United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R04-92/110
June 1992

EPA

Superfund Record of Decision:

Savannah River (USDOE) (Operable Unit 3), SC

NOTICE

The appendices listed in the index that are not found in this document have been removed at the request of the issuing agency. They contain material which supplement, but adds no further applicable information to the content of the document. All supplemental material is, however, contained in the administrative record for this site.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/ROD/R04-92/110	2.	3. Recipient's Accession No.

4. Title and Subtitle SUPERFUND RECORD OF DECISION Savannah River (USDOE) (Operable Unit 3), SC Third Remedial Action - Interim	5. Report Date 06/29/92
	6.
7. Author(s)	8. Performing Organization Rept. No.
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12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460	13. Type of Report & Period Covered 800/000
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15. Supplementary Notes

PB93-964013

16. Abstract (Limit: 200 words)

The 300-square-mile Savannah River site (SRS) is a DOE facility located in Aiken County, 20 miles south of Aiken, South Carolina, and 25 miles southeast of Augusta, Georgia. Land use in the area is primarily industrial, and SRS is a secured facility with no residents. The site, co-operated by Westinghouse Savannah River Company, is a national defense-related facility producing tritium, plutonium, and other special nuclear materials. The A/M area, located in the northwest portion of the SRS, contained many operations that involved the use of hazardous substances. Between 1952 and 1981, an estimated 13 million pounds of chlorinated solvents were used in the A/M area to degrease fuel and target tubes for use in the SRS reactors. An estimated 50 to 90 percent of the solvents evaporated during use; however, the remaining solvents were discharged to the process sewer system. There are four main sections to the A/M area. The A-014 outfall received waste solvents (mainly TCE and PCE) via an underground sewage line from buildings 313-M and 320-M onsite until 1976. From 1958 to 1985, the M-area basin hazardous waste management facility (HWMF) received an estimated 2 million pounds of spent solvents from degreasing operations in buildings

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Savannah River (USDOE) (Operable Unit 3), SC
Third Remedial Action - Interim
Contaminated Medium: gw
Key Contaminants: VOCs (PCE, TCE)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 42
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

313-M, 320-M, and 321-M. In transit, some of the solvents leaked into the ground through cracks in the pipeline. Finally, the 321-M solvent storage area contained various storage tanks for TCE and PCE. In 1975, an estimated 1,200 gallons of PCE leaked from a cracked ceramic pump seal connected to a solvent storage tank located west of building 321-M. As a result of these activities and incidents, a ground water plume, encompassing 1,200 acres beneath the A/M area, is contaminated with significant concentrations of VOCs. In 1981, SRS voluntarily initiated a ground water RCRA corrective action program to investigate the nature and extent of ground water contamination and to develop a remedial program. Ground water monitoring wells were installed, and beginning in 1983, extraction and treatment of ground water began. To date, over 1.3 billion gallons of contaminated ground water have been treated. This ROD addresses an interim remedy for the A/M area ground water subsurface vadose zone, as OU3. Other RODs have addressed interim remedies for the M-area HWMF and the Savannah Metallurgical Laboratory (SRL) HWMF. Future RODs will address final remedies for these OUs. The primary contaminants of concern affecting the ground water in the A/M area are VOCs, including PCE and TCE.

The selected interim remedy for this site includes installing 11 or more ground water recovery wells installed under the RCRA program throughout the A/M area; extracting and treating contaminated ground water using an air stripper to remove volatile solvents, followed by onsite discharge to an NPDES permitted outfall; upgrading the air stripping tower to include an off-gas treatment system, based on the result of a treatability study. The estimated present worth cost for this remedial action is $7,800,000, which includes an annual O&M cost of $20,000 for 30 years.

<u>PERFORMANCE STANDARDS OR GOALS</u>: No chemical-specific clean-up goals were specified in this interim ROD, but they will be provided for the final remedial action. The goal of this remediation is to reduce ground water contaminants and minimize migration of the contaminant plume.

WSRC-RP-92-744

INTERIM ACTION RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION

A/M Area Groundwater Operable Unit

Savannah River Site (o.u-3)
Aiken County, South Carolina

Prepared by:

U.S. Department of Energy
Savannah River Field Office
Aiken, South Carolina

DECLARATION FOR THE INTERIM ACTION RECORD OF DECISION

Site Name and Location

A/M Groundwater Operable Unit

Savannah River Site

Aiken County, South Carolina

Appendix C of the draft Federal Facility Agreement (FFA) refers to this operable unit as the Groundwater Remediation, A- and M-Areas.

Statement of Purpose

This document presents the selected interim remedial action for the A/M Area Groundwater Operable Unit at the Savannah River Site, developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (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 specific operable unit.

Description of the Selected Remedy

The selected interim action remedy involves groundwater recovery with treatment by air stripping. This remedy reduces contaminant levels in the groundwater and minimizes migration of the contaminant plume.

A risk assessment will be conducted in the future to determine if additional remediation is required. Results of the risk assessment will be contained in the final Record of Decision (ROD).

The major components of the interim action remedy include the following:

- Installing strategically located groundwater recovery wells.
- Extracting groundwater and processing it through an air stripper to release volatile organic compounds.
- Discharging the treated water to an NPDES permitted outfall.
- Pursuing the application of new technologies to enhance the reduction of volatile organic compounds in the groundwater.
- Conducting a treatability study to evaluate technologies to control air stripping tower gaseous emissions.

Declaration Statement

The interim action is hereby selected by mutual agreement of the U.S. Department of Energy and the U.S. Environmental Protection Agency. This interim action is protective of human health and the environment and complies with Federal and State applicable or relevant and appropriate requirements (ARARs) for this limited-scope action, and is cost-effective. This action is interim and is not intended to utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable for the A/M Area Groundwater Operable Unit. Because this action does not constitute the final remedy for the A/M Area Groundwater Operable Unit, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, although partially addressed in this remedy, will be fully addressed by the final response action. Subsequent actions are planned to address fully the threats posed by the conditions at the A/M Area Groundwater Operable Unit and to establish final remediation goals. Because this remedy may result in hazardous substances remaining in the operable unit above health-based levels, a five -year review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment after commencement of the remedial action. Because this is an interim action ROD, review of this operable unit and of this remedy will be conducted by the Environmental Protection Agency (EPA) until a final remedial alternative for the A/M Area Groundwater Operable Unit is selected.

6/25/92
Date

L. C. Sjostrom
Assistant Manager for Environmental Restoration and Waste Management
U.S. Department of Energy

JUN 29 1992
Date

for Greer C. Tidwell
Regional Administrator
U.S. Environmental Protection Agency
Region IV

SUMMARY OF INTERIM ACTION REMEDIAL ALTERNATIVE SELECTION

A/M Area Groundwater Operable Unit

Savannah River Site
Aiken County, South Carolina

Prepared by:

U.S. Department of Energy
Savannah River Field Office
Aiken, South Carolina

DECISION SUMMARY
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I. Site and Operable Unit Names, Locations, and Descriptions

The Savannah River Site (SRS) occupies approximately 300 square miles adjacent to the Savannah River, principally in Aiken and Barnwell Counties of South Carolina (Figure 1). SRS is a secured facility with no permanent residents. The site is approximately 25 miles southeast of Augusta, Georgia, and 20 miles south of Aiken, South Carolina. The average population density in the counties surrounding SRS ranges from 23-560 people per square mile with the largest concentration in the Augusta, Georgia, metropolitan area. Based on 1980 census data (1990 data not available), the population within a 50-mile (80 km) radius of SRS is approximately 555,100.

SRS is owned by the United States Department of Energy (DOE). Westinghouse Savannah River Company (WSRC) is a co-operator, providing management and operation services for DOE. SRS produces tritium, plutonium, and other special nuclear materials for national defense. The site also provides nuclear materials for the space program, and conducts medical, industrial, and research efforts. The A/M Area, located in the northwest portion of SRS (Figure 1), contains nuclear fuel fabrication buildings, office buildings, and research areas.

The A/M Area groundwater is a media-specific operable unit within the A/M Area Fundamental Study Area. As a result of past waste disposal practices, the groundwater beneath A/M Area has been contaminated with organic solvents, primarily trichloroethylene (TCE) and tetrachloroethylene (perchloroethylene; PCE). Total plume size beneath the A/M Area, as currently defined, is approximately 1200 acres. This plume has not migrated beyond the SRS boundaries. The contamination in the A/M Area groundwater and the overlying unsaturated zone (vadose zone) appears to be associated with releases from the

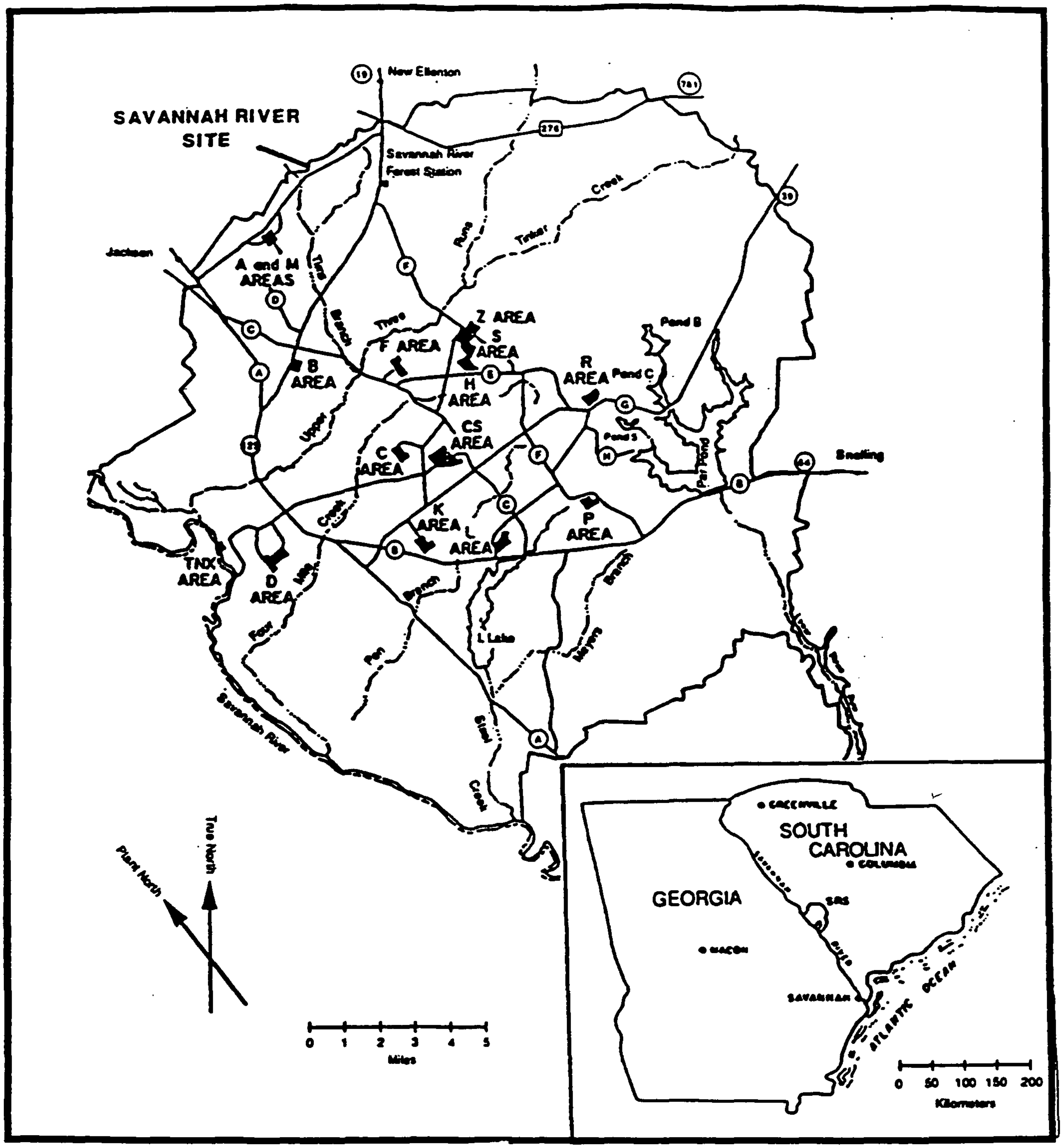

Figure 1 Location of the Savannah River Site (SRS)
(Source: Modified from the Savannah River Environmental Report, 1990)

following A/M Area source units: the A-014 Outfall, the M-Area Settling Basin/Lost Lake (M-Area Hazardous Waste Management Facility (HWMF)), the M-Area HWMF Process Sewer, and the 321-M Solvent Storage Area.

II. Operable Unit History and Compliance History

Operable Unit History

From 1952 to 1981, an estimated 13 million pounds of chlorinated solvents were used in the A/M Area to degrease fuel and target tubes used in SRS reactors. An estimated 50 to 90 percent of the solvents evaporated during degreasing operations. The remaining solvents were discharged as waste to the process sewer system. Additionally, significant quantities of chlorinated solvents were inadvertently spilled during handling and storage.

The waste effluent was piped, via a process sewer system, from the fuel tube processing facility to two primary locations: A-014 Outfall and the M-Area Settling Basin. As a result of this disposal practice and leakage within the process sewer line leading to the Settling Basin, four specific locations within the A/M Area have been identified as being potential sources for significant groundwater contamination by TCE and PCE. Additionally, some smaller sources, such as the Metallurgical Laboratory Basin and Building 313-M, a solvent transfer station, which probably have impacted groundwater, exist in the A-Area. The four specific locations are shown on Figure 2 and are described below.

A-014 Outfall. Buildings 313-M and 320-M were operational by the end of 1952 and used TCE as a degreasing agent. Waste solvents were released to the A-014 Outfall (Tims Branch) via an underground sewer line. In 1962, the processes in Building 313-M were

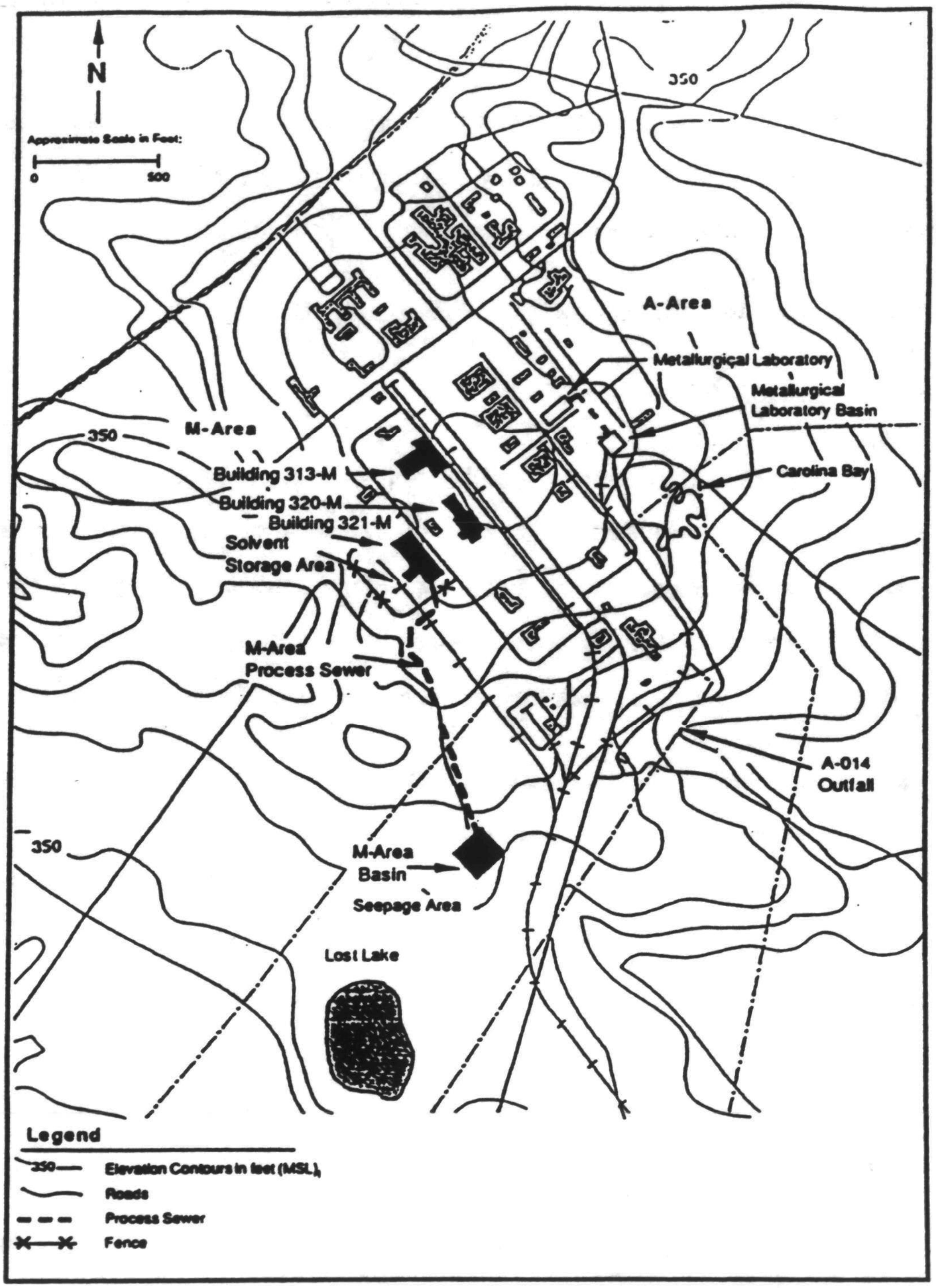

Figure 2 Potential Sources of A/M Area Groundwater Contamination
(Source: SRS Vadose Zone Characterization, 1991)

redesigned, and PCE was substituted for TCE. By 1976, all waste solvents from Building 313-M were diverted and discharged to the M-Area Settling Basin.

M-Area Basin HWMF. Built in 1958, the M-Area HWMF consisted of an unlined Settling Basin that received spent solvents from degreasing operations located in Buildings 313-M, 320-M, and 321-M. The M-Area HWMF also included a natural seepage area and Lost Lake (a Carolina bay) which received effluent from the basin. From 1958 to 1985, an estimated two million pounds of solvent were released to the sewer leading to the Settling Basin. In 1985, discharges of waste solvents to the Settling Basin ceased.

M-Area HWMF Process Sewer. The process sewer was used to transport spent solvents from Buildings 313-M, 320-M, and 321-M to the M-Area Basin beginning in 1958. In transit, some of the solvent leaked into the ground through cracks in the sewer pipeline. The pipe was slip-lined after cracks and misalignments were discovered in 1983, and an inactive portion was excavated in 1989 as part of the Settling Basin closure.

321-M Solvent Storage Area. During 1971, Buildings 320-M and 321-M substituted PCE for TCE in their process operations. In 1975, an estimated 1200 gallons of PCE leaked from a cracked ceramic pump seal connected to a solvent storage tank located west of Building 321-M.

In response to the detection of volatile organic compounds (VOCs) in the groundwater near the M-Area HWMF, SRS voluntarily initiated a groundwater corrective action program (June, 1981). The objective of the program was to investigate the nature and extent of groundwater contamination, and to develop a remediation program. Known and potential sources of groundwater contamination were identified through investigations which included personnel interviews, record reviews, soil borings, and the installation of monitoring wells. SRS now has an extensive groundwater monitoring network in the A/M Area with over 350 monitoring wells installed to provide definition of the aquifer plume.

In February 1983, a South Carolina Department of Health and Environmental Control (SCDHEC)-approved corrective action was initiated with the startup of an experimental pilot air stripper and one recovery well. The system operated at a design capacity of 20 gallons of water per minute (gpm). Later in 1983, two more recovery wells were installed and a 70 gpm air stripper was placed in operation in January 1984. The 70 gpm air stripper replaced the 20 gpm unit. In 1985, eight additional recovery wells were added to the three existing recovery wells, expanding the recovery well network to eleven. The eleven recovery wells were connected to a full scale air stripper which treated 400 gpm. In 1990, the flow of the air stripper was increased to 500 gpm. The air stripper removes the organics to levels below drinking water standards prior to discharge to the NPDES-permitted outfall, A-014. To date, over 1.3 billion gallons of contaminated groundwater have been treated and about 260,000 pounds of solvents have been removed from the subsurface. The eleven recovery wells have been designed and installed to maximize removal and minimize migration of solvents from the center of the plume in the shallow aquifer. The location of the current system, including the existing wells and the air stripper, are shown in Figure 3. An additional recovery well has been installed in A-Area near the Savannah River Laboratory (SRL). The previous M-Area prototype air stripper (the 70 gpm unit) has also been relocated to this part of A-Area. This new system became operational in March 1992. A thirteenth well has also been installed in the Southern Sector of A/M Area to function as an aquifer test well and possibly as a future remediation well.

SRS has initiated an evaluation of a vadose zone corrective action program to remediate soils above the groundwater at specific areas where solvents were released. An

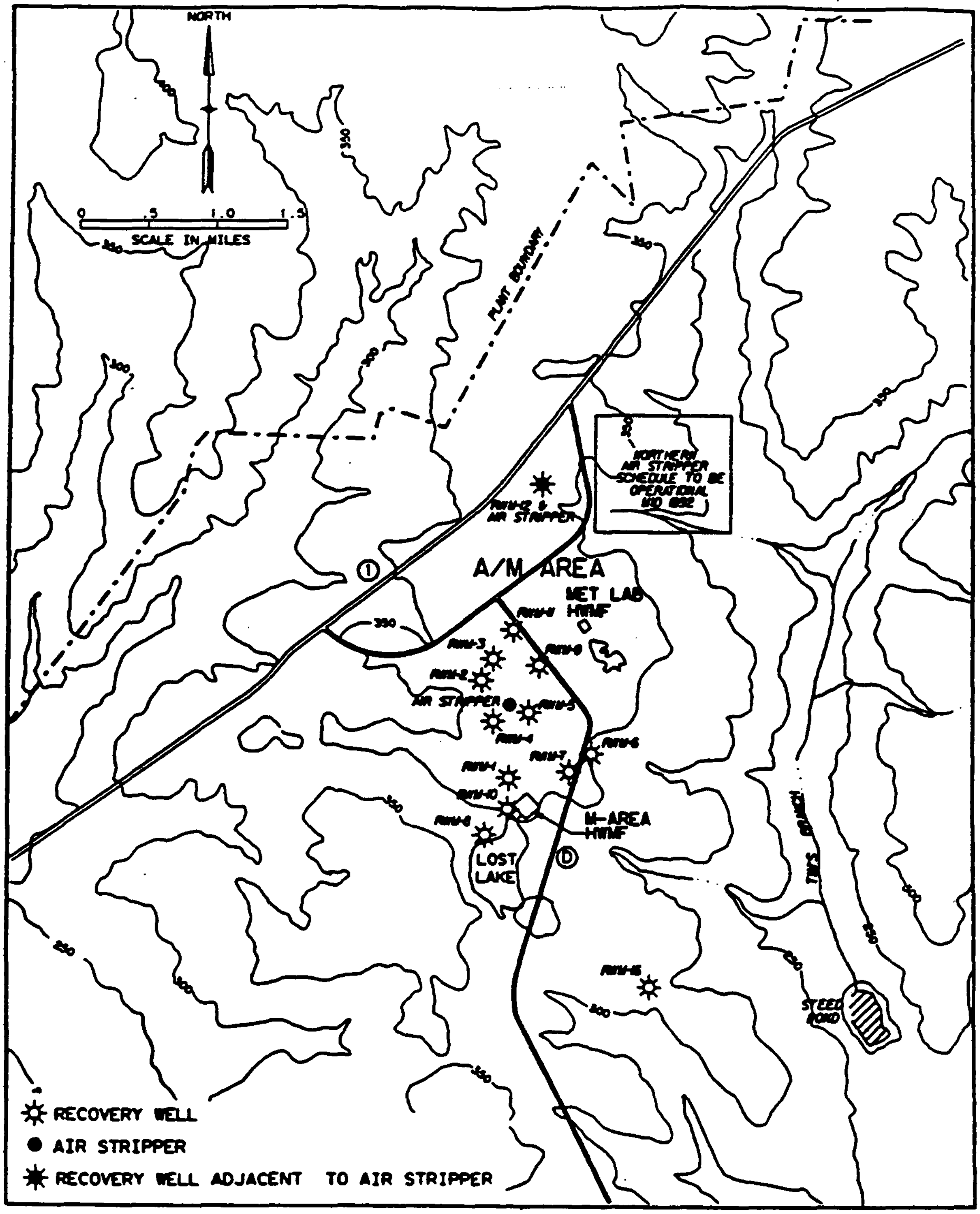

Figure 3 Location of A/M Area Groundwater Recovery Wells and Air Stripper Unit (Source: Figure created from data contained in the M-Area Hazardous Waste Management Facility Post-Closure Permit, 1991, Second Quarter Report)

investigation of the extent of the vadose zone contamination associated with the groundwater contamination has been performed. Presently, SRS is evaluating the designs and costs of potential systems and will be testing several innovative technologies which could be utilized to treat organics recovered from the vadose zone. Selection of a preferred alternative for the vadose zone will be carried out in a future Proposed Plan. Further discussion of the vadose zone remediation activities is contained in Section X.

Compliance History

DOE developed an Implementation Plan and Groundwater Protection Plan in June 1984 which required compliance with the groundwater protection requirements of 40 CFR §§ 264, 265, and 270 and with all other Federal and State regulations. Settlement Agreement SA 86-52-W, signed on June 20, 1986, required groundwater quality assessments at several sites, including the A/M Area. Results of the assessments have been provided to SCDHEC and future actions are being defined under SRS' RCRA Facilities Investigation program.

In 1985, the Natural Resources Defense Council (NRDC), et. al., initiated a lawsuit against DOE for alleged RCRA groundwater management violations at six SRS waste management areas including the A/M Area. On May 26, 1988, a Consent Decree was signed by DOE. Requirements of this decree are outlined in Civil Action No. 1:85-2583-6, filed on May 31, 1988 in the U. S. District Court, District of South Carolina, Aiken Division.

In 1985, a Resource Conservation and Recovery Act (RCRA) Post-Closure Care Part B Permit Application for the M-Area HWMF was submitted to SCDHEC. The application, approved in 1987, describes the A/M Area Groundwater Corrective Action Program in detail. A revised permit application was submitted to SCDHEC in September 1990 and the renewal application was submitted to SCDHEC on April 1, 1992. The revisions describe new groundwater and soil corrective action projects.

Remedial activities in the A/M Area became subject to CERCLA requirements when the entire SRS facility was placed on the National Priorities List (NPL) in December 1989. Due to multiple source areas in close proximity and the co-mingling of contaminants emanating from these source areas, the A/M Area has been designated a Fundamental Study Area. The purpose of this designation is to facilitate the coordination of remedy selection decisions for the operable units in this area. The A/M Area groundwater has been designated as a media-specific operable unit within the Fundamental Study Area.

III. Highlights of Community Participation

No comments were received during the public review period.

IV. Scope and Role of Operable Unit within the Site Strategy

The purposes of the interim action for the A/M Area Groundwater Operable Unit are to prevent further groundwater plume migration and initiate groundwater restoration while risk assessment activities are being planned and conducted, and to obtain further information about the response of the aquifer to remediation measures.

The interim action is consistent with any planned future actions for this operable unit.

Evaluation of treatment for the A/M Area subsurface soils (i.e., vadose zone) containing volatile organic compounds is being conducted as an ongoing treatability study associated with the A/M Area Groundwater Operable Unit. Selection of a preferred remedial action alternative for the vadose zone will be presented in a future Proposed Plan for the A/M Area Vadose Zone Operable Unit.

V. Summary of Operable Unit Characteristics

Closely associated with the A/M Area Groundwater Operable Unit is the Vadose Zone Operable Unit. The vadose zone consists of the subsurface region between the ground (land) surface and the water table. Mobile waste constituents released at the ground surface typically migrate vertically and gradually through the vadose zone to the groundwater. Longitudinal dispersion of contamination also occurs, but generally to a limited extent. Consequently, vadose zone contamination would be localized in areas where contaminants were released. Contamination in groundwater migrates horizontally and vertically depending on recharge/discharge relationships, stratigraphy, and other hydrogeologic factors. If left in place, mobile contaminants in the vadose zone would slowly migrate to the groundwater.

Most of the contaminants in the A/M Area groundwater are located in the uppermost aquifer. Concentrations in the uppermost aquifer range from hundreds of parts per million to less than one part per billion. The plume under A/M Area, as currently defined, encompasses approximately 1200 acres. The contaminated uppermost aquifer is not used as a source of drinking water at SRS but is currently being used for domestic purposes north of the SRS boundary where no contamination is present.

The deepest aquifer beneath the uppermost aquifer provides domestic (drinking) and process water to various facilities at the SRS. A thick and laterally continuous low permeability layer (principal confining unit) separates the uppermost aquifer from the principal confined aquifer and the deepest aquifer, and greatly retards downward migration of chemical residuals. Contamination concentrations of the principal confined aquifer in the A/M Area range from 1000 parts per billion to less than one part per billion. Groundwater flow direction within this unit is to the south-southeast. The town of Jackson, South Carolina, located hydraulically upgradient and three miles west of the A/M Area, also draws water from public supply wells in the deeper aquifer. No off-site groundwater contamination resulting from the migration of the A/M Area groundwater plume has been detected.

Recent monitoring results indicate groundwater contamination has occurred in the Northeastern Sector of the A/M Area in the vicinity of the SRL complex resulting from past uses and disposal of solvents. These findings are significant due to the proximity to the plant boundary and the contamination of the principal confined aquifer. The combined areal extent of the contaminant plume is shown in Figure 4 and represents the maximum lateral extent of detected constituents in all aquifers. The vertical extent of groundwater contamination through the uppermost and principal aquifers (Watertable Unit, Upper Congaree, Lower Congaree, and Peedee) is depicted along one cross section line in Figure 5. These two plume maps reflect TCE and PCE concentrations in excess of detectable quantities.

Groundwater contamination in the Southern Sector of A/M Area (south of the M-Area HWMF and southwest of the A-014 outfall) is presently outside the influence of the present recovery system. The selected interim action addresses areas of higher concentration in the center of the plume and at the sources of contamination. SRS is investigating the Southern Sector of A/M Area to further delineate the extent of contamination and increase understanding of the hydrogeology of the area. SRS also will install a system of recovery wells to remediate groundwater in the Southern Sector.

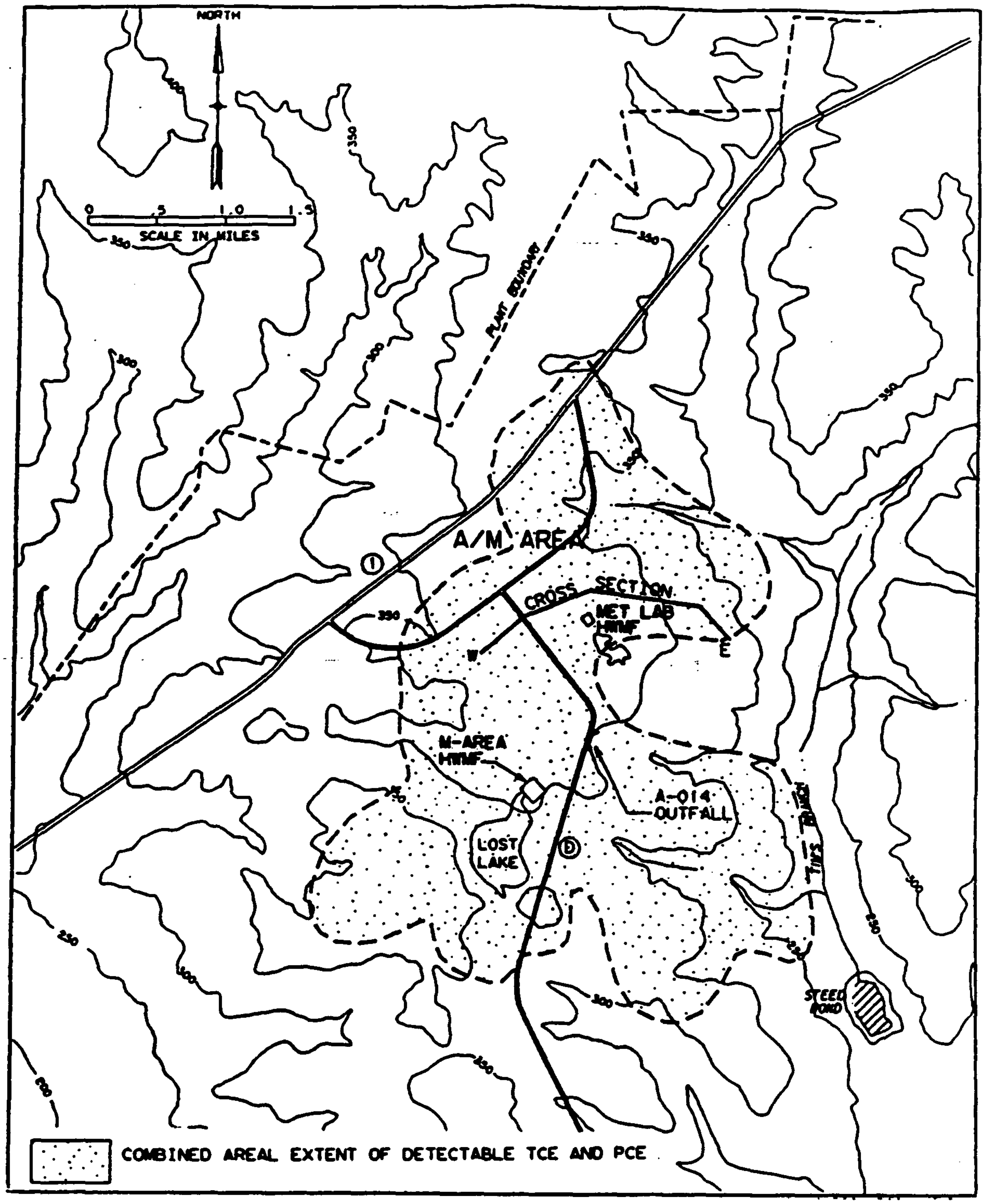

Figure 4 Combined Areal Extent of Detectable TCE and PCE in the Groundwater (Source: Modified from the Metallurgical Laboratory HWMF Part B Post-Closure Permit Application, 1991)

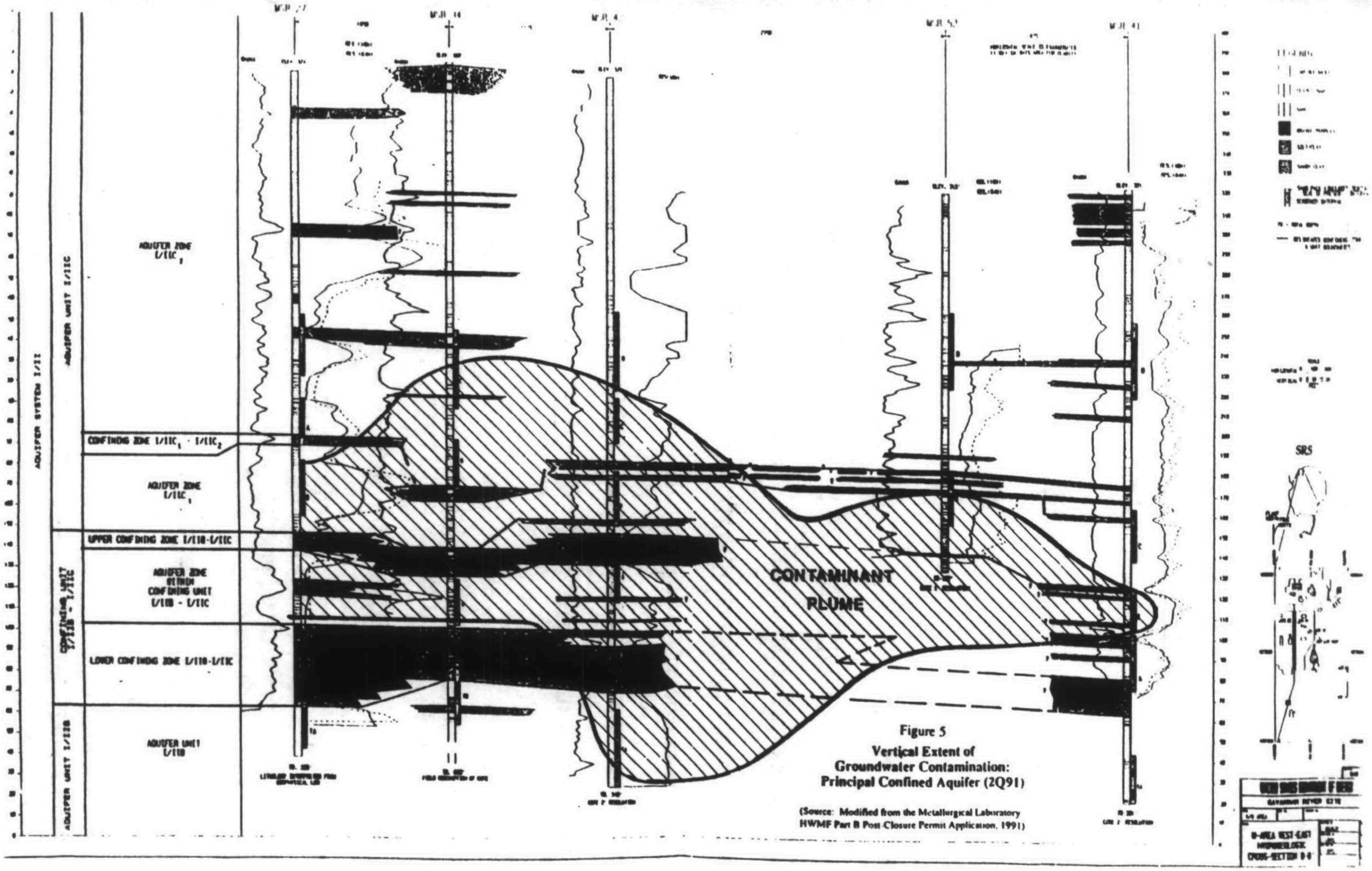

Figure 5
Vertical Extent of Groundwater Contamination: Principal Confined Aquifer (2Q91)

(Source: Modified from the Metallurgical Laboratory HWMF Part B Post Closure Permit Application, 1991)

VI. Summary of Operable Unit Risks

As a result of past waste disposal practices, the groundwater beneath A/M Area has been contaminated with the organic solvents TCE and PCE in both the dissolved state and, in limited occurrences, as concentrated Dense Non-Aqueous Phase Liquids (DNAPLs). These DNAPLs consist of concentrated, undissolved accumulations of chlorinated solvents.

As required by CERCLA, a risk assessment will be performed to provide a basis for determining if additional remediation is required to protect human health and the environment. Previous risk analyses performed in 1985 for the M-Area HWMF and Metallurgical Laboratory HWMF Operable Units were conducted prior to closure of those facilities and were used in the development of closure alternatives. The results of these previous risk analyses and available closure and post-closure data will be utilized as appropriate for evaluation of potential risk for the A/M Area Groundwater Operable Unit.

The risk assessment will address risk associated with groundwater underlying the entire A/M Area. The contribution of contamination to groundwater from the vadose zone will be considered in the evaluation of risk posed by exposure to groundwater. The surface water discharge pathway will be further evaluated.

Generally, for modeling purposes, potential pathways for human exposure are through hypothetical wells on-site, and through discharge to surface water. A program to develop the details of these exposure scenarios is under development and will be addressed in the risk assessment.

Currently, there are no drinking water wells in use within the contaminated zone of the A/M Area Groundwater Operable Unit. However, in the absence of remediation, there is a potential for risk from potential future wells and from exposure to surface waters receiving discharge from A/M Area groundwater. The risk assessment will further characterize and quantify these potential risks. Furthermore, the effect of the ongoing A/M Area Groundwater Corrective Action Program will be considered in the risk assessment. No off-site groundwater contamination resulting from the migration of the A/M Area groundwater has been detected. However, if the contaminants are allowed to remain, the potential for off-site migration and public exposure may exist.

There is limited potential for significant plant uptake of contaminants from the vadose zone. This pathway will be characterized further to confirm this assessment. The primary potential for ecological risks is through exposure to surface water receiving contaminated groundwater discharge. The extent of this potential risk for post-closure conditions will be characterized in the risk assessment currently under development.

VII. Description of Alternatives

The following remedial alternatives were developed in 1985 for the A/M Area Groundwater Operable Unit, based on demonstrated effective technologies available at the time that the M-Area HWMF RCRA Closure Plan was first prepared. In accordance with the NCP, the No Action Alternative was included as a baseline for comparison. The alternatives considered at that time for the Groundwater Corrective Action Program (remediation of the groundwater plume) included:

Alternative 1
No Action

Alternative 2
Groundwater Recovery with Treatment by Air Stripping

Alternative 3
Groundwater Recovery with Treatment by Activated Carbon Adsorption

Alternatives 2 and 3 both called for groundwater recovery by extraction. The alternatives differed only in the type of groundwater treatment technology utilized.

Alternative 2 was implemented in 1985 as an interim remedial action. This section contains a description of each of the three alternatives as they were developed and considered in 1985.

Alternative 1: No Action

Under the No Action Alternative, no groundwater extraction would be conducted. Chlorinated solvent concentrations would gradually be reduced with time and distance through natural attenuation processes such as biodegradation or dispersion. Institutional controls and long-term monitoring of groundwater could be added as components of the No Action Alternative. Further description of this alternative appears below:

Treatment Components. No treatment would be implemented.

Engineering Controls. No engineering controls would be required.

Institutional Controls. Access to SRS is controlled at primary roads by continuously manned barricades. Other roads entering the site are closed to traffic by gates or barriers. The entire facility is surrounded by an exclusion fence, except along the Savannah River. The site is posted against trespassing under state and federal statutes. Much of the A/M

Area is surrounded by a separate fenced area with manned gates. The area is continuously patrolled by security personnel.

Quantity of Waste. SRS estimates that approximately 2 million pounds of chlorinated solvents are currently contained in the A/M Area groundwater plume. Approximately 260,000 pounds of solvents have been extracted and treated to date. The plume, as currently defined, encompasses approximately 1200 acres.

Implementation requirements. This alternative requires no additional implementation.

Estimated Construction and Operation and Maintenance (O&M) Costs. No additional monitoring wells would be installed under this alternative, so there would be no construction costs. Costs for this alternative, excluding groundwater sampling and analysis were originally estimated to be:

- Capital Cost — $0
- Annual O&M Costs — $20,000

ARARs Associated with the Considered Alternative. This alternative would not comply with the South Carolina Primary Drinking Water Regulations (R.61-58) Maximum Contaminant Levels (MCLs) or the Federal Safe Drinking Water Act (SDWA) (40 CFR § 141) promulgated MCLs. Certain contaminants would remain elevated above MCLs and the calculated health-based levels should the No Action Alternative be implemented.

Alternative 2: Groundwater Recovery with Treatment by Air Stripping

Groundwater recovery with air stripping is a demonstrated and widely used technology. Air stripping is considered by EPA as the Best Demonstrated Available Technology

(BDAT) for VOC removal. Air stripping forces the contaminated groundwater into contact with air. The volatile contaminants are then transferred into the air and released to the atmosphere. This alternative includes evaluation of technologies for controlling emissions from the air stripping system. One of the most efficient stripping devices is a counter-current packed column. In this column, the water stream is pumped to the top and allowed to trickle down over the column packing. Air is blown in through the bottom of the column and exits at the top. The stripper requires electricity for a pump and blower and very little maintenance. Further description of this alternative appears below.

Treatment Components. The comprehensive remedial action system in A/M Area (as it was designed in 1985) would consist of treatment components in the general M-Area and in the Northeastern Sector of A/M Area. In the general M-Area, the treatment system would consist of 11 groundwater recovery wells and a full-scale production air stripper with an air blower, effluent pumps, instrument air system, and control building. (The 11 recovery wells (RWM-1 through RWM-11) were installed during 1982-1985). A 20-inch, zero-leakage drainline to transfer treated groundwater from the air stripper to the NPDES-permitted A-014 Outfall would also be included.

In the Northeastern Sector of A/M Area, a groundwater recovery and air stripper system has been installed near the SRL. A zero-leakage drainline to carry treated liquid from the air stripper to a nearby permitted outfall has also been designed. Further design details regarding the air stripping systems were contained in Appendix F of the M-Area Post-Closure Permit Application.

Engineering Controls. The primary engineering control for minimizing the spread of the A/M Area groundwater plume involves installation of 11 or more recovery wells. The recovery wells would be strategically spaced laterally and vertically in an attempt to maximize recovery of high VOC concentration groundwater, and control groundwater migration. Location of the recovery wells is depicted in Figure 2 (Section II).

Institutional Controls. These controls are identical to those discussed in Alternative 1.

Quantity of Waste. The quantity is identical to that discussed in Alternative 1.

Implementation requirements. Implementation time was originally estimated to be 24 to 36 months. Installation of the 11 recovery wells and the M-Area stripping tower was completed in 1985. The system began operating at a 400 gpm treatment rate at that time. The system is currently operating at a rate of 500 gpm. Start-up of the Northeastern Sector recovery system occurred in March 1992.

Estimated Construction and Operation and Maintenance Costs. Costs for this alternative were originally estimated to be:

- Capital Cost $4,800,000
- Annual O&M Costs $100,000

ARARs Associated with the Considered Alternative. The remedial action would minimize migration of contaminated groundwater through groundwater recovery and provide pertinent information for the development of a complete groundwater remediation system.

Groundwater would be treated by an air stripper that would remove VOCs from the groundwater and emit them to the atmosphere. An ongoing treatability study will select an appropriate technology for treating air emissions. ARARs for air emissions include regulations under the Federal Clean Air Act and the South Carolina Air Pollution Control

Regulations (R.61-62), specifically the South Carolina Ambient Air Quality Standards (R.61-62.5). An air emissions permit would be required under the South Carolina regulations prior to operation of the air stripper. Discharge of the treated groundwater will be to NPDES permitted outfalls within SRS. Discharges of this type are regulated under the Clean Water Act and the South Carolina NPDES Permit Regulations (R.61-9). Treated water must meet the discharge limits of the permitted outfall unless a permit modification is obtained.

SRS has evaluated the RCRA Subpart AA "Air Emission Standards for Process Vents" (40 CFR § 265.1030) and has concluded it is not an applicable requirement for the treatment of extracted groundwater at the site. EPA Region IV has stated that the Subpart AA standards may be relevant and appropriate. Therefore, the standards will be evaluated during the off gas treatability study for consideration in the design and implementation of the off gas treatment system for consistency with and relevancy to the Subpart AA emission standards. The system is permitted through the SCDHEC Air Quality Control Program and the Clean Water Act (wastewater treatment discharge permit) rather than through RCRA. Upon completion of the treatability study, the existing M-Area stripping tower will be upgraded, if necessary, with an off-gas treatment system in compliance with ARARs.

Alternative 3: Groundwater Recovery with Treatment by Activated Carbon Adsorption

Activated carbon adsorption is another principal method used for groundwater and drinking water treatment. With carbon adsorption, contaminated water is brought into contact with particles of activated carbon. The organic molecules migrate into microspores on the carbon particles and become trapped. The operating equipment for carbon adsorption is similar to that required for air stripping, except two carbon adsorption beds in series would replace a packed stripping column and an air blower. Two carbon beds allow replacement of the spent bed while groundwater continues to be fed to the fresh carbon unit. Volatile organics are not released to the atmosphere with carbon adsorption but must be disposed of in some other fashion. The system requires considerable attention because of the need to regenerate the carbon adsorbent. Further descriptions of this alternative appear below.

Treatment Components. Two fixed bed carbon adsorption systems would be placed in series. Each bed would be 10 feet in diameter, 10 feet in height, and contain 20,000 pounds of granular activated carbon. One bed would be taken off-line every 1 to 6 months. The carbon media would be shipped off site for regeneration and further treatment of the adsorbed organic constituents. Alternately, an on-site carbon regeneration and treatment system could be adopted. The treated groundwater would be discharged through the NPDES-permitted outfall, A-014.

Engineering Controls. As in Alternative 2, engineering control to minimize the spread of groundwater contamination would be primarily accomplished by installing at least 11 recovery wells at selected A/M Area locations. Further control of volatile constituents would be accomplished during off-site organic residual treatment following carbon regeneration.

Institutional Controls. On-site institutional controls are discussed in Alternative 1.

Quantity of Waste. The quantity of groundwater to be treated would be identical to that discussed in Alternative 1. In addition, waste carbon from the adsorption process would also be generated.

Implementation Requirements. Implementation time for construction and start-up was originally estimated to be 24 to 36 months. One operating option would be to construct a fixed bed system on site and then lease the adsorption system (carbon media) from an industrial supplier. The supplier would be responsible for replacing spent media with clean media and then transporting the spent media off site for regeneration. A pilot test using an M-Area groundwater sample was conducted by the Calgon Corporation prior to 1982, in order to calculate system design parameters.

Estimated Construction and Operation and Maintenance Costs. Costs for this alternative were originally estimated to be:

- Capital Cost $5,000,000
- Annual O&M Costs $100,000

ARARs Associated with the Considered Alternative. ARARs for groundwater recovery and discharge are as discussed for Alternative 2. Treatment under this alternative is by activated carbon adsorption. Spent carbon would be regenerated off site. Organic residuals would be further treated as a final off-site remedy. Shipment of spent carbon would require proper labeling and shipment requirements per DOT regulations (49 CFR §§ 100-172). Spent carbon handling and treatment thereof would be performed by an off-site treatment facility permitted under RCRA.

VIII. Summary of Comparative Analysis of Alternatives

The NCP (40 CFR § 300.430 (e)(9)) sets forth nine evaluation criteria that provide the basis for evaluating alternatives and subsequent selection of a remedy. The criteria are:

- Overall protection of human health and the environment

- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Costs
- State acceptance
- Community acceptance

The three alternatives are compared in this section using these nine evaluation criteria.

Overall Protection of Human Health and the Environment. Alternative 1, the No Action Alternative, is not protective of and offers no reduction in risk to human health and the environment. This approach uses institutional controls to minimize threats to human health. This alternative continues to allow organic constituents in groundwater to migrate horizontally and vertically.

Both Alternative 3, Groundwater Recovery with Treatment by Activated Carbon Adsorption, and Alternative 2, Groundwater Recovery with Treatment by Air Stripping, offer a reduction in risk to human health and the environment. Groundwater recovery wells located at strategic points mitigate the spread of the A/M Area groundwater plume. Volatile organic contaminants are then removed from the groundwater prior to discharge of the treated effluent to a NPDES-permitted outfall, A-014.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs). Alternative 1 will not meet the federal and state groundwater protection standards since groundwater is not treated. Alternatives 2 and 3 both meet the Clean Water Act standards governing the treatment and/or disposal of groundwater. Alternatives 2 and 3 also satisfy requirements under the South Carolina Air Pollution Control Regulations and Standards.

Since the A/M Area Groundwater Corrective Action is still an interim action, additional ARARs will be met or waived, as appropriate, in the final remedial action for this operable unit.

Long-term Effectiveness and Permanence. Alternative 1 does not provide long-term effectiveness and permanence since no active remediation occurs. Groundwater would not be recovered and contaminants would eventually migrate off site where they could present a risk to human health or the environment.

Both Alternatives 2 and 3 provide for a long-term remedy for removal of volatile organic constituents from the A/M Area groundwater. Currently, Alternative 2 is in operation. Initially, during system start up in the mid-1980s, the extracted groundwater entering the air stripper contained 50,000 parts per billion of chlorinated solvents. Effluent leaving the stripper has consistently contained less than 1 part per billion. During the almost six years of operation, influent concentrations have decreased to about 15,000 parts per billion.

Reduction of Toxicity, Mobility, or Volume Through Treatment. Alternative 1 provides no treatment to reduce the toxicity, mobility or volume of the groundwater contaminants.

Both Alternatives 2 and 3 would reduce the quantity of VOCs in the groundwater through treatment. During the almost six years of operation of Alternative 2, the system (including all of the experimental air strippers) has removed about 260,000 pounds of chlorinated solvents from the shallow groundwater. Both alternatives utilize a separation rather than a treatment technology to remove organic constituents from the extracted groundwater. For both air stripping and activated carbon adsorption, an additional technology to treat gaseous effluents would be needed to fully comply with the reduction of toxicity, mobility, and volume criteria. SRS is preparing to initiate an off-gas treatment evaluation for air stripping gaseous effluents.

Short-term Effectiveness. There should be no short-term adverse impacts to human health and the environment resulting from the implementation of any of the three alternatives. Under the No Action Alternative, groundwater is not recovered and has not moved off-site, so there is no additional threat to human health or environment. In Alternative 3, spent activated carbon might be shipped off-site for regeneration. Packaging, labeling, and transport of the spent media in accordance with DOT and RCRA (if necessary) regulations would be followed, so no adverse effects from off-site transit would be anticipated.

Alternative 2 is now in place; no adverse impacts were expected, nor did they occur during the construction or operation of the extraction system. There are no adverse health effects due to operation of the system. In addition, air quality in the immediate vicinity of the stripper was monitored to ensure that there would be no adverse impact to the workers in the area. Air dispersion modeling was also conducted to obtain the required air quality permit from SCDHEC.

Implementability. Each of the three alternatives is technically and administratively feasible. Alternative 3 requires considerable attention due to system requirements, such as replacement of spent adsorption media every 1-6 months, potential off-site shipment of spent carbon, and regeneration of the used media. Operation of an on-site carbon regeneration system could necessitate extensive technical steps (e.g., system design and start up) and administrative constraints (e.g., permitting).

Alternative 2 has been on-line in A/M Area since the mid-1980s. Permitting applications have been submitted and approved. The air stripping unit in the Northeastern Sector completed final technical checks and started operation in March 1992.

Cost. The originally estimated present worth costs of each Alternative are presented below:

Alternative 1	
No Action	$600,000
Alternative 2	
Groundwater Recovery with Treatment by Air Stripping	$7,800,000
Alternative 3	
Groundwater Recovery with Treatment by Activated Carbon Adsorption	$8,000,000

The original estimated costs for all three alternatives include an annual O&M cost of $20,000 for a 30-year period for groundwater monitoring. These costs do not include monitoring beyond the 30-year period potentially required to complete A/M Area groundwater remediation.

State Acceptance. SCDHEC has approved the existing A/M Area Groundwater Corrective Action Program as an intermediate step leading toward a complete RCRA corrective action program. The final action for this media-specific operable unit will be selected through subsequent Proposed Plans and modifications to the RCRA permit.

Community Acceptance. Community acceptance of the interim action will be evaluated and included after the public comment period for the Proposed Plan.

IX. Selected Remedy

The preferred alternative for the A/M Area Groundwater Corrective Action Program is Alternative 2: Groundwater Recovery with Treatment by Air Stripping. This alternative includes installing groundwater recovery wells at strategic locations throughout the A/M Area, extracting the contaminated groundwater, processing the groundwater through an air stripper to remove volatile solvents, discharging the treated effluent to an NPDES permitted outfall, and conducting a treatability study for emissions from the air stripper. This alternative was implemented in 1985 as an interim remedial action.

This alternative calls for the design and implementation of an interim remedial action to protect human health and the environment. The goals of this remedial action are to (1) prevent further groundwater plume migration and initiate groundwater restoration while risk assessment activities are being planned and conducted, and (2) obtain further information about the response of the aquifer to remediation measures. The ultimate goal of remediation will be determined in a final remedial action for this operable unit. This remedial action will be monitored carefully to determine the feasibility of achieving this goal with this method and to ensure that hydraulic control of the contaminated plume is maintained. After completion of the characterization and evaluation of risk of the A/M Area Groundwater Operable Unit and the source-specific operable units impacting the M-Area groundwater, a final ROD for the M-Area groundwater, which specifies the final remediation goals and anticipated remediation timeframe, will be prepared.

X. Path Forward

Currently, the groundwater corrective action program is undergoing enhancements and new technologies are being demonstrated. "Path Forward" accomplishments and programs that are part of the corrective action program and are related to the A/M Area Groundwater Operable Unit are described below.

M-Area Groundwater Remediation. Increasing groundwater flow to the M-Area HWMF air stripper was accomplished during 1990. SRS received approval from SCDHEC to operate the M-Area corrective action system (air stripper and 11 recovery wells) at increased flow rates. The air stripper is currently operating at 500 gpm. Testing will continue in an effort to further increase recovery of groundwater and speed up the removal of VOCs.

SRS is also preparing to initiate an off-gas treatment evaluation for air stripping gaseous effluents. The integrated demonstration program, sponsored by the DOE Office of Technology Development at SRS, will demonstrate and assess the efficiency and cost effectiveness of several innovative destructive or hybrid off-gas treatment systems. Classes of technologies to be demonstrated include catalytic, biologic, thermal, electrochemical, and carbon regeneration systems. The technologies were selected on the basis of technical merit and the appropriateness of the technology for DOE's (complex wide) remedial requirements.

The demonstration of the selected technologies will occur in the A/M Area of SRS in the vicinity of the A-014 outfall where a vadose zone vacuum extraction well currently exists. The technologies slated for assessment, beginning in 1992, include: steam regeneration of activated carbon, gas-phase bioreaction, membrane separation, high-energy corona, photocatalytic destruction, and thermal catalytic destruction.

SRS anticipates that gaseous effluents from the M-Area air stripper will undergo further treatment in the near future using one of these remedial technologies. The air stripper effluent treatment will be added to the A/M Area Groundwater Corrective Action Program upon completion of the technical evaluation. The groundwater recovery efforts in A/M Area will continue to be expanded to meet the requirements of the RCRA Hazardous Waste Permit and the overall goal of achieving hydraulic control to minimize any further migration and expansion of the contaminant plume.

Northeastern Sector Groundwater Remediation. A remediation program is in progress to address contamination near the northern boundary of SRS. SRS has completed construction of a SCDHEC-approved groundwater recovery system located near the SRL facility. An air stripping system has also been relocated to this area which SRS began operating in March 1992. This facility is treating groundwater near the SRS boundary, initially from a single extraction well. Additional recovery systems are planned for this area.

A recovery well, different in design from that used in M-Area, will be used for the Northeastern Sector. The well will be designed to screen only selected zones of high concentration or high water production, instead of the fully penetrating screen design used in M-Area. This will allow for selective pumping of contaminated zones while avoiding pumping of clean zones. This approach is more costly though, since more wells are necessary to screen individual zones. Other designs which will be considered for cost savings include using 4- or 6-inch casing.

The final extent of remediation in the Northeastern Sector will be the initial work involved in a further remediation effort for this area. Design, construction, and implementation of further remediation systems will be the main focus of Phase II. At this time, it is anticipated that an additional air stripper will be required. The air stripping unit will be equipped with an off-gas treatment system which can accommodate the effluent from the 70 gpm air stripper which became operational in March 1992.

Southern Sector Groundwater Remediation. A less concentrated plume of chlorinated solvents exists south of the M-Area HWMF. An investigation was carried out in order to determine the degree and extent of remediation required. The investigation consisted of installing monitoring wells, collecting geologic information, and characterizing the aquifer. In an additional remediation effort, SRS will install additional groundwater recovery wells in order to upgrade the corrective action system to meet the requirements of the RCRA Hazardous Waste Permit.

In addition to further groundwater recovery efforts, SRS will also consider other treatment systems and technologies for the Southern Sector including remote or satellite air stripping, air sparged tanks, spray irrigation, reinjection or artificial recharge, in-situ remediation, UV peroxidation, and enhanced bioreclamation. SRS will use the characterization data, exposure assessment criteria, and technology test information to formulate a detailed corrective action plan.

Vadose Zone Corrective Action Program. SRS has initiated a program to remediate soils above the groundwater at four locations in M-Area where solvents were released. SRS has performed a characterization study of each area. Presently, SRS is preparing the designs and costs of the planned systems.

SRS recently (7/27/90-12/18/90) conducted a large experimental program (In-situ Air-Stripping Demonstration) near the closed M-Area HWMF. This program included implementation of a vacuum extraction system and testing of new well installation techniques. The vacuum extraction system is designed to remove VOCs from soils above the shallow aquifer. The demonstration system has extracted VOCs that, if left in place, would have eventually migrated into the groundwater.

As part of the vacuum extraction system, SRL has installed a series of horizontal wells into contaminated soils and groundwater. These wells are designed to accelerate remediation through in-situ air stripping and have been used for soil and groundwater gas extraction.

The SRS decision to implement a vadose zone corrective action program was voluntary, and was based on the success of a vacuum extraction pilot study conducted in March 1987. The 1987 study was successful, with the removal of almost 1500 pounds of chlorinated solvents during 3 weeks of operation. About 16,000 pounds of chlorinated solvents were removed from the subsurface and groundwater during a 5-month test in 1990. The DOE Office of Technology Development is also sponsoring further demonstration activities associated with remediation of vadose zone soils (and underlying groundwater) using vacuum extraction.

SRS is proposing to conduct further in-situ testing by injecting small amounts of methane into a horizontal well to facilitate and enhance in-situ bioremediation. The demonstration will involve stimulation of indigenous microorganisms to degrade TCE and PCE in-situ by addition of nutrients (methane) to the subsurface via the horizontal well used for air injection during the in-situ air stripping demonstration. Horizontal wells provide an advantage due to the increased surface area for better delivery of nutrients, better extraction of gas in the vadose zone, and lesser likelihood for clogging and plugging of the well casing.

In-situ bioremediation coupled with vapor extraction is expected to lead to a significant reduction in the time required to complete a remediation since bioremediation provides a second simultaneous pathway for removal (destruction) of the TCE. Furthermore, the stimulated indigenous microorganisms will gain access to TCE in the subsurface that may be difficult to remove by conventional methods.

Air/methane mixtures have been demonstrated in the laboratory to stimulate selected members of the indigenous microbial community that have the capability to degrade TCE. The nutrient, methane, will be supplied via the horizontal wells at a low concentration in air (1-3%), for a period not to exceed 12 months. A vacuum will be applied to the upper well (vadose zone) to encourage air/methane movement through the upper saturated zone and lower vadose zone and to inhibit spreading of the plume. This technology also may be applicable to the treatment of underlying groundwater. A lower horizontal well screened in the saturated zone will test the feasibility of this approach.

Dense Non-Aqueous Phase Liquids (DNAPLs). Recent groundwater monitoring results indicate the presence of a separate phase of concentrated, undissolved chlorinated solvents, known as DNAPLs, in one shallow aquifer monitoring well located near the closed M-Area HWMF. SRS has initiated plans to further characterize and recover these chlorinated solvents. These plans include confirmation sampling of specified monitoring wells for DNAPLs at suspect locations, geophysical and geological characterization of the subsurface, developing and testing a system to recover DNAPLs, and a method to treat or dispose of reclaimed DNAPLs.

An information workshop on DNAPLs was sponsored by DOE in mid-1991 in Atlanta, in an effort to better inform investigators and environmental regulators, and to become more familiar with the DNAPLs issue at other industrial sites. The workshop was very successful and promises to attract advanced technical applications to SRS for the planned DNAPLs characterization and assessment studies.

XI. Statutory Determination

The preferred alternative for the A/M Area Groundwater Operable Unit, an interim action, is Alternative 2: Groundwater Recovery with Treatment by Air Stripping. Based on information available at the time that this alternative was selected, and based on currently available information, this alternative appears to provide the best balance with respect to the nine evaluation criteria specified in the NCP. This alternative satisfies the statutory requirements of protection of human health and the environment, with respect to the water extracted from the ground. It was also selected for its cost effectiveness and implementability (minimal attention and maintenance during operation).

However, Alternative 2 is an action which will not fully remediate the A/M Area Groundwater Operable Unit. The action attempts to provide the best currently available method by which to remediate contaminated groundwater. The interim remedy complies with ARARs for that portion of the groundwater removed from the A/M Area Groundwater Operable Unit and treated at the surface, with the final remedy obtaining compliance with ARARs or justifying a waiver for the remainder of the A/M Area Groundwater Operable Unit. For this interim remedy, the alternative permanently and significantly reduces the toxicity, mobility, and volume of hazardous substances through their removal from the groundwater. Air effluent treatment will be discussed in the final proposed plan for this operable unit. This interim remedy is not inconsistent with, nor precludes the implementation of, the expected final remedy because it has, and continues to, reduce the overall quantity of contaminants in the A/M Area groundwater. This is not inconsistent with the overall remedial action goal of removing contaminants which could threaten human health or the environment.

APPENDIX A

References for Development of ROD Format

Crane, Jeffrey L., 1992. "Working Meeting Notice for M-Area RODs: M-Area Groundwater, M-Area Settling Basin, Met Lab Basin," Letter to Chris Bergren (WSRC), U.S. Environmental Protection Agency, Region IV, Atlanta, GA, March 12, 1992.

EPA, 1989. "A Guide to Developing Superfund Records of Decision," OSWER Directive 9335.3-02FS-1, U.S. Environmental Protection Agency, Washington, D.C., November 1989.

EPA, 1991. "Guide to Developing Superfund No Action, Interim Action, and Contingency Remedy RODs," OSWER Publication 9355.3-02FS-3, U.S. Environmental Protection Agency, Washington, D.C., April 1991.

Longest, Henry L., and Bruce M. Diamond, 1990. "Suggested ROD Language for Various Groundwater Remediation Options," OSWER Directive 9283.1-03, U.S. Environmental Protection Agency, Washington, D.C., October 10, 1990.

WSRC, 1990. "RCRA Facility Investigation/Remedial Investigation Program Plan," WSRC-RP-89-994, Chapter 15, Westinghouse Savannah River Company, Aiken, South Carolina, September 1990.

APPENDIX B

Responsiveness Summary

No comments were received during the public comment review period.