LLC	Limited Liability Company
LUC	Land Use Controls
LUCAP	Land Use Controls Assurance Plan
LUCIP	Land Use Controls Implementation Plan
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Protection Act
NPL	National Priorities List
OU	operable unit
PCB	polychlorinated biphenyl
PRG	preliminary remedial goals
PTSM	principal threat source material
RAIP	Remedial Action Implementation Plan
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

RFI	RCRA Facility Investigation
RG	remedial goal
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments Reauthorization Act
SB/PP	Statement of Basis/Proposed Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SCHWMR	South Carolina Hazardous Waste Management Regulations
SRS	Savannah River Site
SVE	soil vapor extraction
TRV	toxicity reference value
UCL	upper confidence limit
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
WSRC	Westinghouse Savannah River Company, LLC

This page intentionally left blank.

I. SAVANNAH RIVER SITE AND OPERABLE UNIT NAME, LOCATION, AND DESCRIPTION

Unit Name, Location, and Brief Description

Chemicals, Metals, and Pesticides Pits Operable Unit (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G)

CERCLIS Identification Number: OU- 24

Savannah River Site

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Identification Number: SC1 890 008 989

Aiken, South Carolina

United States Department of Energy (USDOE)

Savannah River Site (SRS) occupies approximately 310 square miles of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina (Figure 1). SRS is located approximately 25 miles southeast of Augusta, Georgia, and 20 miles south of Aiken, South Carolina.

The USDOE owns SRS, which historically produced tritium, plutonium, and other special nuclear materials for national defense and the space program. Chemical and radioactive wastes are byproducts of nuclear material production processes. Hazardous substances, as defined by CERCLA, are currently present in the environment at SRS.

The FFA (FFA 1993) for SRS lists the Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) (CMP Pits) Operable Unit (OU) as a RCRA/CERCLA unit requiring further evaluation. The CMP Pits OU was evaluated through an investigation process that integrates and combines the RCRA corrective action process with the CERCLA remedial process to determine the actual or potential impact to human health and the environment of releases of hazardous substances to the environment.

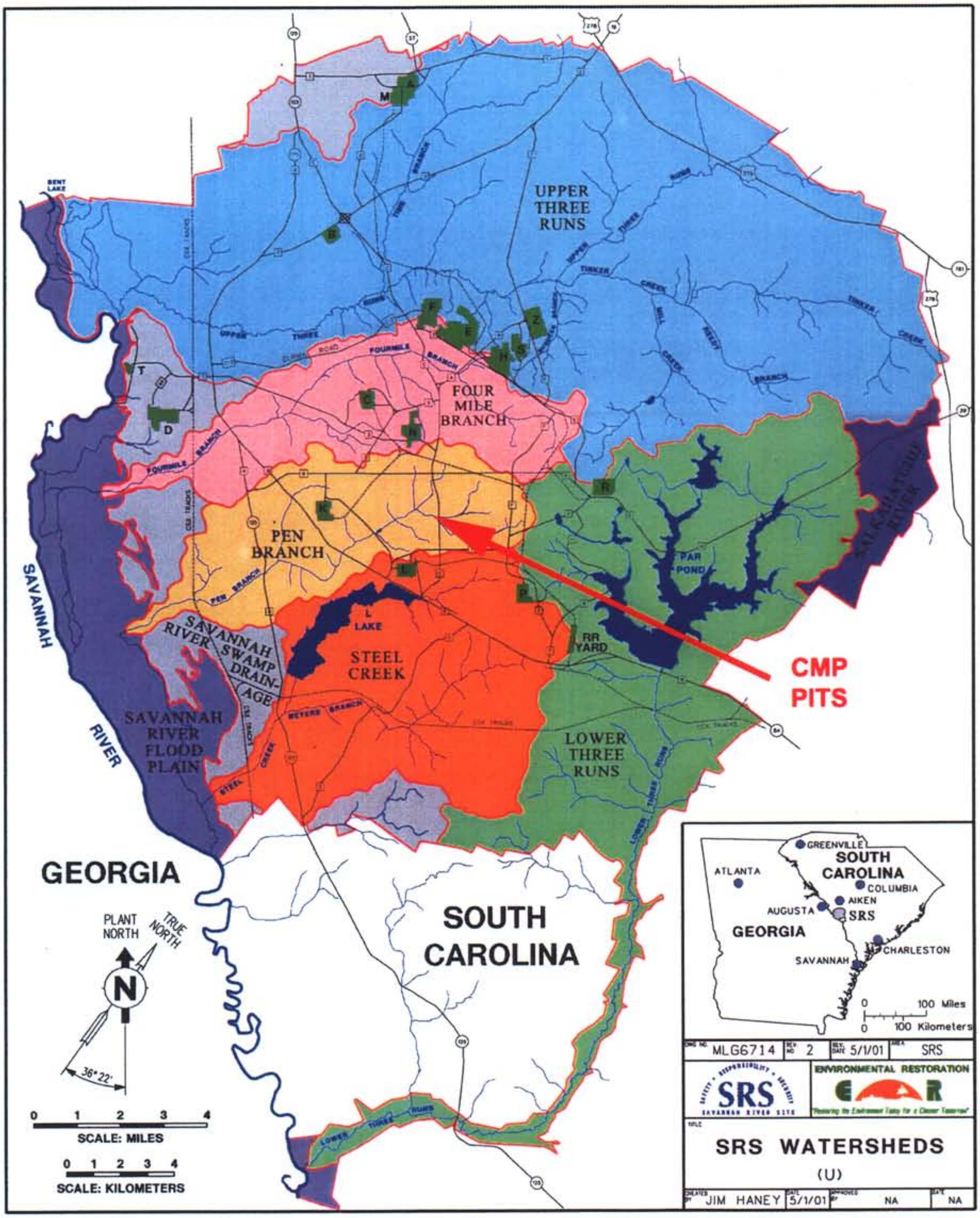


Figure 1. Location of the CMP Pits OU within the Savannah River Site

II. SITE AND OPERABLE UNIT COMPLIANCE HISTORY

SRS Operational and Compliance History

The primary mission of SRS has been to produce tritium, plutonium, and other special nuclear materials for our nation's defense programs. Production of nuclear materials for the defense program was discontinued in 1988. SRS has provided nuclear materials for the space program, as well as for medical, industrial, and research efforts up to the present. Chemical and radioactive wastes are byproducts of nuclear material production processes. These wastes have been treated, stored, and in some cases, disposed of at SRS. Past disposal practices have resulted in soil and groundwater contamination.

Hazardous waste materials handled at SRS are managed under RCRA, a comprehensive law requiring responsible management of hazardous waste. Certain SRS activities require South Carolina Department of Health and Environmental Control (SCDHEC) operating or post-closure permits under RCRA. SRS received a RCRA hazardous waste permit from the SCDHEC, which was most recently renewed on September 30, 2003. Module VIII of the Hazardous and Solid Waste Amendments portion of the RCRA permit mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u).

On December 21, 1989, SRS was included on the National Priorities List (NPL). The inclusion created a need to integrate the established Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) program with CERCLA requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA 42 United States Code Section 9620, USDOE has negotiated a FFA (FFA 1993) with United States Environmental Protection Agency (USEPA) and SCDHEC to coordinate remedial activities at SRS as one comprehensive strategy that fulfills these dual regulatory requirements. USDOE functions as the lead agency for remedial activities at SRS, with concurrence by the USEPA - Region 4 and the SCDHEC.

Operable Unit Operational and Compliance History

The CMP Pits are located approximately 11.9 km (7.4 mi) from the nearest plant boundary and approximately 1,600 m (5,200 ft) north of L Area. The CMP Pits are located within the Pen Branch watershed approximately 380 m (1,250 ft) southeast of Pen Branch (Figure 1). The unit consists of seven former, unlined pits placed in two rows (Figure 2) and occupies an area 3- to 4.5-m (10- to 15-ft) wide, 13.5- to 21-m (45- to 70-ft) long, and 3- to 4.5-m (10- to 15-ft) deep (WSRC 1997).

The CMP Pits were designed to receive nonradioactive wastes (chemicals, metals and pesticides) and operated from August 1971 until February 1979. There is evidence that fluorescent light ballasts containing polychlorinated biphenyls (PCBs) were disposed during April 1977 (Christensen and Gordon 1983).

The CMP Pits OU comprises five subunits:

1. Ballast Area soils,

2. CMP Pits and associated vadose zone (Field A),

3. Vadose zone (Field B),

4. Groundwater, and

5. Pen Branch Surface Water and Sediment.

Fluorescent light ballasts containing PCBs were found and pesticides were detected in soil at or near the ground surface to the west of the CMP Pits. This area is referred to as the Ballast Area.

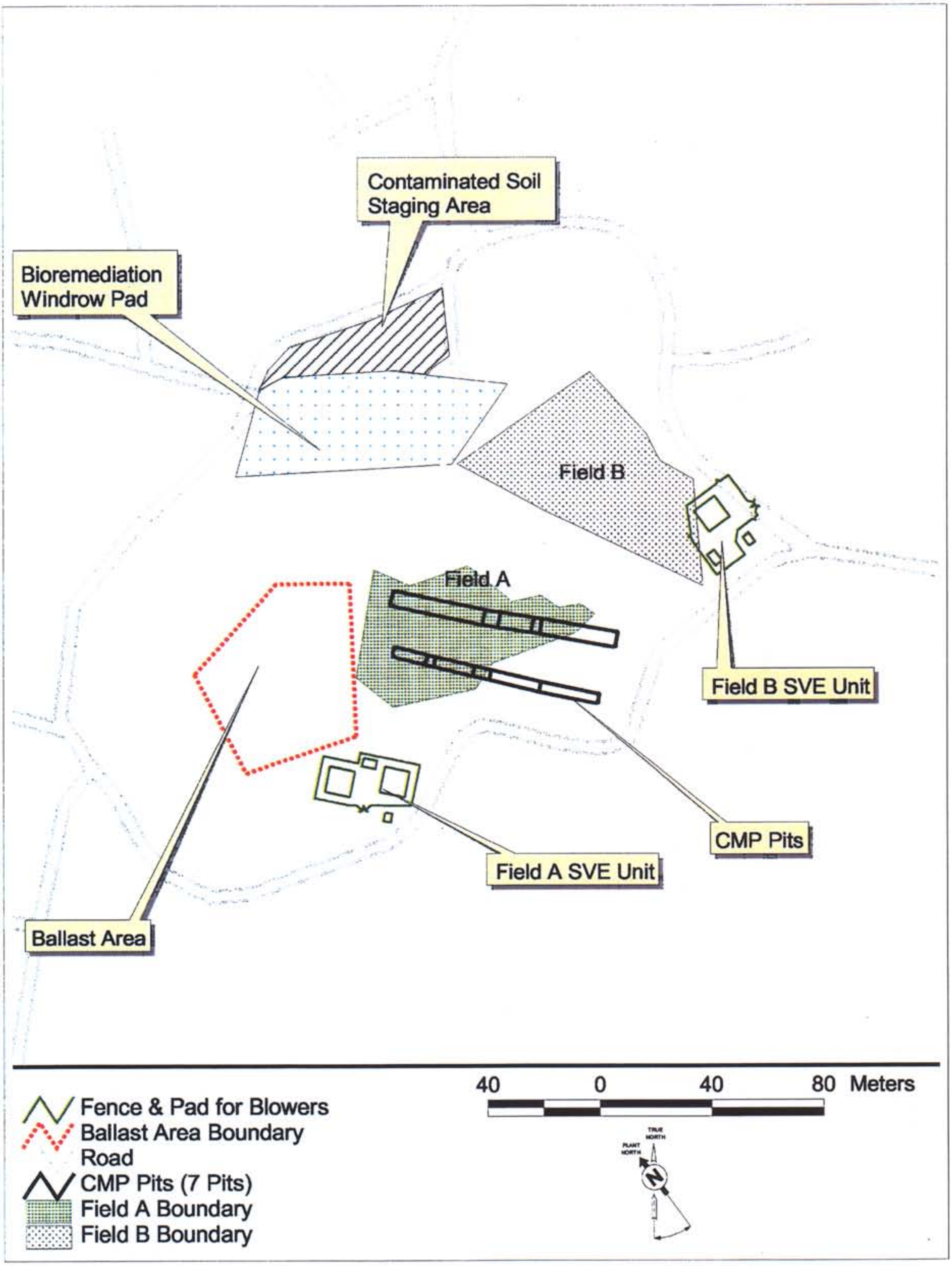


Figure 2. Layout of the CMP Pits OU

Fields A and B have subsurface soil contamination resulting from wastes disposed in the CMP Pits. Groundwater contamination has occurred as a result of the contamination leaching from soil. Two groundwater plumes exist at the CMP Pits, designated as the main plume and the northeast plume. Figures 3 and 4 illustrate the groundwater contamination as interpreted from monitoring well data and CPT analyses collected from 1998 - 2002. These plumes are moving northward towards Pen Branch sediment and surface water. Groundwater modeling indicates that the CMP Pits are the source for the main plume. Particle tracking towards and from the northeast plume suggests that this plume is from a different source than that of the main plume. Extensive soil-gas and direct push measurements were unable to identify a current source for this plume. It is the consensus of the agencies that the original source of this plume is depleted.

History of activities at the CMP Pits OU

In 1979, the CMP Pits were identified by SRS waste management operations as requiring investigation. Beginning in December 1979, when operations were permanently terminated after a review of state and federal regulations, all open pits were covered with clay and graded. In 1981, analytical results indicated the presence of trichloroethylene (TCE) and tetrachloroethylene (PCE) in the groundwater. Soil sampling indicated the presence of similar volatile organic compounds (VOCs) in soil adjacent to the unit. The initial excavation of contaminated soil and debris at the CMP Pits occurred from September to October 1984.

The RCRA requirement to determine whether a solid waste was hazardous was not in effect at the time the CMP Pits were operational. However, after excavation of the soil and debris in 1984, the material was determined to be RCRA-listed waste and was stored in a permitted, RCRA storage facility. The original containers have since been repackaged and sent to a RCRA treatment, storage, or disposal (TSD) facility off the SRS.

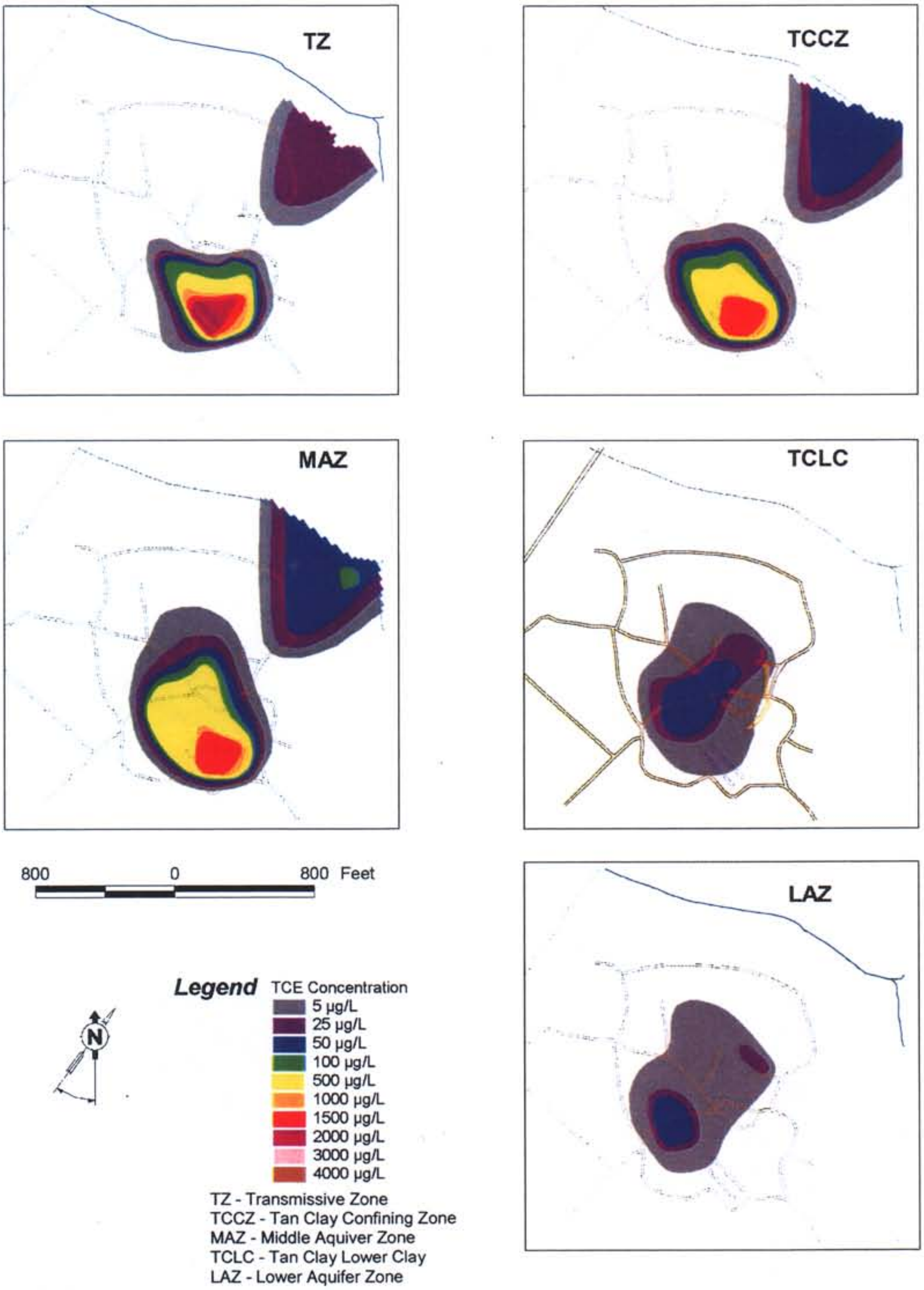


Figure 3. Initial TCE Plume

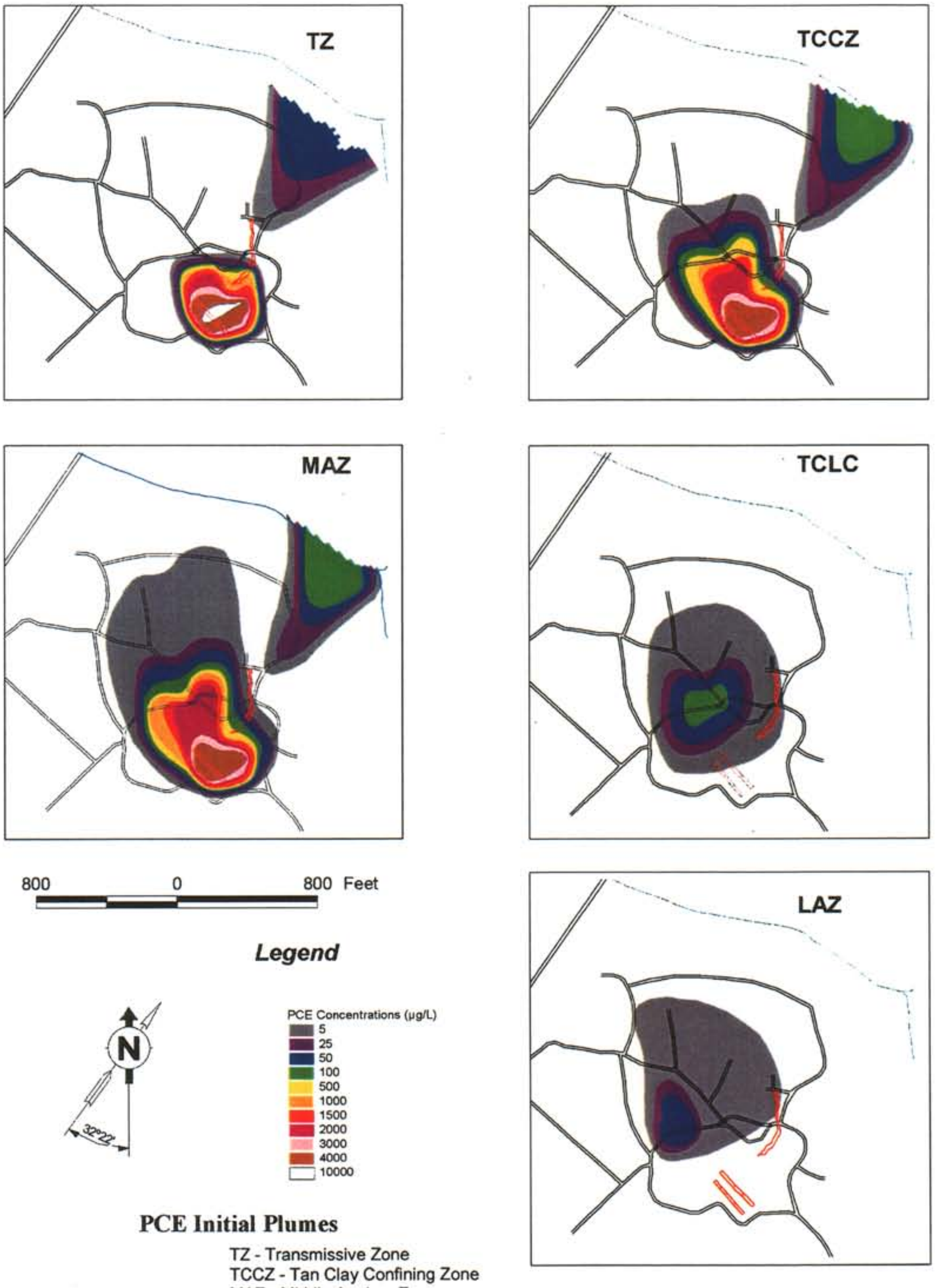


Figure 4. Initial PCE Plume

Confirmatory soil sampling and deep coring followed the excavation and waste removal. A second phase of excavation was performed to remove any remaining, significantly contaminated soil and the pit area was backfilled and capped in accordance with guidance received from SCDHEC. However, the CMP Pits were not formally closed under any regulatory program, nor was the extent of contamination in the area characterized as required by current RCRA and CERCLA standards.

The pits were backfilled with clean soil and a synthetic membrane cap consisting of 80-mil, high-density polyethylene (HDPE) was installed over the pit area. The HDPE cap was covered with 1.1 m (3.5 ft) of clean soil fill and 0.3 m (1 ft) of topsoil (Woodward and Clyde 1985 and 1986).

History of activities at the Ballast Area

The Ballast Area, located immediately west-northwest of the pit area (Figure 2), was identified during a visual walkover survey as an apparent near surface dumping area for ballast units from fluorescent or vapor lighting systems. The ballast units observed at or near the surface were removed from the area and disposed of as potential, PCB-contaminated waste material. Soil sampling indicates that the Ballast Area is contaminated with PCBs and pesticides. The contamination was found to a depth of 1.2 m (4 ft), with the highest concentrations contained within the top 0.3 to 0.6 m (1.0 to 2.0 ft). The Ballast Area was not used for pesticide disposal. The presence of the PCB- and pesticide-contaminated soil is attributed to stockpiling of material removed from the pits during the 1984 excavation. In 1994, soil sampling and an electromagnetic survey were performed to evaluate the nature and extent of contamination in the area and to determine if any additional ballast units were buried in the area.

Ballast Area Interim Action

In August 1999, additional soil sampling was completed at the Ballast Area to further define the contaminated area. Based on the sampling results, an Interim Record of

Decision (IROD) was approved (WSRC 1999b), and later amended in March 2002, that addressed PCB and pesticide-contaminated soil in the Ballast Area, chlorinated VOCs (CVOCs) in the vadose zone, and groundwater under the pits. In June 2003, a second amendment to that IROD was approved. The IROD Amendment specifies enhanced bioremediation for the Ballast Area (WSRC 2003a).

In 2000, approximately 165 m^3 (216 yd^3) of PCB and pesticide-contaminated soil were excavated from the Ballast Area and transported for incineration. During the interim remedial action, excavated soil was found to contain Silvex, an herbicide that cannot be disposed at any treatment or disposal facility in the United States. Additionally, data collected to support the excavation work indicated that the total volume of contaminated soil was 4,587 m^3 versus 994 m^3 (6,000 yd^3 versus 1,300 yd^3), much larger than originally estimated. Additional characterization activities were completed in 2001 to determine the extent of Silvex as well as the true extent of pesticide and PCB contamination.

An on-site treatability study was conducted for the Ballast Area in two phases. Approximately 460 m^3 (600 yd^3) of contaminated soil were excavated from the Ballast Area for Phase I of the treatability study in 2001. Phase I tested the feasibility of bioremediation to treat the PCBs and pesticides. Phase I showed that the process was capable of reducing PCB and pesticide concentrations to regulatory compliance levels (WSRC 2003b). An additional 460 m^3 (600 yd^3) of contaminated soil was excavated from the Ballast Area in 2002 for Phase II to optimize the process in terms of efficiency and degradation rates. The remaining contaminated soil in the Ballast Area will be treated in accordance with the interim action (WSRC 2003a).

CMP Pits Field A and Field B Interim Action

In April 2001 a soil vapor extraction (SVE) unit was placed in operation in Field B. The SVE system was intended as an interim action in conjunction with air sparging to remediate contaminated groundwater from the CMP Pits. However, subsequent to the initial planning of the Field B interim action, a tight clay which would impede sparging was discovered and the water table dropped due to drought conditions. The lowering of the water table stranded CVOCs that were in the groundwater in the vadose zone of Field B. Therefore, the air sparging aspect of the remediation was not implemented and SVE was implemented to remove the stranded CVOCs. As of May 2002, approximately 100 kg (220 lb) of CVOCs were removed from Field B. The active SVE system in Field B was shutdown in May 2002 to support rebound testing. No rebound was indicated and 29 Baroball™, passive SVE units were installed in July 2002.

During 2002, a second SVE system was placed in operation at the Field A Vadose Zone. As of March 2004, the Field A SVE system has removed approximately 8500 lbs of CVOCs. Due to the source control provided by the Field A SVE system, the CVOCs concentration in the Transmissive Zone has reduced significantly (Figures 5 and 6). However, the Field A SVE system does not appear to reduce the groundwater concentration in the Middle Aquifer Zone (Figures 7 and 8). There is uncertainty associated the potential for the clay layer beneath the Transmissive Zone to act as a secondary source for the Middle Aquifer Zone. This uncertainty will be managed during the design phase by obtaining additional samples in the clay layers beneath the CMP Pits to determine if the Transmissive Zone is a secondary source.

Table 1 presents a chronology of major activities and document submittals/approvals for the CMP Pits OU.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Both RCRA and CERCLA require the public to be given an opportunity to review and comment on the draft permit modification and proposed remedial alternative. Public participation requirements are listed in South Carolina Hazardous Waste Management Regulation (SCHWMR) R.61-79.124 and Sections 113 and 117 of CERCLA (42 United States Code Sections 9613 and 9617). These requirements include establishment of an Administrative Record File that documents the investigation and selection of the remedial alternative for addressing the CMP Pits soils and groundwater. The Administrative Record File must be established at or near the facility at issue.

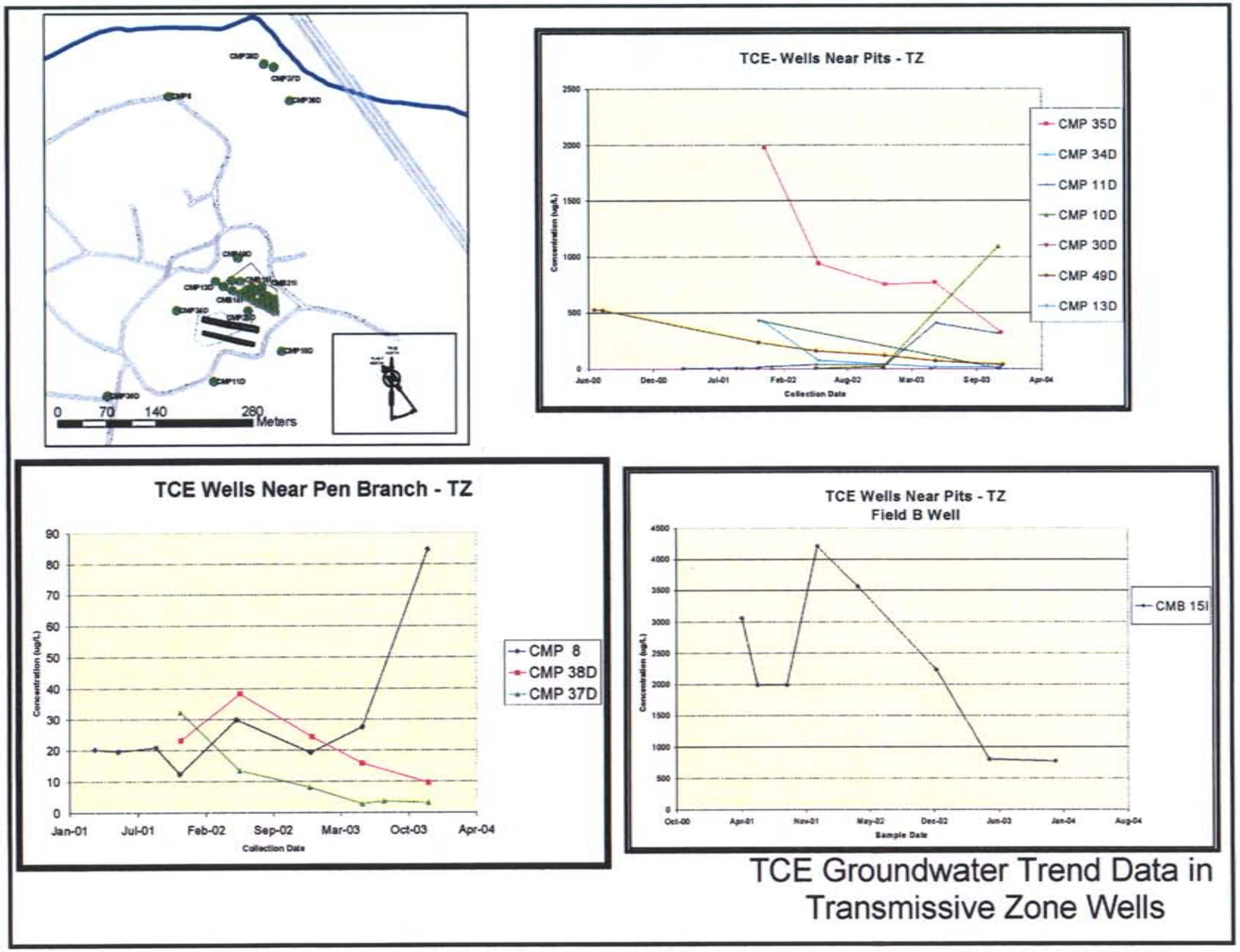


Figure 5. **TCE Concentrations in Transmissive Zone Wells**

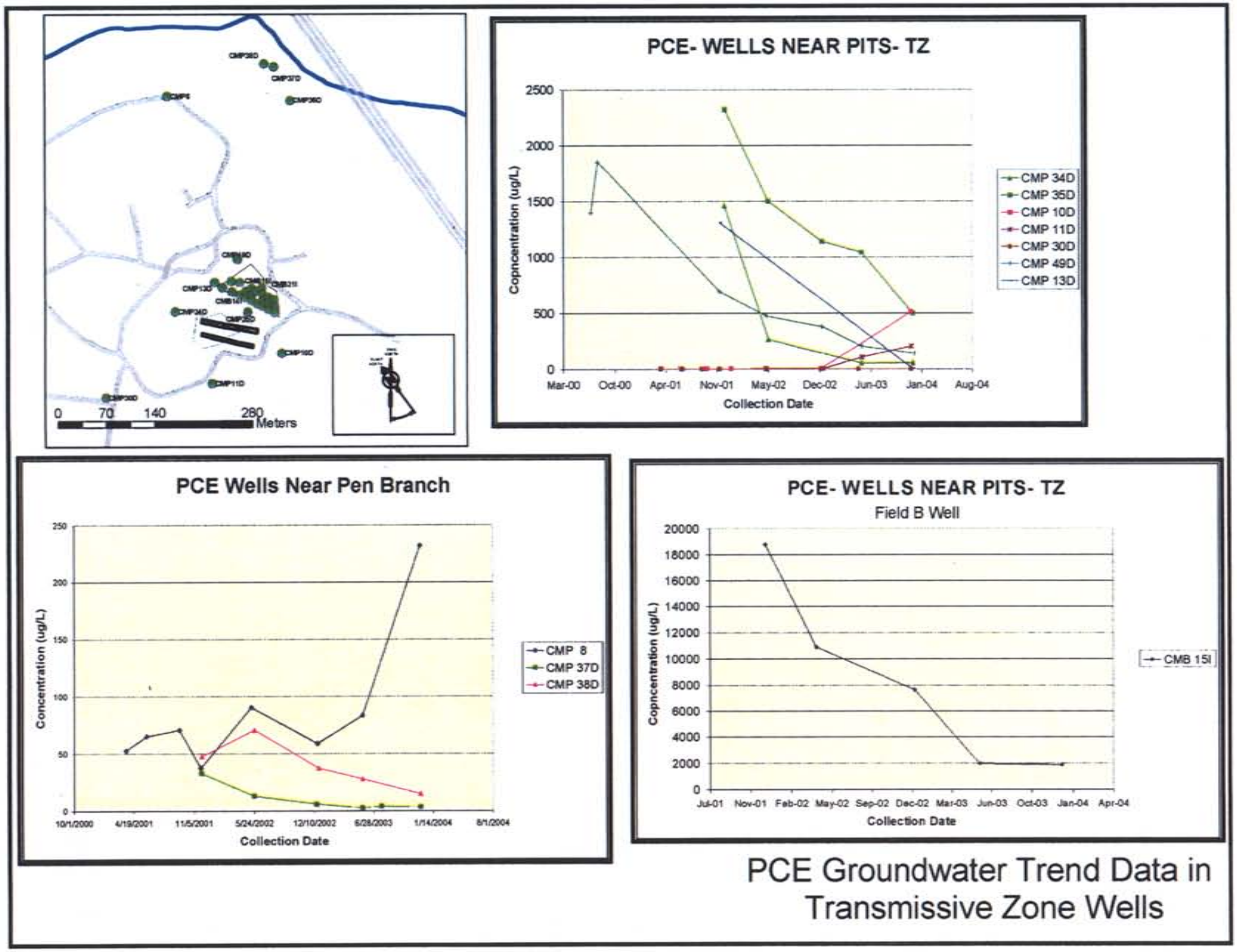


Figure 6. **PCE Concentrations in Transmissive Zone Wells**

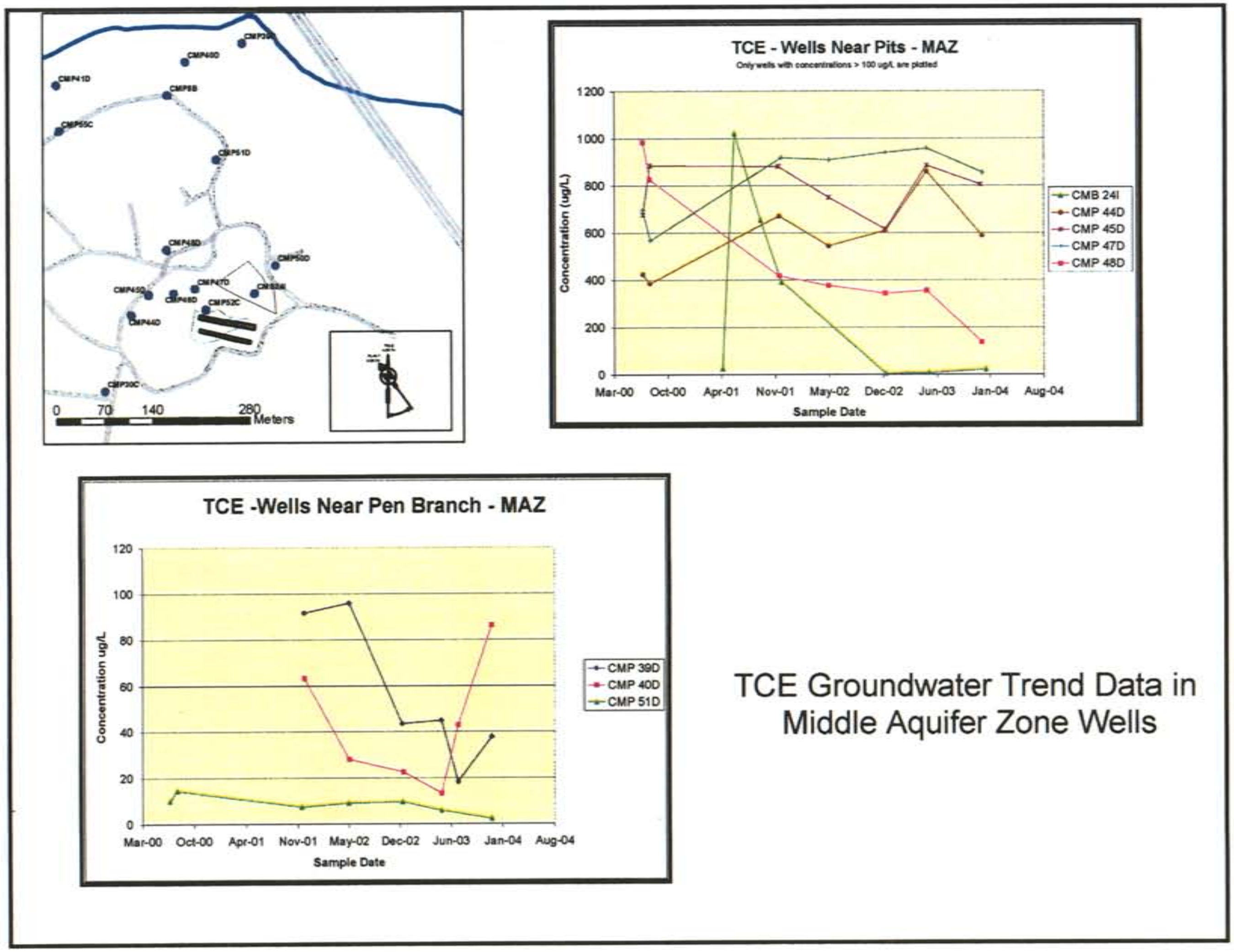


Figure 7. **TCE Concentrations in Middle Aquifer Zone Wells**

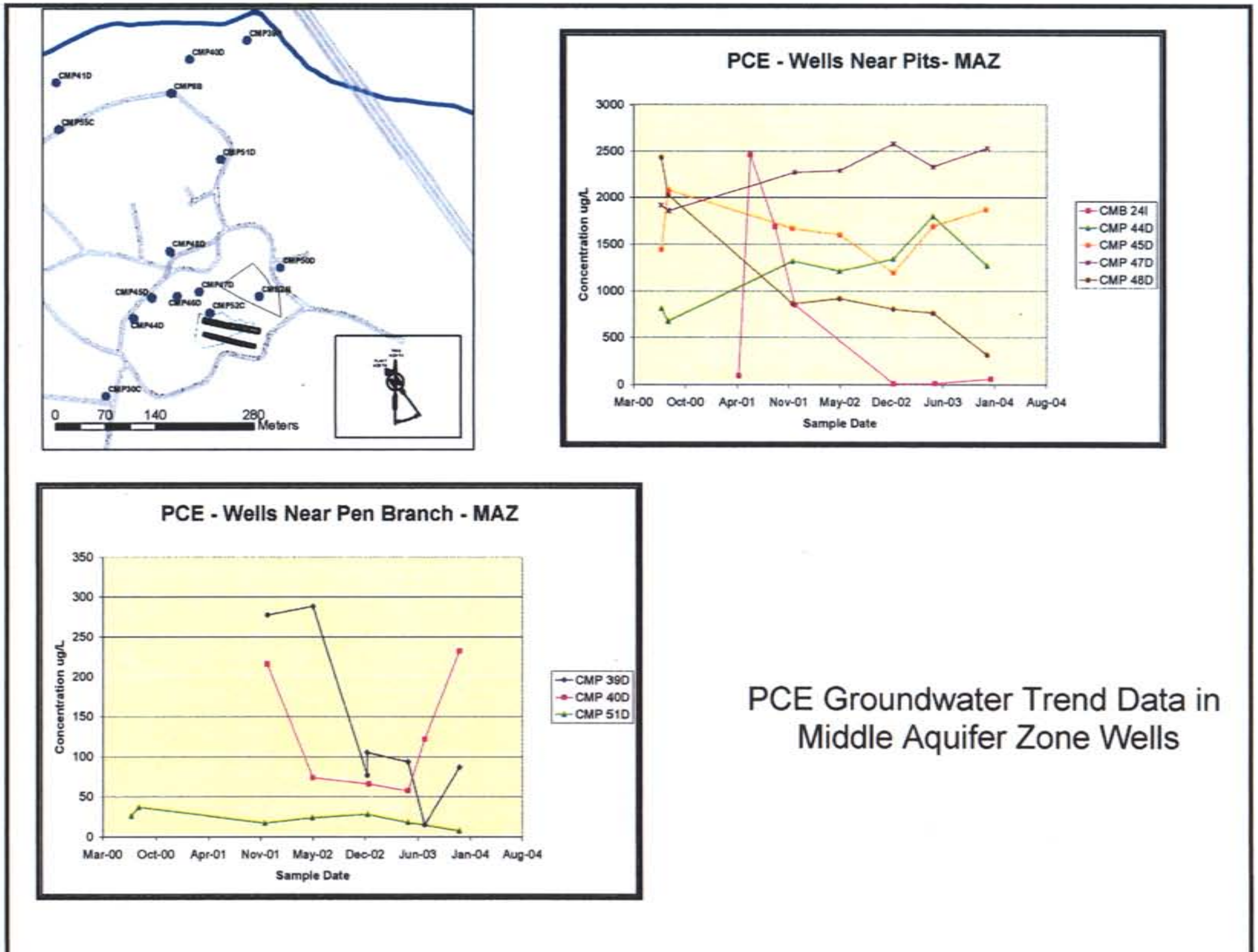


Figure 8. **PCE Concentrations in Middle Aquifer Zone Wells**

Table 1. History of Previous Activities at the CMP Pits OU

Dates	Event	Location (Subunit)
8/71 to 2/79	CMP Pits Operated	CMP Pits
1981	CMP Monitoring Wells Show Contamination	CMP Pits
9/84 to 10/84	Original Excavation Completed	CMP Pits
1991	Soil Gas Survey Completed	CMP Pits
8/94 to 9/94	Electromagnetic Survey Completed	CMP Pits
10/97	RFI/RI with BRA Approved	CMP Pits OU
1999	Additional Soil Sampling	Ballast Area
10/99	IROD Approved	CMP Pits/Ballast Area
2000	Ballast Area Soil Excavation/Off-site Incineration (Interim Action)	Ballast Area
4/01	SVE Units Started (Interim Action)	Field B
2001	Ballast Area Soil Excavation/Bioremediation For Treatability Study – Phase I	Ballast Area
9/01	First IROD Amendment Approved	CMP Pits/Ballast Area
2001/2002	Additional Soil Sampling	CMP Pits/Ballast Area
1/02	SVE Units Started (Interim Action)	Field A
2002	Ballast Area Soil Excavation/Bioremediation for Treatability Study – Phase II	Ballast Area
3/03	Second IROD Amendment Approved	CMP Pits/Ballast Area
5/03	RFI/RI Addendum with BRA Approved	CMP Pits OU
4/04	Ballast Area Soil Excavation/Bioremediation Remedial Action Start (Interim Action)	Ballast Area
5/04	CMS/FS Approved	CMP Pits OU
8/04	SB/PP Approved	CMP Pits OU

The SRS Public Involvement Plan (USDOE 1996) is designed to facilitate public involvement in the decision-making process for permitting, closure, and the selection of remedial alternatives. The SRS Public Involvement Plan addresses the requirements of RCRA, CERCLA, and the National Environmental Policy Act, 1969 (NEPA). SCHWMR R.61-79.124 and Section 117(a) of CERCLA, as amended, require the advertisement of the draft permit modification and notice of any proposed remedial action and provide the public an opportunity to participate in the selection of the remedial action. The *Statement of Basis/Proposed Plan for the Chemicals, Metals, and Pesticides Pits Operable Unit (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G)* (WSRC 2004a), a part of the Administrative Record File, highlights key aspects of the investigation and identifies the preferred action for addressing the CMP Pits OU.

The FFA Administrative Record File, which contains the information pertaining to the selection of the response action, is available at the following locations:

U.S. Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina – Aiken
171 University Parkway
Aiken, South Carolina 29801
(803) 641-3465

Thomas Cooper Library
Government Documents Department
University of South Carolina
Columbia, South Carolina 29208
(803) 777-4866

The RCRA Administrative Record File for SCDHEC is available for review by the public at the following locations:

The South Carolina Department of
Health and Environmental Control
Bureau of Land and Waste
Management
8911 Farrow Road
Columbia, South Carolina 29203
(803) 896-4000

Edisto Savannah District
Environmental Quality Control Office
206 Beaufort Street, Northeast
Aiken, South Carolina 29801
(803) 641-7670

The public was notified of the public comment period through the *SRS Environmental Bulletin*, a newsletter sent to citizens in South Carolina and Georgia, and through notices in the *Aiken Standard*, the *Allendale Citizen Leader*, the *Augusta Chronicle*, the *Barnwell*

People-Sentinel, and *The State* newspaper. The public comment period was also announced on local radio stations.

The Statement of Basis/Proposed Plan (SB/PP) 45-day public comment period began on September 24, 2004 ended on November 8, 2004. A Responsiveness Summary has been prepared to address comments received during the public comment period and included as Appendix A of the ROD. A Responsiveness Summary will also be available in the final RCRA permit.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT

Due to the complexity of multiple contaminant areas, the SRS is divided into integrated operable units (IOUs) for the purpose of managing a comprehensive cleanup strategy. OUs within an IOU are evaluated and remediated individually.

The CMP Pits OU is located within the Pen Branch IOU. This ROD addresses the contamination in CMP Pit OU soils and groundwater and presents the final response action for this site. Upon disposition of the CMP Pits OU and all other OUs within the Pen Branch IOU, a final comprehensive ROD for the Pen Branch IOU will be pursued with additional public involvement. Upon disposition of all IOU RODs, a final comprehensive ROD for the SRS will be pursued with additional public involvement.

V. OPERABLE UNIT CHARACTERISTICS

This section presents an overview of geographical and topographical information for the SRS and the CMP Pits OU and an overview of the conceptual site model (CSM) for the CMP Pits OU, media assessment, and media assessment results.

Geographical and topographical information

SRS is located on the Atlantic Coastal Plain, primarily on the Aiken Plateau. The Savannah River forms the southwestern boundary of SRS. Major tributaries to the Savannah River that flow southwestward across SRS are Upper Three Runs Creek, Tinker Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. Ground surface elevations at SRS range from 30.5 m (100 ft) above mean sea level (msl) in the river valleys to 106.7 m (350 ft) above msl on the plateau.

The CMP Pits OU occupies the top of a knoll at an approximate elevation of 94 m (310 ft) above msl and encompasses approximately 1.6 ha (4 acres). The unit is located in a clear area and has little or no vegetation. The Ballast Area is located at the northern edge of the knoll and extends down the side slope of the knoll for a distance of 6 to 9 m (20 to 30 ft).

Drainage off the CMP Pits OU is radial, and surface water runoff ultimately drains toward Pen Branch. Pen Branch discharges into the Savannah River floodplain and associated swamps rather than flowing directly into the river.

The area within the CMP Pits OU is highly disturbed, with sparse ground cover composed primarily of early successional species of grasses and sedges. A pine forest with some understory vegetation surrounds the unit. Hardwood forests and understory are present as the terrain approaches Pen Branch, north of the unit.

Field surveys were conducted in spring 1994 to compile a threatened, endangered, and sensitive (TES) species listing for the unit and surrounding area (Savannah River Forestry Service [SRFS] 1994). The field surveys indicated that it is unlikely that TES species will be found in the area of the CMP Pits OU because the habitat is incompatible with those species requirements.

No drinking water source wells are located in the CMP Pits OU.

Conceptual Site Model for the CMP Pits OU

Miscellaneous chemicals, metals, and pesticides that were disposed at the pits and lighting ballast and other debris in the Ballast Area represent the primary sources of contamination at the CMP Pits OU. The primary release mechanism of these sources include spills/movement and infiltration/percolation to surface soil, subsurface soil, and deep soil (secondary sources). The CSM (Figure 9) for the CMP Pits OU identifies exposure routes from the primary and secondary sources to potential human and ecological receptors.

Media Assessment

The CMP Pits OU is divided into the following subunits:

- Ballast Area
- CMP Pits and Associated Vadose Zone (Field A)
- Vadose Zone (Field B)
- Groundwater
- Pen Branch Surface Water and Sediment

The findings of the CMP Pits OU investigations are documented in the RFI/RI with BRA (WSRC 1997) and RFI/RI Addendum with BRA (WSRC 2003b). The results of the RFI/RI with BRA were used to implement an interim action at the CMP Pits OU consisting of enhanced bioremediation in the Ballast Area and SVE in Fields A and B (WSRC 2003a). The result of the RFI/RI Addendum with BRA are briefly summarized in the following paragraphs and will be used to support final remedial alternatives documented in this ROD. A schematic cross section of the CMP Pits OU is included to illustrate the media assessment results (Figure 10).

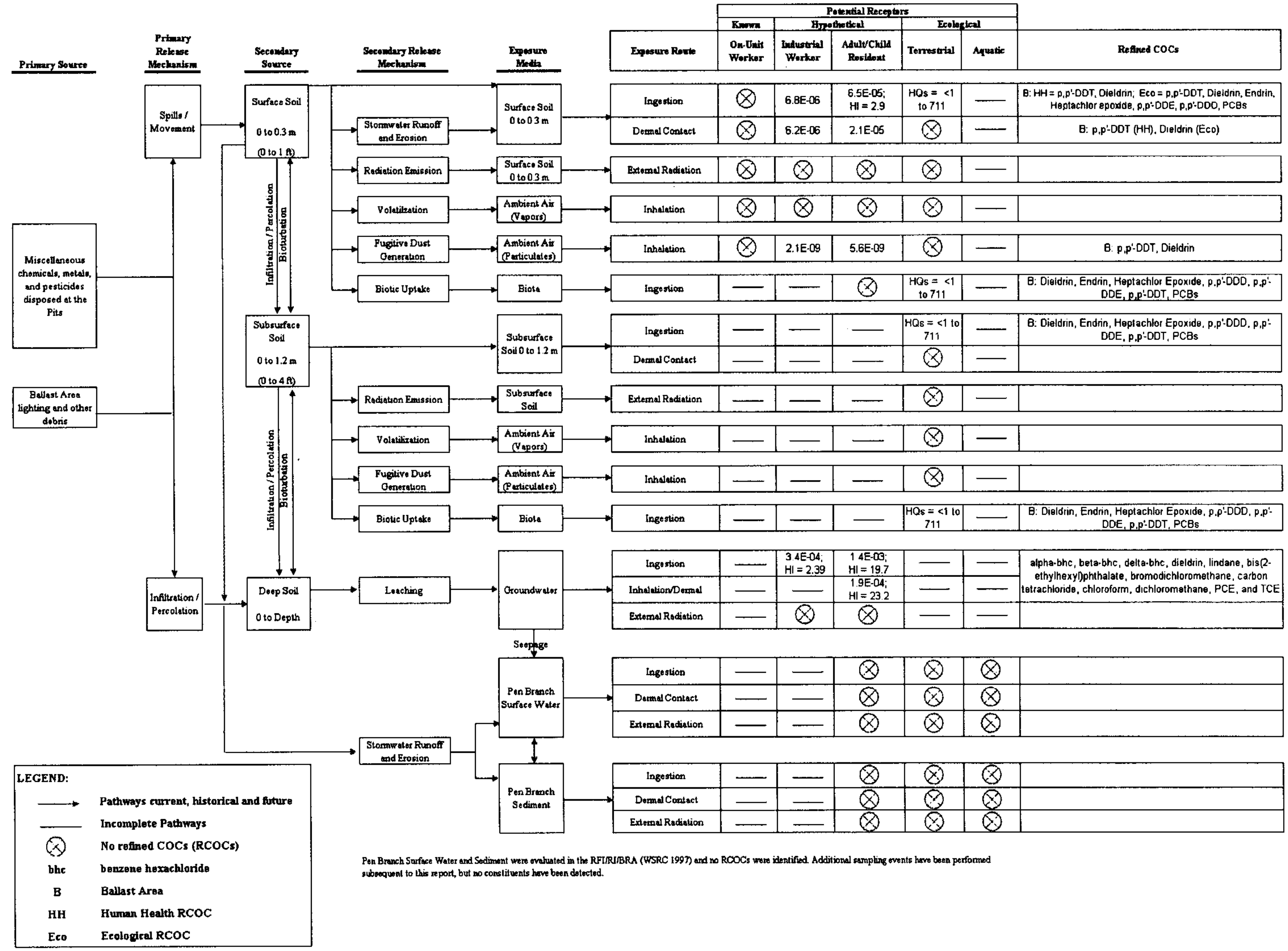


Figure 9. Conceptual Site Model for the CMP Pits OU

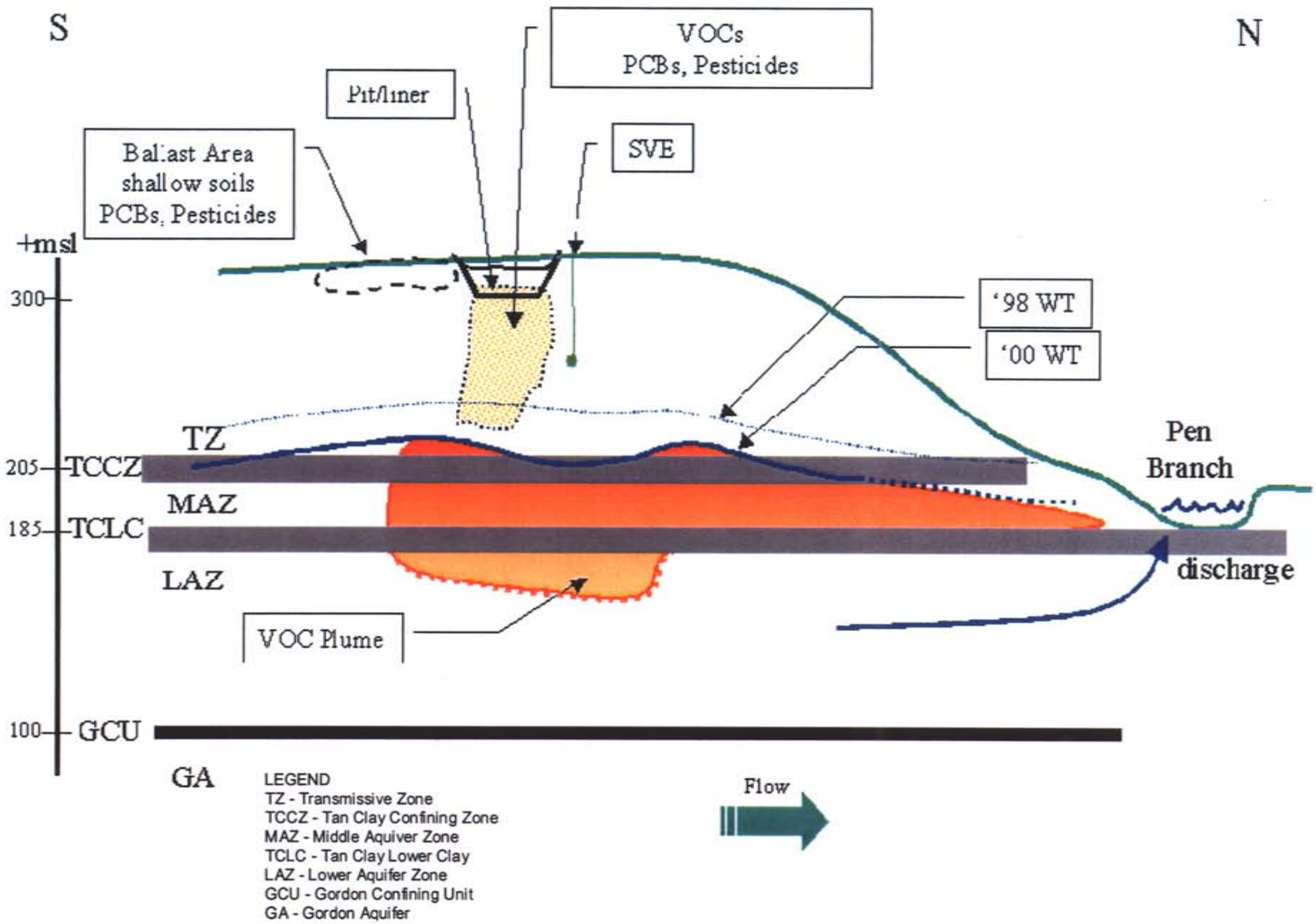


Figure 10. Schematic Cross Section of the CMP Pits OU

Ballast Area Soil Investigation

Sampling was performed in the Ballast Area to define the extent of contamination to support the interim action. Contaminants detected in the Ballast Area soil included pesticides, PCBs, inorganics, semi-volatile organic compounds (SVOCs), and VOCs. No PTSM was identified in the Ballast Area.

Field A and B Vadose Zone Investigation

Sampling was performed in Field A and B Vadose Zone to determine the effectiveness of the interim action (SVE). VOCs were detected in Field A and Field B Vadose Zone. Tetrachloroethylene and dichloromethane were identified as PTSM based on contaminant migration.

Groundwater Investigation

Groundwater samples were collected to determine the extent of contamination and determine the effectiveness of the interim action (SVE). Contaminants detected in groundwater include pesticides, PCBs, herbicides, inorganics, SVOCs, and VOCs.

The TCCZ and/or TCLC may potentially be a secondary source for groundwater contamination.

Site-Specific Factors

No site-specific factors requiring special consideration that might affect the remedial action for the CMP Pits OU are present at the site.

Contaminant Transport Analysis

Groundwater modeling was performed to estimate the extent and magnitude of future contaminant migration in groundwater and evaluate the potential for contaminant discharge to surface waters at concentrations greater than maximum contaminant levels (MCLs). The numeric modeling was carried out using Modular Three-Dimensional Finite-Difference Groundwater Flow (MODFLOW) and Modular 3-D Multi-Species Transport (MT3DMS) within the groundwater modeling system. Although PCE and TCE have not been detected above MCLs in the Pen Branch surface water, the model indicated that PCE and TCE were significant contaminants that would result in discharges to Pen Branch exceeding MCLs.

Fate and Transport for groundwater COCs

The fate and transport of PCE, TCE, Lindane and Carbon Tetrachloride were specifically modeled and reported in the groundwater modeling report (WSRC 2002).

DCE was not specifically modeled. However, it is a daughter product of PCE & TCE and it has similar physical characteristics to these constituents. It is assumed that its fate is similar to the results of the PCE and TCE analysis. The Lindane plume is a low concentration plume located close to the pits and no source term was simulated, therefore the 0.2 ug/L MCL is never exceeded at discharge locations. The Carbon Tetrachloride is also a small, low concentration plume and the discharge concentration drops below the MCL in about 10 years.

The groundwater pesticide RCOCs have higher Kd values than the VOCs therefore they are less mobile. SRS modeled the VOCs and predictions based on that modeling bound the extent of pesticide groundwater contamination (Alpha-benzene hexachloride, beta-benzene hexachloride, delta-benzene hexachloride, Dieldrin, Lindane).

Therefore, based on all these considerations, and our knowledge of our COCs and our site specific conditions, we can confidently predict that these contaminants will not increase in plume size, concentration, or discharge to surface water.

VI. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land Uses

Current Land Use

The CMP Pits OU is located in the unrestricted land-use zone of SRS, outside any industrial buffer zone as defined by the Land Use Control Assurance Plan. The potential receptor for exposure to constituents associated with the CMP Pits OU is the known on-unit worker who comes into the area on an infrequent or occasional basis. Known on-unit workers are defined as SRS employees who work at or in the vicinity of an OU under current land use conditions.

Future Land Use

Although the CMP Pits OU is located in the unrestricted land-use zone of SRS, the presence of contaminated soil will result in land-use restrictions at the CMP Pits OU. According to the Savannah River Site Future Use Project Report (USDOE 1996), residential uses of SRS land should be prohibited. The potential receptor for exposure to constituents associated with the CMP Pit OU will be the future industrial worker.

Groundwater Uses/Surface Water Uses

Groundwater beneath the CMP Pits OU is not used for any type of human consumption. Furthermore, it is unlikely that this groundwater will be used for human consumption in the future. Although there are monitoring wells in the vicinity of the CMP Pits OU, there are no wells that can be used as drinking water sources. The groundwater beneath the CMP Pits OU discharges into Pen Branch.

There are no distinct surface water features on the unit, and no drainage or surface runoff features that indicate that the surface runoff is being used for irrigation or any other beneficial uses. Pen Branch discharges to the Savannah River which borders the SRS.

Surface water downstream from SRS is subject to beneficial uses such as irrigation or drinking water.

VII. SUMMARY OF OPERABLE UNIT RISKS

Baseline Risk Assessment

As a component of the RFI/RI process, a BRA (WSRC 2003b) was performed to evaluate risks associated with the CMP Pits OU. The BRA determines what risks would be posed by the unit if no action were taken. The BRA provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The findings of the BRA include human health and ecological risk assessments and are summarized in the following paragraphs.

Summary of Human Health Risk Assessment

Identification of COCs

The following tables (Tables 2 through 4) present the refined constituents of concern (RCOCs) and exposure point concentrations (EPCs) for each COC identified at the CMP Pits OU. RCOCs are those constituents that are targeted for further remedial evaluation following the BRA and uncertainty analysis. The EPC is the concentration used to estimate the exposure and risk for each COC. The tables include the range of concentrations detected for each COC, as well as the frequency of detection, the EPC, and the statistical method used to derive the EPC. The EPC is determined as the lesser of the maximum detected concentrations and the 95th percent upper confidence limit (95% UCL) on the mean. Chapters 9 and 5 in the RFI/RI Addendum with BRA (WSRC 2003b) contain additional information regarding selection of the RCOCs and EPC respectively.

Table 2. Summary of Human Health Constituents of Concern and Medium-Specific Exposure Point Concentrations for the CMP Pits sub-unit Soil

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: CMP Pits sub-unit Surface Soil

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Direct	--	--	--	--	--	--	--	--
Contact	--	--	--	--	--	--	--	--

There are no surface soil RCOCs for the CMP Pits sub-unit.

Table 3. Summary of Human Health Constituents of Concern and Medium-Specific Exposure Point Concentrations for the Ballast Area sub-unit Soil

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Ballast Area sub-unit Surface Soil

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Direct	p,p'-DDT	9.52E-03	1.15E+02	mg/kg	16 / 21	1.15E+02	mg/kg	MAX
Contact	Dieldrin	9.21E-04	9.81E-01	mg/kg	14 / 27	1.77E-01	mg/kg	95% UCL

Key
95% UCL: 95% Upper Confidence Limit
MAX: maximum concentration

Table 4. Summary of Human Health Constituents of Concern and Medium-Specific Exposure Point Concentrations for Groundwater

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Tap Water and Shower Vapors	Alpha-BHC	1.27E-05	2.01E-03	mg/L	82 / 150	2.01E-04	mg/L	95% UCL
	Beta-BHC	7.08E-06	4.94E-04	mg/L	72 / 150	1.16E-04	mg/L	95% UCL
	Delta-BHC	6.00E-06	2.53E-03	mg/L	82 / 150	2.35E-04	mg/L	95% UCL
	Dieldrin	5.00E-06	6.80E-05	mg/L	19 / 148	6.80E-05	mg/L	95% UCL
	Lindane	1.10E-05	4.23E-03	mg/L	88 / 150	4.33E-04	mg/L	95% UCL
	Bis(2-ethylhexyl) phthalate	2.69E-04	1.19E-02	mg/L	26 / 57	1.25E-03	mg/L	95% UCL
	Bromodichloro-methane	2.81E-04	3.44E-02	mg/L	39 / 139	1.88E-03	mg/L	95% UCL
	Carbon Tetrachloride	4.56E-04	8.10E-01	mg/L	85 / 139	4.13E-02	mg/L	95% UCL
	Chloroform	2.58E-04	2.50E-01	mg/L	90 / 139	1.77E-02	mg/L	95% UCL
	Dichloromethane	4.70E-04	2.54E-01	mg/L	49 / 139	2.89E-02	mg/L	95% UCL
	PCE	2.65E-04	1.88E+01	mg/L	109 / 139	1.57E+00	mg/L	95% UCL
	TCE	5.94E-04	4.21E+00	mg/L	107 / 139	5.30E-01	mg/L	95% UCL

Key
BHC: benzene hexachloride
PCE: Tetrachloroethylene
TCE: Trichloroethylene
MAX: maximum concentration
95% UCL: 95% Upper Confidence Limit

Exposure Assessment

Potential receptors are expected to differ for the current and future land use scenarios. The possible receptor under the current land use scenario is the known on-unit worker. Possible receptors under the future land use scenario include the hypothetical on-unit industrial worker and hypothetical on-unit residents (adult and child).

Current Land Use

The current potential receptor for exposure to constituents associated with the CMP Pits OU is the on-unit worker who comes to the area on an infrequent or occasional basis. Known on-unit workers are defined as SRS employees who work at or in the vicinity of the CMP Pits OU under current land use conditions. A known on-unit worker may be a researcher, environmental sampler, or personnel in close proximity to the unit. Although any of these receptors may be involved in the excavation or collection of contaminated media, they would follow SRS safety procedures and protocols for sampling at hazardous waste units. Nevertheless, limited exposure to unit media is a possibility.

Future Land Use

The potentially exposed receptors evaluated for the future land use scenario include the hypothetical on-unit industrial worker (adult) and hypothetical on-unit resident (adult and child). Although residential development is unlikely, a hypothetical residential exposure scenario for both adults and children was performed for comparative purposes (WSRC 2003b) in accordance with USEPA Region IV guidance (USEPA 1995). The hypothetical on-unit industrial exposure scenario addresses long-term risks to workers who are exposed to unit-related constituents while working within an industrial setting. The hypothetical on-unit industrial worker is an adult who works in an outdoor industrial setting in direct proximity to the contaminated media for the majority of his or her working time.

The hypothetical on-unit resident exposure scenario evaluates long-term risks to individuals expected to have unrestricted use of the unit. It assumes that residents live on-unit and are chronically exposed (both indoors and outdoors) to unit-related constituents. The hypothetical on-unit resident includes adults and children who are routinely exposed to contaminated media. For noncarcinogenic exposures for residents, a child and an adult are the receptors evaluated. For carcinogenic exposures for residents, a weighted average child/adult is evaluated. This scenario assumes that a portion of the overall lifetime exposure to carcinogens occurs at a higher level of intensity during the first six years of a child's life (i.e., accounts for increased soil ingestion during child years). This receptor is exposed to all unit media, including soil, sediment, and surface water. Sediment and surface water exposure would occur while playing/wading in the local streams/wetlands.

Exposure routes describe the way a chemical or physical agent comes into contact with a receptor (i.e., by means of ingestion, inhalation, or dermal exposure). Exposure points are locations where contact between contaminant and receptor may occur. If a complete exposure route is suspected, the exposure assessment attempts to quantify contaminant concentrations and uptake at the exposure point. Hazard and risk estimates are then calculated for exposures occurring to environmental media at the exposure point via the relevant exposure routes. Identified below are the probable exposure routes for the CMP Pits OU based on the contaminated media and anticipated activities at the exposure points:

- Ingestion (soil and groundwater)
- Inhalation (of particles and vapors from soil and groundwater)
- Dermal exposure (soil and groundwater)

Toxicity Assessment

Tables 5 and 6 summarize the cancer and non-cancer toxicity data used in the risk calculations for the COCs identified at the CMP Pits OU.

Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of unit-related exposure. This is referred to as an "excess lifetime cancer risk" because it is in addition to the cancer risks individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk range for unit-related exposures is 10^{-4} to 10^{-6}.

Table 5. Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal

Constituent of Concern	Oral Cancer Slope Factor	Dermal Cancer Slope Factor	Slope Factor Units	Cancer Guideline Description	Source	Date (M/D/Y)
Alpha-BHC	6.30E+00	6.49E+00	1/(mg/kg)/day	B2	IRIS	06/05/02
Beta-BHC	1.80E+00	1.98E+00	1/(mg/kg)/day	C	IRIS	06/05/02
Delta-BHC	1.80E+00	3.60E+00	1/(mg/kg)/day	D	IRIS	06/05/02
Dieldrin	1.60E+01	3.20E+01	1/(mg/kg)/day	B2	IRIS	06/05/02
DDT	3.40E-01	4.86E-01	1/(mg/kg)/day	B2	IRIS	06/05/02
Lindane	1.30E+00	1.34E+00	1/(mg/kg)/day	B2	HEAST	06/05/02
Bis(2-ethylhexyl) phthalate	1.40E-02	7.37E-02	1/(mg/kg)/day	B2	IRIS	06/05/02
Bromodichloro-methane	6.20E-02	6.33E-02	1/(mg/kg)/day	B2	IRIS	06/05/02
Carbon Tetrachloride	1.30E-01	2.00E-01	1/(mg/kg)/day	B2	IRIS	06/05/02
Chloroform	6.10E-03	3.05E-02	1/(mg/kg)/day	B2	IRIS	06/05/02
Dichloromethane	7.50E-03	7.89E-03	1/(mg/kg)/day	B2	IRIS	06/05/02
PCE	5.20E-02	5.20E-02	1/(mg/kg)/day	NA	IRIS	06/05/02
TCE	1.10E-02	7.33E-02	1/(mg/kg)/day	NA	IRIS	06/05/02

Pathway: Inhalation

Constituent of Concern	Unit Risk	Units	Inhalation Cancer Slope Factor	Slope Factor Units	Cancer Guideline Description	Source	Date (M/D/Y)
Alpha-BHC	1.80E+00	1/ug/m^3	6.30E+00	1/(mg/kg)/day	B2	RAIS	06/05/02
Beta-BHC	5.30E-01	1/ug/m^3	1.86E+00	1/(mg/kg)/day	C	RAIS	06/05/02
Delta-BHC	5.30E-01	1/ug/m^3	1.86E+00	1/(mg/kg)/day	D	RAIS	06/05/02
Dieldrin	4.60E+00	1/ug/m^3	1.61E+01	1/(mg/kg)/day	B2	RAIS	06/05/02
DDT	9.70E-02	1/ug/m^3	3.40E-01	1/(mg/kg)/day	B2	RAIS	06/05/02
Lindane	--	--	--	--	B2	IRIS	06/05/02
Bis(2-ethylhexyl) phthalate	--	--	--	--	--	RAIS	06/05/02
Bromodichloro-methane	--	--	--	--	--	RAIS	06/05/02
Carbon Tetrachloride	1.50E-02	1/ug/m^3	5.25E-02	1/(mg/kg)/day	B2	RAIS	06/05/02
Chloroform	2.30E-02	1/ug/m^3	8.05E-02	1/(mg/kg)/day	B2	RAIS	06/05/02
Dichloromethane	4.70E-04	1/ug/m^3	1.65E-03	1/(mg/kg)/day	B2	RAIS	06/05/02
PCE	5.80E-04	1/ug/m^3	2.00E-03	1/(mg/kg)/day	NA	RAIS	06/05/02
TCE	1.70E-03	1/ug/m^3	6.00E-03	1/(mg/kg)/day	NA	RAIS	06/05/02

Pathway: External (Radiation)

Constituent of Concern	Cancer Slope Factor	Exposure Route	Units	Cancer Guideline Description	Source	Date (M/D/Y)
None	--	--	--	--	--	--

Key
—: No information available
HEAST: Health Effects Assessment Summary Tables
IRIS: Integrated Risk Information System, USEPA
RAIS: Risk Assessment Information System
NA: Not Applicable

A- Human carcinogen
B1- Probable human carcinogen – indicates that limited human data are available
B2- Probable human carcinogen – indicates sufficient evidence in animals and inadequate or no evidence in humans
C- Possible human carcinogen
D- Not classifiable as a human carcinogen
E- Evidence of non-carcinogenicity

Table 6. Non-Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal									
Constituent of Concern	**Chronic/ Subchronic**	**Oral RfD Value**	**Oral RfD Units**	**Dermal RfD**	**Dermal RfD Units**	**Primary Target Organ**	**Combined Uncertainty/ Modifying Factors**	**Sources of RfD: Target Organ**	**Dates of RfD: Target Organ (M/D/Y)**
Alpha-BHC	--	--	--	--	--	--	--	--	--
Beta-BHC	--	--	--	--	--	--	--	--	--
Delta-BHC	--	--	--	--	--	--	--	--	--
Dieldrin	Chronic	5.0E-05	mg/kg-day	2.5E-05	mg/kg-day	Liver	100	IRIS	06/04/02
DDT	Chronic	5.0E-04	mg/kg-day	3.5E-04	mg/kg-day	Liver	100	IRIS	06/04/02
Lindane	Chronic	3.0E-04	mg/kg-day	2.91E-04	mg/kg-day	Liver	1000	IRIS	06/04/02
Bis(2-ethylhexyl) phthalate	Chronic	2.0E-02	mg/kg-day	3.8E-03	mg/kg-day	Liver	1000	IRIS	06/04/02
Bromodichloro-methane	Chronic	2.0E-02	mg/kg-day	1.96E-02	mg/kg-day	Kidney	1000	IRIS	06/04/02
Carbon Tetrachloride	Chronic	7.0E-04	mg/kg-day	4.55E-04	mg/kg-day	Liver	1000	IRIS	06/04/02
Chloroform	Chronic	1.0E-02	mg/kg-day	2.0E-03	mg/kg-day	Liver	100	IRIS	06/04/02
Dichloromethane	Chronic	6.0E-02	mg/kg-day	5.7E-02	mg/kg-day	Liver	100	IRIS	06/04/02
PCE	Chronic	1.0E-02	mg/kg-day	1.0E-02	mg/kg-day	Liver	1000	IRIS	06/04/02
TCE	Chronic	6.0E-03	mg/kg-day	9.0E-04	mg/kg-day	Liver	NA	RAIS	06/04/02
Pathway: Inhalation									
Constituent of Concern	**Chronic/ Subchronic**	**Inhalation RfC**	**Inhalation RfC Units**	**Inhalation RfD**	**Inhalation RfD Units**	**Primary Target Organ**	**Combined Uncertainty/ Modifying Factors**	**Sources of RfC:RfD: Target Organ**	**Dates (M/D/Y)**
Alpha-BHC	Chronic	--	--	--	--	--	--	--	--
Beta-BHC	Chronic	--	--	--	--	--	--	--	--
Delta-BHC	Chronic	--	--	--	--	--	--	--	--
Dieldrin	Chronic	--	--	5.0E-05	mg/kg-day	CNS	--	IRIS	06/04/02
DDT	Chronic	--	--	--	--	--	--	--	06/04/02
Lindane	Chronic	--	--	3.0E-04	mg/kg-day	CNS	--	IRIS	06/04/02
Bis(2-ethylhexyl) phthalate	Chronic	--	--	2.2E-02	mg/kg-day	Blood	--	IRIS	06/04/02
Bromodichloro-methane	Chronic	--	--	--	--	--	--	--	06/04/02
Carbon Tetrachloride	Chronic	--	--	7.0E-04	mg/kg-day	Liver	--	IRIS	06/04/02
Chloroform	Chronic	--	--	8.6E-05	mg/kg-day	Liver	--	NCEA	06/04/02
Dichloromethane	Chronic	3.0E+00	mg/m^3	8.57E-01	mg/kg-day	Liver	--	RAIS	06/04/02
PCE	Chronic	6.0E-01	mg/m^3	1.71E-01	mg/kg-day	Liver	--	RAIS	06/04/02
TCE	Chronic	--	--	6.0E-03	mg/kg-day	CNS	--	NCEA	06/04/02

Key

—:	**no information available**
IRIS:	**Integrated Risk Information System, USEPA**
NCEA:	**National Center for Environmental Assessment**
RAIS:	**Risk Assessment Information System**
RfDs:	**reference dose**
RfC:	**reference concentration**

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD and that toxic noncarcinogenic effects from that chemical are unlikely. The hazard index (HI) is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI> 1 indicates that unit-related exposures may present a risk to human health.

Human health COCs were identified only for the future land use scenario because no COCs were identified for the current use scenario. Tables 7 through 14 summarize cancer and non-cancer risk for the COCs identified at the CMP Pits OU.

Ecological Risk Assessment

Ecological Setting

Based on field observations and literature review, major vegetative community types are identified within the study area. Vegetative community type patterns at SRS are dependent on topography, soil type, moisture, and degree of disturbance. Three primary plant community types were identified at the CMP Pits OU: old field, pine (young and more mature), and bottomland hardwoods.

Table 7. Risk Characterization Summary for the CMP Pits Sub-unit - Carcinogens

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Ground-water	Groundwater	Tap Water	Alpha-BHC	4.4E-06	N/A	N/A	N/A	4.4E-06
			Delta-BHC	1.5E-06	N/A	N/A	N/A	1.5E-06
			Dieldrin	3.8E-06	N/A	N/A	N/A	3.8E-06
			Lindane	2.0E-06	N/A	N/A	N/A	2.0E-06
			Carbon Tetrachloride	1.9E-05	N/A	N/A	N/A	1.9E-05
			PCE	2.9E-04	N/A	N/A	N/A	2.9E-04
			TCE	2.0E-05	N/A	N/A	N/A	2.0E-05
							Groundwater Risk =	3.4E-04
							Total Risk =	3.4E-04

Key
---: Toxicity criteria are not available to quantitatively address this route of exposure.
N/A: Route of exposure is not applicable to this medium.

There are no surface soil RCOCs for the CMP Pits sub-unit. Groundwater presents a risk of 3.4×10^{-4}.

Table 8. Risk Characterization Summary for the CMP Pits Sub-unit - Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Ground-water	Groundwater	Tap Water	Alpha-BHC	1.9E-05	N/A	N/A	N/A	1.9E-05
			Beta-BHC	3.1E-06	N/A	N/A	N/A	3.1E-06
			Delta-BHC	6.3E-06	N/A	N/A	N/A	6.3E-06
			Dieldrin	1.6E-05	N/A	N/A	N/A	1.6E-05
			Lindane	8.4E-06	N/A	N/A	N/A	8.4E-06
			Bis(2-ethylhexyl) phthalate	1.5E-06	N/A	N/A	N/A	1.5E-06
			Bromodichloro-methane	1.7E-06	N/A	N/A	N/A	1.7E-06
			Carbon Tetrachloride	8.0E-05	N/A	N/A	N/A	8.0E-05
			Chloroform	1.6E-06	N/A	N/A	N/A	1.6E-06
			DCM	3.2E-06	N/A	N/A	N/A	3.2E-06
			PCE	1.2E-03	N/A	N/A	N/A	1.2E-03
			TCE	8.7E-05	N/A	N/A	N/A	8.7E-05
							Groundwater Tap Water Risk Total =	1.4E-03
	Air	Shower Vapors	Alpha-BHC	N/A	1.9E-05	N/A	N/A	1.9E-05
			Beta-BHC	N/A	3.2E-06	N/A	N/A	3.2E-06
			Delta-BHC	N/A	6.5E-06	N/A	N/A	6.5E-06
			Dieldrin	N/A	1.6E-05	N/A	N/A	1.6E-05
			Lindane	N/A	--	N/A	N/A	--
			Bis(2-ethylhexyl) phthalate	N/A	1.5E-06	N/A	N/A	1.5E-06
			Bromodichloro-methane	N/A	--	N/A	N/A	--
			Carbon Tetrachloride	N/A	3.2E-05	N/A	N/A	3.2E-05
			Chloroform	N/A	2.1E-05	N/A	N/A	2.1E-05
			DCM	N/A	7.1E-07	N/A	N/A	7.1E-07
			PCE	N/A	4.7E-05	N/A	N/A	4.7E-05
			TCE	N/A	4.7E-05	N/A	N/A	4.7E-05
							Air Shower Vapors Risk Total =	1.9E-04
							Groundwater Risk =	1.6E-03
							Total Risk =	1.6E-03

Key
---: Toxicity criteria are not available to quantitatively address this route of exposure.
N/A: Route of exposure is not applicable to this medium.

There are no surface soil RCOCs for the CMP Pits sub-unit. Groundwater presents a risk of 1.6 × 10^{-3}.
***RCOCs – refined constituents of concern**

Table 9. Risk Characterization Summary for the Ballast Area Sub-unit - Carcinogens

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Surface Soil	Surface Soil	Direct Contact	p,p'-DDT	6.8E-06	N/A	6.2E-06	N/A	1.3E-05
	Surface Soil Direct Contact Risk Total =							1.3E-05
	Air Particulates	Inhalation of Soil as Dust	p,p'-DDT	--	2.1E-09	--	N/A	2.1E-09
	Air Particulate Risk Total =							2.1E-09
Soil Risk Total =								1.3E-05
Ground-water	Groundwater	Tap Water	Alpha-BHC	4.4E-06	N/A	N/A	N/A	4.4E-06
			Delta-BHC	1.5E-06	N/A	N/A	N/A	1.5E-06
			Dieldrin	3.8E-06	N/A	N/A	N/A	3.8E-06
			Lindane	2.0E-06	N/A	N/A	N/A	2.0E-06
			Carbon Tetrachloride	1.9E-05	N/A	N/A	N/A	1.9E-05
			PCE	2.9E-04	N/A	N/A	N/A	2.9E-04
			TCE	2.0E-05	N/A	N/A	N/A	2.0E-05
Groundwater Risk =								3.4E-04
Total Risk =								3.5E-04

Key
---: Toxicity criteria are not available to quantitatively address this route of exposure.
N/A: Route of exposure is not applicable to this medium.

The cumulative future industrial worker risk at the Ballast Area is 3.5×10^{-4}.

Table 10. Risk Characterization Summary for the Ballast Area Sub-unit - Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Surface Soil	Surface Soil	Direct Contact	p,p'-DDT	6.1E-05	N/A	1.9E-05	N/A	8.0E-05
			Dieldrin	4.4E-06	N/A	1.9E-06	N/A	6.3E-06
							Surface Soil Direct Contact Risk Total =	8.6E-05
	Air Particulates	Inhalation of Soil as Dust	p,p'-DDT	N/A	5.2E-09	N/A	N/A	5.2E-09
			Dieldrin	N/A	3.8E-10	N/A	N/A	3.8E-10
							Air Particulate Risk Total =	5.6E-09
							Soil Risk Total =	8.6E-05
Ground-water	Groundwater	Tap Water	Alpha-BHC	1.9E-05	N/A	N/A	N/A	1.9E-05
			Beta-BHC	3.1E-06	N/A	N/A	N/A	3.1E-06
			Delta-BHC	6.3E-06	N/A	N/A	N/A	6.3E-06
			Dieldrin	1.6E-05	N/A	N/A	N/A	1.6E-05
			Lindane	8.4E-06	N/A	N/A	N/A	8.4E-06
			Bis(2-ethylhexyl) phthalate	1.5E-06	N/A	N/A	N/A	1.5E-06
			Bromodichloro-methane	1.7E-06	N/A	N/A	N/A	1.7E-06
			Carbon Tetrachloride	8.0E-05	N/A	N/A	N/A	8.0E-05
			Chloroform	1.6E-06	N/A	N/A	N/A	1.6E-06
			DCM	3.2E-06	N/A	N/A	N/A	3.2E-06
			PCE	1.2E-03	N/A	N/A	N/A	1.2E-03
			TCE	8.7E-05	N/A	N/A	N/A	8.7E-05
							Groundwater Tap Water Risk Total =	1.4E-03
	Air	Shower Vapors	Alpha-BHC	N/A	1.9E-05	N/A	N/A	1.9E-05
			Beta-BHC	N/A	3.2E-06	N/A	N/A	3.2E-06
			Delta-BHC	N/A	6.5E-06	N/A	N/A	6.5E-06
			Dieldrin	N/A	1.6E-05	N/A	N/A	1.6E-05
			Lindane	N/A	--	N/A	N/A	--
			Bis(2-ethylhexyl) phthalate	N/A	1.5E-06	N/A	N/A	1.5E-06
			Bromodichloro-methane	N/A	--	N/A	N/A	--
			Carbon Tetrachloride	N/A	3.2E-05	N/A	N/A	3.2E-05
			Chloroform	N/A	2.1E-05	N/A	N/A	2.1E-05
			DCM	N/A	7.1E-07	N/A	N/A	7.1E-07
			PCE	N/A	4.7E-05	N/A	N/A	4.7E-05
			TCE	N/A	4.7E-05	N/A	N/A	4.7E-05
							Air Shower Vapors Risk Total =	1.9E-04
							Groundwater Risk =	1.6E-03
							Total Risk =	1.7E-03

Key
---: Toxicity criteria are not available to quantitatively address this route of exposure.
N/A: Route of exposure is not applicable to this medium.

The cumulative future resident risk at the Ballast Area is 1.7 × 10^{-3}.

Table 11. Risk Characterization Summary for the CMP Pits Sub-unit – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground-water	Groundwater	Tap Water	Alpha-BHC	--	--	N/A	N/A	--
			Delta-BHC	--	--	N/A	N/A	--
			Dieldrin	Liver	0.013	N/A	N/A	0.013
			Lindane	Liver, Kidney	0.014	N/A	N/A	0.014
			Carbon Tetrachloride	--	--	N/A	N/A	--
			PCE	Liver	1.5	N/A	N/A	1.5
			TCE	Liver, Kidney	0.86	N/A	N/A	0.86
Groundwater Hazard Index Total =								2.39
Total Hazard Index Total =								2.39

Key
---: Toxicity criteria are not available to quantitatively address this route of exposure.
N/A: Route of exposure is not applicable to this medium.

There are no surface soil RCOCs for the CMP Pits sub-unit. The groundwater hazard index for the future industrial worker is 2.39 and is driven primarily by the presence of PCE and TCE. The primary target organ is the liver.

Table 12. Risk Characterization Summary for the CMP Pits Sub-unit – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground-water	Groundwater	Tap Water	Alpha-BHC	--	--	N/A	N/A	--
			Beta-BHC	--	--	N/A	N/A	--
			Delta-BHC	--	--	N/A	N/A	--
			Dieldrin	Liver	0.087	N/A	N/A	0.087
			Lindane	Liver, Kidney	0.092	N/A	N/A	0.092
			Bis(2-ethylhexyl) phthalate	Liver	0.023	N/A	N/A	0.023
			Bromodichloro-methane	Kidney	0.006	N/A	N/A	0.006
			Carbon Tetrachloride	Liver	3.8	N/A	N/A	3.8
			Chloroform	Liver	0.11	N/A	N/A	0.11
			DCM	Liver	0.031	N/A	N/A	0.031
			PCE	Liver	10	N/A	N/A	10
			TCE	Liver, Kidney	5.6	N/A	N/A	5.6
					Groundwater Tap Water Hazard Index Total =			19.7
	Air	Shower Vapors	Alpha-BHC	--	N/A	--	N/A	--
			Beta-BHC	--	N/A	--	N/A	--
			Delta-BHC	--	N/A	--	N/A	--
			Dieldrin	CNS	N/A	0.087	N/A	0.087
			Lindane	CNS, Liver	N/A	0.092	N/A	0.092
			Bis(2-ethylhexyl) phthalate	CNS, Blood	N/A	0.021	N/A	0.021
			Bromodichloro-methane	--	N/A	--	N/A	--
			Carbon Tetrachloride	CNS, Liver, Kidney	N/A	3.8	N/A	3.8
			Chloroform	Liver, Kidney	N/A	13	N/A	13
			DCM	CNS, Liver, Kidney	N/A	0.002	N/A	0.002
			PCE	CNS, Liver, Kidney	N/A	0.59	N/A	0.59
			TCE	CNS, Liver, Kidney	N/A	5.6	N/A	5.6
					Air Shower Vapors Hazard Index Total =			23.2
					Groundwater Hazard Index Total =			42.9
					Total Hazard Index Total =			42.9

Key
---: Toxicity criteria are not available to quantitatively address this route of exposure.
N/A: Route of exposure is not applicable to this medium.

There are no surface soil RCOCs for the CMP Pits sub-unit. The groundwater hazard index for the future resident is 42.9 and is driven primarily by carbon tetrachloride, chloroform, PCE, and TCE. The primary target organs are the liver and kidney.

Table 13. Risk Characterization Summary for the Ballast Area Sub-unit – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Direct Contact	p,p'-DDT	Liver	0.11	N/A	0.10	0.21
	Surface Soil Direct Contact Hazard Index Total Total =							0.21
	Air Particulates	Inhalation of Soil as Dust	p,p'-DDT	--	N/A	--	N/A	--
	Air Particulate Hazard Index Total Total =							--
	Soil Hazard Index Total Total =							0.21
Ground-water	Groundwater	Tap Water	Alpha-BHC	--	--	N/A	N/A	--
			Delta-BHC	--	--	N/A	N/A	--
			Dieldrin	Liver	0.013	N/A	N/A	0.013
			Lindane	Liver, Kidney	0.014	N/A	N/A	0.014
			Carbon Tetrachloride	--	--	N/A	N/A	--
			PCE	Liver	1.5	N/A	N/A	1.5
			TCE	Liver, Kidney	0.86	N/A	N/A	0.86
Groundwater Hazard Index Total =								2.39
Total Hazard Index Total =								2.60

Key
---: Toxicity criteria are not available to quantitatively address this route of exposure.
N/A: Route of exposure is not applicable to this medium.

The cumulative hazard index for the future industrial worker is 2.60 and is driven primarily by the presence of PCE and TCE in groundwater. The primary target organ is the liver.

Table 14. Risk Characterization Summary for the Ballast Area Sub-unit – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult/Child

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Direct Contact	p,p'-DDT	Liver	2.9	N/A	0.38	3.3
			Dieldrin	Liver	0.045	N/A	0.008	0.053
	Surface Soil Direct Contact Hazard Index Total Total =							3.35
	Air Particulates	Inhalation of Soil as Dust	p,p'-DDT	--	N/A	--	N/A	--
			Dieldrin	CNS	N/A	2.6E-06	N/A	2.6E-06
	Air Particulate Hazard Index Total Total =							2.6E-06
Soil Hazard Index Total Total =								3.35
Ground-water	Groundwater	Tap Water	Alpha-BHC	--	--	N/A	N/A	--
			Beta-BHC	--	--	N/A	N/A	--
			Delta-BHC	--	--	N/A	N/A	--
			Dieldrin	Liver	0.087	N/A	N/A	0.087
			Lindane	Liver, Kidney	0.092	N/A	N/A	0.092
			Bis(2-ethylhexyl) phthalate	Liver	0.023	N/A	N/A	0.023
			Bromodichloro-methane	Kidney	0.006	N/A	N/A	0.006
			Carbon Tetrachloride	Liver	3.8	N/A	N/A	3.8
			Chloroform	Liver	0.11	N/A	N/A	0.11
			DCM	Liver	0.031	N/A	N/A	0.031
			PCE	Liver	10	N/A	N/A	10
			TCE	Liver, Kidney	5.6	N/A	N/A	5.6
	Groundwater Tap Water Hazard Index Total =							19.7
	Air	Shower Vapors	Alpha-BHC	--	N/A	--	N/A	--
			Beta-BHC	--	N/A	--	N/A	--
			Delta-BHC	--	N/A	--	N/A	--
			Dieldrin	CNS	N/A	0.087	N/A	0.087
			Lindane	CNS, Liver	N/A	0.092	N/A	0.092
			Bis(2-ethylhexyl) phthalate	CNS, Blood	N/A	0.021	N/A	0.021
			Bromodichloro-methane	--	N/A	--	N/A	--
			Carbon Tetrachloride	CNS, Liver, Kidney	N/A	3.8	N/A	3.8
			Chloroform	Liver, Kidney	N/A	13	N/A	13
			DCM	CNS, Liver, Kidney	N/A	0.002	N/A	0.002
			PCE	CNS, Liver, Kidney	N/A	0.59	N/A	0.59
			TCE	CNS, Liver, Kidney	N/A	5.6	N/A	5.6
	Air Shower Vapors Hazard Index Total =							23.2
Groundwater Hazard Index Total =								42.9
Total Hazard Index Total =								46.3

Key

---: Toxicity criteria are not available to quantitatively address this route of exposure.
N/A: Route of exposure is not applicable to this medium.

The cumulative hazard index for the future resident is 46.3 and is driven by the presence of DDT in soil and carbon tetrachloride, chloroform, PCE, and TCE in groundwater. The primary target organs are the liver and kidney.

Wildlife species inhabiting the CMP Pits OU include white-tailed deer, wild turkey, feral hogs, squirrels, raccoons, small rodents, frogs, toads, and many songbirds. A variety of reptiles and other amphibians can also be expected to occur in this area. The diversity of habitats and the diversity of moisture regimes allow many animal species to thrive. The ecosystem potentially at risk at the CMP Pits OU includes the terrestrial habitats associated with the CMP Pits sub-unit and Ballast Area sub-unit. The old field vegetative community is the dominant community type associated with these sub-units.

A TES species field survey has been performed at the CMP Pits OU. This survey was performed by the Savannah River Forest Station (SRFS) in 1994. The survey identified bog spice bush (*Lindera subcoriacea*), which is a candidate species, as the only species in Branch.the general vicinity. The bog spice bush was located along the northern bank of Pen

Ecological exposure pathways and the associated assessment and measurement endpoints are presented in Table 15.

Table 15. Ecological Exposure Pathways of Concern

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered/ Threatened Species Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Soil	N	Insectivorous Mammals	N	Ingestion, direct contact, and indirect ingestion of chemicals in soil	Ensure that exposure of contaminants in prey, forage, and soils do not have a negative impact on growth, survival, and reproduction	Measured concentrations in soil used to model food chain uptake and compared to literature-based toxicity reference values
Soil	N	Insectivorous Birds	N	Ingestion, direct contact, and indirect ingestion of chemicals in soil	Ensure that exposure of contaminants in prey, forage, and soils do not have a negative impact on growth, survival, and reproduction	Measured concentrations in soil used to model food chain uptake and compared to literature-based toxicity reference values

Identification of COCs

Ecological risks due to soil exposure were assessed for soil invertebrates, herbivorous mammals, insectivorous mammals, omnivorous mammals, insectivorous birds, and carnivorous birds. Ecological risks due to sediment exposure were assessed for benthic invertebrates, mammalian aquatic predators, and avian aquatic predators. Ecological risks due to surface water exposure were assessed for aquatic organisms, mammalian aquatic predators, and avian aquatic predators. Available ecological research, including TES species surveys, was used to identify specific ecological concerns.

At the CMP Pits sub-unit surface and subsurface soil exposure groups, there are no ecological refined constituents of concern (RCOCs).

At the Ballast Area sub-unit surface and subsurface soil exposure groups, dieldrin, endrin, heptachlor epoxide, p,p'-DDD, p,p'-DDE, p,p'-DDT, Aroclor-1248, and Aroclor-1254 are identified as ecological RCOCs. Based on food chain modeling, HQs greater than one for the insectivorous mammal were observed for: dieldrin (HQ range of <1 to 144); heptachlor epoxide (HQ range of <1 to 105); p,p'-DDT (HQ range of <1 to 54); and Aroclor-1248 (HQ range of <1 to 115). HQs greater than one for the insectivorous bird were also observed for dieldrin (HQ range of <1 to 92) and p,p'-DDT (HQ range of 3.7 to 711). An additional qualitative evaluation identified endrin, p,p'-DDD, p,p'-DDE and Aroclor-1254 as RCOCs based on the elevated concentrations observed in screening level data. The insectivorous mammal and insectivorous bird communities are expected to be exposed to the RCOCs through ingestion of soil invertebrates and incidental ingestion of soil material. Protective concentrations for the ecological RCOCs at the Ballast Area are presented in Table 16.

Table 16. COC Concentrations Expected to Provide Adequate Protection of Ecological Receptors at the Ballast Area Sub-unit

Habitat Type/ Name	Exposure Medium	COC	Protective Level	Units	Basis	Assessment/ Measurement Endpoint
Ballast Area	Soil	Dieldrin	0.0684	mg/kg	HQ=1	Ensure that exposure of contaminants in prey, forage, and soils do not have a negative impact on growth, survival, and reproduction
		Endrin	0.0397	mg/kg	HQ=1	
		Heptachlor Epoxide	0.021	mg/kg	HQ=1	
		p,p'-DDD	0.287	mg/kg	HQ=1	
		p,p'-DDE	0.554	mg/kg	HQ=1	
		p,p'-DDT	1.62	mg/kg	HQ=1	
		Total PCBs	1.0	mg/kg	ARAR	

Based on the original ecological risk assessment (WSRC 1997), PCBs were identified as an ecological COC. The remedial goal (RG) selected at the time was 1.0 mg/kg. Remedial efforts, in the form of bioremediation and off-SRS disposal, have removed the majority of PCB-contaminated soil in the Ballast Area.

The highest concentrations of PCB-contaminated soils were disposed off-site or treated on-site through bioremediation. The Phase I Treatability Study soils were treated to a RG of 1.0 mg/kg (selected based on the appropriate or relevant and applicable requirement [ARAR]). Upon treatment to the RG, these soils were returned to the Ballast Area. The area these soils cover in the Ballast Area is approximately 0.2 to 0.5 acres (0.08 to 0.20 hectares). This area represents approximately one-fifth to one-half of the home range of small terrestrial mammals (i.e., shrews). Application of the reduced unit-specific foraging factor to the lowest observable adverse effect level (LOAEL)-based RGO of 0.22 mg/kg results in an ecological RG of 0.44 to 1.1 mg/kg. The Phase I Treatability Study achieved an average concentration of 0.85 mg/kg, which satisfied the selected RG of 1.0 mg/kg.

It is highly unlikely that the one or two mammals with a small foraging range if affected by the PCBs at the site, would have an effect on the population of such mammals at SRS. Additionally, because such small mammals are prey for avian raptors, the PCBs could magnify through the food chain. However, the foraging areas of avian raptors such as hawks and eagles are considerably greater than the impacted area. Hence, the actual potential for PCBs to magnify through the food chain through predation is considered low.

Although the baseline ecological risk assessment identified unacceptable ecological risk, the risk management process allows the decision makers some latitude in establishing cleanup levels. Considering the previous discussion, and the conservative assumptions inherent in the risk assessment process, USEPA, USDOE, and SCDHEC agree that the actual ecological risk is likely lower, and the identified receptors are not threatened or endangered. Accordingly, USEPA, USDOE, and SCDHEC have identified future industrial use as the risk management scenario, and selected a cleanup level of 1.0 mg/kg as protective of human health and the environment.

Summary of the Contaminant Migration Analysis

A contaminant migration analysis was performed to identify refined contaminant migration (CM) COCs. The contaminant migration analysis was performed only for the soil exposure groups. A constituent is identified as a CM RCOC if leachability modeling predicts the constituent will leach to groundwater and exceed MCLs, preliminary remediation goals (PRGs), or risk-based activities (RBAs) within 1,000 years.

CM RCOCs identified for the CMP Pits sub-unit include dichloromethane and PCE. No CM RCOCs were identified for the Ballast Area sub-unit.

Discussion of Principal Threat Source Material

Wastes that generally will be considered to constitute principal threats include liquids, mobile source material, or highly-toxic source material. The CMP Pits and associated vadose zone (Field A) has PTSM based on contaminant mobility. Dichloromethane (DCM) and PCE are present in the groundwater above MCLs and in the vadose zone at concentrations that are predicted to be a continuing source of contamination to the groundwater.

Conclusions

Actual or threatened releases of hazardous substances from these subunits, if not addressed by the preferred alternative or one of the other active measures considered, may present a current or potential threat to public health, welfare, or the environment.

- There are no RCOCs in the surface soil of the CMP Pits subunit. DCM and PCE have been identified as PTSM in subsurface soil based on their mobility.

- VOCs, SVOCs, pesticides and PCBs were identified in groundwater as RCOCs. Current conditions in groundwater present an elevated risk to the future industrial worker (3.4×10^{-4}) and the future resident (1.6×10^{-3}).

- PCBs and pesticides were identified as RCOCs in surface soil in the Ballast Area. Current conditions present an elevated risk to the future industrial worker (3.5×10^{-4}) and the future resident (1.7×10^{-3}) when exposed to contaminants in surface soil and groundwater. Soil concentrations of pesticides and PCBs also present an unacceptable risk to ecological receptors (HQ > 1).

VIII. REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS

Remedial action objectives (RAOs) are unit-specific quantitative goals that define the extent of cleanup required to achieve the goal of protecting human health and the environment. The RAOs are based on the nature and extent of contamination, threatened resources, and the potential for human, environmental or ecological exposure, and ARARs. The RAOs are designed to protect human health, environmental resources, and the ecology (i.e., biota exposure) from unacceptable exposure to COCs and are used as the framework for developing remedial alternatives. The RAOs for the Ballast Area, CMP Pits and Associated Field A Vadose Zone, and Groundwater subunits are as follows (WSRC 2004a).

Ballast Area

- Prevent ecological receptors from direct contact with PCB-contaminated surface soil at concentrations > 1 mg/kg.

- Prevent direct contact with pesticide-contaminated surface soils, such that COCs do not present an unacceptable risk to human and ecological receptors.

CMP Pits and Associated Field A Vadose Zone

- Prevent COC migration to groundwater.

- Prevent residential exposure to surface soil above RGs.

Groundwater

- Prevent human exposure to contaminated groundwater above MCLs or RGs.
- Reduce the COC concentrations in the groundwater plume to MCLs.
- Prevent discharge of contaminated groundwater to surface water at concentrations above MCLs.

RGs are the final acceptable exposure levels that are determined on the basis of the results of the BRA and evaluation of the expected exposures and associated risks. The CMP Pits OU RGs in soil (Table 17) have been developed to be protective based upon future industrial land use and in groundwater have been developed to achieve MCLs or residential RGs.

The Treatability Study demonstrated that enhanced bioremediation could achieve the 1.0 mg/kg remedial goal for PCB-contaminated soil in the Ballast Area. Enhanced bioremediation is currently being implemented at the Ballast Area as part of an interim action. Therefore, it is expected that the final remedial goal (Table 17) will be met for all of the PCB-contaminated soils in the Ballast Area at the completion of the interim action.

Summary of Key Applicable or Relevant and Appropriate Requirements

Unit source data were compared to ARARs to determine if a constituent exceeds an established standard or information to-be-considered (TBC) (Table 18). ARARs considered included ambient water quality criteria for the protection of human health and aquatic life, and RCRA/CERCLA screening values and Toxic Substances Control Act (TSCA) limits for lead. Constituents that exceed an ARAR are identified as ARAR RCOCs.

No ARAR RCOCs were identified for the CMP Pits OU soil exposure groups.

Table 17. Summary of Remedial Goals for the CMP Pits OU

		Type of RCOC and RGO[1]					
Area of Concern	**RCOC**	**ARAR (mg/kg)**	**CM/PTSM (mg/kg)**	**HH (mg/kg)**	**ECO (mg/kg)**	**Final RG (mg/kg)**	**Final RG Basis**
Ballast Area	PCB	1.00E+00			2.19E-01	1.0E+00	ARAR
	Dieldrin			1.57E-01	6.84E-02	6.84E-02	ECO
	Endrin				3.97E-02	3.97E-02	ECO
	Heptachlor epoxide				2.10E-02	2.10E-02	ECO
	p,p'-DDD				2.87E-01	2.87E-01	ECO
	p,p'-DDE				5.54E-01	5.54E-01	ECO
	p,p'-DDT			8.79E+00	1.62E+00	1.62E+00	ECO
CMP Pits and Field A Vadose Zone[2]	Dichloromethane		2.48E-02			2.48E-02	CM
	Tetrachloroethylene		3.07E+01			3.07E+01	CM
		ARAR (mg/L)		**HH (mg/L)**		**Final RG (mg/L)**	
Groundwater	Alpha-benzene hexachloride			5.33E-06		5.33E-06	HH
	Beta-benzene hexachloride			1.84E-05		1.84E-05	HH
	Delta-benzene hexachloride			1.84E-05		1.84E-05	HH
	Dieldrin			2.09E-06		2.09E-06	HH
	Lindane	2.00E-04		5.17E-05		2.00E-04	ARAR[4]
	Bis(2-ethylhexyl) phthalate	6.00E-03		2.40E-03		6.00E-03	ARAR
	Total Trihalomethanes[3]	1.00E-01		See Footnote 3		1.00E-01	ARAR[4]
	Carbon Tetrachloride	5.00E-03		3.68E-04		5.00E-03	ARAR[4]
	Dichloromethane	5.00E-03		7.36E-03		5.00E-03	ARAR[4]
	Tetrachloroethylene	5.00E-03		1.24E-03		5.00E-03	ARAR[5]
	Trichloroethylene	5.00E-03		3.95E-03		5.00E-03	ARAR[5]

1 – The risk based RGOs are calculated as follows: HH Soil – 1×10-6 Future Industrial Worker; HH Groundwater – 1×10-6 Future Resident; ECO – HQ=1 (WSRC 2003b).

2 – Vadose zone Final RGs apply anywhere in the vadose zone and are based on maintaining the existing cover. The RGOs are target values based on available data. During remedial action implementation, vadose zone and groundwater monitoring may indicate that different values may be protective and meet the RAO of preventing migration to groundwater.

3 – Total Trihalomethanes include chloroform and bromodichloromethane. These constituents do not have an individual MCL; however, Total Trihalomethanes is assigned an MCL. Although these constituents are not ARAR COCs, site concentrations pose a risk. The HH RGOs for chloroform and bromodichloromethane are 7.75E-04 and 1.08E-03 mg/L, respectively. The MCL is an ARAR and, as such, is the appropriate final RG.

4 – Although the HH RGO for groundwater may be more conservative than the MCL, the MCLs have been set as close as possible to health based goals. The ARAR RGO (the MCL) is the appropriate final RG as per SC Water Classification Standards (SC R.61-68).

5 – Final RG is based on SC Water Classification Standards (SC R.61-68).

Table 18. Key ARARs for the CMP Pits

ACTION-SPECIFIC ARARs				
Action	**Citation**	**Requirement Synopsis**	**Comments**	**Remedial Alternative**
Discharge of treatment system effluent	National Pollutant Discharge Elimination System (NPDES) 40 *CFR* 122-125 SC R61-9.122.26 SC R61-9.122.50 SC R61-9.125	Regulates direct discharges to waters of the U.S.	Wastewater treatment technologies are required to meet best available technology requirements; substantive requirements of the NPDES regulations apply to on-site discharge of treated or untreated groundwater to surface water systems.	VZA-3b, VZA-3d, VZA-3g, VZA-3h
Treatment / storage / disposal	RCRA Hazardous Waste 40 *CFR* 261 40 *CFR* 262 SC R61-79.261 SC R61-79.262	Defines criteria for determining whether a waste is RCRA hazardous waste. Identifies generator requirements for waste manifests, packaging, labeling, records, and reporting associated with management of RCRA hazardous waste	Any waste media that are actively managed or shipped off site must be tested to determine if they are RCRA characteristic wastes.	Ballast Area
Air Stripping	Toxic Air Pollutants SC R61-62.5, standard 8	Identifies allowable air concentrations and permit requirements for air emissions of toxic chemicals from new and existing sources	Substantive requirements limiting air concentrations (24-hr averages) of contaminants such as vinyl chloride and PCBs must be met during remediation; measurements are made at the property line.	VZA-3b, VZA-3d, VZA-3g, VZA-3h
Discharge of treatment system effluent	Indirect discharge to Publicly Owned Treatment Works (POTWs) 40 CFR 403	Prohibits discharge of pollutants that pass through a POTW without treatment, contaminate POTW sludge, or endanger health and safety of POTW workers.	Discharge must comply with the Effluent Treatment Facility pretreatment regulations, including POTW-specific pollutants, spill prevention program requirements, and reporting and monitoring requirements.	VZA-3b, VZA-3d, VZA-3g, VZA-3h, GW-4b

Table 18. Key ARARs for the CMP Pits (Continued)

Backfilling borings	South Carolina Well Standards, SC R61-71	Borings greater than five feet in depth shall be completely filled from the bottom of the borehole to the land surface with bentonite-cement, neat cement, or 20% high solids sodium bentonite grout.	Borehole cores will be required to support the vadose zone remedial action at depths greater than five feet.	VZA-3i
LOCATION-SPECIFIC ARARs				
Site-Feature / Location	**Citation**	**Requirement Synopsis**	**Comments**	**Remedial Alternative**
Areas with NEPA concerns	Savannah River Site NEPA/CERCLA Integration Guidance (Marcy and Sessions 1997), and US DOE Order 451.1A	An assessment of NEPA values is integrated into the CERCLA process.	Not an ARAR but considered a TBC	GW-3b, GW-3d, GW-3f, GW-3h, GW-3i, GW-4b
Classification and potential use of an aquifer and surface water	SC Water Classification Standards (SC 61-68)	Consider state aquifer classification in the assessment of RAOs.	Potential ARAR because surface drainage from the CMP Pits waste unit could impact adjacent Pen Branch	GW-3b, GW-3d, GW-3f, GW-3h, GW-3i, GW-4b
CHEMICAL-SPECIFIC ARARs				
	Citation	**Requirement Synopsis**	**Comments**	**Remedial Alternative**
Classification and potential use of and aquifer and surface water.	Class Freshwater (FW) groundwater standards are set in the South Carolina Classifications and Standards (R.61-68).	Class FW groundwater standards are set in the SC Classifications and Standards (R.61-68). MCLs are ARAR water quality standards because all waters of the state area classified as FW suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the State of South Carolina.	ARAR because contamination has been detected in groundwater.	GW-3b, GW-3d, GW-3f, GW-3h, GW-3i, GW-4b

No ARAR RCOCs were identified for surface water concentrations in Pen Branch, because no constituents were identified at concentrations greater than the ambient water quality criteria.

IX. DESCRIPTION OF ALTERNATIVES

This section describes the remedial alternatives for the Ballast Area, CMP Pits and Field A Vadose Zone, Field B Vadose Zone, and Groundwater. A comparison of the CMP Pits Field A Vadose Zone and Groundwater alternatives. Only one alternative is provided for the Ballast Area and Field B Vadose Zone due to the effectiveness of the interim action.

Description of Alternative for the Ballast Area

Institutional controls after completion of the enhanced bioremediation interim action for pesticide and PCB contaminated surface soils

Estimated Present Worth Cost: $0

Construction Time to Complete: 0 weeks

No present worth costs are identified for the Ballast Area. Since the CMP Pits Vadose Zone Field A is located adjacent to the Ballast Area and the Field A remedy will include institutional controls, present worth costs to provide institutional controls at the Ballast Area are included with the CMP Pits Vadose Zone Field A cost estimate.

Enhanced bioremediation for pesticide and PCB contaminated soil is being performed as part of the interim action in the Ballast Area (WSRC 2003a.) Treatability results indicated that enhanced bioremediation would reduce the pesticide and PCB concentrations to below RGs. Since the residual contamination following the interim action will not allow for unrestricted use, institutional controls will be required to prevent human exposure to contaminated soil.

Following completion of the interim action, institutional controls will be implemented to prevent unacceptable human receptors from direct contact with PCB and pesticide contaminated soil. Future activities will be restricted by identifying the Ballast Area as an area subject to land use controls (LUCs). The time to construct and implement institutional controls is 0 months. Upon implementation of the interim action and institutional controls, RAOs will be met. The estimated cost for implementing institutional controls is negligible because LUCs implemented at the CMP Pits soils subunit will be inclusive of the Ballast Area.

Description of Alternatives for CMP Pits and Associated Field A Vadose Zone

SVE is currently operating in the Field A Vadose Zone in accordance with the interim action (WSRC 1999b). As of March 2004, the SVE system removed approximately 8500 pounds (3856 kg) of VOC contamination from Field A. While soil-gas concentrations have been reduced, soil samples indicate that VOC contamination is sorbed onto the clay layers in the vadose zone. The following alternatives were evaluated to enhance the SVE system performance by targeting the clay layers for remediation.

VZA-1 No Action

The No Action Alternative is required by the NCP in order to provide a baseline for comparison against remedial actions.

Estimated Present Worth Cost: $0

Construction Time to Complete: 0 months

There is no present worth cost associated with the No Action alternative. The No Action alternative for the Field A Vadose Zone makes no remedial effort to control risks, treat or remove wastes, or reduce the toxicity, mobility, or volume of contaminated media. Under this hypothetical scenario, the ongoing, interim action SVE would be discontinued. No action would be taken to maintain the existing cover.

VZA-3b Soil Fracturing with SVE

This alternative involves fracturing low-permeability portions of the Field A Vadose Zone, continuing the operation of the interim action SVE system, maintaining the existing cover, and implementing institutional controls until the vadose zone RAOs are achieved.

Estimated Present Worth Cost: $1,465,000

Construction Time to Complete: 18 to 24 weeks

The estimated present worth cost is based on fracturing the soil, 4 years of active SVE operations using a 2.5% discount rate, and 3 years of passive SVE operation using 3.0% discount rate.

Fracturing enhances the permeability and allows the SVE system to draw vapor from low-permeability portions of the vadose zone. The fracturing process creates an interconnected network of fractures and enhances permeability, thus, allowing the interim remedial action SVE system to draw vapor from low-permeability portions of the vadose zone. Fracturing often increases the SVE offgas concentrations by several fold. Offgas treatment using granular activated carbon is provided as necessary. Institutional controls are implemented to prevent the disturbance of the existing cover and the excavation of soil at depth.

VZA-3d Soil Heating with SVE

This alternative involves electrical-resistivity heating (ERH) of the low-permeability portions of the Field A Vadose Zone, continuing the operation of the interim action SVE system to remove volatilized contaminants, maintaining the existing cover, and implementing institutional controls until the vadose zone RAOs are achieved.

Estimated Present Worth Cost: $2,437,000

Construction Time to Complete: 18 to 24 weeks

The estimated present worth cost is based on 2 years of soil heating and active SVE at a 2.1% discount rate and 3 years of passive SVE at a 2.8% discount rate.

The SVE system would recover vapor phase material that would be discharged per an air quality control permit. Electrical current would be passed through the soil between electrodes; electrical resistance of the soil would result in heating. An injection permit from SCDHEC will be required if it becomes necessary to add electrolyte at each electrode to compensate for drying of the soils in the treatment zone. The temperature of the treatment zone would be monitored with thermocouples.

Institutional controls are implemented to prevent the disturbance of the existing cover and the excavation of soil at depth.

VZA-3g Chemical Oxidation using Permanganate with SVE

This alternative consists of fracturing low-permeability portion of the Field A Vadose Zone chemically oxidizing the RCOCs in low-permeability portions of the Field A Vadose Zone by injecting permanganate solution, continuing operation of the interim action SVE system to address more permeable portions, maintaining the existing soil cover, and implementing institutional controls until the vadose zone RAOs are achieved.

Estimated Present Worth Cost: $1,728,000

Construction Time to Complete: 18 to 24 weeks

The estimated present worth cost is based on injecting permanganate, 2 years of active SVE at a 2.1% discount rate, and 3 years of passive SVE at a 2.8% discount rate.

Potassium or sodium permanganate is used in a solution form or solid form as an oxidant. Permanganate rapidly oxidizes chlorinated organics such as PCE and DCM to carbon dioxide and water. Reaction mechanism with permanganate involves direct electron transfer as opposed to formation of oxidation species such as hydroxyl radicals; therefore, permanganate is a highly stable and long-lasting oxidant. During the process of oxidation, permanganate is converted to insoluble manganese dioxide. CVOC destruction of up to 95% is possible using in situ chemical oxidation, which places it in between the reduced-source and no-source scenarios considered in vadose zone and groundwater modeling. It is assumed that three to four injection points, and 15 injections per point would be required. Approximately 5899 kg (13,000 lbs) of permanganate would be injected in solution form at a rate of 5% of the volume of soil to be treated.

Operation of the existing SVE system is continued to recover CVOCs from permeable portions of the vadose zone. Institutional controls are implemented to prevent the disturbance of the existing cover and the excavation of soil at depth.

VZA-3h Zero-Valent Iron (ZVI) Injection with SVE

This alternative consists of injecting ZVI into low-permeability portions of the Field A Vadose Zone to promote abiotic-reductive dechlorination of CVOCs, continuing interim action SVE system operation to address the permeable portions of the vadose zone, maintaining the existing soil cover, and implementing institutional controls until the vadose zone RAOs are achieved.

Estimated Present Worth Cost: $2,764,000

Construction Time to Complete: 18 to 24 weeks

The estimated present worth cost is based on injecting ZVI, 2 years of active SVE at a 2.1% discount rate, and 3 years of passive SVE at a 2.8% discount rate.

CVOCs are degraded by abiotic-reductive dechlorination when contacted by ZVI in the presence of moisture. Upon complete dechlorination, the CVOCs are degraded to harmless end products, such as ethenes, ethanes, and chloride. ZVI reaction requires the presence of moisture. Soil moisture levels of 10 to 15% are found sufficient to carry out the reaction. CVOC destruction of up to 95% is possible using in situ chemical oxidation. Effectiveness may be reduced if soil moisture levels drop, or if ZVI cannot be efficiently delivered to the contaminants. ZVI can be delivered by pneumatic or hydraulic fracturing methods. The fracturing process used to deliver ZVI also would result in enhancing the mobility of COCs to the SVE system.

As the subsurface conditions of each site are different, bench-scale and pilot-scale treatability studies normally are required to determine the design parameters. Initially, a bench-scale test is performed on soil samples collected from the vadose zone to determine treatability and gather data for the design of a pilot-scale system. Subsurface environmental data such as soil pH, Eh, and moisture content are collected. It is assumed that pilot-scale testing would be conducted in the Manhole 3 area by installing one injection point and injecting ZVI at multiple depths. Pre- and post-treatment soil cores are collected to estimate the contaminant destruction, radius of injection, and iron distribution of ZVI. Full-scale application of ZVI injection is implemented contingent on favorable, pilot scale results. It is assumed that three to four injection points, and 15 injections per point would be required. A colloidal solution of 5-micron size ZVI suspended in water and stabilized with guar gum gel would be injected at a rate of approximately 180 kg (400 lbs.) per every pound of contaminant to be treated. Institutional controls are implemented to prevent the disturbance of the existing cover and the excavation of soil at depth.

Operation of the existing SVE system is continued to recover CVOCs from permeable portions of the vadose zone. Performance monitoring is conducted to trigger switching to passive SVE. Institutional controls (e.g., signs, fences, excavation permit restrictions, deed restrictions) are implemented until the vadose zone RAOs are achieved. The purpose of institutional controls for the vadose zone is to prevent the disturbance of the existing cover and the excavation of soil at depth. The existing cover is maintained through implementing proper erosion and sediment control measures.

Description of Alternative for Field B

Passive SVE

Passive SVE was implemented in Field B as part of the interim action and is identified as an alternative for the final action. Passive SVE has maintained VOC soil-gas concentrations below 10 ppmv. Land use controls will be implemented at Field B to (1) ensure no construction or excavation and (2) ensure no residential use of the property.

Estimated Present Worth Cost: $0

Construction Time to Complete: 0 weeks

There is duplication between the O&M at Field B (groundwater monitoring, soil-gas sampling, effectiveness reporting, and land use controls) and Field A. Due to this duplication, O&M costs reported for Field A are inclusive of O&M costs for Field B. Therefore, there is no present worth cost being reported for the Passive SVE alternative. Remedial alternatives for Field B have been evaluated against the nine CERCLA criteria in the Interim Action Proposed Plan (WSRC 1999a).

Description of Alternatives for Groundwater

Two numeric models and one analytical model have been completed for this OU to estimate the extent and magnitude of future contaminant migration in the groundwater (WSRC 2002a and WSRC 2003a). The analytical model is a one-dimensional model that was completed for the vadose zone to determine future mass flux to the water table. The numeric models are three-dimensional flow and transport models. The transport model simulated several possible remedial alternatives for both the main CMP Pits plume and the north east plume including no action/MNA, recirculation wells, source area treatment, treatment walls, and collection trenches.

The findings of these modeling reports indicate that controlling the vadose zone source is the best focus in terms of overall reduction of contamination in the groundwater. This is also the case when considering the length of time required for operation of any other groundwater remedy.

The "Time to achieve RAOs" in Table 20 is based on (1) reducing the mass of contaminants in the aquifer to eliminate human exposure to contaminated groundwater and (2) preventing discharge of contaminated groundwater to Pen Branch above MCL. The "Time to achieve RAOs" for each alternative is based on the analysis in the *Groundwater Remediation Alternative Modeling Report for the Chemicals, Metals, and Pesticides Pits Operable Unit* (WSRC 2003c). The "time for the groundwater concentration to reach MCL in the plume" was not reported in the Groundwater Remediation Alternatives Modeling (WSRC 2003c) and the "time until the mass in the aquifer is predicted to go to zero" is used as a bounding condition to estimate when MCL is reached throughout the plume. Since the source area remedial actions do not remove 100% of the mass, the "time until the mass in the aquifer is predicted to go to zero" represents the time for groundwater contamination to travel from the source area and discharge to Pen Branch which is approximately 40 years. Therefore, 40 years represents the time for RAOs to be achieved in the entire groundwater.

The following alternatives present either active remedial measures located in the high-concentration source area to remove source-zone contaminants, or passive remedies located near the CVOC plume toe to prevent contaminant migration to Pen Branch. Source-zone alternatives include implementing MNA and long-term monitoring outside the source area.

GW-1 No Action

The No Action Alternative is required by the National Oil and hazardous Substances Pollution Contingency Plan (NCP) in order to provide a baseline for comparison against remedial actions.

Estimated Present Worth Cost: $0

Construction Time to Complete: 0 weeks

There is no present worth cost associated with the No Action alternative. The No Action alternative is required by the NCP. This alternative indicates that no action is taken to restrict access, limit exposure, or reduce contaminant toxicity, mobility, or volume at the OU.

The time to achieve RAOs will be 40 years based on the time required to reduce the mass of contaminants in the aquifer. (Table 9)

GW-3b Groundwater Recirculation Wells and Monitored Natural Attenuation (MNA)

This alternative consists of installing and operating recirculation wells within the groundwater-source area, implementing MNA and institutional controls until RAOs are achieved.

Estimated Present Worth Cost: $5,041,000

Construction Time to Complete: 6 to 12 months

The estimated present worth cost is based on installing groundwater recirculation wells, operating the recirculation wells for 2 years at a 2.1% discount rate, and 18 years of groundwater monitoring a 3.9% discount rate.

Recirculation well remediation, also known as in-well vapor stripping, is an innovative technology in which dissolved CVOCs are stripped from groundwater in specially designed wells and treated water re-injected into the aquifer without bringing it above ground. CVOC vapors are extracted from the well via a vacuum pump and transferred above ground for treatment, if treatment is required.

It is assumed that approximately 12 wells would be required and that the extraction rates range from 1 to 5 gpm per well. Recirculation wells can achieve 90 to 95% removal rates. Although particular types of recirculation wells are considered an innovative technology, extraction and reinjection have been practiced for several decades and are well established.

Groundwater modeling (WSRC 2003c) for this alternative indicates that recirculation wells would achieve MCLs at Pen Branch within two years of implementation. Therefore, an active operation period of two years is assumed. MNA is implemented for 18 years to achieve the groundwater RAOs.

Institutional controls are established to prohibit future, residential land usage and restrict access to prevent unacceptable human exposures to contaminated groundwater during implementation of this alternative.

GW-3d Zero-Valent Iron Injection in the Source Area with MNA

This alternative consists of injecting ZVI into the groundwater-source area to promote abiotic-reductive dechlorination of CVOCs, implementing MNA and institutional controls until RAOs are achieved.

Estimated Present Worth Cost: $5,987,000

Construction Time to Complete: 12 to 18 months

The estimated present worth cost is based on injecting ZVI, 3 years of operations and maintenance (O&M) at 2.1% for the ZVI system and 40 years of groundwater monitoring at a 3.9% discount rate.

ZVI is injected into the saturated zone using soil fracturing techniques at 135 points. Approximately 6 tons (12,000 pounds) of ZVI would be required per point. Based on case studies and data available in literature, it is expected that 90 to 99% of the source-area mass would be destroyed in two to three months.

Groundwater modeling was not used for this alternative. However, based on the results of other alternatives, it is assumed that the MCLs at Pen Branch would be achieved within 39 years of implementation. MNA is implemented for 40 years to achieve RAOs.

Institutional controls are established to prohibit future, residential land usage and restrict access to prevent unacceptable human exposures to contaminated groundwater during implementation of this alternative.

GW-3f Chemical Oxidation in the Source Area, MNA, and Institutional Controls

This alternative consists of chemically oxidizing the CVOCs in the groundwater-source area, implementing MNA, and institutional controls until RAOs are achieved.

Estimated Present Worth Cost: $3,936,000

Construction Time to Complete: 12 to 18 months

The estimated present worth cost is based on injecting chemicals and 40 years of groundwater monitoring at a 3.9% discount rate.

Permanganate solution is applied to groundwater through direct injection or through groundwater recirculation. Permanganate emplacement is combined with soil fracturing to address the low-permeability portions. It is assumed that 135 wells are required to cover an area of 22,300 m^2 (240,000 ft^2) within the 1,000 ppb dissolved PCE contour. Permanganate is injected into the saturated zone using soil fracturing techniques. Approximately 45.4 kg (100 pounds) of permanganate per point is assumed. Based on case studies and data literature, it is expected that 90 to 95% of the mass in the source area would be destroyed in three to six months.

The groundwater remediation alternatives modeling did not model this alternative. However, based on the results of other alternatives, it is assumed that the MCLs at Pen Branch would be achieved within 39 years of implementation. MNA is implemented for 40 years until groundwater RAOs are achieved.

Institutional controls are established to prohibit future, residential land usage and restrict access to prevent unacceptable human exposures to contaminated groundwater during implementation of this alternative.

GW-3h Bioremediation using Anaerobic Reductive Dechlorination with MNA

This alternative consists of supplying an easily degradable carbon source, nutrients, and microorganisms to the saturated zone, as required, to dechlorinate the CVOCs in the source area, implementing MNA, and institutional controls until RAOs are achieved.

Estimated Present Worth Cost: $4,789,000

Construction Time to Complete: 24 to 36 months

The estimated present worth cost is based on injection chemicals and 40 years of groundwater monitoring at a 3.9% discount rate.

In anaerobic degradation, microorganisms use CVOCs as electron acceptors and during that process sequentially dechlorinate the CVOCs under reducing conditions. If favorable environmental conditions are provided, PCE and TCE would be sequentially dechlorinated all the way to ethene. This process can be viewed as enhanced natural attenuation via supplying organic carbon to the carbon-limited natural system. Bioaugmentation would be used if indigenous organisms are not present in sufficient numbers.

Anaerobic biodegradation can be enhanced using Hydrogen Release Compound ™ (HRC), which is a low-cost, time-release method of providing electron donors to the surficial aquifer. HRC is a polylactate ester that releases lactic acid. HRC, along with its metabolites, ferments over time, causing the release of hydrogen. The released hydrogen enhances reductive dechlorination of parent and daughter CVOCs by microorganisms. It is assumed that 135 wells are required to cover an area of 22,300 m^2 (240,000 ft^2) within the 1,000 ppb dissolved PCE contour. HRC is injected into the saturated zone using soil fracturing techniques. It is assumed that each injection point would require approximately 113.4 kg (250 pounds) of HRC. Based on case studies and data available in literature, it is expected that 75 to 90% of the mass in the source area would be destroyed in two to three years.

The bioremediation alternative modeled by the groundwater remediation alternatives modeling appears as a bioremediation trench downgradient of the source area. Direct HRC injection into the source area is much more aggressive. Therefore, it is assumed that MCLs at Pen Branch would be achieved in 39 years of implementation. MNA is implemented for 40 years until groundwater RAOs are achieved.

Institutional controls are established to prohibit future, residential land usage and restrict access to prevent unacceptable human exposures to contaminated groundwater during implementation of this alternative.

GW-3i Monitored Natural Attenuation and Institutional Controls

This alternative consists of implementing MNA and institutional controls until RAOs are achieved. MNA will be effective in achieving RAOs when implemented in conjunction with other alternatives that provide source control in the vadose zone. Reporting would be consistent with SC R.61-68.

Estimated Present Worth Cost: $1,289,000

Construction Time to Complete: 3 to 6 months

The estimated present worth cost is based on 40 years of groundwater monitoring at a 3.9% discount rate.

MNA relies on natural, intrinsic processes (e.g., adsorption and dilution) to reduce groundwater CVOC concentrations. Passive-aquifer restoration is provided via abiotic processes such as advection, dispersion, and adsorption and natural biotic processes (i.e., biodegradation). Groundwater modeling for MNA (e.g., removal of the source term, no action on the residual plume, and monitoring) (WSRC 2003c) confirms that non-biological natural attenuation processes will be effective in meeting MCL concentrations following source removal.

This alternative is easily implemented and overall capital costs are relatively low. For estimating cost, twelve monitoring wells are proposed; eight plume wells will reside in the plume between the CMP Pits and Pen Branch while four additional wells will be located on the plume boundaries. The proposed wells would be sampled semiannually for the RCOCs to be remediated. If necessary, the frequency of groundwater monitoring will be changed with the concurrence of EPA and DHEC, based on monitoring results.

The monitoring data would be reported annually with the Effectiveness Monitoring Report and evaluated five years after completion of the ERH remedial action. The delayed evaluation would allow for the effects of the vadose zone remedial action to be seen in the groundwater. The data will be evaluated against the groundwater RGs in Table 17. If the data do not agree with predicted results, a groundwater contingency action would be evaluated and implemented subject to SCDHEC and the USEPA approval. Figure 11 illustrates the predicted decrease in TCE mass in the aquifer based on the Groundwater Remediation Alternative Modeling Report (WSRC 2003c). The contingency action may be an alternative that was evaluated in the CMS/FS or may be different based on new technologies.

The time to achieve MCLs at Pen Branch is dependent on the source remedy. Based on the No Action scenario for groundwater, the time to achieve RAOs is 40 years. Therefore, 40 years of O&M is conservatively assumed.

MNA will be implemented until groundwater RAOs are achieved.

Institutional controls are established to prohibit future, residential land usage and restrict access to prevent unacceptable human exposures to contaminated groundwater during implementation of this alternative.

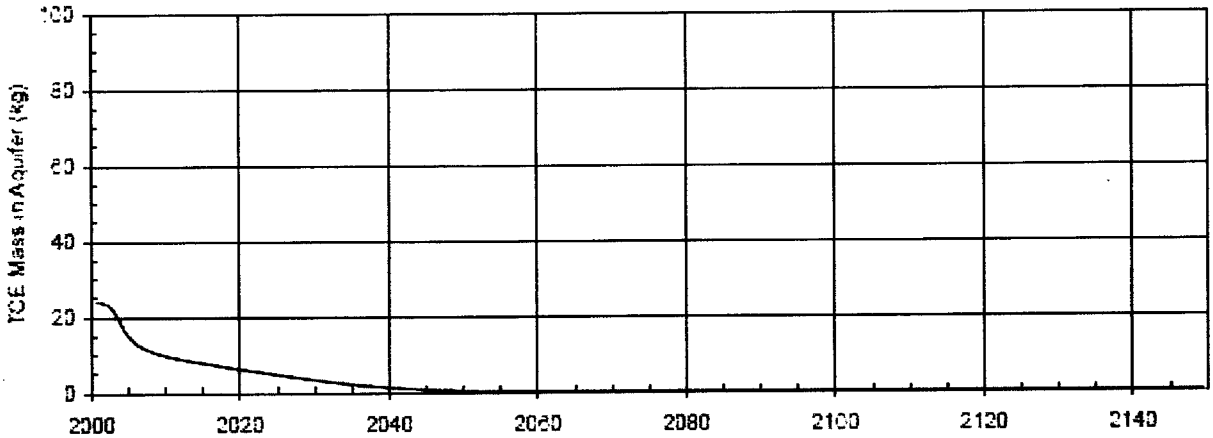


Figure 11. TCE Mass in the Aquifer

GW-4b Source-Area Extraction, Ex Situ Treatment, MNA, and Institutional Controls

This alternative consists of extracting groundwater from a set of vertical extraction wells located in the groundwater-source area, treating the extracted water above ground using ZVI, implementing MNA, and institutional controls until RAOs are achieved.

Estimated Present Worth Cost: $5,836,000

Construction Time to Complete: 3 to 6 months

The estimated present worth cost is based on 11 years of extraction well operation at a 3.1% discount rate and 40 years of groundwater monitoring at 3.9% discount rate.

ZVI offers a simple and efficient process for destroying the CVOCs in extracted groundwater. While the cost of ZVI is subject to change due to market conditions, ZVI is considered a cost-effective method for reductive dechlorination and, therefore, is considered for use with this alternative. The groundwater extraction system would consist of vertical extraction wells, submersible pumps, and a manifold system to collect the extracted water. The extracted water is passed through a series of vessels that contain ZVI filings. CVOCs and other chlorinated compounds (e.g., lindane and benzene hexachloride) are dechlorinated by ZVI abiotically. Reduction efficiencies of 90 to 95% in CVOC concentrations via abiotic dechlorination are possible if sufficient retention time is provided. Treated water is discharged to Pen Branch under an NPDES permit.

The Groundwater Remediation Alternatives Modeling report modeled a source-area extraction alternative and indicates that it achieves MCLs at Pen Branch in 11 years of implementation. A 39-year operation period to achieve groundwater RAOs is assumed, based on the modeling results, with an 11-year active operation of the extraction system. MNA is implemented for 40 years to achieve the groundwater RAOs.

Institutional controls are established to prohibit future, residential land usage and restrict access to prevent unacceptable human exposures to contaminated groundwater during implementation of this alternative.

X. COMPARATIVE ANALYSIS OF ALTERNATIVES

The Vadose Zone (Field A) and Groundwater remedial alternatives were evaluated against the nine criteria established by the NCP 40 CFR 300. The Ballast Area and the Field B remedial alternatives were evaluated during implementation of the interim action (WSRC 1999b and WSRC 2003a) and are included to document the final decision. The criteria are derived from the statutory requirements of CERCLA Section 121. The criteria provide the basis for evaluating the alternatives and selection of a remedy.

The nine criteria are categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The threshold criteria must be satisfied in order for an alternative to be eligible for selection. The primary balancing criteria are used to weigh major tradeoffs among the alternatives. Generally, the modifying criteria are taken into account after public comment is received on the SB/PP. The nine criteria are listed below:

Threshold Criteria

1. Overall protection of human health and the environment

2. Compliance with ARARs (or justify a waiver)

Primary Balancing Criteria

3. Long-term effectiveness and permanence

4. Reduction of toxicity, mobility, or volume through treatment

5. Short-term effectiveness

6. Implementability

7. Cost

Modifying Criteria

8. State acceptance/approval of the ROD will constitute approval of the preferred alternative by the regulatory agencies)

9. Community acceptance will be assessed after close of the public comment period

Tables 19 and 20 summarize the nine CERCLA criteria evaluation for the CMP Pits and Field A Vadose Zone and Groundwater remedial alternatives.

Comparative Analysis of Alternatives for the CMP Pits and Associated Field A Vadose Zone

The following sections present a comparative analysis of the five corrective measure/remedial action alternatives considered for the CMP Pits and Field A Vadose Zone. The alternatives are compared based on their relative achievement of NCP-threshold and primary-balancing criteria. This analysis identifies the trade-offs between alternatives. The comparative analysis of vadose zone alternatives is summarized in Table 19.

Table 19. Comparison of Vadose Zone Alternatives against the Nine Criteria

Criterion	Alternative VZA-1 No Action	Alternative VZA-3b Soil Fracturing, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3d Soil Heating, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3g Chemical Oxidation using Permanganate, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3h Zero-Valent Iron Injection, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls
Overall Protectiveness					
Human Health	Not protective	Accelerates achievement of groundwater RAOs to protect human health	Accelerates achievement of groundwater RAOs to protect human health	Accelerates achievement of groundwater RAOs to protect human health	Accelerates achievement of groundwater RAOs to protect human health
Environment	Not protective	Protects groundwater by depleting contaminant source	Protects groundwater by depleting contaminant source	Protects groundwater by depleting contaminant source	Protects groundwater by depleting contaminant source
Effectiveness in Meeting Remediation Goals	Not effective	Source treatment reduces time required to achieve groundwater RAOs	Source treatment reduces time required to achieve groundwater RAOs	Source treatment reduces time required to achieve groundwater RAOs	Source treatment reduces time required to achieve groundwater RAOs.
Compliance with ARARs					
Chemical-Specific	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Location-Specific	Not applicable	Complies with erosion and runoff control requirements to protect wetlands and surface water	Complies with erosion and runoff control requirements to protect wetlands and surface water	Complies with erosion and runoff control requirements to protect wetlands and surface water	Complies with erosion and runoff control requirements to protect wetlands and surface water
Action-Specific	Not applicable	Sampling performed to ensure compliance with air emissions requirements; complies with hazardous waste management requirements	Sampling performed to ensure compliance with air emissions requirements; complies with hazardous waste management requirements	Sampling performed to ensure compliance with air emissions requirements; complies with hazardous waste management requirements	Sampling performed to ensure compliance with air emissions requirements; complies with hazardous waste management requirements
Long-Term Effectiveness and Permanence					
Magnitude of Residual Risks	Vadose zone CVOCs pose continued risk to groundwater quality	No residual risk	No residual risk	No residual risk	No residual risk
Adequacy of Controls	Not Adequate	Adequate	No controls required	Adequate	Adequate
Permanence	Not permanent	Permanent	Permanent	Permanent	Permanent

Table 19. Comparison of Vadose Zone Alternatives against the Nine Criteria (Continued)

Criterion	Alternative VZA-1 No Action	Alternative VZA-3b Soil Fracturing, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3d Soil Heating, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3g Chemical Oxidation using Permanganate, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3h Zero-Valent Iron Injection, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Covers
Reduction of Toxicity, Mobility, or Volume					
Treatment Process Used and Materials Treated	None	Extracted vapor treated using granular activated carbon, if necessary	Extracted vapor treated using granular activated carbon, if necessary	Chemical oxidation to destroy CVOCs in low permeability portions; extracted vapor treated using granular activated carbon, if necessary	Abiotic reductive dehalogenation to destroy CVOCs in low permeability portions; Extracted vapor treated using granular activated carbon, if necessary
Degree of Expected Reduction in Toxicity, Mobility, or Volume	None	Medium to High Contaminant mobility is reduced by removing CVOCs from subsurface; toxicity and volume not reduced; CVOCs destroyed when carbon is regenerated, if off-gas treatment is necessary	High Contaminant mobility is reduced by removing CVOCs from subsurface; toxicity and volume not reduced; CVOCs destroyed when carbon is regenerated, if off-gas treatment is necessary	Medium to High Contaminant mobility, toxicity, and volume is reduced as permanganate oxidizes CVOCs, destroyed when carbon is regenerated, if off-gas treatment is necessary	Medium to High Contaminant mobility, toxicity, and volume is reduced as CVOCs are degraded when contacted by ZVI, CVOCs when carbon is regenerated, if off-gas treatment is necessary
Amount of Hazardous Materials Destroyed or Treated	None	Would reduce substantially the amount of CVOCs in vadose zone	Would reduce substantially the amount of CVOCs in vadose zone	Would reduce substantially the amount of CVOCs in vadose zone	Would reduce substantially the amount of CVOCs in vadose zone
Degree to Which Treatment is Irreversible	No treatment	Irreversible	Irreversible	Irreversible	Irreversible
Types and Quantities of Residuals Remaining after Treatment	None	Spent carbon, if off-gas treatment is necessary	Spent carbon, if off-gas treatment is necessary	Spent carbon, if off-gas treatment is necessary	Spent carbon, if off-gas treatment is necessary
Short-Term Effectiveness					
Risks to Remedial Workers	None	Minor risk from airborne particulates and contact with contaminated soil during construction	Minor risk of from airborne particulates and contact with contaminated soil during construction; potential safety risks from use of high voltage electricity during remediation	Minor risk from airborne particulates and contact with contaminated soil during construction; potential safety risks from use of hazardous chemicals during remediation	Minor risk from airborne particulates and contact with contaminated soil during construction
Risks to Community	None	Negligible	Negligible	Negligible	Negligible
Risks to Environment	None	Negligible	Negligible	Negligible	Negligible

Table 19. Comparison of Vadose Zone Alternatives against the Nine Criteria (Continued)

Criterion	Alternative VZA-1 No Action	Alternative VZA-3b Soil Fracturing, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3d Soil Heating, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3g Chemical Oxidation using Permanganate, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3h Zero-Valent Iron Injection, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Covers
Short-Term Effectiveness					
Time to Achieve Remedial Action Objectives	140 years	4-7 years	3-6 years	3-6 years	3-6 years
Implementability					
Availability of Materials, Equipment, Skilled Labor	Not applicable	Available from specialty vendors/subcontractors	Available from specialty vendors/subcontractors	Available from specialty vendors/subcontractors	Available from specialty vendors/subcontractors
Ability to Construct and Operate the Technology	Not applicable	Easily implemented	Easily implemented	Easily implemented	Easily implemented
Ability to Obtain Permits/Approvals from Other Agencies	Readily implemented – five-year remedy review	Routine permits - easily obtained	Routine permits - easily obtained	Special underground injection permit may be required	Routine permits - easily obtained
Ability to Monitor Effectiveness of Remedy	Not applicable	Easily monitored through vacuum and flow measurements and sampling	Easily monitored through vacuum, flow and temperature measurements and sampling	Easily monitored through vacuum and flow measurements and sampling	Easily monitored through vacuum and flow measurements and sampling
Ease of Undertaking Additional Actions (if necessary)	Not incompatible	Not incompatible	Not incompatible	Not incompatible	Not incompatible
Time to Implement	Minimal	18-24 weeks after approval of post-ROD documentation	18-24 weeks after approval of post-ROD documentation	18-24 weeks after approval of post-ROD documentation	18-24 weeks after approval of post-ROD documentation
Cost					
Present Worth Capital Cost	$0	$183,000	$1,441,000	$947,000	$1,766,000
Present Worth O&M Cost	$0	$1,282,000	$996,000	$781,000	$997,000
Total Present Worth Cost	$0	$1,465,000	$2,437,000	$1,728,000	$2,764,000

Table 19. Comparison of Vadose Zone Alternatives against the Nine Criteria (Continued)

Criterion	Alternative VZA-1 No Action	Alternative VZA-3b Soil Fracturing, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3d Soil Heating, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3g Chemical Oxidation using Permanganate, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls	Alternative VZA-3h Zero-Valent Iron Injection, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Covers
State Acceptance					
	Not acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Community Acceptace					
	Not acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Table 20. Comparison of Groundwater Alternatives against the Nine Criteria

Criterion	Alternative GW-1 No Action	Alternative GW-3b Groundwater Recirculation Wells, MNA, and Institutional Controls	Alternative GW-3d Zero-Valent Iron Injection in the Source Area, MNA, and Institutional Controls	Alternative GW-3f Chemical Oxidation in the Source Area, MNA, and Institutional Controls	Alternative GW-3h Bioremediation using Anaerobic Reductive Dechlorination MNA, and Institutional Controls	Alternative GW-3i Monitored Natural Attenuation and Institutional Controls	Alternative GW-4b Source-Area Extraction, Ex Situ Treatment, MNA, and Institutional Controls
Overall Protection of Human Health and the Environment							
Human Health	Not protective	Protective for all possible uses of groundwater	Protective for all possible future uses of groundwater	Protective for all possible future uses of groundwater	Protective for all possible uses of groundwater	Protective for all possible uses of groundwater	Protective for all possible future uses of groundwater
Environment	Not protective	Protective	Protective	Protective	Protective	Protective	Protective
Prevent Exposure of Human and Ecological Receptors to Contaminated Groundwater	Not effective	Effective	Effective	Effective	Effective	Effective	Effective
Effectiveness in Meeting Remediation Goal Options	Not met	Goals met for both future industrial and hypothetical future residential land usage for COCs	Goals met for both future industrial and hypothetical future residential land usage for COCs	Goals met for both future industrial and hypothetical future residential land usage for COCs	Goals met for both future industrial and hypothetical future residential land usage for COCs	Goals met for both future industrial and hypothetical future residential land usage for COCs	Goals met for both future industrial and hypothetical future residential land usage for COCs
Compliance with ARARs							
Chemical-Specific	Does not meet MCLs	Meets MCLs for COCs sitewide	Meets MCLs for COCs sitewide	Meets MCLs for COCs sitewide	Meets MCLs for COCs sitewide	Meets MCLs for COCs sitewide	Meets MCLs for COCs sitewide
Location-Specific	Not applicable	Alternative must be implemented in a manner that is protective of nearby wetlands (SC Water Classification Standards SC 61-68)	Alternative must be implemented in a manner that is protective of nearby wetlands. SC Water Classification Standards (SC 61-68)	Alternative must be implemented in a manner that is protective of nearby wetlands (SC Water Classification Standards SC 61-68)	Alternative must be implemented in a manner that is protective of nearby wetlands (SC Water Classification Standards SC 61-68)	Alternative must be implemented in a manner that is protective of nearby wetlands (SC Water Classification Standards SC 61-68)	Alternative must be implemented in a manner that is protective of nearby wetlands (SC Water Classification Standards SC 61-68)

Table 20. Comparison of Groundwater Alternatives against the Nine Criteria (Continued)

Criterion	Alternative GW-1 No Action	Alternative GW-3b Groundwater Recirculation Wells, MNA, and Institutional Controls	Alternative GW-3d Zero-Valent Iron Injection in the Source Area, MNA, and Institutional Controls	Alternative GW-3f Chemical Oxidation in the Source Area, MNA, and Institutional Controls	Alternative GW-3h Bioremediation using Anaerobic Reductive Dechlorination MNA, and Institutional Controls	Alternative GW-3i Monitored Natural Attenuation and Institutional Controls	Alternative GW-4b Source-Area Extraction, Ex Situ Treatment, MNA, and Institutional Controls
Compliance with ARARs							
Action-Specific	Not applicable	System construction must comply with fugitive dust, NESHAPs, and hazardous waste management requirements (RCRA Hazardous Waste); system operation must comply with effluent discharge requirements	System construction must comply with fugitive dust, NESHAPs, and hazardous waste management requirements (RCRA Hazardous Waste)	System construction must comply with fugitive dust, NESHAPs, and hazardous waste management requirements (RCRA Hazardous Waste)	System construction must comply with fugitive dust, NESHAPs, and hazardous waste management requirements (RCRA Hazardous Waste); operation must comply with SCDHEC MNA criteria	Well installation comply with SCDHEC requirements (RCRA Hazardous Waste)	System construction must comply with fugitive dust, NESHAPs, and hazardous waste management requirements (RCRA Hazardous Waste); system operation must comply with effluent discharge requirements; SCDHEC MNA criteria,
Long-Term Effectiveness and Permanence							
Magnitude of Residual Risks	Risk not reduced	Risk reduced, eventually to levels allowing unrestricted usage	Risk reduced, eventually to levels allowing unrestricted usage	Risk reduced, eventually to levels allowing unrestricted usage	Risk reduced, eventually to levels allowing unrestricted usage	Risk reduced, eventually to levels allowing unrestricted usage.	Risk reduced, eventually to levels allowing unrestricted usage
Adequacy of Controls	Not adequate	Adequate, but requires long-term institutional controls to protect from COCs	Adequate, but requires long-term institutional controls to protect from COCs	Adequate, but requires long-term institutional controls to protect from COCs	Adequate, but requires long-term institutional controls to protect from COCs	Adequate, but requires long-term institutional controls to protect from COCs	Adequate, but requires long-term institutional controls to protect from COCs
Permanence	Not applicable	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent
Reduction of Toxicity, Mobility, or Volume							
Treatment Process Used and Materials Treated	None	In situ treatment of dissolved organics in the source area using recirculation wells/air stripping; MNA of residual COCs	In situ treatment of organics in groundwater using zero-valent iron; MNA of residual COCs	In situ treatment of organics in groundwater using permanganate oxidation and MNA of residual COCs	In situ treatment of organics in groundwater using bioremediation and MNA of residual COCs	No treatment process used, MNA plume	Ex situ treatment of dissolved organics using dehalogenation with ZVI; MNA of residual COCs

Table 20. Comparison of Groundwater Alternatives against the Nine Criteria (Continued)

Criterion	Alternative GW-1 No Action	Alternative GW-3b Groundwater Recirculation Wells, MNA, and Institutional Controls	Alternative GW-3d Zero-Valent Iron Injection in the Source Area, MNA, and Institutional Controls	Alternative GW-3f Chemical Oxidation in the Source Area, MNA, and Institutional Controls	Alternative GW-3h Bioremediation using Anaerobic Reductive Dechlorination MNA, and Institutional Controls	Alternative GW-3i Monitored Natural Attenuation and Institutional Controls	Alternative GW-4b Source-Area Extraction, Ex Situ Treatment, MNA, and Institutional Controls
Reduction of Toxicity, Mobility, or Volume through Treatment							
Degree of Expected Reduction in Toxicity, Mobility, or Volume through Treatment	None	Medium In situ stripping of organics reduces CVOC volume	Medium to High In situ destruction of CVOCs reduces volume	Medium to High In situ destruction of CVOCs reduces volume	Medium to High In situ destruction of CVOCs reduces volume	Low MNA reduces toxicity of CVOCs due to attenuation	Medium Extraction and ex situ treatment of organics reduces CVOC volume and toxicity
Amount of Hazardous Materials Destroyed or Treated	Protective for all possible future uses of groundwater	Significant mass reduction achieved in the source area	Significant mass reduction (up to 90-99%) achieved in the source area	Significant mass reduction (up to 90-95%) achieved in the source area	Significant mass reduction (up to 75 - 90%) achieved in the source area	Low mass reduction in the groundwater prior to discharge to Pen Branch from MNA.	Significant mass reduction achieved in the source area
Types and Quantities of Residuals Remaining after Treatment	Effective	Activated carbon, if off-gas treatment is necessary	No residuals	No residuals	No residuals	No residuals	Spent iron from ex situ ZVI treatment
Short-Term Effectiveness							
Risks to Remedial Workers	None	Minor potential risk from airborne particulates and contact with contaminated soil during construction	Minor potential risk from airborne particulates and contact with contaminated soil during construction	Minor potential risk from airborne particulates and contact with contaminated soil during construction; potential risks from exposure to hazardous chemicals	Minor potential risk from airborne particulates and contact with contaminated soil during construction	Low potential risk to remedial worker from groundwater monitoring.	Minor potential risk from airborne particulates and contact with contaminated soil during construction
Risks to Community	None	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Risks to Environment	None	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Time to Achieve Remedial Action Objectives	Not achieved	18 years (2 years of active operation)	40 years (Mass reduction in 2-3 months)	40 years (Mass reduction in 3-6 months)	40 years (Mass reduction in 2-3 years)	40 years	40 years (11 years of active operations)

Table 20. Comparison of Groundwater Alternatives against the Nine Criteria (Continued)

Criterion	Alternative GW-1 No Action	Alternative GW-3b Groundwater Recirculation Wells, MNA, and Institutional Controls	Alternative GW-3d Zero-Valent Iron Injection in the Source Area, MNA, and Institutional Controls	Alternative GW-3f Chemical Oxidation in the Source Area, MNA, and Institutional Controlsg	Alternative GW-3h Bioremediation using Anaerobic Reductive Dechlorination MNA, and Institutional Controls	Alternative GW-3i Monitored Natural Attenuation and Institutional Controls	Alternative GW-4b Source-Area Extraction, Ex Situ Treatment, MNA, and Institutional Controls
Implementability							
Availability of Materials, Equipment, Skilled Labor	Not applicable	Readily available	Available from specialty vendors	Available from specialty vendors	Available from specialty vendors	Readily available	Readily available
Ability to Construct and Operate the Technology	Not applicable	Straightforward	Straightforward	Straightforward	Straightforward	Straightforward	Straightforward
Ability to Obtain Permits/Approvals from Other Agencies	Not applicable	Readily implemented; five-year remedy reviews required until MCLs achieved	Readily implemented; five-year remedy reviews required until MCLs achieved	Readily implemented; five-year remedy reviews required until MCLs achieved; special underground injection permit may be required	Readily implemented; five-year remedy reviews required until MCLs achieved	Readily implemented; five-year remedy reviews required until MCLs achieved	Readily implemented; five-year remedy reviews required until MCLs achieved
Ability to Monitor Effectiveness of Remedy	Not applicable	Groundwater and air monitoring readily accomplished	Groundwater monitoring readily accomplished	Groundwater monitoring readily accomplished	Groundwater monitoring readily accomplished	Groundwater monitoring readily accomplished	Groundwater monitoring readily accomplished
Ease of Undertaking Additional Actions (if necessary)	Not incompatible	Not incompatible	Not incompatible	Not incompatible	Not incompatible	Not incompatible	Not incompatible
Time to Implement	Minimal	6-12 months	12-18 months	12-18 months	24 – 36 months	3 – 6 months	3-6 months
Cost							
Present Worth Capital Cost	$0	$3,022,000	$4,080,000	$1,491,000	$1,894,000	$182,000	$1,205,000
Present Worth O&M Cost	$0	$2,019,000	$2,221,000	$2,445,000	$2,895,000	$1,107,000	$4,631,000
Total Present Worth Cost	$0	$5,041,000	$6,301,000	$3,936,000	$4,789,000	$1,289,000	$5,836,000

Table 20. Comparison of Groundwater Alternatives against the Nine Criteria (Continued)

Criterion	Alternative GW-1 No Action	Alternative GW-3b Groundwater Recirculation Wells, MNA, and Institutional Controls	Alternative GW-3d Zero-Valent Iron Injection in the Source Area, MNA, and Institutional Controls	Alternative GW-3f Chemical Oxidation in the Source Area, MNA, and Institutional Controlsg	Alternative GW-3h Bioremediation using Anaerobic Reductive Dechlorination MNA, and Institutional Controls	Alternative GW-3i Monitored Natural Attenuation and Institutional Controls	Alternative GW-4b Source-Area Extraction, Ex Situ Treatment, MNA, and Institutional Controls
State Acceptance							
	Not acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Community Acceptance							
	Not acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Overall Protection of Human Health and the Environment

The No Action alternative (VZA-1) does not reduce the time necessary to remediate groundwater. All other action alternatives help protect human health by reducing the time necessary to achieve groundwater RAOs.

Compliance with ARARs

Chemical-Specific ARARs: There are no chemical-specific ARARs for CVOCs in the CMP Pits Vadose Zone.

Location-Specific ARARs: There are no location-specific ARARs for the No Action alternative. Since construction activities for the action alternatives are limited to borehole installation and small-system setup, there is very limited potential for erosion and runoff problems.

Action-Specific ARARs: There are no action-specific ARARs for the No Action alternative. Fugitive dust generation is controlled during construction activities for Alternatives VZA-3b, VZA-3d, VZA-3g and VZA-3h to meet South Carolina regulations (SC R61-62.6), Control of Fugitive Particulate Matter. The very limited scale of construction activities also limits potential problems with particulate emissions.

Substantive requirements of South Carolina Air Pollution Control Standards apply to emissions of CVOCs (SC R61-62.5). Therefore, under the action alternatives, offgas emissions from the SVE system are treated as necessary to meet discharge limits specified by South Carolina Regulations.

Long-Term Effectiveness and Permanence

The No Action alternative provides no long-term protection of the environment. All the other alternatives permanently remove contaminants from the vadose zone and are long-term in nature. Soil heating under VZA-3d does not have delivery and contaminant access limitations, unlike other alternatives, and is expected to be more efficient. VZA-3d does not require controls following remediation because ERH is accomplished via conduction and is more effective in removing contaminants from the low permeability soils at the Source Area (Field A). VZA-3b, VZA-3g and VZA-3h will require adequate controls following remediation because injection/extraction near the Source Area (Field A) will be difficult to implement due to the low permeability soils and will not be as effective.

Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action alternative does not reduce the toxicity, mobility, or volume of CVOCs. Alternatives VZA-3b and 3d and SVE component in VZA-3g and 3h reduce volume by removing CVOCs from the vadose zone and fixing them to granular-activated carbon, if needed. Chemical oxidation in VZA-3g and ZVI injection in VZA-3h reduce toxicity, mobility, and volume of contaminant through treatment. All action alternatives satisfy the preference for treatment, while the No Action alternative does not.

Short-Term Effectiveness

Remedial actions under the No Action alternative pose no short-term risks to the community, remedial workers, or the environment. All action alternatives require handling relatively small volumes of contaminated soil. Engineering controls and health/safety procedures are implemented to protect remedial workers, on-unit workers, the community, and the environment.

High voltage electricity application in Alternative VZA-3d and hazardous chemical handling in Alternative VZA-3g require implementation of additional health and safety measures.

The No Action alternative does not achieve RAOs, while all the other action alternatives achieve substantial source removal in three to seven years.

Implementability

The No Action alternative requires no effort to implement. The IRA SVE system currently exists and requires no construction. The design and/or installation of a more innovative, ERH system and soil fracturing could require a specialty vendor. However, components of all action alternatives are easily installed using conventional drilling and construction techniques. Chemicals and materials are readily available. Subsurface chemical injection in Alternative VZA-3g could require special permits. All action alternatives involve the installation of injection points through the existing cover. For Alternatives VZA-3b, 3g and 3h, due to the high pressures involved, soil fracturing operation could disturb the existing cover soil, although the liner is expected to withstand ground movement. Soil heating operation of VZA-3d is not expected to impact the existing cover. Cover maintenance and repair is included in the scope of Alternatives VZA-3b, VZA-3g, and VZA-3h. Due to the installation of electrical probes to support soil heating operation of VZA-3d, the integrity of the existing cover may be compromised. In order to rectify this, the existing cover system will be repaired or replaced as necessary.

Cost

The total, present worth costs of the alternatives addressing the CMP Pits and Associated Field A Vadose Zone are as follows:

VZA-1: No Action $0

VZA-3b: Soil Fracturing, Operation of the IRA SVE. Maintaining the Existing Cover, and Institutional Controls $1,486,000

VZA-3d: Soil Heating, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls $2,450,000

VZA-3g: Chemical Oxidation using Permanganate, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls $1,737,000

VZA-3h: Zero-Valent Iron Injection, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls $2,771,000

State Acceptance

Approval of the ROD by SCDHEC and USEPA constitutes acceptance.

Community Acceptance

The PP provided for community involvement through a document review process and a public comment period. Public input is documented in the Responsiveness Summary.

Comparative Analysis of Groundwater Alternatives

A comparative analysis of the seven corrective measure/remedial action alternatives considered for remediating contaminated groundwater are discussed in the following sections. The alternatives are evaluated against the NCP-threshold and primary-balancing criteria, similar to the individual analysis of each alternative. This analysis identifies the trade-offs between alternatives. The comparative analysis of groundwater alternatives is summarized in Table 20.

Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway area eliminated, reduced or controlled, through treatment, engineering controls, and/or institutional controls.

All of the alternatives, except the No Action (GW-1) alternative are protective of human health and the environment by eliminating, reducing, or controlling risks posed by the

CMP Pits groundwater through treatment of groundwater contaminants, engineering controls, and/or institutional controls. Overall protectiveness achieved by Alternative GW-3i (MNA) is highly dependent upon the ability of the corresponding vadose zone alternative to provide source control. Alternatives GW-3b, GW-3d, GW-3f, GW-3h and GW-4b achieve protectiveness by utilizing active and passive groundwater remedial actions in addition to vadose zone remediation to provide source control.

Compliance with ARARs

Chemical-Specific ARARs: The No Action alternative allows groundwater contaminants to continue to exceed MCLs. Alternative GW-3i utilizes MNA to achieve ARARs. All action alternatives use combinations of removal/treatment and/or MNA of CVOCs to achieve ARARs. MCLs for other RCOCs, dieldrin and alpha-benzene hexachloride, are achieved through implementation of MNA.

Location-Specific ARARs: There are no location-specific ARARs applicable to the No Action alternative (GW-1). The action alternatives are implemented in a manner that is protective of nearby wetlands to comply with ARARs.

Action-Specific ARARs: There are no action-specific ARARs applicable to the No Action alternative. ARARs applicable to other alternatives include South Carolina regulations for well installation and RCRA waste management requirements. Effluent water from the ex situ treatment (Alternative GW-4b) is subject to the substantive requirements of NPDES regulations (SC R61-9.122). An underground injection permit could be required for permanganate injection under Alternative GW-3f.

Long-Term Effectiveness and Permanence

The No Action alternative provides no long-term protection of the environment. MNA (Alternative GW-3i) utilizes passive processes to provide long-term protection of the environment. All action alternatives implemented in the CVOC-source area either remove contaminants from the groundwater or destroy them in situ and, therefore, are long-term, permanent remedies. However, less than nearly 100% source removal could result in, long-term rebound in CVOC concentrations in groundwater. Groundwater remedial alternatives also remove CVOCs from groundwater or destroy them in situ. These remedies require extended treatment periods since they rely on advective contaminant transport; however, significant rebound in dissolved-CVOC concentrations does not occur once treatment is complete. The long-term effectiveness and permanence of all alternatives is dependent on continued O&M and institutional controls until RAOs are achieved.

Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action alternative does not reduce the toxicity, mobility, or volume of contaminants or contaminated media. Recirculation wells (GW-3b), ZVI injection (GW-3d), chemical oxidation (GW-3f), and bioremediation (GW-3h) reduce CVOC toxicity and volume by destroying/degrading contaminants in situ. Groundwater extraction alternative (GW-4b) reduces CVOC mobility and contaminated groundwater volume. MNA, a component of all action alternatives, reduces contaminant mobility through retardation and reduces contaminant toxicity through dispersion and dilution.

Short-Term Effectiveness

Implementation of the No Action alternative presents no short-term risk to the community or the environment. Direct contact with contaminated soil and/or groundwater and fugitive dust inhalation are potential hazards to remedial workers during implementation of all action alternatives. However, remedial worker exposure is minimized and maintained below occupational health criteria through the proper use of engineering controls, procedures, appropriate personal protective equipment (PPE), site monitoring, and adherence to a health and safety plan. Potential contact with chemicals presents an additional hazard during implementation of in situ chemical oxidation (GW-3f); the risk must be mitigated by establishing an exclusion zone around the injection wells and using appropriate PPE for workers who handle the chemicals. Time to alternative implementation and time to achieve significant mass reduction and RAOs for all alternatives, assumed for estimating costs, are summarized in Tables 19 and 20.

Implementability

The No Action alternative requires no effort to implement. Some treatability and pilot testing is required for all action alternatives. Lengthy pilot studies are required for Bioremediation (Alternative GW-3h). System installation for all action alternatives is achieved using conventional construction equipment, materials, and methods that are readily available. Some specialty equipment/vendors are required for ZVI Injection (Alternative GW-3d), Chemical Oxidation (Alternative GW-3f), and Bioremediation (Alternative GW-3h). Complete treatment of low-permeability zones is often difficult for all source-zone alternatives. However, technology effectiveness is optimized using data gathered during pilot testing and well installation. Institutional controls are easily implemented by establishing land-use restrictions, and MNA is accomplished using conventional sampling and analysis methods. Only Chemical Oxidation (Alternative GW-3f) is likely to require special permits associated with underground injection.

Cost

The total present worth costs of alternatives addressing the CMP Pits groundwater are as follows:

GW-1: No Action $0

GW-3b: Groundwater Recirculation Wells, MNA, and Institutional Controls $5,041,000

GW-3d: Zero-Valent Iron Injection in the Source Area, MNA, and Institutional Controls $6,301,000

GW-3f: Chemical Oxidation in the Source Area, MNA, and Institutional Controls $3,936,000

GW-3h: Bioremediation using Anaerobic Reductive Dechlorination MNA, and Institutional Controls $4,789,000

GW-3i: Monitored Natural Attenuation and Institutional Controls $1,289,000

GW-4b: Source-Area Extraction, Ex Situ Treatment, MNA, and Institutional Controls $5,836,000

The total present worth cost is based on a 39-year period at a discount rate ranging from 2.1 to 3.9% for comparison purposes.

State Acceptance

Approval of the ROD by SCDHEC and USEPA constitutes acceptance.

Community Acceptance

The PP provided for community involvement through a document review process and a public comment period. Public input is documented in the Responsiveness Summary.

XI. THE SELECTED REMEDY

Detailed Description of the Selected Remedy

Based on the RAOs and detailed evaluation of alternatives performed in the SB/PP (WSRC 2004a), the selected alternatives for the CMP Pits OU are addressed in the following paragraphs:

Ballast Area

Institutional controls after completion of the enhanced bioremediation interim action for pesticide- and PCB-contaminated surface soils.

Enhanced bioremediation for pesticide and PCB contaminated soil is being performed as part of the interim action in the Ballast Area (WSRC 2003c). Treatability results indicated that enhanced bioremediation would reduce the pesticide and PCB concentrations to below RGs. Since the residual contamination following the interim action will not allow for unrestricted use, institutional controls will be required to prevent unacceptable human exposure to contaminated soil.

Source Area (Field A)

Combination of ERH to remove DNAPL and continued operation of the SVE system.

Electrical resistance heating was identified as the preferred alternative for the Source Area (CMP Pits in Field A) because soil heating (1) effectively mobilizes dense non-aqueous phase liquid (DNAPL) and (2) is compatible with the existing SVE system. ERH in the Source Area (Field A) is more effective than injection/extraction technologies because injection/extraction near the Source Area (Field A) has been difficult to implement due to the low permeability soils while soil heating is accomplished via conduction. Continued operation of the SVE system is included as the preferred alternative to support removal of volatized contaminants and steam generated during ERH operation.

Field B

Passive SVE (Baroballs™)

SVE was selected as the preferred remedial action in Field B as part of the interim action at the CMP Pits OU because it has effectively removed VOC contamination. Following one year of operation, an active SVE system reduced the total VOC soil-gas concentration in the vadose zone to less than 10 ppmv and removed approximately 230 pounds of VOCs. The active SVE system was shutdown due to the low soil-gas concentration and a passive SVE system (Baroballs™) was installed. Passive SVE has maintained the protectiveness achieved by the active SVE system.

Groundwater

MNA and Institutional controls

This alternative has been identified as the preferred alternative because it effectively remediates groundwater contamination that will remain following implementation of a source control remedial action. Since a source control remedial action in the vadose zone is required to achieve CMP Pits Source Area (Field A) RAOs, MNA was selected as the preferred alternative because all other groundwater remedial alternatives (except for the No Action alternative) only provide redundant groundwater protection and do not significantly affect the time to achieve RAOs. Based on the results of the Groundwater Remediation Alternatives Modeling (WSRC 2003), source control in the vadose zone has the greatest impact on groundwater remediation. The report indicated that if No Action were taken in the vadose zone, it would take 150 years to achieve groundwater RAOs as opposed to 40 years with MNA.

Source control is limited to reducing contamination in the vadose zone. The TCCZ and/or TCLC may potentially be a secondary source for groundwater contamination. There is uncertainty associated with the potential for the clay layer beneath the Transmissive Zone to act as a secondary source for the Middle Aquifer Zone. This uncertainty will be managed during the design phase by obtaining additional samples in the clay layers beneath the CMP Pits to determine if the Tan Clay Confining Zone is a secondary source. Cleanup levels for groundwater RCOCs are listed in Table 17.

The 2002 modeling results will be updated by modeling the Tan Clay Confining Zone as a potential secondary source to generate time-trend plots for groundwater contamination. Upon implementation of this remedy, there will be known and projected points where contaminated groundwater may discharge to surface water at Pen Branch. However, groundwater and surface water compliance monitoring and computer modeling will ensure that the groundwater discharge does not result in any statistically significant increase of constituents from the groundwater in the surface water at the point of entry or at any point where there is reason to believe accumulation of constituents might occur downstream. Groundwater monitoring will be performed semi-annually. The frequency of groundwater monitoring will be changed with the concurrence of EPA and DHEC, based on monitoring results. In the event that the plume behavior in any aquifer zone departs significantly from the behavior projected in the model, additional evaluation and possibly more active measures will be invoked. Additionally, the remedial action includes enforceable land use controls to preclude human exposure to contaminated groundwater at any point between the facility boundary and all known and projected points of entry of the groundwater into the surface water.

Institutional Controls

Figure 12 illustrates the anticipated area subject to LUCs. The area subject to land use controls will be included in the Land Use Control Implementation Plan (LUCIP) which will be submitted with the RAIP.

The following LUC objectives necessary to ensure the protectiveness of the selected remedy have been selected:

- Prevent contact, removal, or excavation of Ballast Area and Vadose Zone contaminated soil.

- Maintain the integrity of the existing cover.

- Prohibit use of the area for residential development, elementary and secondary schools, child care, and playgrounds

- Prevent unauthorized access to contaminated groundwater in the area.

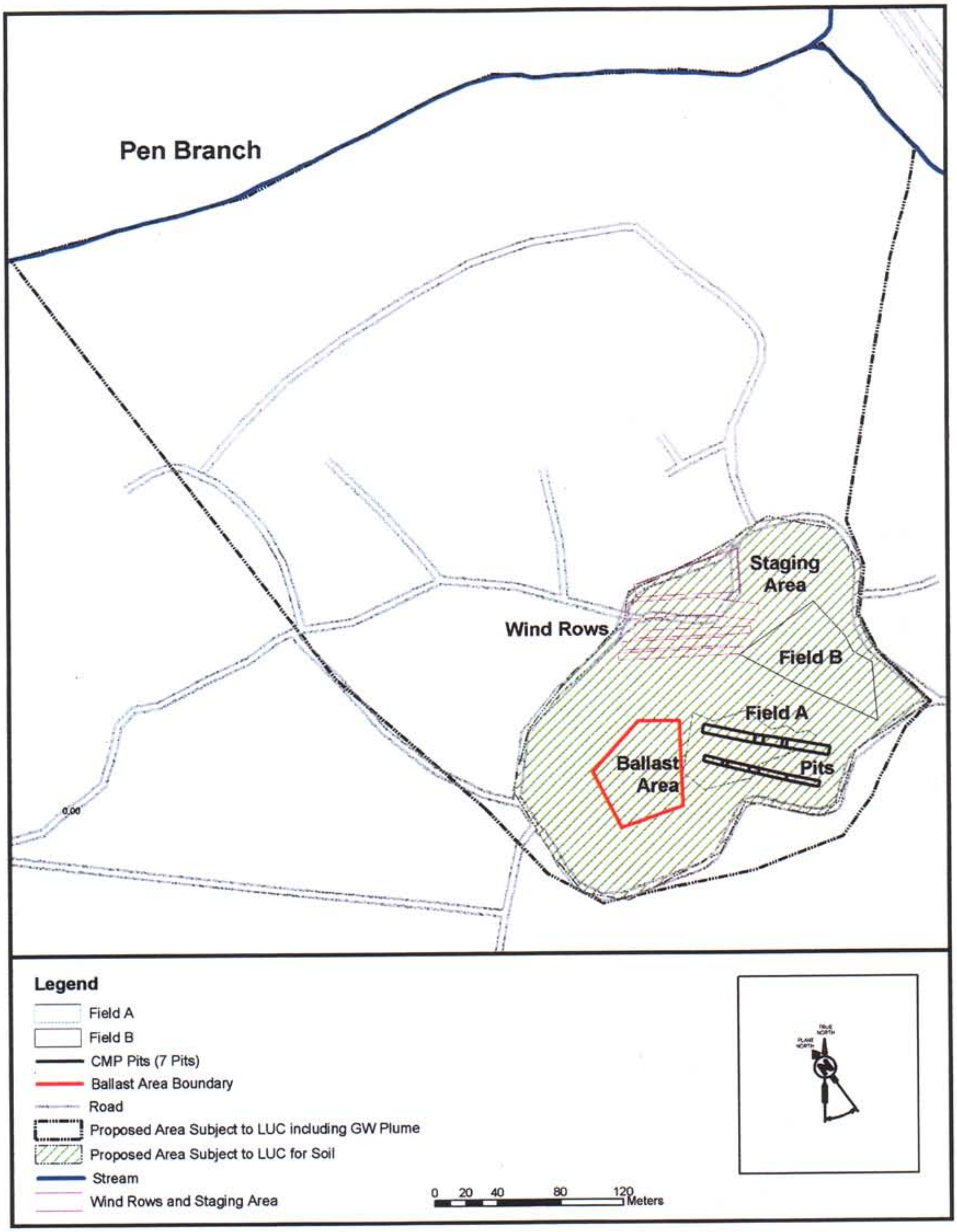


Figure 12. Proposed Area Subject to Land Use Controls

Institutional controls will be implemented by the following:

- Access controls to prevent exposure to on-site workers via the Site Use Program, Site Clearance Program, work control, worker training, worker briefing of health and safety requirements and identification signs located at the waste unit boundaries.

- Access controls to prevent unacceptable exposure to trespassers, as described in the 2000 RCRA Part B Permit Renewal Application, Volume I, Section F.1, which describes the security procedures and equipment, 24-hour surveillance system, artificial or natural barriers, control entry systems, and warning signs in place at the SRS boundary.

A detailed description of access controls are included in Table 21.

In the long term, if the property is ever transferred to nonfederal ownership, the US Government will take those actions necessary pursuant to Section 120(h) of CERCLA. Those actions will include a deed notification disclosing former waste management and disposal activities as well as remedial actions taken on the site. The contract for sale and the deed will contain the notification required by CERCLA Section 120(h). The deed notification shall, in perpetuity, notify any potential purchaser that the property has been used for the management and disposal of waste. These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination will remain at the unit.

The deed shall also include deed restrictions precluding residential use of the property. The deed shall contain provisions to ensure that appropriate LUCs remain with the affected area upon any and all transfers. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for the deed restrictions will be done through an amended ROD with USEPA and SCDHEC review and approval.

Table 21. Land Use Controls for the CMP Pits OU

Type of Control	Purpose of Control	Duration	Implementation	Affected Areas[a]
1. Property Record Notices[b]	Provide notice to anyone searching records about the existence and location of contaminated areas.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Notice recorded by DOE in accordance with state laws at County Register of Deeds office if the property or any portion thereof is ever transferred to non-federal ownership.	Ballast Area and Vadose Zone where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions.
2. Property record restrictions[c]: A. Land Use B. Groundwater	Restrict use of property by imposing limitations. Prohibit the use of groundwater.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Drafted and implemented by DOE upon transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office.	Ballast Area, Vadose Zone, and Groundwater (until RAOs are achieved) where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions.
3. Other Notices[d]	Provide notice to city &/or county about the existence and location of waste disposal and residual contamination areas for zoning/planning purposes.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Notice recorded by DOE in accordance with state laws at County Register of Deeds office if the property or any portion thereof is ever transferred to non-federal ownership.	Ballast Area, Vadose Zone and Groundwater (until RAOs are achieved) where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions.
4. Site Use Program[e]	Provide notice to worker/developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/penetration activity.	As long as property remains under DOE control	Implemented by DOE and site contractors Initiated by permit request	Ballast Area, Vadose Zone, and Groundwater (until RAOs are achieved) where levels requiring land use and / or groundwater restrictions.
5. Physical Access Controls[f] (e.g., fences, gates, portals)	Control and restrict access to workers and the public to prevent unauthorized use.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Controls maintained by DOE	Fence at the SRS boundary.

Table 21. Land Use Controls for the CMP Pits OU (continued)

Type of Control	Purpose of Control	Duration	Implementation	Affected Areas[a]
6. Warning Signs[g]	Provide notice or warning to prevent unauthorized uses	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Signage maintained by DOE	Signs around the area subject to LUC for soil (Figure 12) at the CMP Pits OU.
7. Security Surveillance Measures	Control and monitor access by workers/public	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Established and maintained by DOE Necessity of patrols evaluated upon completion of remedial actions.	Patrol of selected area throughout SRS, as necessary.

[a]Affected areas – Specific locations identified in the SRS LUCIP or subsequent post-ROD documents.
[b]Property Record Notices – Refers to any non-enforceable, purely informational document recorded along with the original property acquisition records of DOE and its predecessor agencies that alerts anyone searching property records to important information about residual contamination; waste disposal areas in the property.
[c]Property Record Restrictions – Includes conditions and/or covenants that restrict or prohibit certain uses of real property and are recoded along with original property acquisition records of DOE and its predecessor agencies.
[d]Other Notices – Includes information on the location of waste disposal areas and residual contamination depicted on as survey plat, which is provided to a zoning authority (i.e., city planning commission) for consideration in appropriate zoning decisions for non-DOE property.
[e]Site Use Program – Refers to the internal DOE/DOE contractor administrative program(s) that requires the permit requestor to obtain authorization, usually in the form of a permit, before beginning any excavation/penetration activity (e.g., well drilling) for the purpose of ensuring that the proposed activity will not affect underground utilities/structures, or in the case contaminated soil or groundwater, will not disturb the affected areas without the appropriate precautions and safeguards.
[f]Physical Access Controls – Physical barriers or restrictions to entry.
[g]Signs – Posted command, warning or direction.

In addition, if the site is ever transferred to nonfederal ownership, a survey plat of the OU will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency.

The selected remedy for the CMP Pits OU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for an indefinite period of time. As agreed on March 30, 2000, among the USDOE, USEPA, and SCDHEC, SRS is implementing a LUCAP to ensure that the LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific LUCIP referenced in this ROD will provide details and specific measures required to implement and maintain the LUCs selected as part of this remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the Corrective Measures Implementation (CMI)/Remedial Action Implementation Plan (RAIP) as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA and the SRS FFA. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect unless and until modifications are approved as needed to be protective of human health and the environment. The deed shall contain provisions to ensure that appropriate LUCs remain with the affected area upon any and all transfers. The LUCs shall be maintained until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use. Approval by USEPA and SCDHEC is required for any modification or termination of the institutional controls.

USDOE has recommended that residential use of SRS land be controlled; therefore, future residential use and potential residential water usage will be restricted to ensure long-term protectiveness. LUCs, including institutional controls, will restrict the CMP Pits OU to future industrial use and will prohibit residential use of the area. Unauthorized excavation will also be prohibited and the waste unit will remain undisturbed. LUCs selected as part of this action will be maintained for as long as they are necessary and termination of any LUCs will be subject to CERCLA requirements for documenting changes in remedial actions.

Cost Estimate for the Selected Remedy

The cost estimates for the selected remedies are provided in Appendix B. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record File, an Explanation of Significant Difference (ESD), or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Estimated Outcomes of Selected Remedy

Following completion of the selected remedies, the CMP Pits OU will be available for industrial use. Institutional controls will be maintained to prevent residential use of the CMP Pits OU. RGs will be achieved in the Ballast Area following completion of the interim action. RGs will be achieved in Field A vadose zone in 3 to 6 years. RGs will be achieved in groundwater in 39 years. Groundwater will be available for primary and secondary contact, recreation, and as a source for drinking water supply.

Waste Management

Environmental media (soil and water) at the CMP Pits contains RCRA listed waste that is subject to applicable RCRA requirements until determined to no longer contain hazardous waste. Consistent with USEPA policy, environmental media and/or secondary waste for disposal off-unit will be determined to no longer contain listed hazardous waste if the media is determined to be below the Health Based Levels (HBLs) found in the IDW Management Plan (WSRC 2004b). Unless otherwise noted in this section of the ROD and the subsequent CMI/RAIP all waste will be managed consistent with the latest approved IDW Management Plan.

Consistent with EPA's Area of Contamination (AOC) Policy, environmental media designated for land application will be evaluated against the soil Remedial Goals (RGs) established in Table 17 of the ROD. Where soil RGs are not available, media will be evaluated against the appropriate standard to ensure protection of human health and the environment. Due to the lack of potential for contaminants to be present at characteristic levels on job control waste (JCW), JCW will be managed as CERCLA Sanitary Waste. Equipment, for reuse or disposal, will be thoroughly rinsed on unit and released as clean. Rinse water will be discharged to the ground on unit.

Waste will be managed on unit in a waste storage area pending characterization and determination of appropriate treatment or disposal method. Any facility receiving this waste will have the appropriate "Offsite Rule" approval per CERCLA.

XII. STATUTORY DETERMINATIONS

Based on the unit RCRA Facility Investigation (RFI)/Remedial Investigation (RI) with Baseline Risk Assessment (BRA) report the CMP Pits OU poses a threat to human health and the environment. Therefore, the selected remedies for the CMP Pits OU are institutional controls for the Ballast Area, ERH and SVE for the Source Area (Field A), Passive SVE (Baroballs^{TM}) for Field B, and MNA and institutional controls for groundwater. The future land use of the CMP Pits OU is assumed to be industrial land use.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The vadose zone remedy satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduce the toxicity, mobility, or volume of materials comprising principal threats through treatment).

In the long term, if the property is ever transferred to nonfederal ownership, the US Government will take those actions necessary pursuant to Section 120(h) of CERCLA. Those actions will include a deed notification disclosing former waste management and disposal activities as well as remedial actions taken on the site. The contract for sale and the deed will contain the notification required by CERCLA Section 120(h). The deed notification shall, in perpetuity, notify any potential purchaser that the property has been used for the management and disposal of waste. These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination will remain at the unit.

The deed shall also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for the deed restrictions will be done through an amended ROD with USEPA and SCDHEC review and approval.

In addition, if the site is ever transferred to nonfederal ownership, a survey plat of the OU will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency.

The selected remedy for the CMP Pits OU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for an indefinite period of time. As agreed on March 30, 2000, among the USDOE, USEPA, and SCDHEC, SRS is implementing a Land Use Control and Assurance Plan (LUCAP) to ensure that the LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific LUCIP incorporated by reference into this ROD will provide details and specific measures required to implement and maintain the LUCs selected as part of this remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the CMI/RAIP, as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect unless and until modifications are approved as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

XIII. EXPLANATION OF SIGNIFICANT CHANGES

The remedies selected in this ROD do not contain any significant changes from the preferred alternatives presented in the SB/PP. Any comments received during the public comment period will be identified in the Responsiveness Summary.

XIV. RESPONSIVENESS SUMMARY

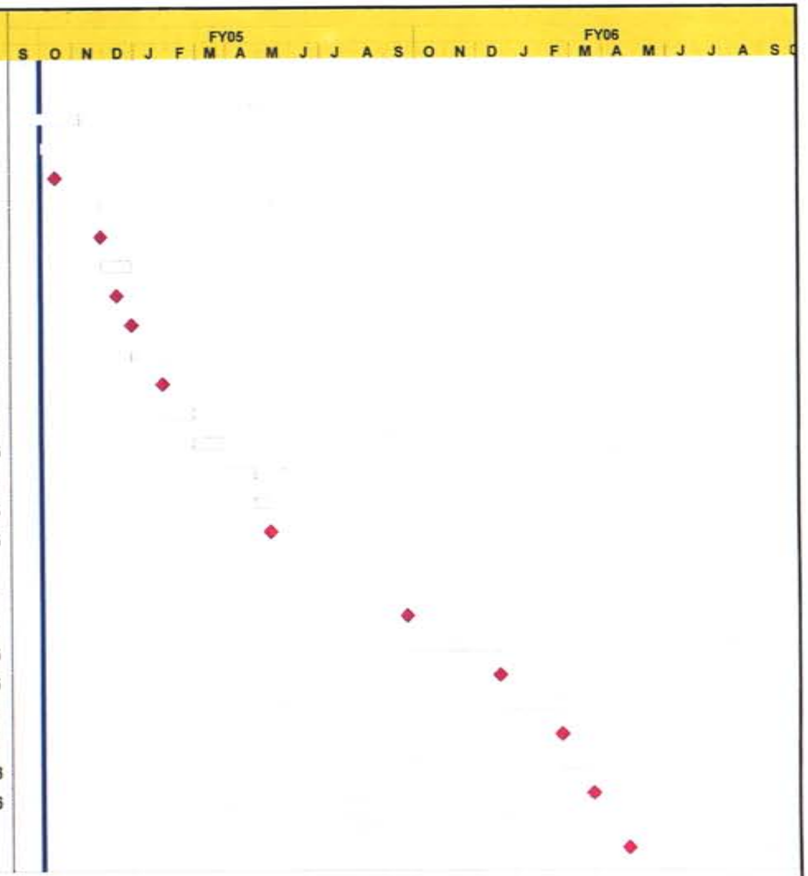
The Responsiveness Summary has been included as Appendix A of this document.

XV. POST-ROD DOCUMENT SCHEDULE AND DESCRIPTION

The following major post-ROD submittals and activities are highlighted in the attached schedule (Figure 13).

- Submittal of the Corrective Measures Implementation/Remedial Action Implementation Plan
- Remedial Action Start
- Submittal of the Post-Construction Report
- Remedial Action Completion

Activity Description	Orig Dur	Early Start	Early Finish
CA 1201 CMP PITS			
LCS 14 - STATEMENT OF BASIS/PROPOSED PLAN & ROD			
PUBLIC COMMENT PERIOD	45	24SEP04A	08NOV04
DEVELOP ROD FY05	10	01OCT04A	14OCT04
SUBMIT REV.0 ROD	0		14OCT04
EPA/SCDHEC REVIEW OF REV.0 ROD	45	15OCT04	28NOV04
EPA/SCDHEC RETURNS REV.0 COMMENTS FOR ROD	0		28NOV04
SRS INCORPORATES EPA/SCDHEC COMMENTS ROD	30	29NOV04	28DEC04
ROD COMMENT RESOLUTION MEETING	0	14DEC04	
SRS SUBMITTAL OF REV.1 ROD	0		28DEC04
EPA/SCDHEC FINAL REVIEW AND APPROVAL OF ROD	30	29DEC04	27JAN05
RECEIPT OF ROD APPROVAL	0		27JAN05
DOE OBTAIN SIGNATURE ON ROD	30	28JAN05	26FEB05
EPA OBTAIN SIGNATURE ON ROD	30	27FEB05	28MAR05
SCDHEC OBTAIN SIGNATURE ON ROD	30	29MAR05	27APR05
PREPARE FOR PUBLIC NOTICE	14	28APR05	11MAY05
ISSUE ROD	0		11MAY05
LCS 15 - DETAILED ENG & PRECONST ACTIVITIES			
DEVELOP CMI/RAIP REV.0 & LUCIP (FINAL)	85	20MAY05	20SEP05
SRS SUBMITTAL OF REV. 0 CMI/RAIP & LUCIP	0		20SEP05
EPA/SCDHEC RVW REV.0 CMI/RAIP & LUCIP	90	21SEP05	19DEC05
EPA/SCDHEC RETURN COMMENTS CMI/RAIP & LUCIP	0		19DEC05
SRS INCORPORATE EPA/SCHDEC COMMENTS	60	20DEC05	17FEB06
SRS SUBMITTAL OF REV.1 CMI/RAIP & LUCIP	0		17FEB06
EPA/SCHDEC FINAL REVIEW & APPR CMI/RAIP & LUCIP	30	18FEB06	19MAR06
EPA/SCDHEC APPROVAL OF REV.1 CMI/RAIP & LUCIP	0		20MAR06
LCS 16 - REMEDIAL ACTION IMPLEMENTATION			
REMEDIAL ACTION (RA) START DATE	0	24APR06	



Start Date	01OCT92
Finish Date	09SEP16
Data Date	01OCT04
Run Date	07OCT04 08:55

Early Bar
Progress Bar
Critical Activity

IMPL - ATPC

Environmental Restoration
CA 1201 CMP IHMU
RCRA/CERCLA Implementation Schedule

Date	Revision	Checked	Approved

Figure 13. Post-ROD Schedule for the CMP Pits OU

XVI. REFERENCES

Christensen, E.I., and Gordon, D.E., 1983. *Technical Summary of Groundwater Quality Protection Program at Savannah River Plant, Vol. 1: Site Geohydrology, and Solid and Hazardous Wastes*, DPST-83-829, E.I. du Pont Nemours and Company, Savannah River Laboratory, Aiken, SC

FFA 1993. *Federal Facility Agreement for the Savannah River Site,* Administrative Docket No. 89-05-FF (Effective Date: August 16, 1993)

Office of Management and Budget 2002. *Real Interest Rates on Treasure Notes and Bonds of Specified Maturities*, OBM Circular No. A-94, Appendix C (Revised February 2002).

Savannah River Forestry Service, 1994. *Threatened, Endangered and Sensitive Species Listing, 1994 Savannah River Forest Station Site 24, CMP Pits (Waste Site #43, 132-137)*, USDA Forest Service, Savannah River Forest Station, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site: Future Use Report Stakeholder Recommendations for SRS Land and Facilities,* Savannah River Site, Aiken, SC

Woodward & Clyde Consultants, 1985. *Preliminary Report, Site Remediation and Closure CMP Pits, Savannah River Plant*, Report by Woodward & Clyde Consultants for E.I. du Pont de Nemours and Company, Savannah River Plant, Aiken, SC

WSRC, 1996. *Savannah River Site Federal Facility Agreement Implementation Plan,* WSRC-RP-94-1200, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC 1997. *RCRA Facility Investigation/Remedial Investigation Report with Baseline Risk Assessment for the Chemicals, Metals, and Pesticides Pits (U)*, WSRC-RP-96-

00112, Rev. 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999a. *Interim Action Proposed Plan for the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (U)*, Revision 1.1, WSRC-RP-98-4130, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999b. *Interim Record of Decision Remedial Action Alternative Selection for the Chemicals, Metals, and Pesticides Pits (080-17G, 080-17.1G, 080-18G, 080-18.1G, 080-18.2G, 080-18.3G, 080-19G) (U)*, WSRC-RP-98-4192, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Savannah River Site, Aiken SC

WSRC 2002. *Groundwater Modeling for the Chemicals, Metals, and Pesticides Pits Operable Unit (U)*, WSRC-RP-2002-4195, October 2002, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC 2003a. *Interim Record of Decision Amendment for the Chemicals, Metals, and Pesticides Pits (II) – Ballast Area (U)*, WSRC-RP-2001-4232, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC 2003b. *RCRA Facility Investigation/Remedial Investigation Addendum with Baseline Risk Assessment for the CMP Pits (U)*, WSRC-RP-2002-4049, Rev. 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2003c. *Groundwater Remediation Alternative Modeling for the Chemicals, Metals, and Pesticides Pits Operable Unit (U)*, Revision 0, WSRC-RP-2003-4026, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC 2004a. *Statement of Basis/Proposed Plan for the Chemicals, Metals, and Pesticides Pits Operable Unit (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) (U)*, WSRC-RP-2004-4011, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC 2004b. *SRS Investigation-Derived Waste Management Plan*, WSRC-RP-94-1227, Revision 6, June 2004, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC 2004c. *Report on the Effectiveness of the Chemicals, Metals, and Pesticides (CMP) Pits Interim Remedial Action for 2003* (U), WSRC-RP-2004-4067, June 2004, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

APPENDIX A -
RESPONSIVENESS SUMMARY

Responsiveness Summary

The 45-day public comment period for the *Statement of Basis/Proposed Plan for the CMP Pits OU (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G)* began on September 24, 2004 and ended on November 8, 2004.

Public Comments

The following comments were received at the Citizens Advisory Board Meeting on October 19, 2004.

Response to Technical Comments from the Citizens Advisory Board
Meeting of October, 19, 2004

1. Describe the chemical breakdown of trichloroethylene (TCE) and tetrachloroethylene (PCE) in the atmosphere following Soil Vapor Extraction.

Response:

The atmospheric fates of TCE and PCE are complicated. The degradation of these contaminants in the atmosphere is discussed in detail in the Savannah River Laboratory Technical Memorandum, *Atmospheric Fates of Trichloroethylene, Tetrachloroethylene and 1, 1,1-Trichloroethane*, DPST-85-240, from P. Cordo to D.E. Gordon, February 8, 1985.

TCE and PCE break down in the atmosphere. Mechanisms for this include direct photolysis, which is chemical decomposition induced by radiant energy (in this case sunlight), and reactions with other chemicals in the atmosphere. Chemical reaction chains occur in the presence of oxygen and ozone. Chemical oxidation of TCE and PCE in the atmosphere is not complete. Byproduct compounds include carbon monoxide, acetyl chlorides, hydrochloric acid, and phosgene. The concentrations of these byproducts are very low due to the effects of atmospheric dilution.

Atmospheric emissions of TCE and PCE are regulated under South Carolina Air Quality Control Permits. Emissions are calculated for each soil vapor extraction unit and submitted to SCDHEC in a permit application. The soil vapor extraction units at CMP are operating under an approved permit and emissions remain well below allowable levels.

2. Provide the groundwater modeling report that evaluates and compares various groundwater remedial scenarios including MNA.

Response:

A copy of the groundwater modeling report, *Groundwater Remediation Alternatives Modeling for the Chemicals, Metals, and Pesticides Pits (U)*, WSRC-RP-2003-4026, Rev. 0, May 2003, is provided with this response.

3. Provide a cost estimate of an excavation alternative for the contaminated soil in the source zone below the CMP Pits.

Response:

Cost estimates have been prepared for two remedial alternatives that are not included in the Proposed Plan. Line item estimates for each are attached.

Alternative 1 is to excavate the contaminated soil beneath the CMP Pits and ship it off SRS for disposal. Disposal costs for this material are very expensive because of the contaminants found at the CMP Pits. This alternative would require the excavation and disposal of much of the existing soil vapor extraction system wells and piping as well as soil. It also would require back filling of the excavation with clean fill. The cost estimate for this alternative is $15M.

Alternative 2 is to excavate the contaminated soil beneath the CMP Pits and treat it on unit. This alternative would require the excavation and disposal of much of the existing soil vapor extraction system wells and piping. Contaminated soils would be treated on site and then used to back fill the excavation. The estimated cost for this alternative is $12.5M.

APPENDIX B -
COST ESTIMATES

Table A-3
Alternative VZA-3d
Soil Heating, Operation of the IRA SVE, Maintaining the Existing Cover, and Institutional Controls
CMP Pits and Associated Field A Vadose Zone

CMP Pits OU
Savannah River Site

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
Air Emissions Permit	1	ea	$15,000	$15,000
Active SVE System Equipment & Construction				
SVE System Existing and Operational				
Six-Phase Heating Treatment				
SPSH Pilot Study	1	ea	$200,000	$200,000
Electrical Resistance Heating System Setup	1	ea	$415,000	$415,000
Carbon Off-Gas Treatment System	1	ea	$8,000	$8,000
Passive SVE Equipment				
Passive Pressure Check Valve System	68	ea	$500	$34,000
Institutional Controls	1	ea	$10,997	$10,997
Subtotal - Direct Capital Cost				$682,997
Mobilization/Demobilization	3% of subtotal direct capital			$20,490
Site Preparation	5% of subtotal direct capital			$34,150
Total Direct Capital Cost	(sum of * items)			**$737,636**
Indirect Capital Costs				
Engineering & Design				$150,000
Project/Construction Management	25% of direct capital			$184,409
Health & Safety	5% of direct capital			$36,882
Overhead	30% of direct capital			$221,291
Contingency	15% of direct capital			$110,645
Total Indirect Capital Cost				**$703,227**
Total Estimated Capital Cost				**$1,440,864**
Direct O&M Costs				
Annual Costs (Active SVE Operations)	2.1% discount rate			
	2 year O&M period			
Air Emissions Monitoring	0	ea	$16,400	$0
Electrical Resistance Heating Operations	333	cy	$100	$33,333
SVE System Operation	1	ea	$146,500	$146,500
Offgas Treatment (Media Changeout)	1	ea	$15,829	$15,829
SVE System Performance Reporting	1	ea	$25,000	$25,000
Cover Maintenance	1	ea	$8,280	$8,280
Institututional Controls	1	ea	$1,700	$1,700
Subtotal - Annual Costs				$230,642
Present Worth Annual Costs				$447,151
Annual Costs (Passive SVE Operations)	2.8% discount rate			
	3 year O&M period			
Air Emissions Monitoring	1	ea	$16,400	$16,400
Electrical Resistance Heating Operations	333	cy	$100	$33,333
SVE System Operation	1	ea	$10,000	$10,000
SVE System Performance Reporting	1	ea	$25,000	$25,000
Cover Maintenance	1	ea	$8,280	$8,280
Institututional Controls	1	ea	$1,700	$1,700
Subtotal - Annual Costs				$94,713
Present Worth Annual Costs				$252,625
Five Year Costs				
Remedy Review	1	ea	$13,308	$13,308
Subtotal - Five Year O&M Costs				$13,308
Present Worth Five Year Costs				$11,592
Total Present Worth Direct O&M Cost				**$711,367**
Indirect O&M Costs				
Project/Admin Management	5% of direct O&M			$35,568
Health & Safety	5% of direct O&M			$35,568
Overhead	30% of direct O&M			$213,410
Total Present Worth Indirect O&M Cost				**$284,547**
Total Estimated Present Worth O&M Cost				**$995,914**
TOTAL ESTIMATED COST				**$2,436,778**

Alternative GW-3i
Monitored Natural Attenuation, Institutional Controls,
and Periodic Groundwater Sampling
Groundwater at the CMP Pits OU

CMP Pits OU
Savannah River Site

Item		Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs						
Install Monitoring System						
Install Monitoring Wells		12	ea	$7,200	$86,400	
Institutional Controls						
Land Use Control Implementation Plan		1	ea	$5,000	$5,000	
Deed Restrictions		1	ea	$5,000	$5,000	
	Subtotal - Direct Capital Cost				$96,400	*
	Mobilization/Demobilization	3% of subtotal direct capital			$2,892	*
	Site Preparation	5% of subtotal direct capital			$4,820	*
	Total Direct Capital Cost	(sum of * items)			**$104,112**	
Indirect Capital Costs						
Engineering & Design					$0	
Project/Construction Management		25% of direct capital			$26,028	
Health & Safety		5% of direct capital			$5,206	
Overhead		30% of direct capital			$31,234	
Contingency		15% of direct capital			$15,617	
	Total Indirect Capital Cost				**$78,084**	
	Total Estimated Capital Cost				**$182,196**	
Direct O&M Costs						
		3.9% discount rate				
Annual Costs (Existing System during Post-ROD Design & Const)		40	years O&M		*Year 2007 - 2047*	
Access Controls		1	ea	$500	$500	
Monitoring System Maintenance		12	well	$1,200	$14,400	
Groundwater Monitoring (VOCs)		2	event	$10,999	$21,997	
	Subtotal - Annual Costs				$36,897	
	Present Worth Annual Costs				$741,297	
Five Year Costs		8				
Remedy Review		1	ea	$13,308	$13,308	
	Subtotal - Five Year O&M Costs				$13,308	
	Present Worth Five Year Costs				$49,462	
	Total Present Worth Direct O&M Cost				**$790,759**	
Indirect O&M Costs						
Project/Admin Management		5% of direct O&M			$39,538	
Health & Safety		5% of direct O&M			$39,538	
Overhead		30% of direct O&M			$237,228	
	Total Present Worth Indirect O&M Cost				**$316,303**	
	Total Estimated Present Worth O&M Cost				**$1,107,062**	
	TOTAL ESTIMATED COST				**$1,289,258**	

This page intentionally left blank.